Cartography M.Sc.

Master thesis

A Systematic Approach to Formulate Design Recommendations for Location-based Stories in Augmented Reality

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2020

A Systematic Approach to Formulate Design Recommendations for Location-based Stories in Augmented Reality

submitted for the academic degree of Master of Science (M.Sc.)
conducted at the Department of Civil, Geo and Environmental Engineering
Technical University of Munich

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Date of submission: 22.03.2021

Statement of Authorship

Herewith I declare that I am the sole author of the submitted Master's thesis entitled:

"Design Recommendations for Location-based Stories in Augmented Reality"

I have fully referenced the ideas and work of others, whether published or unpublished. Literal or analogous citations are clearly marked as such.

Munich, 22.03.2021 Nuzhat Tabassum Nawshin

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Acknowledgements

The Cartography M.Sc. programme has been a long journey for me but surely a remarkable one! I am immensely grateful to everyone who came forward with a helping hand along the way.

The foremost appreciation goes to the Cartography MSc. Consortium for making the dream come true and giving me the opportunity and financial support to have a lifetime experience.

I want to express my deepest gratitude to my supervisor, Dr.-Ing. Mathias Jahnke, for being so kind and supportive. Your invaluable guidance and insightful remarks made the completion of this thesis possible.

I sincerely thank my reviewer Prof. Dr. Menno-Jan Kraak and Prof. Dr.-Ing. Liqiu Meng for every piece of valuable advice and constructive suggestion for my work.

I want to express my heartfelt admiration for Dr. Corné van Elzakker and Edyta for your warm encouragements and the research materials.

A very special thanks to all the 22 participants of my user study and the map providers for your time and participation.

Thank you Dr.-Ing. Christian Murphy, for giving me the opportunity to work and learn by your side. And a huge thanks to all other faculty members of TUM, TUW, TUD and ITC.

To Juliane, I will forever be grateful to you for being amazingly patient with me and making me feel at home since the first day, and for introducing me to my thesis topic. Your positive energy and your ability to make everything look effortless is something I've always admired.

My greatest appreciation to my Carto family. The inspiration I got from knowing each of you is just priceless! And thank you Marko, Mariana, Maria, Wouter and Cinthya for making this journey a little more bearable at times.

A big thanks to my German family Lisa, Werner and Nelly; my uncle-aunty from Bangladesh and Shafiq bhai for all your care and support and food!

Also, to the Bangladeshi people in Munich and Dr. Schroeter for helping me during the hardship.

Thanks to my friends…

Shanto, for making me apply here. The amount of time and energy you have dedicated on my tiniest problems can never be matched.

Nandiny, for the distractions and concerns, and for always keeping it interesting.

Risat, for sharing your wisdom and for the occasional reminders of my capabilities.

Joyeeta, for being my safe haven and having such high hopes for me in life.

Kiron & Fifa, for the technical support and the other *bosties*, for always being there!

Bhaia & bhabi, thanks for always believing in me and cheering me up.

To Ahnaf, thanks for becoming the *silver-lining* to all my struggles.

And to my parents… it doesn't get said much but I am always grateful for your endless love and your constant worries about me. I wish I could make you more proud someday.

Abstract

Location-based stories are everywhere around us. Any location that we travel to or walk by in our everyday lives can become the backdrop or even the main character of a story at any point. Like humans, places have a lot to tell about their history and evolution with time. Since the dawn of time maps have acted as a powerful medium for telling stories either showing the locations where the stories or events took place or telling stories about the places themselves. With the advancement of technology and with the widening of the scopes of stories, maps themselves have changed their forms from printed to digital and it is still expanding. Mobile augmented reality (AR) is one of the latest additions to this field which extends the dimensions of maps by combining reality with virtuality. With augmented reality, the virtual story elements can be displayed on the mobile camera screen where the real life scenarios in the background act like a realistic three dimensional base map. Although the technology is growing popularity in many ways, the scientific exploration of the design concept for telling location-based stories with AR has received little attention.

This research addresses this issue and aims to recommend some design principles for location-based storytelling in AR to provide the audience with the best possible experience. To achieve this goal, the existing patterns of using different visualization elements in map-based stories are looked into through a comparative study on three different media: printed maps, web maps and existing augmented and virtual reality applications. Based on the findings and patterns derived from the comparative study, a conceptual design, portrayed through mockups, is developed for a mobile AR application as a case study. The purpose of the intended application is to give a tour of the main campus of the Technical University of Munich (TUM) for tourists and students combining elements for storytelling and route visualization. The usability of the mockup design is then evaluated through a user study conducted as an online semi-structured interview involving observation and thinking aloud methods. From the user requirements and feedback obtained from the usability evaluation, the general recommendations for designing a mobile AR app for location-based storytelling is proposed to help with the future application development in the early phase of designing.

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Chapter 1
Introduction

This first chapter introduces the research topic with the basic concepts and general background of the research problems and the motivation behind the research. The overall research objectives and sub-objectives along with the identified research questions are listed followed by the hypotheses that needs to be tested. Finally, a workflow of the thesis is presented with brief description of the contents of each chapter.

1.1 Problem statement and research motivation

Nowadays, human beings are surrounded by countless stories at all times. Any place we can walk to or travel towards in our everyday life becomes the screen for a story (Bucher, 2018). If we turn to any media e.g. newspapers, television and social media, we find numerous stories on everyday issues from all over the world. Many of these stories are *location-based* or *map-based* which are particularly of interest to cartographers, for instance, BBC news stories about the US election backed up by data and static maps (bbc.com, 2020) or the interactive map by Berliner Morgenpost showing the updated everyday situation of coronavirus cases (morgenpost.de, 2021). However, the fundamental issues related to mapping any kind of story remain very similar, for instance, how to visualize stories in sequences and in multiple scales, and how to convey the approximate nature of places in stories (Caquard and Cartwright, 2014).

One motivation behind the research done in the field of narrative cartography in earlier days was that stories are easier to comprehend and audiences find them more engaging than traditional ways of data visualization (Bruner, 1986).They can stimulate imagination and challenge people's assumptions (Cattoor and Perkins, 2014). In cartography, storytelling became a significant concept as cartographers have been looking into different forms and methods of telling location-based data-driven stories for a long time. Researchers (Pearce, 2008 and Caquard and Cartwright, 2014) have been making some great efforts in the field of narrative cartography in the past few decades.

In modern times, the scope and context of the stories have spread beyond spatial or temporal edges. Audiences now are more encouraged to change their ways of engaging with the stories (Bucher, 2018). With this breakthrough, the need for exploring new and effective methods of map-based storytelling has become crucial in cartography. While professional cartographers are struggling to make their maps relevant (Norwood and Cumming, 2012), amateur map-makers are sharing curiosity-driven maps via social media. To facilitate proper comprehension of spatial patterns and processes, maps need to be well designed, engaging and interesting (Kraak & Fabrikant, 2017). However, good design is disappearing in the age of web mapping because of less time spent of the aesthetics (Muehlenhaus, 2014). Despite attempts to incorporate advanced geovisualization techniques with cartography, there is a need of broad theoretical framework to improve map design that serve the needs of the society.

The latest development in the field of storytelling has been aided by the emergence of technologies like Virtual Reality (VR), Mixed Reality (MR) and Augmented Reality (AR). Azuma (2015) stated that AR will be an ultimate tool for storytelling by enabling meaningful connections between virtual content and real space and extending the dimensions of maps. It lets the audience to immerse and interact with both virtual and real objects to keep a realistic impression (Bobrich and Otto, 2002). Therefore, AR allows an enhanced experience where the form of the story is adapted to the audience moving in real time in a real environment, providing a sense of control over the course of the story (Bostan and Marsh, 2010). Current norms of social distancing and lower mobility due to Covid-19 also suggests that the demand for mobile and web-based AR is going to increase highly, especially among tourists.

However, having all these novel technologies at hand, both the authors and audiences are more focused on the technology itself and not on how to tell or design a visual story with it (Bucher, 2018). Because of the complexities and fast changes in device capabilities, most of the research in AR has been focused on overcoming technical problems with little concern for the user interface design (Dünser et al., 2007). Although some attempts have been made to develop applications for gaming, navigation and even storytelling for children, not much has been known yet to discover the way of telling a location-based story in real-time using AR (Bucher, 2018).

The motivation behind this thesis is to assess how different visual elements have been depicted for visualizing location-based stories in a meaningful and engaging manner in different media. By assessing the existing methods of telling location-based or map-based stories, with a focus on spatially guided tours for tourists, the aim is to formulate suggestions for designing new AR storytelling experiences. The suggestions include ideas on how the cartographic visual elements and multimedia can be used in the AR environment and what possible changes or improvements can be made.

1.2 Research identification

1.2.1 Research objectives

The overall objective of this research is to give suggestions on how to transform the existing methods of location-based storytelling into AR environment by identifying how stories with spatial information are visualized in different media (print, web and AR) and what improvements can be made to use AR tools for an enhanced storytelling experience.

Thereby, the sub-objectives of this thesis are defined as follows:

1. To explore, through a comparative study, the visualization pattern of location-based stories using different types of visual elements (maps, infographics, etc.) in different media (print, web and AR).
2. To formulate a conceptual design based on the comparative study for visualizing different elements of a location-based story for tourists in the AR environment.
3. To evaluate the effectiveness of the proposed design and derive further recommendations.

1.2.2 Research questions

According to the aforementioned objectives, the following research questions are defined to structure the research process:

RQ 1: How are location-based stories for tourists realized in print media, online web platforms and in the AR environment?

a. What visual elements have been used to display different types of tourist information in a story or different phases of a story in each media?
b. What visual elements have been used to display route visualization for tourists?
c. What are the similarities and dissimilarities in the patterns of using visual elements among the three different media?

RQ 2: How can AR technology be used in cartographic storytelling?

a. How can the existing methods or patterns of using visual elements in storytelling be employed or transformed into the AR environment?
b. What visual elements can be used in AR for making a location-based story more engaging and/or informative?

RQ 3: How effective is the proposed design?

a. How to evaluate the proposed design concept based on user requirements and feedbacks?
b. How effective is the proposed design and what improvements can be made?

1.2.3 Hypotheses

The hypotheses steering this research are delineated below:

1. All cartographic stories follow a systematic approach in terms of the visual elements used.
2. A well designed Augmented Reality aided visual story can be a useful method to tell a location-based story.

1.3 Research structure

This thesis is structured in to 7 chapters in order to find the answers to the research questions. The first chapter gives an introduction to the purpose for the research along with the research objectives, research questions and the hypotheses. The second chapter provides an overview of the theoretical background of location-based storytelling in cartography and in AR. The third chapter provides the scientific background and the workflow of the adopted methodology for performing the comparative study and the case study with conceptual design development and user evaluation. The fourth chapter presents the complete process and results of the comparative study with selected existing materials. The fifth chapter focuses on the case study which is conducted in two phases: developing the conceptual design and evaluating the design through a semi-structured interview. The sixth chapter presents the final results and an overall discussion with the derived design recommendations. The seventh chapter summarizes the work and answers the research questions including the future outlook for further research.

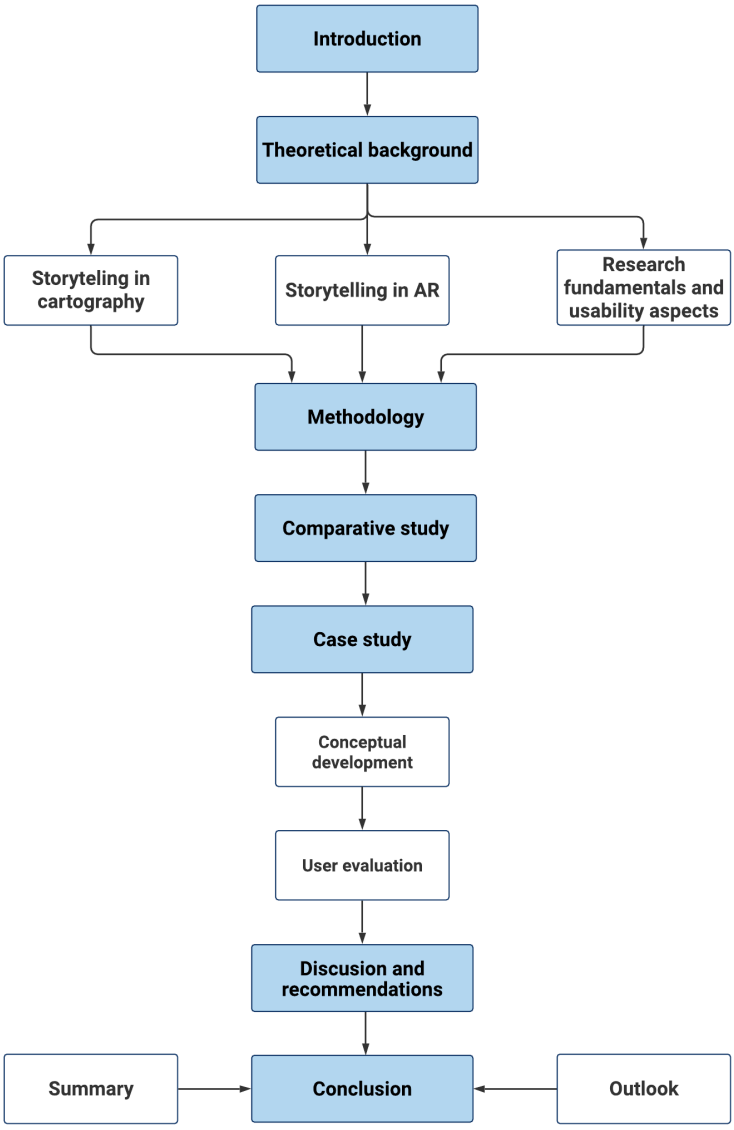

Figure 1. 1: Research structure

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Chapter 2
Theoretical Background

This chapter provides an overview of the literature and previous theories and research on topics that are relevant to the scope of this thesis. Section 2.1 explores the topics related to research question 1 mentioned in chapter 1. Starting with a brief history of storytelling with maps and narrative cartography, the notion of location- or place-based stories is introduced and their application in tourism and in different media is looked into along with the design structure and elements for visual storytelling. Topics related to research question 2 are looked into section 2.2. This section introduces the concept of augmented reality (AR) and mobile AR technology and briefly discusses its application in storytelling, navigation and in the field of tourism. Section 2.3 provides a scientific background on some selected research fundamentals and methods relevant to this study that have been mentioned and/or applied in cartography as well as in other disciplines.

2.1 Location-based storytelling in Cartography

2.1.1 Storytelling and narrative cartography

The idea of storytelling lies deep in the social behavior of humans (Eisner, 2008). It has even been referred to as "the world's second-oldest profession" (Gershon and Page, 2001). The emergence of storytelling goes as far back as the beginning of civilization when people used to express and record their life events through crude images that turned into cave paintings or vocal sounds that later emerged into languages (Eisner, 2008). This also indicates the origin of two fundamental ways of storytelling: words (oral or written) and images. Over the centuries, the art of storytelling has taken new forms with the discovery of paper, electronic storage, transmission devices (Eisner, 2008) and, not to mention, internet. Maps, also created in the forms of cave paintings and later on paper, were initially used for explaining and navigating the world and eventually became a useful tool for telling stories too. Since the ancient times, maps are regularly used to study the geographic nature of stories (Caquard and Cartwright, 2014). The earliest world map of Babylon of the 6th or 5th century B. C. also tells us the story of the geography of ancient Mesopotamia (Figure 2.1). This potential of maps to tell a story lays the foundation of Narrative Cartography.

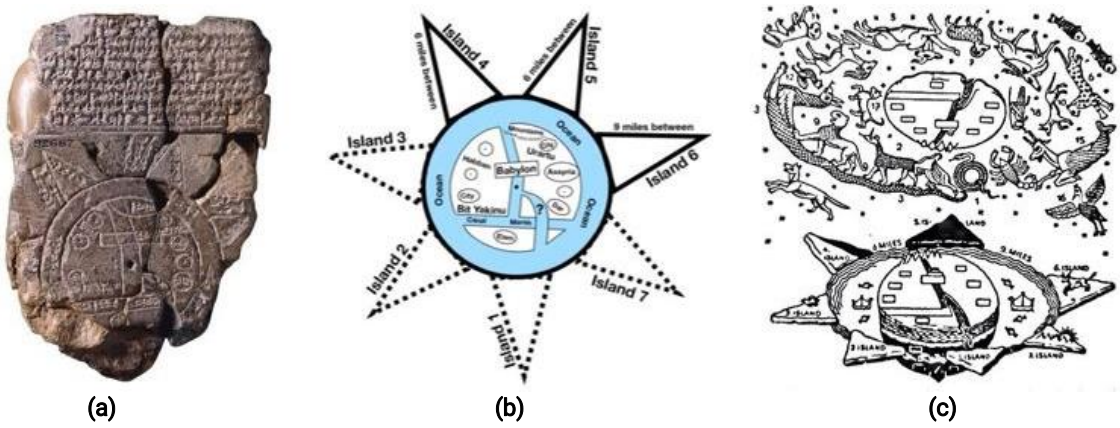


Figure 2. 1: (a) Babylonian World Map, British Museum, London; (b) Schematic representation of the map; (c) Reconstruction of the meaning of the map by Karl Maasz (*Source: traveltoeat.com*)

In the field of Narrative Cartography, the terms *Stories* and *Narratives* are often used synonymously although there is a subtle distinction between them. Will Eisner (2008) defines a story as a narration of events arranged for telling. He states that a story should have a structure with a beginning, ending and a series of events in the middle holding them together. Narrative, on the other hand, is the presentation of that story in a particular way (Chatman, 1978). Pearce (2008) states that narratives are shaped by temporality. Data-driven stories try to develop the structure and content of a story based on quantitative and/or qualitative information (Roth, 2020).

Cartographers traditionally have relied on stories from travelers and explorers to help them fill in the blanks on their maps. As a story can be told using different methods and the potential of maps to both uncover and convey stories is virtually unlimited, the narrative power of maps has been exploited extensively not only by cartographers but also writers, filmmakers, journalists and individuals to tell fictional and non-fictional stories (Caquard and Cartwright, 2014). Artists use maps to place their narratives to tangible and credible locations (Caquard, 2013) whereas scholars and journalists use it to tell non-fictional stories, as support tools to develop arguments about places in their research. Literary scholars have employed maps to better understand how a narrative is confined in a particular geography and how it influences the author and the audience. (Caquard, 2014) Maps have not only been

used to interpret and geolocate stories, but to tell them as well. Pearce (2008) stated that the unique power of a map is its ability to delineate "simultaneity". The entire story is conveyed to the map-reader in a single gaze and that draws the reader into the details of places.

Many researchers think that one of the first maps telling an extensive story based on location was the map of Napoleon's army in the Russian campaign 1812–1813 (Rendgen, 2019), drawn by Charles Minard (Figure 2.2). It relates the demolition of the French army to the ambient temperatures and why it reduced in size (Mocnik and Fairbairn, 2018). The map does not tell the story about the locations but it relates the locations of the journey of Napoleon's army and their experiences. It is also a great example of how time can be visualized in maps (Kraak, 2014).

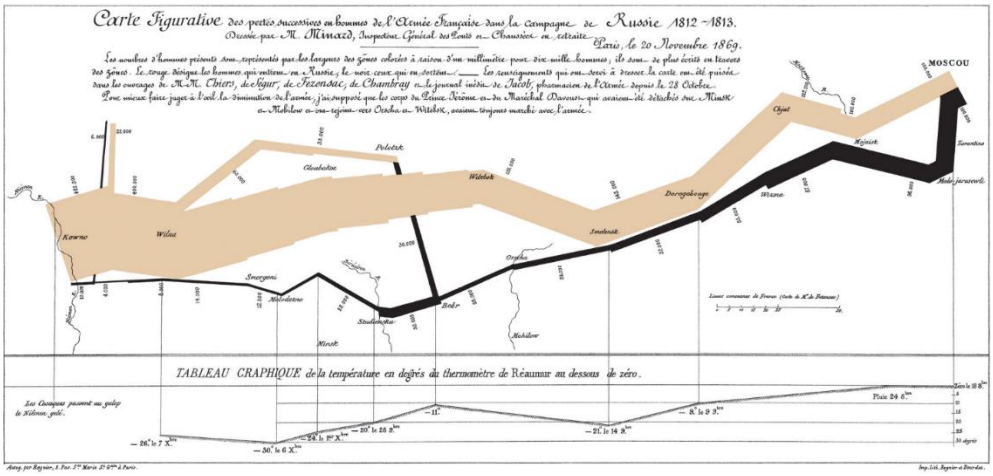


Figure 2. 2: Minard's Map depicting the successive losses in men of Napoleon's army in the Russian campaign 1812–1813, first published on 20 November 1869. (*Source: Wikipedia*)

2.1.2 Location or place-based stories

Since maps are capable of revealing connections and trends (Kraak & Fabrikant, 2017) turns space into place and gives meaning to spatial relationships (Kent, 2018). A narrative place-based map must simultaneously represent places and relationships between them. Robert MacFarlane (2007) introduced the concept of *story maps* to describe spatial expressions incorporating personal experiences of the environment and contribute to a deep understanding of places. As story maps defined by their experiential nature, the importance of developing emotionally charged maps and geovisualizations to better understand places are being more acknowledged by researchers (Caquard, 2013). However, stories told in a map can also be entirely about a place or a location rather than people. With the growing popularity of data visualization and novel technologies of mapping stories, the potential of maps to tell stories about places are further approached by different authors.

Mapping narratives requires representing not only the different geographic locations of a story, but also the geometry that exists between the locations (Caquard and Fiset 2014) which is an important aspect of location-based stories. Places often contribute to shaping a story, just as stories contribute to producing spatial entities. As pointed out by Moretti (2007), the distinction between geography (location) and geometry (relationships) is that, geography in a map has to be associated with referential places, while the geometry represents the relationships between elements in the story (e.g. characters, scenes). The relationship between maps and stories indicate the importance of spatiality as well as the significance of the visualization of spatial data or information (Dodge, 2011).

According to Segel and Heer (2010), stories with data differ in important ways from traditional storytelling. Visualized data in story maps for instance, can be either in a linear sequence (author-driven) or can also be interactive (reader-driven). Visualizations may incorporate a variety of media, including text, images and video, and can also be interactive where the audience can choose the story path. Figure 2.3 presents an example of a location-based story that portrays the northern part of Italy in the map and tells the stories of different touristic places around the Lake Garda. It shows a mixed linearity approach where the stories are arranged in a linear way (with numbers) but the reader still has the ability to choose their own path. This map is also used for the comparative study in chapter 4.

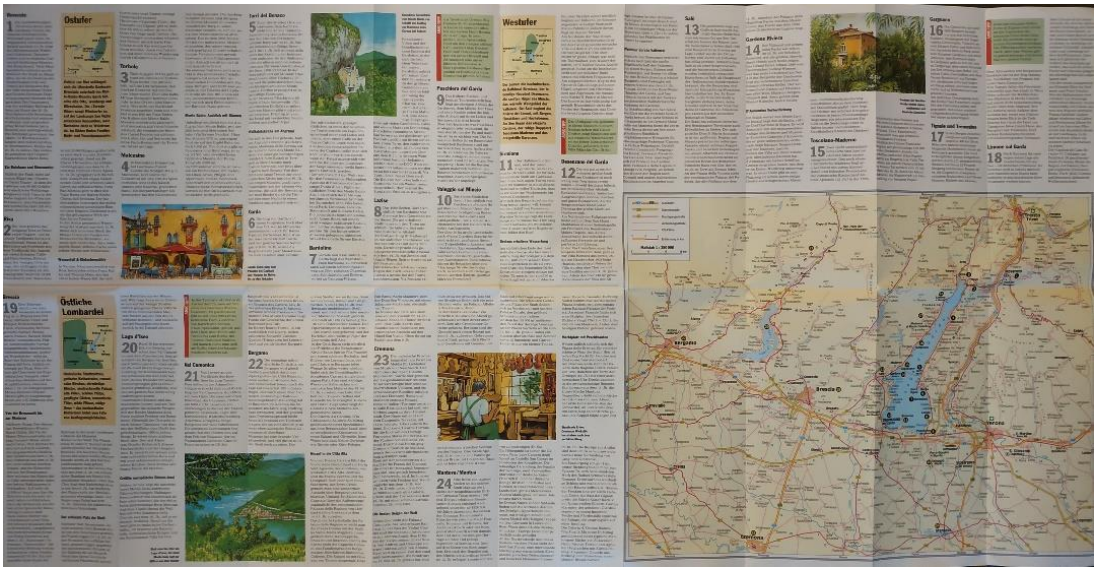


Figure 2. 3: Gardasee Map telling the story of the northern part of Italy surrounding the lake (Appendix A)

2.1.3 Storytelling in different media and tourism

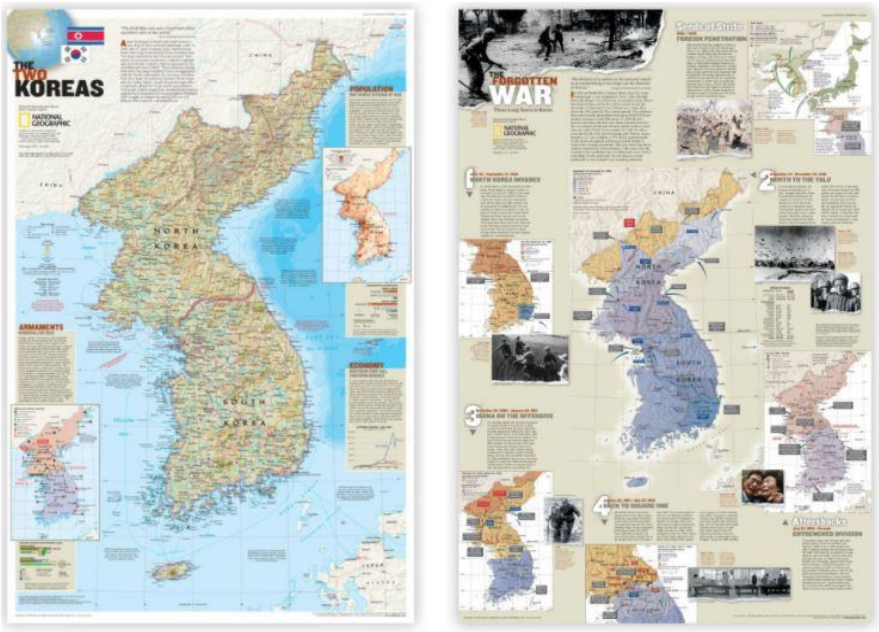
Technological advancements have modified the relationships between maps and stories (Caquard 2013). The dominant cartographic medium shifted from paper to digital since access to global navigation satellite systems (GNSS) and geographic information systems (GIS). Emergence of OpenStreetMap and google maps was made possible, and location-based services, governmental geographical data and volunteered geographic information (VGI) were made available (Kent, 2018). Modern-day cartographers need to acquire programming and database management skills to correctly handle the large volume of heterogeneous data from different sources (Kraak & Fabrikant, 2017).

Stories based on a location supported by facts and statistics exist in many different ways in the analog and digital environments (Riche et al., 2018). Kraak and Kveladze (2017) emphasized the Space-Time Cube as an alternative addition to traditional mapping approaches. They showed an enhanced demonstration by linking two stories: the path of Minard's map and a similar trip made by the authors in a different time, by annotating their paths.

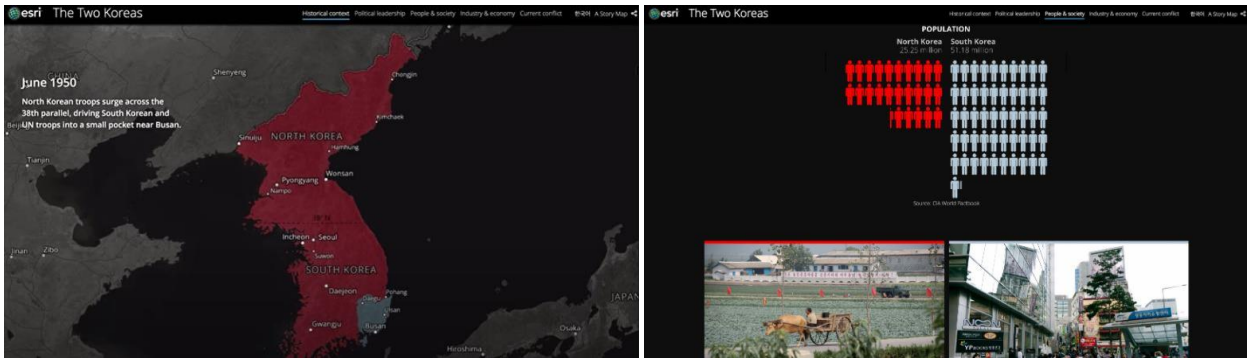
One significant innovation in digital storytelling is the Story Maps. Web platforms like ArcGIS StoryMaps[1], TimeMapper[2], StoryMap JS – Knight Lab[3], etc combine maps with other elements like text, pictures, popups, timeline, audio, video, etc. to help interpreting the map that forms the centerpiece of the story (Esri, 2012). Carroll (2018), in his online essay, compares and contrasts between the

[1] https://storymaps.arcgis.com/ (accessed on 19.03.2021)
[2] https://timemapper.okfnlabs.org/ (accessed on 19.03.2021)
[3] https://storymap.knightlab.com/ (accessed on 19.03.2021)

approaches of telling stories with printed and digital maps. As a case study, two projects both called *The Two Koreas* are mentioned. Both show the landscapes of North and South Korea and the history of conflicts between them using maps, however, in different media, first one in printed and the other in Esri StoryMaps. (Figure 2.4). He stated that the limitations of printed maps regarding size, scale, symbology, filter and interactivity pave the way for cartographers to explore digital media.



(a)



(b) (c)

Figure 2. 4: The Two Koreas; (a) printed map by cartographers at National Geographic; (b, c) Esri StoryMap[4]

Location-based stories are becoming more popular in the fields of travel and tourism as these the are domains in which individuals and groups are mobile, sometimes in new and unknown cities, and places that they like to discover (Ahlers et al., 2008). While tourists choose to travel for many reasons, there is a number of tourists who wish to learn about the places they visit (Schöning et al., 2008). The most convenient way for them to do that is to use a map, preferably one that tells the stories about these places. These maps can be in the forms of a static medium such as a printed map or leaflet or they can be interactive online visualizations like story maps and virtual tours.

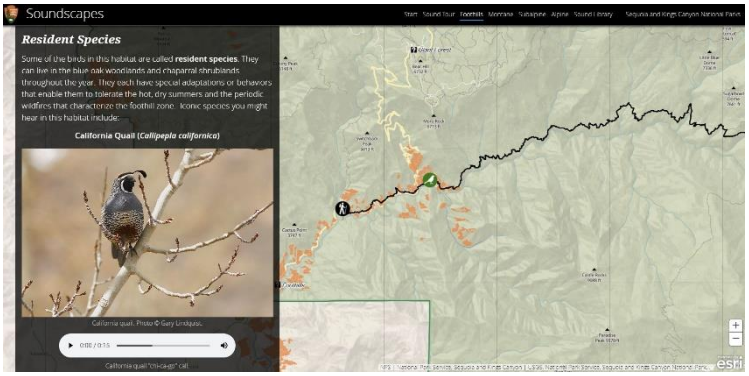
Modern conventional tourism uses techniques such as signposts or brochures to convey information to tourists. Contemporary innovations in multimedia cartography attempt to overcome some of the

[4] https://storymaps.esri.com/stories/2017/two-koreas/index.html (accessed on 19.03.2021)

limitations of printed maps by incorporating contrasting media such as texts, diagrams, images, video, sound, etc (Cartwright et al., 2007). For instance, additional or in-depth information usually cannot be accessed during a hike. However, additional rich multimedia information conveyed through maps allows hikers to learn more about their surroundings and appreciate their vacation area and allows deeper insights about its relevance (Ahlers etal., 2008).

(a)

(b)



(c)

Figure 2. 5: (a) Erlebnisregion Zurich printed map; (b) Soundscape Esri StoryMap; (c) Youvisit NYC virtual tour (Appendix A)

In virtual environment, a similar approach is adopted to give the tourists a virtual tour of a city or a touristic spot like museums, parks, etc. For instance, the Youvisit NYC[5] virtual tour gives a tour of the most popular places of the New York City using multimedia elements like video, audio, avatar, text, hyperlinks and maps all combined with a 360 degree view of the real places (Figure 2.5c). These three maps are also included in the comparative study of chapter 4 and thus, are presented in Appendix A.

[5] https://www.youvisit.com/tour/nyc (accessed on 19.03.2021)

2.1.4 Visual storytelling design with maps

In 1952, Arthur Robinson proposed that the basic function of maps is to communicate to people (Montello, 2002). Robinson and Petchenik (1975) introduced the fundamental concepts of 'encoding', 'transmission', and 'decoding' to improve communicating cartographic information to users and suggested to reduce 'noise' caused by poor symbol design that hinders the communication. Researchers (e.g., Dent, 1972 and Cleveland et al., 1982) have largely acknowledged the role of visual perception and user responses in cartographic design. Nevertheless, the earlier map communication models were based on paper as the dominant medium which is static, and limited, with no user feedback. Chilton and Kent (2017) found that 'neo-cartographers' with no expertise in map-making also puts communication as a primary goal. Kent (2018) critically examined the early map communication models and their limitations and proposed a new model considering new map making technologies. The model suggests continuous refinement of maps based on user feedbacks which is also crucial for the design and development modern applications.

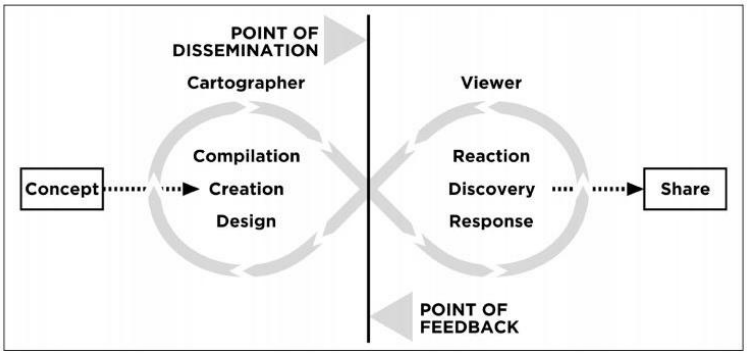


Figure 2. 6: A new map communication model by Kent (2018)

Since storytelling is also about communicating to the audience, it is important to structure the data and information in the maps to tell stories, especially with advanced methods. Segel and Heer (2010) introduced three most common visualization structures (Figure 2.7). The "Martini glass" structure starts with an author-driven approach (stem of the glass) taking the readers towards the intended path and then opens up to a reader-driven approach (mouth of the glass) where the user can explore the data. The "Interactive slideshow" is a mixed approach that allows the author to expose different data dimensions and manipulations and the user can move forward and repeat the steps when needed. The "Drill-down" story displays a general theme and provide detailed information on user's demand. For example, a map with markers that users can click for more details.

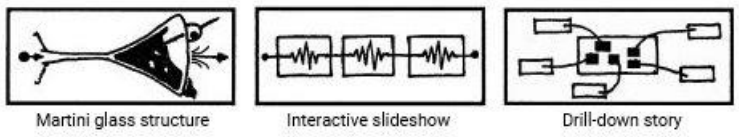


Figure 2. 7: Visualization structures by Segel and Heer (2010)

Different studies present different approaches to structure and design stories. Thöny et al. (2018) discuss in their paper about storytelling techniques in 3D geographic visualizations so that authors and developers working with geospatial data can use these techniques to conceptualize their visualization and interaction design. Two examples which apply the given concepts are also outlined in the end.

Lee et al. (2015) discusses the process of transforming data into visual stories involving discovering a set of raw data, sequencing them logically and communicating them with chosen medium while asking

for feedbacks (Figure 2.8). Components that form the story (structures, elements, and concepts) and that influence the telling of stories (people, tools, and channels) are also described.

Roth (2020) suggests a similar approach and divides a visual story into a linear three-act narrative. The first act is the *set-up* that introduces the setting or the spatial reference including story location and geographic scale for a place-based story. It also includes characters that can be the places themselves, a problem context or additional background information for the story and finally, a hook that captures attention from the audience which conforms to Segel and Heer's "Drill-down" structure (2010). The next act is *conflict* that is expressed through plot points or pauses that can be a "single point" on the map or a "stand-alone map plot" that help developing characters and build interest. The final act is the resolution where the designer shapes the meaning of the story and gives the audience the opportunity to explore relevant data for their context and this conforms to Segel and Heer's "Martini glass" structure.

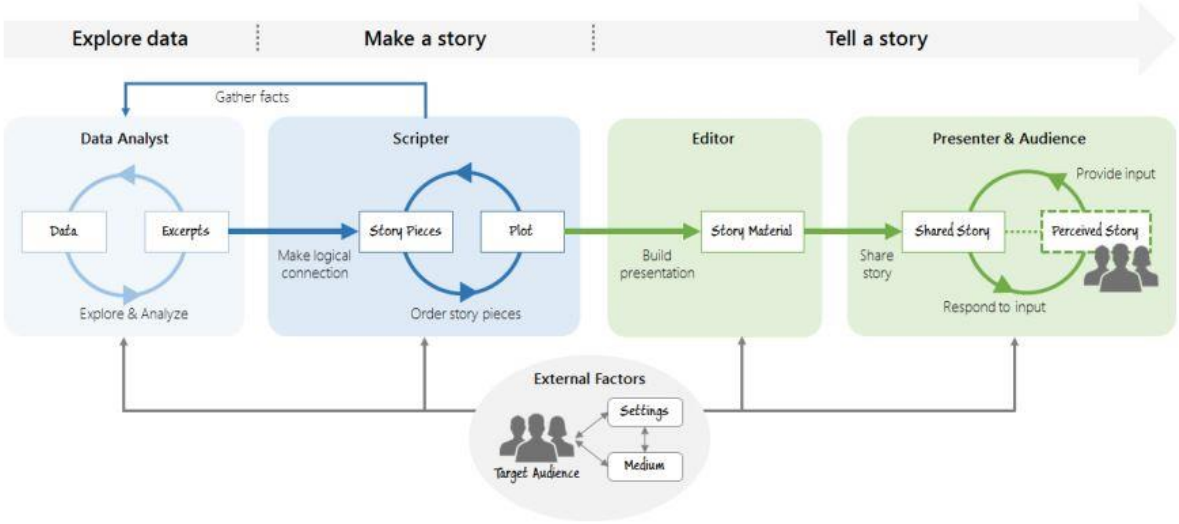


Figure 2. 8: The process of visual storytelling proposed by Lee et al. 2015

Maps and data visualizations being inherently two-dimensional often lack a temporal sequence to the plotline (Mocnik and Fairbairn, 2018). Moreover, static visualizations e.g., tourist maps, brochures, etc. might employ a "choose-your-own-adventure" format to allow audience to determine their own path through the content (Segel and Heer, 2010). Another important aspect of visual storytelling is to represent and/or evoke emotion (Griffin and McQuoid, 2012). It is not only about how the information is presented in the maps or visuals, but also about how it makes the audience feel and relate to the places or people (Roth, 2020). In facilitating at-a-glance comprehension of spatial patterns and processes, maps should be well designed, engaging and interesting (Kraak & Fabrikant, 2017)

2.1.5 Visual Storytelling Elements

Stories need something to adhere to visually (Pearce, 2008) and storytelling strategies vary among media and genre. For instance, stories told through writing have access to a different set of formal mechanisms and narrative structures than stories told through film (Segel and Heer, 2010). Segel and Heer (2010) and Roth (2020) use the term *visual story* for stories that are "communicated through illustrations, graphics, imagery and video instead of or in addition to oral, written, and audio formats".

In printed media, static visualizations have long been used to support storytelling, usually in the form of diagrams and charts (e.g., graphs, infographics, pictograms, etc.) embedded in a larger body of text. Placed alongside the map, texts convey the story, and images provide related details. By organizing the

visual elements, cartographers can direct users' attention to certain symbols. A visual hierarchy can be applied by putting visual weight to symbols for instance, by color and size. Any features distracting the user from the main theme can be defined as noise. However, visualizations on paper do not provide much scope for interaction or animation. Although, some workarounds are possible such as comics can use a series of increasing close-up frames to convey the camera zoom effect (McCloud, 2006).

For digital mapping, numerous researchers have attempted to explore the use of visual and non-visual storytelling elements. To mention a few, Caquard et al. (2009) deployed a cybercartographic atlas which allowed interaction and data input from professionals and communities in their own language in different formats including voice input. Roth (2016) proposed a taxonomy of genres based on how graphics are presented linearly. He also identified the rhetorical devices by Gershon and Page (2001) and transformed them into map-based storytelling techniques. Esri StoryMaps are more recent examples of a web application that combines maps with narrative text, images and multimedia like audio, video, links, etc. (Esri, 2017) and offer an array of templates with different layouts and interaction (Austin, 2018). Ren et al. (2017) recognized the role of annotation in datadriven storytelling. Brehmer et al. (2017) created a design space for timelines, dividing space across representation, scale and layouts.

To categorize the visualization styles of visual stories, Segel and Heer (2010) named 7 genres based on the number and order of frames and visual elements which can be made interactive as well: magazine style, annotated chart, partitioned poster, flow chart, comic strip, slide show, and film/video/animation (Figure 2.9). There are cases where one genre is more appropriate for a particular purpose such as annotated maps would be more useful for tourists. Roth (2020) proposed a revised taxonomy of visual genres based on Segel and Heer's (2010) approach considering the possibilities with new media and geoweb technologies (Figure 2.10).

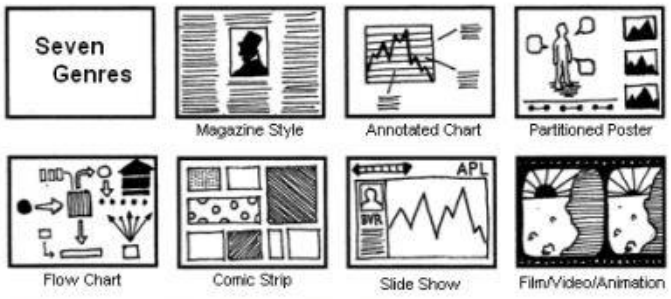


Figure 2. 9: Genres of narrative visualization by Segel and Heer (2010)

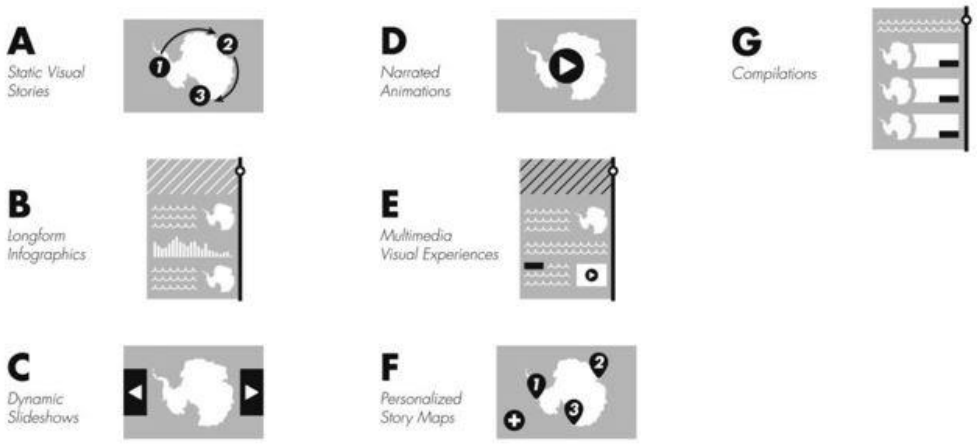


Figure 2. 10: Visual storytelling genres by Roth (2010)

Segel and Heer (2010) also stated, visual narrative tactics such as visual structuring and highlighting can draw viewer's attention to particular elements by using color, motion, framing, size, boldness, audio, etc. along with transitions between scenes like timeline, slider and progress bar. An order and pacing is also enforced to the reading of these visual elements (Ormeling, 1995). Narrative structure tactics include: i) ordering the path (linear, random, user-centered) viewers take through the visualization, ii) interactivity in the form of navigation buttons, filtering, searching, zooming, infographics, time sliders, etc. and iii) messaging in the forms of headlines, labels, annotations or descriptions like introductions, summaries and even audio to provide explanations to the viewer.

2.1.6 Route visualization in maps

Maps have always been used as a means of navigation and there has been plenty of research on the use and design of maps for indoor and outdoor wayfinding for decades. Although the notion of route visualization has not been considered much in story maps, it is an essential aspect for location-based stories, for tourists in particular. A tour map can enhance the efficiency of traveling (Zheng, 2015) and provide a memorable experience to tourists and travelers by acting as a tour guide combining the stories about the places and direction to reach those places. Considering small screen sizes of modern navigation devices like smartphones and the wide range of users, maps need to be designed with effective and comprehensible visual elements (Fuest et al., 2021).

In an earlier study, Goldsberry (2008) proposed using cultural metaphors like traffic lights, so that the map-readers can easily understand the information associated with the symbology. Lautenschütz (2012) proposed different visualizations, such as dot representations, variations in line thickness, line spacing, and color to visualize speed and movement dynamics.

Among recent studies on route visualization through maps, Zheng (2015) tried to determine how using a tour map containing route guidance can be effective for promoting circuitous tourism. The study compared the effectiveness between two maps with and without route recommendation for the same area. It concluded that the maps with recommended routes give the tourists a chance to explore more attractions in a reduced amount of time while touring through an area and recall the route more effectively afterwards. The author also mentioned the necessity of future research on the visual presentation such as using solid and dashed curves or arrows to indicate direction.

In another study, Fuest et al. (2021) investigates the effectiveness of using different cartographic variables to influence people's willingness to take the recommended longer route by making use of digital maps with two route options. The study concluded that among the six variables used to modify the visual representation of routes, symbol and length distortion have a higher impact on the users than size, spacing and distortion whereas color seemed to have none. These studies indicate the necessity of considering the design elements for route visualization in for guiding the tourists.

2.2 Location-based storytelling in augmented reality

2.2.1 Augmented reality (AR)

According to Azuma (2015), augmented reality (AR) is an experience that superimpose virtual (computer-generated) content directly over the physical environment in real time. Whereas virtual reality (VR) completely substitutes reality, AR overlaps virtual information with reality. AR offers information delivery, acquisition, and application by observing and identifying objects. Those information are overlaid or augmented as a virtual layer on the real world objects using a screen like platform. Studies on AR technology started in the 1960s, however, the term "augmented reality" was first used in the 1990s. Milgram et al. (1994) employed the term the "reality–virtuality continuum" placed AR in the mixed reality spectrum close to the reality end of the continuum (Figure 2.11). Since then, AR has been recognized as an independent field of study (Ko et al., 2013).

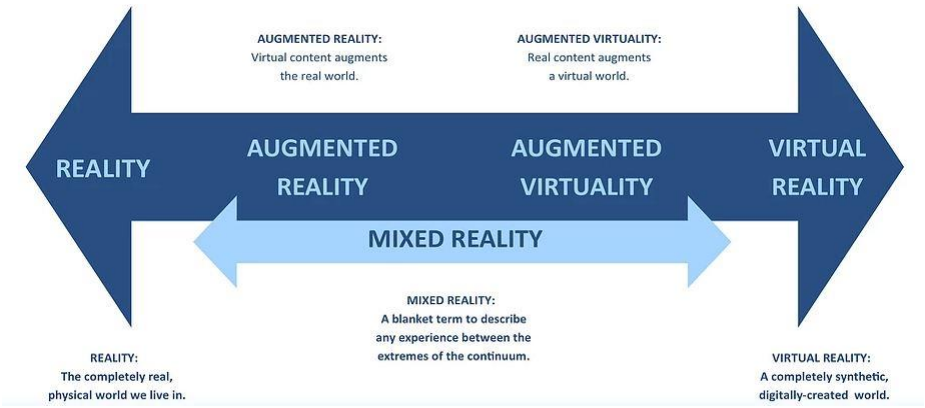


Figure 2. 11: The reality-virtuality continuum by Milgram et al. (1994)

According to Azuma (2001), three representative characteristics of AR are the combination of reality and virtuality, interaction in real time, and observing the real world in 3D. AR platforms can be of two types: i) using a headset with a see-through screen and the visuals projected on it, and ii) using a camera to show the real environment and visuals overlaid on the screen, for example, using smartphones.

Early AR-related technologies were developed and studied for using in industry, military readiness, surgery training, computer games, and computer-supported collaboration (Ko et al., 2013). Until the mid-2000s, AR studies remained limited to research and development, and trial applications. However, the occurrence of high-end smartphones with global positioning systems (GPS), geo-magnetic sensors, high resolution cameras, graphic-processing capabilities, and wireless communication function elevated the importance and applications of AR technology (Ko et al., 2013). AR is now being applied to fields like gaming, education, navigation, tourism and so on.

2.2.2 Mobile AR

The mechanism of mobile AR is to overlay digital information on the display having real environment in the background through the mobile camera. The characteristics of mobile AR include combining real and virtual imagery, interactivity in real-time, registering the virtual imagery with the real world and accessibility by mobile devices (Goh et al., 2019).

For the immersive experience in AR, some aspects of mobile AR need to be considered.

Tracking

Tracking is the technique of detecting spatial objects or the targets of augmented objects. It helps to align the augmented information and the real life objects on the screen. Tracking is related to *registration* that is the correct overlay of virtual information according to the tracking targets (Schmalstieg and Höllerer 2016). There are various tracking methods for mobile AR: camera-based, sensor-based, location-based, SLAM and hybrid tracking (Bekele et al., 2018). *Camera-based* tracking employs image processing algorithms of computer vision for object recognition. The real objects can be tracked using a marker in the form of a matrix barcode or an image with distinct features which makes it an easy and convenient way. The marker-less technique recognizes geometric features from real objects based on embedded 3D point cloud data. *Sensor-based tracking* detects the position of the device and the real objects using the gyroscopes and accelerometer of the mobile device. *Location-based* tracking uses GPS to track the location of the device and the objects such as in Pokemon GO[6]. *SLAM (simultaneous localization and mapping)* is a technique of robotic engineering that senses the unknown environment (Miyake et al., 2017) and detects the distance and features of the surfaces. The combination of camera-based and GPS tracking is usually used for *Hybrid* tracking (Bekele et al., 2018).

Interaction

Mobile interaction refers to the ways in which the users manipulate and interact with the augmented information while communicating with the real world. Research on mobile interaction began in the late 1990s (Sá and Churchill 2013). As most of the earlier AR applications focused only on viewing the augmented objects with not much scope to modify them, Goh et al. (2019) acknowledged the role of manipulation in mobile AR and categorized them into three groups: i) touch-based (directly on-screen), ii) mid-air gestures-based (detecting finger gestures) and iii) device-based interaction (moving the device itself).

Visualization

Visualization in mobile AR is more complicated than other visualization environments as it consists of three layers. One is the background layer with real objects captured by camera, second is the augmented information overlaid on it and the third is the mobile screen where the touch-based interaction happens (Keil et al., 2018). Although many visualization techniques for AR have been proposed, adaptive techniques need more attention (Grasset et al., 2012). Julier et al. (2002) proposed using filtering technique to reduce visual clutter and information overload. Webel et al. (2011) proposed changing the strength of information dynamically by adaptive visual aids. Kalkofen et al. (2009) investigated the layout of AR contents while Grasset et al. (2012) looked into the optimal placement of the visuals. Keil et al. (2018) identified and categorized some common visual AR elements: annotations and labels, highlights, assisting visual aids like guiding-geometry, additive elements like XRay and explosion diagrams, and trans-media material.

Annotations and labels are visual components that anchor the points of interest in real world and adds contextual information. They can be icon-like or twin elements of labels (2D or 3D) with leader lines. Highlights visually enhances parts of an object, by using the object's shape or a point if the shape is not available to catch user's attention. Assisting visual aids are stronger visual elements such as arrows, markers, metaphorical indicators, etc. and act as containers for textual information and draw attention to missed details. XRay or ghosting visual effects remove parts of real world objects artificially, for instance by changing transparency, to uncover the objects behind them. Explosion diagrams are a series of technical illustrations of objects with complex structure that stimulate the creation of mental models and act as linking elements to other objects or information. Trans-media material can be in any

[6] https://pokemongolive.com/en/ (accessed on 19.03.2021)

form from 2D or 3D illustrations to video which are overlaid on real objects to enrich information about them. (Keil et al., 2018)

2.2.3 AR in storytelling

One of the uses of augmented reality (AR) now is to enable new forms of storytelling that requires virtual content to be connected in meaningful ways to particular locations, whether those are places, people or objects.

Azuma (2015) hypothesizes three approaches of AR storytelling. The first, *reinforcing*, locates an AR storytelling experience, such as a historical event, on the real location itself. Kampa & Spierling (2017) aimed to develop a similar location-based AR prototype for outdoor museum tours named SPIRIT that presents interactive video content to fit the position of the user at any time for delivering of adaptive and interactive stories (Figure 2.12). They addressed the "technical authoring process" to develop a non-linear story content and also proposed smart authoring tools for assisting non-programmers.

Figure 2. 12: Spirit prototype test for location-based AR (Source: YouTube, 2016)

The second approach, *reskinning*, is to reformulate reality to fit the purpose of the story. Most of the functionalities here come from the virtual content and how it adapts and exploits the real world. One example for this is Alice's Adventures in New Media, an early AR narrative experiment based on Alice in Wonderland by Lewis Carroll. In this system, the user can see and interact with three other characters from the book while sitting in a table and sipping tea (Moreno et al., 2001). The third approach is *remembering* where the AR storytelling strategy is to draw upon memories and retell those stories. In this approach, the stories and memories can vary greatly, even at the same location. 110stories is such a platform that lets people share their stories and previous experiences about a site or a building with others. The 110stories WTC project had pioneered the use of AR as a legitimate storytelling device commercially (110stories, n.d.).

The research of Indans et al. (2019) aimed at developing an approach that combine different elements of audio media playback, geolocation and other sensor capabilities of smartphones to create immersive geolocated narratives within a mobile application. For this, a prototype was made by intertwining sound, space and time into a mobile application for storytelling with semi-linear narrative structures including a map. The resulting prototype is described as a story game with spatial properties creating an audio-based augmented reality experience.

2.2.4 AR in navigation/route visualization

AR allows for a vast array of possibilities for navigation by embedding space along the route with visual elements. Using the AR technology, the navigation experience can be enhanced for the users by creating 2D or 3D visualizations or animations to point or highlight the routes. Additionally, AR provides the users with the possibility to interact with the augmentations while walking through the real environment. The global positioning systems (GPS) in the smartphones allow the user to track their location. Mobile AR applications are used in providing location based services (LBS), which make use of the location information of the smartphones (Ko et al., 2013). The navigation feature of AR has a great potential in the field of tourism as tourists can use it to find their way through a new and unfamiliar destination (Yovcheva et al., 2013).

In order to exploit the AR functionalities for route visualization, Akaho et al. (2011) developed and evaluated an AR based car navigation system that captures live video with a camera and overlays it with graphic elements for guiding directions. McMahon (2015) performed a comparative study by monitoring the effects of three different navigation media: paper maps, Google maps and AR application, with intellectually disabled students and argued that the AR application was the most effective medium for them. In 2020, Huang et al. proposed a solution for indoor navigation system inside large buildings by developing an AR application named ARBIN that had the accuracy of 3-5 meters and could guide the users with correct instructions.

2.2.5 AR in tourism

Mobile AR applications provide highly interactive and dynamic experiences for tourists and travelers while allowing them to explore the world by adding new layers to their reality. AR helps retrieving information and navigating through a place in a faster and more effective way (Yovcheva et al., 2013). Moreover, mobile AR applications can function as a tour guide as they are highly portable and the information can be tailored according to users' needs resulting in a memorable experience. It minimizes information overload and redundancy caused by overwhelming transmitted information, pace of navigation and so on (Kounavis et al., 2012). AR applications uses multimedia elements such as images, video, 3d models, as well as hyperlinks that can direct the user to another website outside the application. With careful design and appropriate use of multimedia, the users can also have the ability to make a list of their favorite spots with the augmented information.

Several research have been done regarding the scope and implementation of AR in tourism. Han et al. (2013) investigated the user requirements by interviewing tourists visiting the city of Dublin for developing a mobile AR tourism application for urban heritage. The study suggested that the application should be designed to fulfill specific purposes such as multi-language functionality and ease of use for the user. Wei et al. (2014) evaluated two non-visual elements, haptic and audio, and their combination in representing tourism information to users in the mobile AR environment. Cranmer (2019) identified and classified the value adding features in four categories: visitor value, organizational value, stakeholder value and economic value, to be considered for effectively design AR tourism application and enhance tourist experience. Recently, Mohanty et al. (2020) have attempted to explore the prospects of AR for relaunching the tourism sector following the guidelines by WHO and UNWTO in a post-COVID-19 context.

Although there have been many initial experiments, storytelling and route visualization in AR is still in an early, exploratory phase. One of the most important challenges in AR storytelling is motivating people to make the necessary effort to participate in these location-based media. There is no single standard platform or system that dominates and a lack of research in the exploration of the possible

use of visual elements to narrate a location-based story through AR. It remains an open question how the design of such tools might be evolved to support richer and more diverse forms of storytelling.

2.3 Research fundamentals and usability aspects

2.3.1 Research design

A research design is the framework to guide the proper execution of a research method and the subsequent data analysis process (Bryman, 2012). The selection of research design depends on, and eventually decides, whether the purpose is to collect quantitative or qualitative data. Nevertheless, depending on the objectives the research can be qualitative, quantitative or somewhere in between (Bryman, 2012). A quantitative design performs systematic investigations with mathematical, statistical or computational techniques that generates numeric data by theory testing in an artificial setting. On the other hand, qualitative research focuses on non-numeric data obtained by the researcher from first-hand observation, interviews, questionnaires, recordings, etc. to increase contextual understanding. The main advantage of using qualitative method is that they generate a full and detailed set of data that provides multiple contexts to realize the phenomenon (Flick, 2010). To investigate the case intensively and to find the best results, usually a mixed design approach is adopted combining multiple methods that fit the research purpose (van Elzakker et al., 2008) into a single case study.

2.3.2 Comparative study

The comparative study entails studying multiple contrasting cases, for which similar methods are used (Bryman, 2012). The aim is to “determine and quantify relationships between two or more variables by observing different groups that either by choice or circumstances is exposed to different treatments” (Bukhari, 2011). For this, research data is collected for at least two cases, which can be groups of people, collection of samples or different media (as in this research), and then compared. A set of characteristics is defined between the cases for the comparison. The data resulted from the comparative study can be quantitative or qualitative depending on the characteristics.

Roth et al. (2013) conducted a similar approach called competitive analysis to collect and evaluate the available web mapping technologies. The technique is similar to a comparative study in the sense that they both use theory-based method to compare a group of related materials, however, a competitive analysis does it more critically to find the better candidate or solution to a problem. In their research, Roth el al. (2013) collected website links to JavaScript web-mapping technologies and then coded them according to their representation and interaction functionalities. This was followed by a needs assessment survey to reveal the user perspectives on the collected technologies. Finally, a diary study was conducted which is a *user-based participant observation method* done in a discount, convergent manner to find out the most suitable platform.

2.3.3 Data coding

Coding is “a process of concept labelling and categorizing, where ideas with identical phenomena are clustered into a category”. By applying this method, the meaning of the data is understood. The data coding phase consists of several stages, three (initial, theme-indicator and focused) are relevant to this research. In the *initial* stage large quantity of raw data is filtered. The next stage is *theme-indicator coding* where data are organized together by allowing connections between categories. The *focused coding* stage involves identifying and choosing core categories by investigating similarities and relationships between data systematically. (Corbin and Strauss, 1990)

2.3.4 Conceptual design development

Conceptual design is an early phase of a design process where the broad outlines of function and structure of future products are articulated including processes, interactions and strategies (Wang, van Elzakker and Kraak, 2017). The basic scheme consists of concept generation and representation. The concept generation includes the clarification of requirements and combination of ideas generated from the collected information regarding the problem. The representation includes selection of a design language or medium such as sketches, models, prototypes and mockups. Different innovation ideas are considered that are stimulated through advanced technologies and the users' requirements. For instance, innovation can be achieved by adopting a new form of technology or improving an existing one.

Ylirisku et al. (2016) defined the term conceptual design as a "constructive framing and re-framing activity" in order to create new design concepts to use design and research projects. Wang, van Elzakker and Kraak (2017) presented a conceptual design for a mobile application called GeoFARA for human geography fieldwork based on a review of existing mobile AR applications, user surveys and use scenarios. The study also incorporated a comparison between printed maps and mobile mapping tools and afterwards, a usability evaluation (more in section 2.3.4) with the thinking aloud method (more in section 2.3.8) among others.

2.3.5 Usability testing

Usability testing is a technique that evaluates a product by testing it on users. It is mostly applied for user-centered interaction design as it gives direct impression of how real users perceive and interact with the system (Nielsen, 1994). This method is concerned with the intuitiveness of the design and tested with users who have no prior exposure to it. The quantitative method for usability testing involves indirect assessment of the usability of a design where the performance of the users on certain tasks are quantified such as task-completion times, number of errors and so on (Budiu, 2017). The qualitative method conducts a direct assessment by observing the user insights and interactions. It enables the researcher to develop categories and patterns between them (Suchan et al., 2010).

Usability studies are often quantitative and controlled in the cartographic discipline (Roth et al., 2017) mostly looking into the influence that a certain map-based design has on the users. There are two types of research on map use, *perceptual and cognitive research* and *functional map use research* that complement each other (van Elzakker, 2004). The former deals with initial reactions of the user further including user experience and thought processes to discover if and why maps work. The latter assesses to what extent a map fulfills the purpose that it was made for. The majority of these studies has been focused on interactivity with the advancement in technologies in the past few decades. However, many of the recommendations can be applied to paper maps and static digital maps as well. It is recommended that purposeful sampling should be conducted and the participants should represent future users (Roth et al., 2017).

The International Organization for Standardization (ISO) has come up with the ISO 9241-11 standard that provides guidelines to design, perform, and evaluate usability tests with visual displays with a focus on user performance and satisfaction (ISO, 1998). This standard has been well accepted and widely applied in usability research in the field of cartography (Çöltekin et al., 2009; Nivala et al., 2003, 2008; van Elzakker et al., 2008). The most recent version of the ISO standard has listed effectiveness, efficiency and satisfaction as the three important concepts of usability. Effectiveness consists of the accuracy and completeness with which users achieve specific goals, efficiency summarizes the resources needed to achieve the results and satisfaction measures the extent to which the user's

responses (physical, cognitive and emotional) are in accordance with the user's requirements and expectations after interacting with a product (ISO, 2018).

2.3.6 Usability testing with Mockups

For mobile applications, usability testing for user interface is an important aspect. This is often achieved by conducting a task-based user experiment with the developed app and/or a user survey or interview after using the app. To perform a usability testing in the early stages of the development process, often a prototype of the intended app or mockups are used. The use of mockups for usability evaluation has been largely adopted in case of web applications (Rivero, 2014). Mockups of a mobile application are images/sketches representing what the app interface should look like when implemented. Several tools exist for developers to transform the images into interactive mockups. Barra et al. (2019) proposed a methodology for automating usability testing using mockup interfaces directly on the mobile device without involving expert users or supervisors and to automatize the report of the results. By pairing the test with post-test survey, they detected the usability problems with the mobile applications to be able to improve the design in the advanced development phase.

2.3.7 Semi-structured interview

Face-to-face interview is a survey technique that is perhaps the most widely used method in qualitative research (Martin, 2008 and Bryman, 2012). In this method, the interviewer and interviewee meet at a chosen location for an interactive conversation including a question-answer session. The interview can be structured, semi-structured or unstructured. In a structured interview, the conversation or questions are mostly close-ended and the answers are controlled for an easier analysis, whereas an unstructured interview is more free and explorative in nature. A semi-structured interview combines the advantageous and convenient characteristics of both to achieve the most suitable results for the research such as having a predetermined script to keep the conversation on track and mixing open- and close-ended questions considering the type of information needed for the analysis. Data can be collected from a sample of people and if the process goes well, the results can be generalized for a larger population (Martin, 2008).

2.3.8 Observation method

When it comes to gather information about the user's perception to a certain product, observation method can be very useful (Sullivan, 1989). An observation study involves "the systematic recording of observable phenomena or behavior in a natural setting" (Gorman and Clayton, 2005). An observation can be *overt* where the researcher being an observer is disclosed to the participants, or it can be *covert* where the researcher's objective is kept a secret (Bryman, 2012). Observations can be *structured* or *unstructured*. The former observes the behavior of participants systematically by following explicitly formulated rules for recording the behavior. Unstructured observation is more flexible. The observation method that can also be *simple* or *contrived* based on the level of obtrusiveness (Bryman, 2012). In a simple observation the researcher has a nonintrusive and passive role in an experiment or interview whereas in contrived observation, the observer actively participates and manipulates the setting and/or record the observations by using hardware. A *participant observation* is more suitable for the observer to immerse in a certain social setting (Bryman, 2012) such as a semi-structured interview.

2.3.9 Thinking aloud method

The think aloud method is a technique where an interviewee or a test participant is asked to speak up and share their thoughts continuously while performing a set of tasks (Lea & MacLeod, 2018). It is a widely accepted method in the fields of design and development, psychology and social sciences. It helps to understand the thought process of the users as they attempt to solve a problem. According to van Elzakker (2004), observing the reactions of the participants at the same time as the experiment is taking place helps to avoid distortions and invalidities caused by memory errors and their inclination to rationalize the behavior. Thinking aloud requires continuous attention and so the participants need to divide their concentration between performing the task and speaking aloud (Kjeldskov and Stage, 2004). The users may need some time to get familiarized and comfortable with the verbalization of their thoughts. However, it does not disturb their thought process in general (Schoberberger, 2012). In an interview or observation method, the verbal reactions of the participants are often recorded. Thinking aloud involves the analysis of the recorded verbal protocols (van Elzakker, 2004). The non-verbal expressions are also considered important, such as tone of voice, facial expressions, gestures, etc. (Charters, 2003).

2.4 Conclusion

This chapter outlined the theoretical background of this research and some related work. The first section dealt with the concepts and process of telling location-based stories in analogue and digital cartography and how they can be designed to facilitate tourists. The second section delineated the fundamentals and existing studies on AR technology in the context of storytelling and route visualization. It also gave insight on how AR has been and can be used in tourism. Some relevant research methods have been described in the third section that could be adopted in this study to answer the research questions. The literature review did not reveal a comprehensive study that provides design recommendations considering storytelling, route visualization and user requirements at the same time. The next chapter will cover the adopted methodology for this thesis to fill this research gap on providing design recommendations for the simultaneous use of the above-mentioned aspects.

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Chapter 3
Methodology

This chapter presents the adopted research design and workflow for achieving the research objectives and answering the research questions specified in the first chapter. The chosen research methods such as the comparative study, conceptual development and usability evaluation are discussed in this sub-chapter.

3.1 Adopted Methodology

To meet the research goals and to answer the research questions set in chapter 1, the most appropriate research design needs to be adopted. This study focuses on recommending design principles for developing a mobile AR application by reviewing existing story samples in different media to find patterns, developing a conceptual design based on the patterns and finally evaluating the design to make final suggestions. Since all these steps are largely dependent on non-numeric data like design elements and user reactions, the research will be qualitative in nature and hence, a mixed research design is adopted (section 2.3.1). The methods and techniques used for this thesis and the logic behind choosing then are presented in the next sub-sections. Figure 3.1 depicts the overall workflow of the adopted methodology.

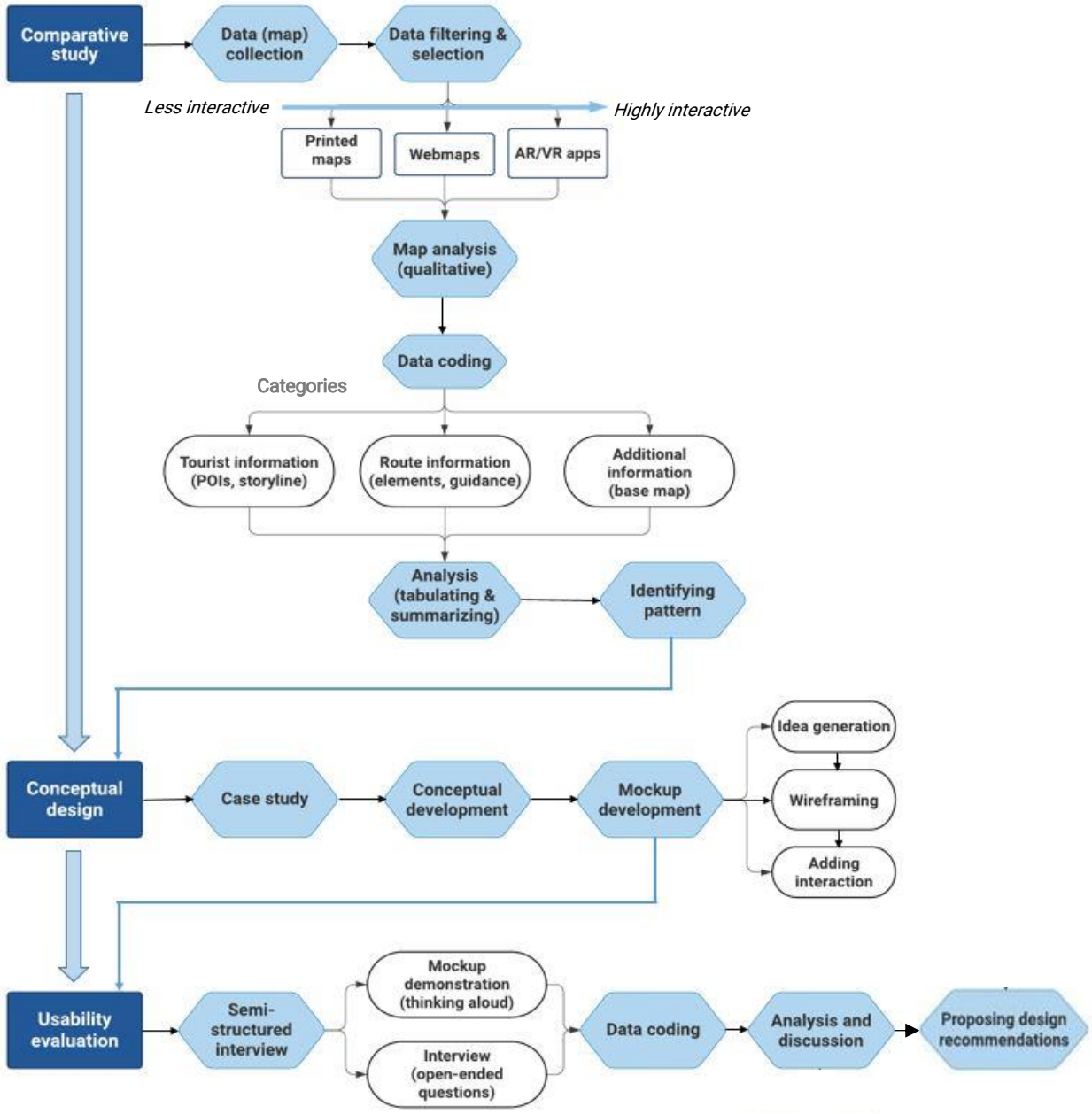

Figure 3. 1: Adopted research methodology

3.2 Comparative Study

In order to detect the visualization pattern for location-based stories, reviewing and comparing existing materials (maps and map-based applications) is taken as a first step. This is to inspire the study and eventually the intended recommendations with the valuable findings of previous examples. Three media are chosen as contrasting cases (see section 2.3.2): printed maps, online interactive maps or web maps and augmented reality (AR) applications to get a comprehensive view. Virtual reality (VR) applications are also considered to compensate for the lack of usable AR samples. These three media are chosen considering their variety in the representation (cartographic and multimedia elements) and the level of interactivity (section 2.3.2). AR itself is considered as a comparison case in order to see the tools and functionalities already offered in it. Keeping in mind the limited timeframe for conducting the research, the samples for comparison were limited to the three categories only.

The comparative study consists of three phases: data collection, data coding and data analysis. The search of related samples is based on the closely related areas such as story maps, tourist maps, travel apps, etc. from various sources. As a next step, the necessary information (qualitative data) is extracted from the collected samples and categorized by applying a **data coding** process (section 2.3.3). In this process, the samples are filtered (initial coding) applying some criteria to finalize only on the relevant samples to be used for this research. The next phase of coding (theme-indicator) is achieved by reviewing the contents of the selected samples and simultaneously making comparisons between different map designs. The process ends with choosing and defining core categories (tourist information/story visualization, route visualization and additional information) by systematically connecting coding classifications (focused coding). As a final step, the findings are tabulated, summarized and analyzed to identify a pattern for using visual elements including color and interactivity aspects into consideration which helps to answer research question 1. (more details in chapter 4)

3.3 Case study

Usually, multiple research methods are combined in a field or an indoor setting to perform a case study during a scientific research. Some common methods used for qualitative research using this kind of design are participant observation, field experiments, semi-structured and unstructured interviews. For designers, web developers and mobile developers, it also includes designing or developing prototypes and mockups and conducting a usability testing. In order to connect the theoretical findings from the comparative study with the practical demonstration for real-life users, a case study needs to be performed which consists of two major phases: the conceptual design development and the usability evaluation which will help to answer the research questions 2 and 3 respectively.

3.3.1 Conceptual design development

First, a conceptual design (section 2.3.4) for an AR application needs to be developed for the case study based on the combination of ideas generated from the comparative study (section 2.3.2). Initially, the design elements and a case study area are selected for designing the application. The next step is to transform the ideas into sketches or wireframing (details in chapter 5.1) using previously mentioned insights to guide the design and to develop a mockup version for the application prototype from the sketches. The decision to create a mockup is made taking into account the time needed and the complications in coding an actual AR application including all the functionalities as well as the added restrictions on the campus and other touristic spots because of the pandemic. Nevertheless, the standard procedure of an app development including generating the ideas and wireframing followed by adding functionalities to make it interactive are adopted to answer research question 2.

3.3.2 Usability Evaluation

To answer the third research question, a **qualitative usability evaluation** (section 2.3.5) is designed combining a number of research methods and techniques to gather user perspectives. For qualitative results, in general unstructured interview is more helpful as the question are mostly open-ended so that the interviewee can express all sorts of reactions and emotions in an uncontrolled environment and both sides can choose to go more into details for any particular topic. While a lot of in-depth information can be gathered in this method, the conversation could easily go off-track and the responses from different participants might not be comparable (van Elzakker, Delikostidis, and van Oosterom, 2008).

To overcome this conflict, a **semi-structured interview** (section 2.3.7) is designed where the interview steps can be structured to maintain the track while gathering information that cannot be directly measured e.g. opinions and motivations (Martin, 2008). The interviews will be conducted in an indoor virtual setting using online tools such as Zoom[7] for video conferencing. For purposeful sampling (Roth et al., 2017, in section 2.3.5), the participants are selected from versatile professions and different regions of the world as these factors can influence user perceptions. However, the age group is limited to young generation as they might be more interested in the technology and understand it better.

The evaluation process also contains a **mockup demonstration** session (section 2.3.6) to perform an *overt* **participant observation** method to oversee the experience and interactions of the participants in a *contrived* manner (section 2.3.8). The demonstration process will also employ the **thinking aloud** method (section 2.3.9) from the participant's side. It is important to note that the thinking aloud method does not reveal the deep and complex thought process of the participants since it can be hard for some people to simplify their thoughts into words. Thus, non-verbal characteristics will also be observed and noted by the researcher. A post-interview session will follow afterwards to assess the *effectiveness* and *satisfaction* level of the participants considering the ISO standards (section 2.3.5). The *efficiency* is not considered here given the nature and purpose of the research. The interview will contain open-ended questions. The participants' reactions will be recorded on an audio recorder device to further analyze and categorize the recorded qualitative data (details in chapter 5.2). By reflecting the recordings and opinions of the participants, a design recommendation for an AR app with a location or map based story will be proposed (chapter 6).

3.4 Conclusion

In this chapter, the complete methodology that is going to be implemented in the later sections to answer the research questions was drawn. Some fundamental and most commonly used research methods relevant and adopted to this thesis were discussed. A mixed design is adopted with a combination of various approaches including the phases of comparative study, conceptual development and user evaluation. The research methods should generate a wide range of qualitative data to be analyzed. The following chapters will cover the execution of these research methods.

[7] https://zoom.us/ (accessed on 19.03.2021)

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Chapter 4
Comparative Study

Chapter 4 focuses on applying in practice the first step described in the methodology chapter. In this chapter, the whole process of the comparative study including the data/sample collection process, the analysis and the findings will be described.

4.1 Data/Sample collection

To conduct the comparative study (section 3.2), a number of existing maps and mobile applications were collected. Considering that maps from different media vary in design elements and their level of interactivity, the samples were collected from three different media, printed maps, interactive web maps and AR or VR applications to observe and compare. Printed and web maps were chosen to observe the design elements from the cartographic point of view. AR applications were collected to check the existing designs and the possible functionalities in the AR environment. VR applications were also looked into to compensate for the lack of AR examples considering their similarities in design and in presenting digital information on the screen.

The printed maps were gathered from several sources such as peers and colleagues, author's personal collection, and internet. Leaflets or brochures with maps giving tour of an indoor or outdoor tourist location seemed to be an ideal example for the printed media. The web maps were all searched and found in internet from different websites. Some of the AR applications were downloaded from Google Play Store while the others were found on online platforms (especially the VR experiences) and on YouTube as they were from other regions and required the user to be at the real location for the AR experience.

The initial search was conducted for printed tourist maps. The web maps were searched using the keywords "story maps", "city tours" and "tourist maps". For the third category, the search was directed to travel and tour apps and was also extended to apps for archeological sites. Initially, 47 maps and applications were collected and put through a selection process for the comparative study to make sure they were fit into the scope of this research. The main criteria for this selection were that the samples had to be story maps or guided tours based on a location showing multiple points of interest and some indication for the route. At the end, a total of 38 samples were selected that included 15 printed maps, 15 web maps and 8 AR and VR applications. The samples are presented in Appendix A.

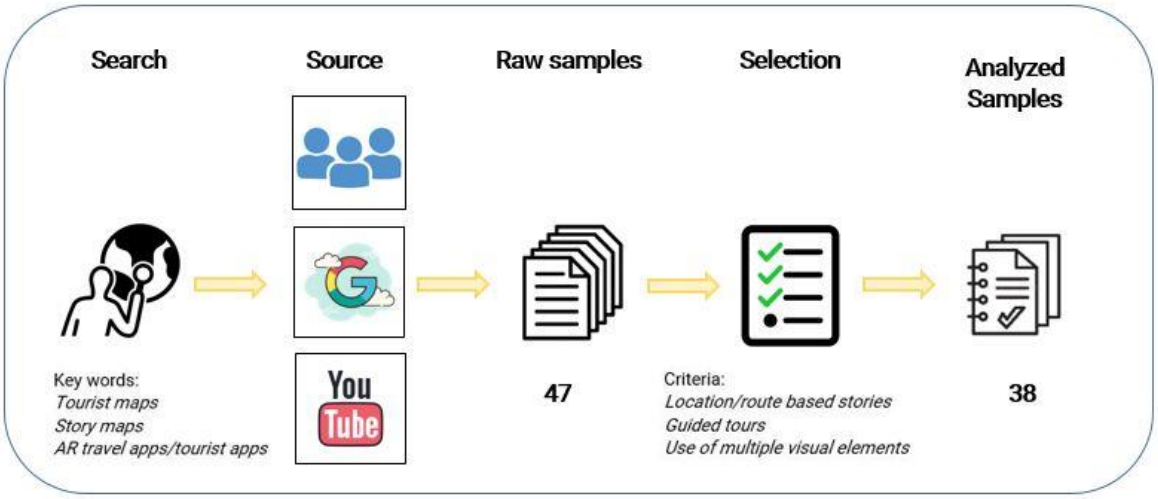


Figure 4. 1: Sample selection process

Every region or country in the world has its own way of designing maps or telling stories. Considering that, the samples were collected from different regions (table 4.1), and they covered a wide range of themes and locations (figure. 4.2).

Figure 4. 2: Percentage of samples collected from different countries

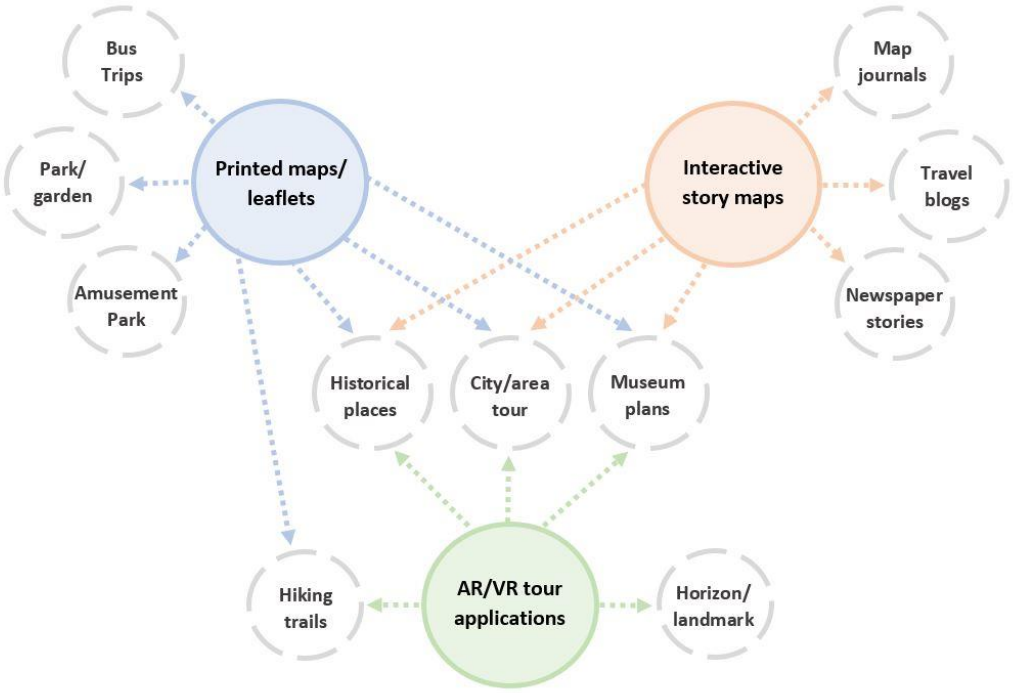


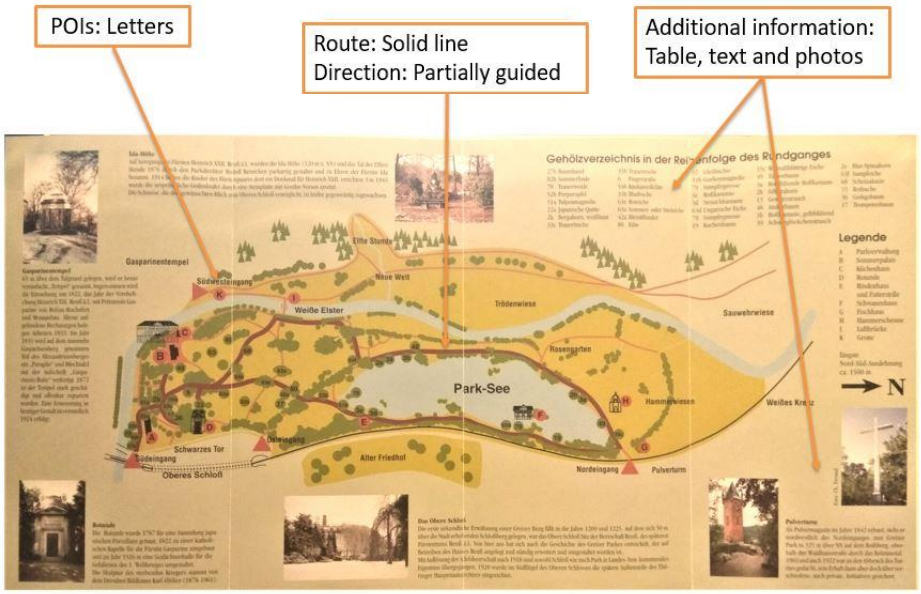
Figure 4. 3: Themes covered in the selected samples

4.2 Map analysis and data coding

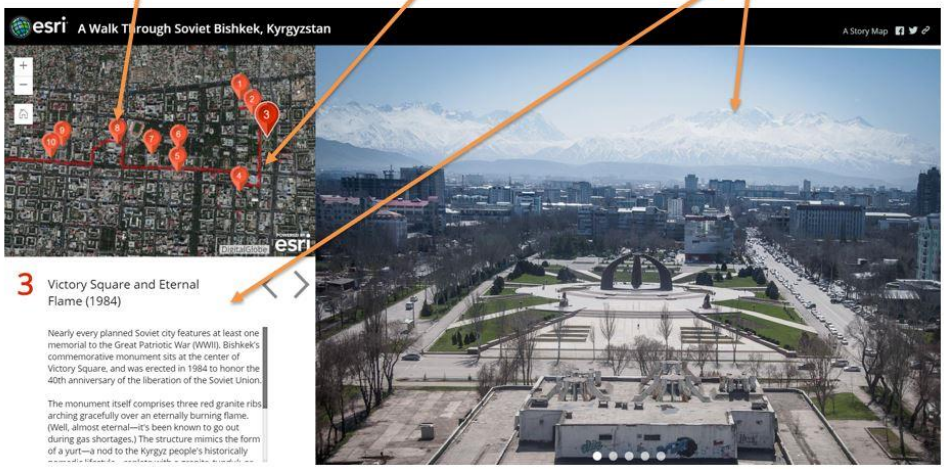
For the extraction of information from the selected map and applications, a data coding process (section 3.2), was applied. First, the information on the samples were divided into 3 broad categories: 1) Tourist related information, 2) Route information and 3) Background information

As a first step, the visual and non-visual elements used for these categories such as cartographic symbols (lines, points, polygons, etc.), multimedia elements (photos, text, audio, etc.), and their interactivity functionalities were observed from all the samples (Figure. 4.3).

(a)


POIs: Letters
Route: Solid line
Direction: Partially guided
Additional information:
Table, text and photos
Gehölzverzeichnis in der Reihenfolge des Rundganges
Legende
Gasparinentempel
Südwesteingang
Elite Stunde
Neue Welt
Weiße Elster
Trödenwiese
Sauwehrwiese
Rosengarten
Park-See
Hammerwiesen
Weißes Kreuz
N
Schwarzes Tor
Südeingang
Alter Friedhof
Nordeingang
Pulverturm
Oberes Schloß

(b)


POIs: Numbers
Route: Solid line + numbers
Direction: Guided
Additional information:
Text and photos
esri A Walk Through Soviet Bishkek, Kyrgyzstan
A Story Map
3 Victory Square and Eternal Flame (1984)
Nearly every planned Soviet city features at least one memorial to the Great Patriotic War (WWII). Bishkek's commemorative monument sits at the center of Victory Square, and was erected in 1984 to honor the 40th anniversary of the liberation of the Soviet Union.
The monument itself comprises three red granite ribs arching gracefully over an eternally burning flame. (Well, almost eternal—it's been known to go out during gas shortages.) The structure mimics the form of a yurt—a nod to the Kyrgyz people's historically

(c)


POIs: 360◦ view
Route: List
Direction: Self Guided
Additional information:
Popups, photos, videos, audio
New York City
Statue of Liberty
Ellis Island
Drag to look around
Liberty's Symbols

(d)

Figure 4. 4 Elements observed from the samples for comparative study; (a) sample 3: printed map of Greizer Park, (b) sample 16: A Walk through Soviet Bishkek, Kyrgystan, (c) sample 31: NYC VR tour and (d) sample 37: Buenos Aires Travel Guide AR (Appendix A)

4.3 Tabulating and summarizing extracted information

For each of the categories, the information was observed from 4 aspects: i) type of information provided, ii) element used for visualizing the information, iii) color used for the element and iv) interactivity functions of the element. The results were recorded using MS Excel.

The combined tables are provided in Appendix B.

1. **Tourist related information:** This category consisted of the visualization of the main points of interest and the storytelling elements. Thus, the information were classified into two sub-categories:
   a) Points of interest (POIs) and b) Description/stories of POIs.
   The same observation method from 4 aspects were applied to each of these sub-categories. Three examples, one from each medium, is shown in Table 4.2.

2. **Route information:** For this category, only routes for the POIs and/or other touristic spots were observed. Other than the main routes, alternative routes and routes to secondary POIs were also considered.
   Further analysis took place to check the type of direction or guidance provided for the tourists in the maps which were then categorized into three types: i) guided (linear path provided), ii) self-guided (no predetermined path provided) and iii) partially guided (containing both guided and self-guided options for the user to choose from). (Figure 4.3 (a), (b), (c) & (d); and Table 4.3)

Table 4. 1: Three selected examples (one for each medium) of tourist information tabulated from the samples (Appendix B)

Map No.	Map Title	Medium	Map Type	Theme	Tourist Information			
					Information provided	Element Used	Color Used	Interactivity functions
3	Greizer Park	Printed	Pictorial map	Tour of a park showing some interesting spots and vegetation	Park Entrance	2d symbol	Orange	
					Major spots/POIs	Letters	Black & Orange	
						Legend	Black	
						2d Illustrations	Black	
					Tree Species	Numbers	Black & Green	
						List	Black	
					Names of places	Labels	Black	
					Description of POIs	Photos		
						Text	Black	
16	A Walk Through Soviet Bishkek, Kyrgyzstan (ESRI Storymap)	Interactive web map	Satellite image	A tour of 12 noteworthy places of the city of Bishkek	Major spots/POIs	Numbers	Red	click to see popup information
					Description of POIs	Photos		
						Text	Black	
						Sliders		move to other pages
						Scrollbar		read text
31	NYC Tour (Youvisit)	VR app	3d Illustrated map, virtual tour	A virtual tour of 11 most significant places of New York	Major spots/POIs	360 view		Drag to see around
						Sidebar		Choose POIs
					Description of POIs	Audio		Replace narration with text
						Text	White	
						Photos		choose from multiple photos
						Video		
						2d icons	White	Click to open popup pages

Table 4. 2: Three selected examples (one for each medium) of route information tabulated from the samples (Appendix B)

Map No.	Map Title	Medium	Map Type	Route Information				
				Information provided	Element Used	Color Used	Interactivity functions	Guidance
3	Greizer Park	Printed	Pictorial map	Main route	Solid line (thick)	Red		Partially guided
				Other routes	Solid line (thin)	Orange		
16	A Walk Through Soviet Bishkek, Kyrgystan	Web map (ArcGIS story map)	Satellite image	Main Route	Dashed line	Red		Guided
31	NYC Tour (Youvisit)	VR app	3d Illustrated map, virtual tour	Main route	List / sidebar		choose location	Self guided
					Sliders		go to next location	
					Markers		choose location from overview map	

3. **Background/additional information:** This category consisted of all the information that were not specifically related to the points of interest or the route visualization. Table 4.4 shows four examples from the collected samples including one printed map, one web map and two VR and AR applications as the primary difference between VR and AR lies in their background visualization. For printed and web maps, the boundaries, landuse, geographic names, roads, etc. were analyzed. For web maps and AR/VR applications, map/website layout and navigation functionalities were also recorded like map scale, zooming and panning options, scrolling, search bar, buttons and general information on navigating the map or website.

4.4 Analysis and Findings

The elements used for tourist and route information and theirs sub-categories were summarized and compared for further analysis and comparison.

4.4.1 Identifying design elements

Table 4.5 shows the occurrences of different elements used to depict the points of interest in the printed maps as an example. Multiple elements used in the same map were also recorded in the chart. The same method was applied for the web maps and AR/VR media to gather the elements used for description/stories and additional information as well as for route depiction. All the tables are listed in Appendix C.

Table 4. 3: Four selected examples from printed, web, VR and AR medium and the background information tabulated from the samples (Appendix B)

Map No.	Map Title	Medium	Map Type	Theme	Background Information			
					Information provided	Element Used	Color Used	Interactivity
5	Gardasee Regional-guide	Printed	Thematic map	The main map tells the story of the northern part of Italy, a large region surrounding the Lake Garda along with two small maps of the cities of Verona and Trento	Landscape		Green	None
					Waterbodies	Polygons	Blue	
					Road distance	Numbers, markers	Blue	
					Names of places	Text	Black	
					Location	Inset map		
					Information on the cities	Additional maps		
						Text	Black	
30	Kangaroo Island Map	Web map	Static map with interactive elements	The map describes the interesting tourist spots and activities throughout the Kangaroo island and lets the user make their own itinerary	Significant areas	2d pictograms	White, brown	
					Names of places	Text	White	
					Map scale	Zoom buttons, spread/double click	Black	zoom in-out
					Search bar	Button	Black	choose from the list
					Navigation	Button	Black	find location through GPS
					Language	Menu	B&W	Change language
					Additional Information	Text	Black	
						Photos		
						Location map		Interactive maps
						Video		driving information and hiring cars
32	Dresden 360 Interactive Experience	VR/AR	Virtual tour	A virtual tour of 11 most significant places of New York	Background	360 view	-	drag to see around
					View mode	Button	White	VR mode on
					Map scale	Spread/Double click, Pinch		zoom in-out
					Control Mode	Button	White	choose from two different dragging options
37	Buenos Aires Travel Guide AR	VR/AR	AR app for Apple iphone and ipad	The app gives all the necesarry information for tourists to explore the city of Buenos Aires, Argentina	Background	Camera view		see the surroundings through device's camera
					Overview map	Street map		see the surroundings and landscape
					Navigation	Home button	Blue	go the main page
					GPS	GPS button	Red	see user's current location on map
					Map scale	Double click, spread, pinch		zooming in/out
					Additional Features	Filter icons (on map)	Categri zed	customize the type of place/service
						Audio		more information
						Menu/list		see itineraries and details on sights, shopping centers and restaurants

Table 4. 4: Elements used to indicate POIs in printed maps (Appendix C)

Map No.	Numbers	Letters	Markers	Symbols	Labels (names)	No element/ Camera view	2d/3d Illustrations	Icons	Filter	List/ Legend/ Sidebar
01	√				√		√	√		
02	√			√	√		√	√		
03	√	√		√	√		√			√
04	√			√	√		√			
05	√									
06	√	√	√	√				√		
07	√	√						√		√
08				√			√	√		√
09	√	√			√					
10	√	√						√		
11	√	√						√		
12								√		
13	√									√
14	√				√		√			√
15	√	√						√		√

4.4.2 Summarizing design elements

The occurrences of the design elements found in each medium were combined and summarized to find the most used elements for each category of tourist and route information.

A normalization method was needed to be able to compare among the three media as there were less samples for AR/VR applications. Hence, the total number of occurrences of the elements were converted into percentages (Appendix C). Table 4.6 shows the occurrences in percentage of each element used for depicting POIs in the printed maps.

Table 4. 5: Occurrences of elements used to indicate POIs in printed maps (Appendix C)

Occurrences	Numbers	Letters	Markers	Symbols	Labels	No element/ Camera view	2d/3d Illustra-tions	Icons	Filter	List/ Legend / Sidebar
Total	13	7	1	5	6	-	6	9	-	6
%	86.7	46.7	6.7	33.3	40	-	40	60	-	40

4.5 Comparison of the findings

4.5.1 Tourist information

The combined results for all three media are shown in the following column charts.

The results (Figure 4.4) show that *numbers* are the most popular element for depicting points of interest in both printed and web maps with 87% and 60% occurrences respectively. However, they were not present in any of the AR/VR applications. This also indicates that while numbers might be useful to give a sense of direction in maps as maps give an overview of the whole area, they might not be a logical choice for closer real-life views as in AR experiences. *Icons* possessed the second highest occurrence (60%) in printed maps. Comparing the rest, the elements that had their fair share of occurrences in all three media were *labels, icons and list/legend/sidebars*.

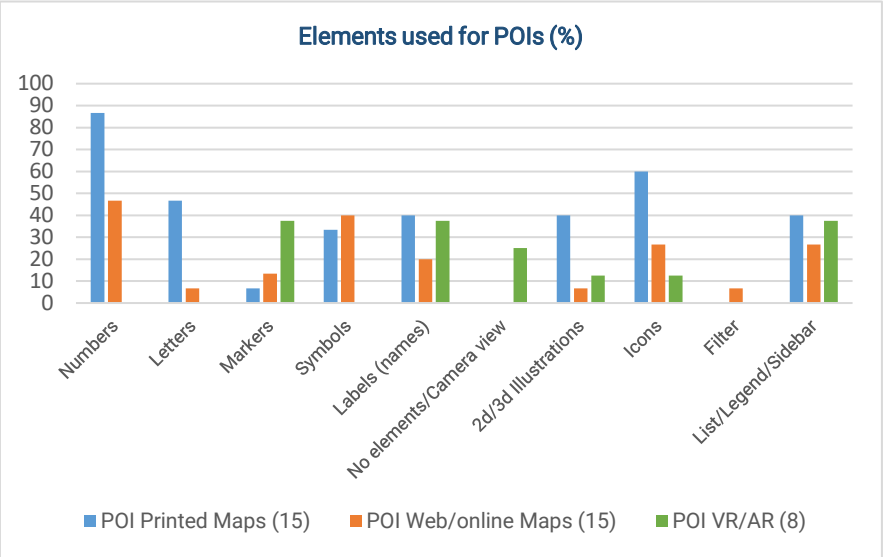


Figure 4. 5: Occurrence of elements used for POIs in the collected samples (in percentage)

Regarding description or story, *text* and *photos* were the most popular in all three media (Figure 4.5). Especially in web maps, all the samples had used them as the primary storytelling elements. The Popups and links to other websites were the next most occurring storytelling elements for AR/VR applications (37.5% each) and web maps (33.3% each). Sliders and scrollbar also had a percentage of 37.5% for the AR/VR medium. These two were considered in this category as they provided useful additional functionality for conveying the story.

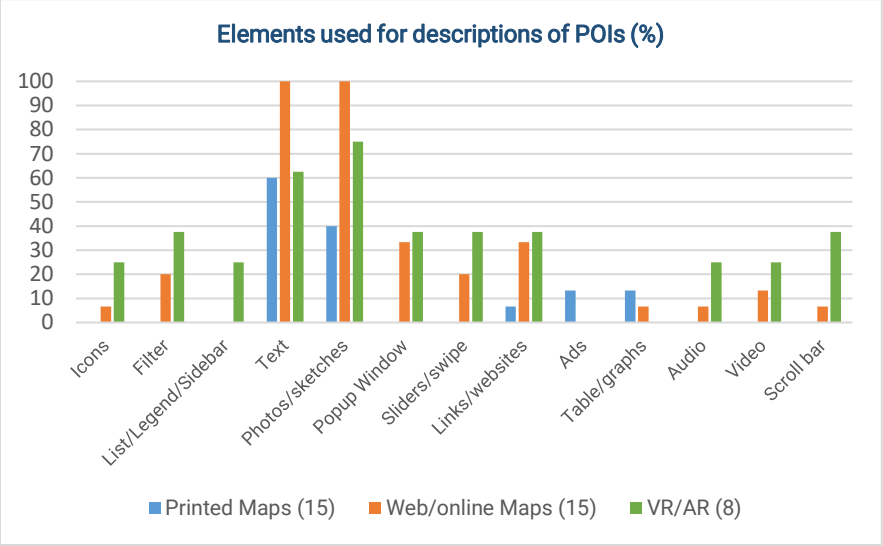


Figure 4. 6: Occurrence of storytelling elements in the collected samples (in percentage)

4.5.2 Route information

For route visualization (Figure 4.6) *solid* and *dashed lines* seem to be the most occurring element in printed and web maps. On the other hand, for AR/VR, markers function as the most prominent route element (37.5%) followed by lists/timelines (25%). Moreover, it seemed to be quite usual for all three

media to have *no particular element* visualizing the route, especially for the AR apps as they have the ability to show the real-life route on the screen with camera view.

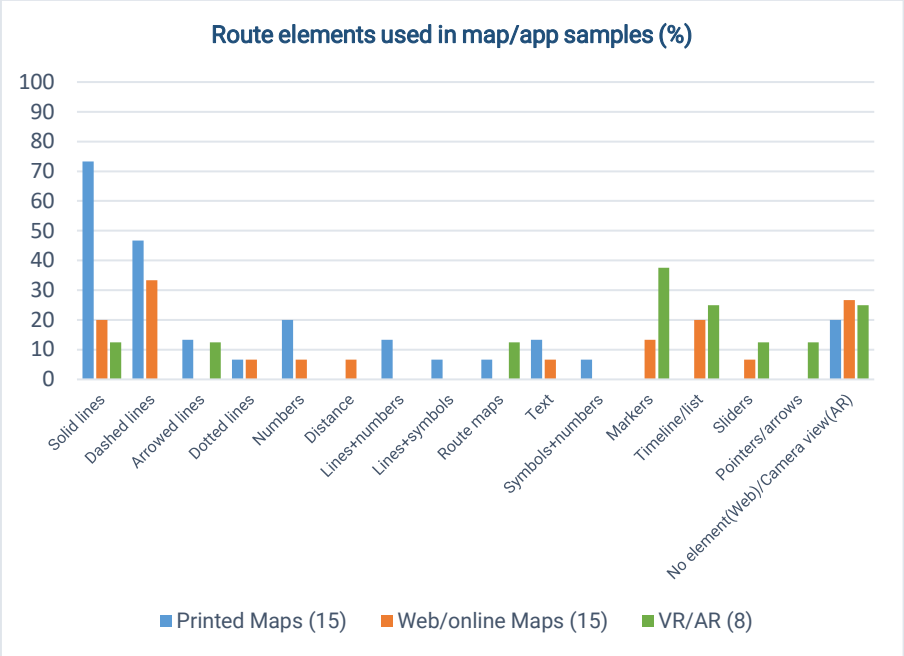


Figure 4. 7: Occurrence of route elements in the collected samples (in percentage)

Figure 4.7 gives a brief overview of the percentage of samples providing different types of route directions. It seems that most of the maps and apps (42%) had a guided route predetermined for the tourists or users. This is closely followed by samples with no direction guided (37%) so that the user has to define or choose the route to the next destination on their own either from the map or from seeing the road in AR. The rest gave the users a partial guidance of the main route with several optional routes to choose from.

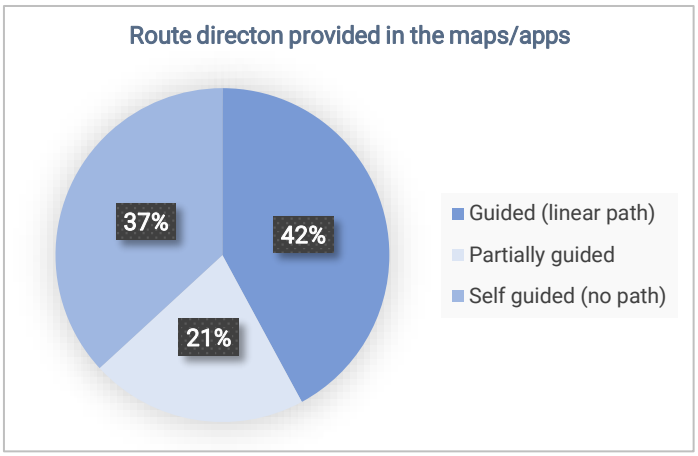


Figure 4. 8: Route direction provided in the samples

4.5.3 Background/additional information

In the following graph (Figure 4.8), a brief comparison is shown for the background and additional information in the samples. The first four elements in the chart indicate a major difference in the background visualization, e.g. polygons, symbols, shades and contours are used in the printed maps for depicting landscapes while web maps use interactive maps like OpenStreetMap[8] and the AR/VR media use real/virtual 3d backgrounds.

For additional information or functionality, both web maps and AR/VR use a wide range of interactive and multimedia elements like overview maps (interactive), zooming and panning, changing map-camera mode, GPS or menu button and so on.

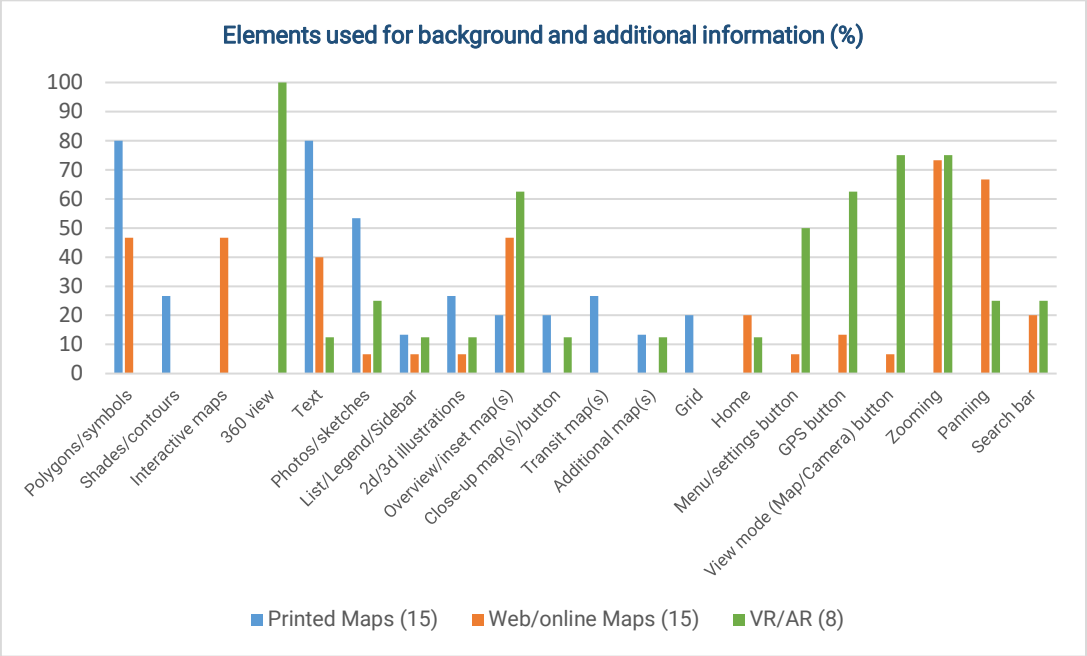


Figure 4. 9: Occurrence of elements for background/additional information in the samples (in percentage)

4.6 Pattern identification

4.6.1 Pattern for using visual elements

Combining and comparing all the results from section 4.5, an overall pattern in the use and occurrences of the visual elements was derived. Figure 4.6 and 4.7 give a clear picture of the patterns in using visual elements for route direction in the selected media.

In Table 4.6, the overall pattern attained for the tourist and additional information is visualized in a tabular form. The four major background elements mentioned in section 4.5.3 were excluded from this visualization as these elements are the fundamentally associated with the corresponding media.

[8] https://www.openstreetmap.org/#map=6/51.330/10.453 (accessed on 19.03.2021)

Table 4.6: Pattern identification for the use of elements for tourist and additional information in the samples

Elements used	Tourist information						Additional Information		
	POI			Information on POI/Storyline					
	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)
Numbers									
Letters									
Markers									
Symbols									
Labels (names)									
No element/360 view									
Icons									
Filter									
2d/3d Illustrations									
List/Legend/Sidebar									
Text (long)									
Photos/sketches									
Popup Window									
Sliders/swipe									
Links									
Ads									
Table/graphs									
Audio									
Video									
Scroll bar									
Map grid									
Overview/inset map(s)									
Additional map(s)									
Transit map(s)									
Close-up map(s)/button									
Search bar									
Menu/settings button									
GPS button									
View mode button									
Zooming									
Panning									

Legend						
Map percentage	0	1-20	21-40	41-60	61-80	81-100
Representative color						

4.6.2 Pattern for using colors

The findings of the comparative study indicated that there was no defined pattern of using different colors for the visual elements in most cases, especially for the background/additional information. One reason behind this is that each medium seems to have its own preference and inclination towards using colors.

Printed maps and web maps ideally follow the traditional cartographic color schemes to portray the map layers. It is very important to use appropriate and understandable colors for the user to read the map correctly and to receive the correct information. For instance, for the background elements in maps, it is common practice to use keep the natural colors for natural objects such as green color for trees and blue for waterbodies (Figure 4.3 Grezier Park map). The rules could be varied as well, especially for web maps, although a general color palette is maintained. For example, in story map of Bishkek, Kyrgyzstan, the basemap used was a satellite image and followed the corresponding color scheme (Figure 4.3). Moreover, in online story maps, it partially depends on the author's preferences as well. In the story map *Literary Knox Walking Tour* (sample 23, appendix A), the author used a color palette completely consisting of grey and purple shades to give a historic feeling to the audiences (Figure 4.9).

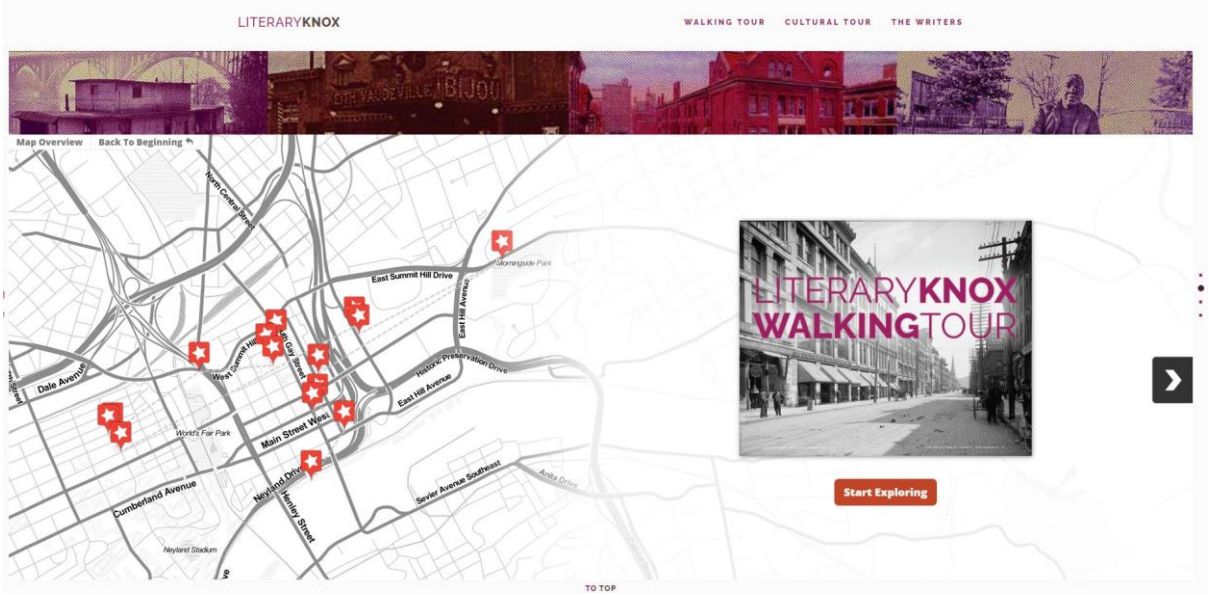


Figure 4. 10: Screenshot of web map sample 23 "Literary Knox Walking Tour" (Appendix A)

For AR experience, on the other hand, the background color is only relevant if there is an additional map used. Although the colors must be considered for the other elements in the application, it highly depends on the color scheme adopted for the whole application and the developer's preferences.

Some key patterns that could be derived from the collected samples are listed below:

- For route visualization (guided routes) *Red* was the most used color for the lines in printed (53%) and web maps (40%), *Black* being the second most used in printed maps (40%)
- For AR, although in most cases there was no route element given, one app used *Red* line (sample 35, Appendix A) while another used a *blue* line (sample 36, Appendix A) and one app also used a *Red-blue* marker (sample 34, Appendix A) to point the direction.
- For text, *Black* was used in 87% of the printed, 80% of the web maps and 50% of the AR/VR applications with white being used in the other 50%.

- For POIs the colors varied on a wide range depending on how the points are categorized. Nevertheless, *red* and *black* seems to be the most favorable color for numbers, letters, icons and markers in all three media combined. The other colors that seemed to appear in multiple samples included blue, purple, orange, yellow and various shades of green and brown.

4.6.3 Pattern for interactivity

The difference in the level of interactivity is strongly visible for the three media which is also the reason for choosing them. Table 4.6 shows the drastic shift in the level of interactivity vertically. The elements in the table are horizontally distributed considering their medium and information provided. The least interactive options are placed on top of the more interactive ones. As a result there is somewhat a diagonal shift in the distribution of elements in terms of interactivity.

It is quite logical that printed maps do not have the ability to use the interactive elements like zooming, search options, GPS buttons, etc. and so these elements are placed at the very bottom of the table in the right. Although for the POIs and the stories most elements are used in all three media, some of these elements possess additional interactivity features in the web maps and AR/VR applications. For example, POI elements like markers, icons and 3d illustrations might have the possibility to click on for more information. Lists or sidebars can be hidden at the side of the screen or behind a button. Texts can be used with a scrollbar or put inside a popup window and photos can be scrolled down or slid left to right to get the next piece of photo or information. Even with route direction it is apparent that most of the AR applications use minimal or no element for guiding the route as it can be seen from the camera view or chose from the real environment by the user themselves. (Figure 4.3)

It can be stated from reviewing the samples that the range or the level of interactivity that can be provided in a particular map or a story depends completely on the technology used.

4.7 Conclusion

The comparative study was performed with 38 selected map based stories from three media to generate an overview of the elements that are used. After analyzing the samples individually, the visualization elements were summarized and a brief discussion was done on the pattern of using these elements. The results and findings of this chapter (section 4.5 and 4.6) provide the answer to research question 1.

A design concept will be generated in the next chapter (section 5.1) for a location-based story in AR considering the visual elements and patterns found from the comparative study to answer research question 2. Some elements are selected based on the frequency of their occurrence in the map/application samples to be used in the conceptual design. It is important to note that the aim is not to find one overall winner from the categories but to find a set of elements considering the criteria based on the purpose of implementation. The selected elements are summarized and listed in Figure 5.1 as a part of the conceptual design development process (section 3.3.1).

As a next step, a usability evaluation will conducted (section 5.2) to test the developed conceptual design with actual user feedbacks in order to answer research question 3.

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Chapter 5
Case Study

Chapter 5 describes the complete process of the case study phase of the methodology (section 3.3). As a first step, the conceptual development of the mockup designs of an AR application for a selected location is presented in section 5.1 and afterwards the user evaluation study for the mockups in presented in section 5.2. The results from the user evaluation are also discussed in the end of the chapter.

5.1 Conceptual development

The conceptual development of the design mockups was constructed initially on the basis of the results and patterns found in Chapter 4. The process starts with selecting visual and non-visual elements for the AR application based on the comparative study, followed by selecting the case study area and developing the mockup design.

5.1.1 Selection of design elements

Considering the findings from the comparative study, the following elements (Figure 5.1) were selected to design the mockups from the three categories mentioned in section 4.3. For tourist related information, the elements were selected separately for visualizing the points of interest (POIs) and their description or story. Also, for route visualization, the type of guidance (section 4.5.2) was considered. The elements were then grouped into two classes. The primary elements class consist of the ones that appear the most combining all three media. The secondary class contains the ones that appear the most in any one medium and also the ones that appear in all three media in a significant number. Two elements (with red exclamation points) were excluded in the end as they did not seem to have a purpose in the case study.

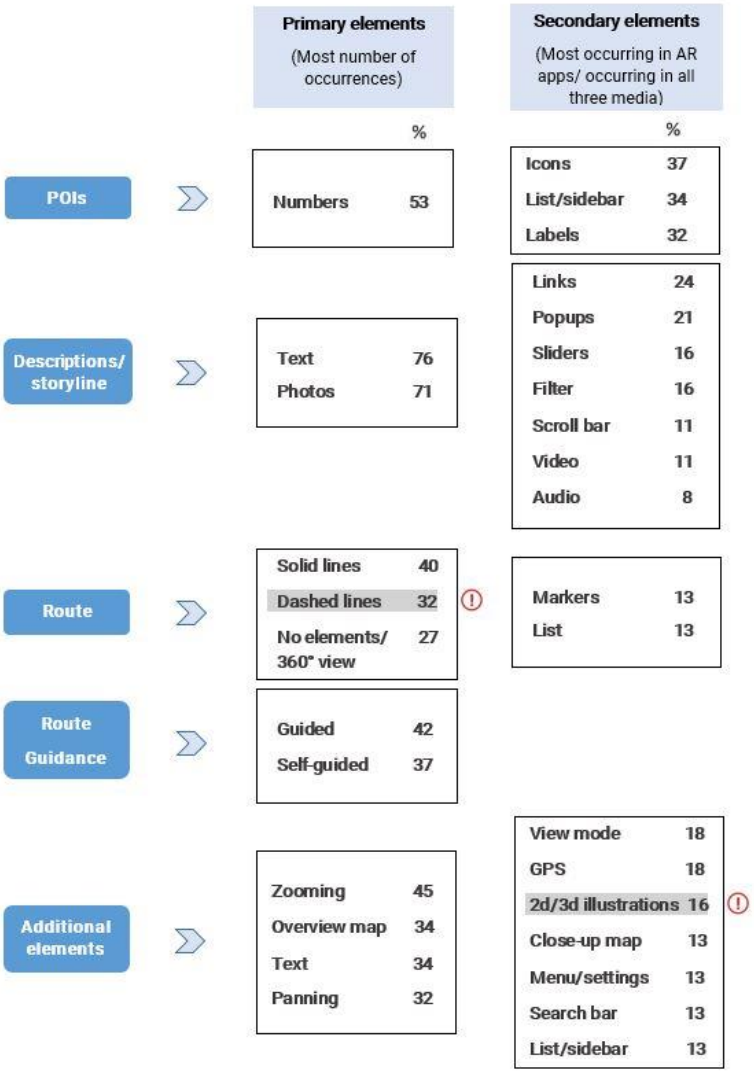

Figure 5. 1: Selection of elements for mockup design

5.1.2 Case study area

To prepare the design concept, the main campus of the Technical University of Munich (TUM) was chosen as the case study area. TUM is one of the leading universities of Munich and a place of interest for both students and tourists. It is Germany's second-largest technical university with research sites on four continents, with 15 departments, 177 degree programmes, more than 40 thousand students. It's a member of the TU9[9], a society of the most notable German institutes of Technology, and has been a "University of Excellence" since 2006. Currently, it has more than 60 English-taught programs making it an ideal destination for international students (currently, 27%). Other than supporting advanced research, innovation and startups, TUM also has high influence behind Bavaria's status as a high-tech hub. (*https://www.munich.travel*)

Apart from academics, TUM has a glorious history of more than 150 years which makes it an interesting place for tourists to visit. The university was founded by King Ludwig II in 1868 as the "Königlich-bayerische Polytechnische Schule" (Royal Bavarian Polytechnic School). Its purpose was "to bring the igniting spark of science" in rural Bavaria. From 1877 onwards, it evolved as the Technical University of Munich (Figure 5.2). From Carl Linde's discovery of cooling machine (1975), forerunner of refrigerators, to breakthroughs in mapping Alpine glaciers (1892), discovering new form of matter "quantum gas" (1995), observing nerve cells in the brain (2015), and winning the Hyperloop Pod competition for two times (2015 & 2017), TUM has given birth to many stories in the world of science. (*https://www.150.tum.de*). On top of that, TUM is the only university in the entire world that has its own beer, something that is constantly found fascinating by locals and visitors (*https://www.munich.travel).*

Figure 5. 2: New Polytechnic Building, 1877 *(Source: Neubau und Neureuther-Renaissance 1868-1882)*

Figure 5. 3: Main entrance of TUM, Arcisstraße (Source: Kunstareal Munchen)

[9] https://www.tu9.de/en/ (accessed on 19.03.2021)

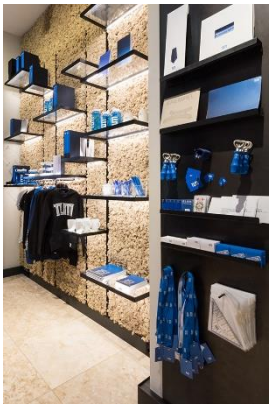

Figure 5. 4: TUM shop

Figure 5. 5: Audimax (the largest lecture hall, TUM)

Figure 5. 6: Inside/out pavilion (inner yard)

5.1.3 Mockup development

This section focuses on developing an interactive mockup of an AR tour app for the TUM main campus as a next step to visualize the conceptual design (Figure 3.1). First, the initial idea of a mobile AR app is generated to give the students and tourists a tour of the campus. Four locations are selected (as a subset) for the mockup design: POI 1: main entrance (Figure 5.3), POI 2: TUM shop (Figure 5.4), Audimax (Figure 5.5) and the Inside/out pavilion (Figure 5.6). The AR app is intended to be used on an android device so the users can go to the locations, scan them with the camera (preferably with marker-based tracking as the buildings seemed to be too close to the camera to adjust the field of view) to identify the locations and see the information/story about them on the screen. The app will also show them the route to the next locations as part of the recommended tour and use map views where necessary (more details in the next sub-section).

5.1.3.1 Wireframing

The first draft of ideas and sketches (wireframes) were designed manually. Each frame was designed taking into consideration the selected elements from section 5.5.1. The wireframes shown in the next sub-sections correspond to the skeleton of the app. The frames, functionalities and their relations are explained along with the used elements.

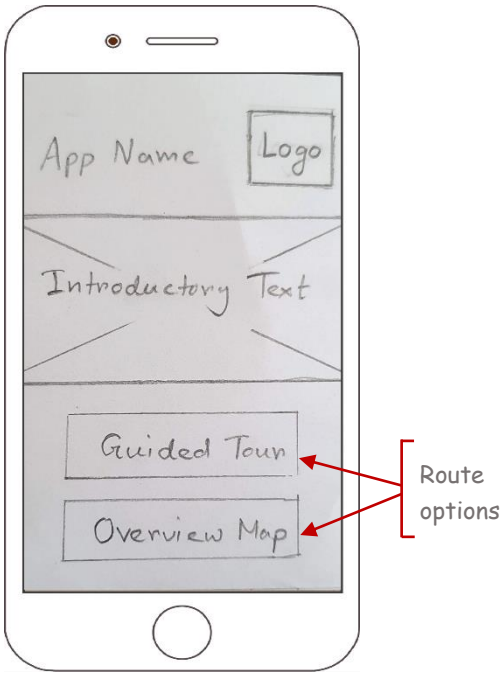

Figure 5. 7: Opening screen

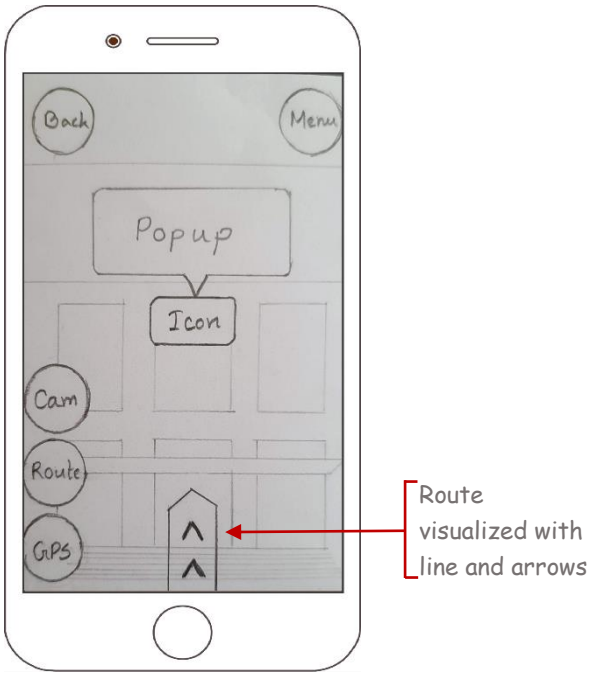

Figure 5. 8: Guided tour

Route visualization

Route visualization being one of the most important functions for the tour app, it was considered in the beginning what kind of route guidance should be provided in the app. Since both the guided and self-guided options were quite close in popularity, 42% and 37% respectively (section 4.5.2), it was decided to have both options for the users and arrange the elements accordingly (Figure 5.7).

Guided route

In the guided tour option, the user is given a tour of some selected important places of the campus by the app itself. This function follows a linear route direction such as a real-life guided tour. The AR tour starts from POI 1: the main entrance and takes the user from one point to another by showing a route line on the display, so it combines the solid line and the 360 camera view (Figure 5.8). Once the user reaches the next point of interest, they should see an icon on the screen using the AR functionalities that would be placed on the point of interest where they can click and see a popup with introductory information. The names of the POIs as well as other spots inside the camera view will also appear on the screen.

Self-guided routing

The self-guided tour is designed with an interactive overview map, for the user to choose their place of origin and destination pointed by markers and numbers on the map (Figure 5.9). Once the locations are determined in the map, the user can go to the route option and either search or type the names of the places and the route line (same as the guided option) will be shown again (Figure 5.10).

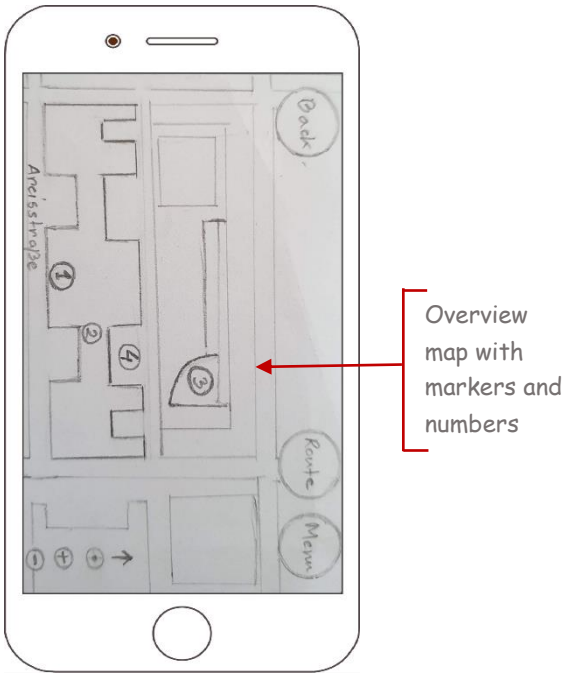

Figure 5. 9: Self-guided tour

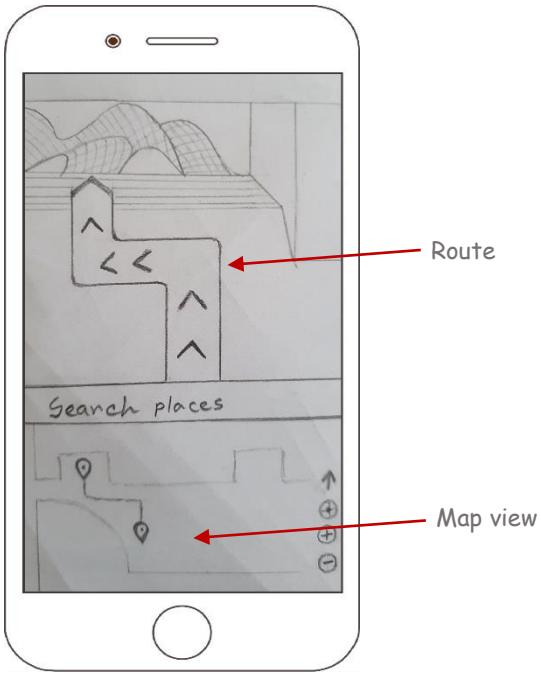

Figure 5. 10: Route with close-up map

Story visualization

The format of visualization of the story or information provided on each POI are kept in the same format for both guided and self-guided options. In the popup window the user can choose to learn more to be directed to the story page. Multiple elements were selected for conveying the story to give the user a whole experience with options that might be interesting for different user groups such as text, photos, audio, video and website links (Figure 5.11 and 5.12). The sliders and scrollbars were used as supporting elements as like in the web maps (section 4.5.1).

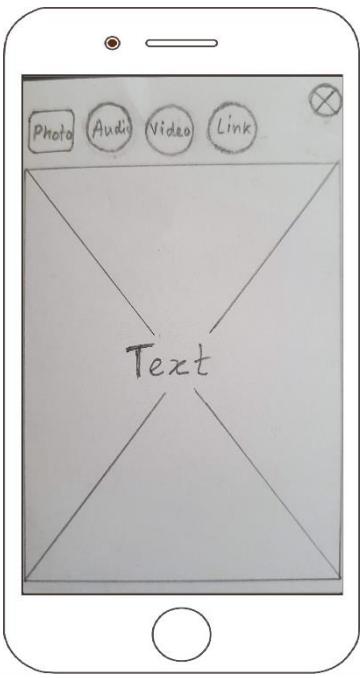

Figure 5. 11: Story page

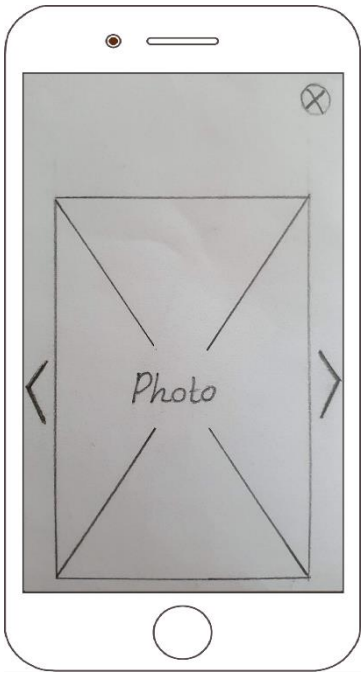

Figure 5. 12: Photo page

Use of maps

Other than the overview map, a static map is used in the beginning of the guided tour to show the building structure and the starting point of the tour which is the main entrance (Figure 5.13). A GPS location button is placed on the information display so that the user can be aware of their current location on the map at each point (Figure 5.14). Additionally, a close-up map view of the surroundings (as found both in paper and interactive maps) was added in the same display with the route visualization (Figure 5.10). This was placed only in the self-guided route as an experiment to check the users' reaction on both visualization designs.

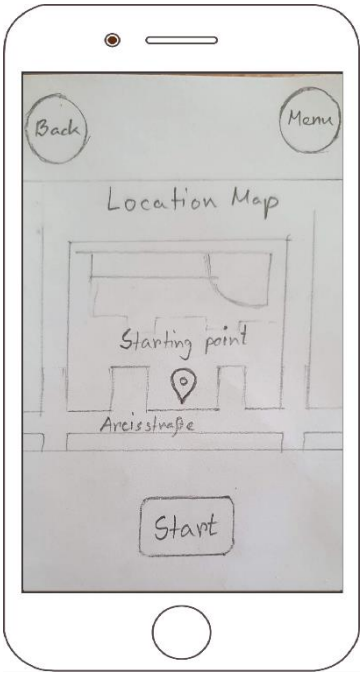

Figure 5. 13: Starting point on the map

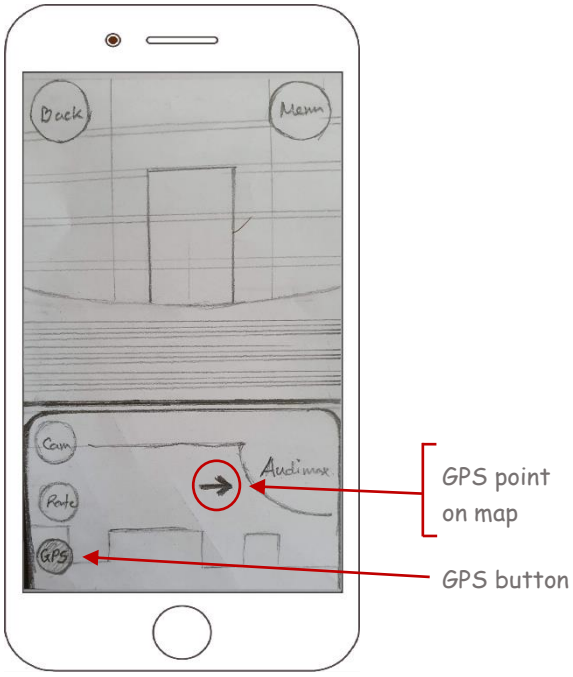

Figure 5. 14: GPS location on the map

Additional information

As an additional support and assistance to navigate the app, a menu button is included for every display that included options as homepage, settings and help. A list of the places that could be visited is also included here for the user to be able to choose from including search options and a filter option for different types of POIs (Figure 5.15 and 5.16).

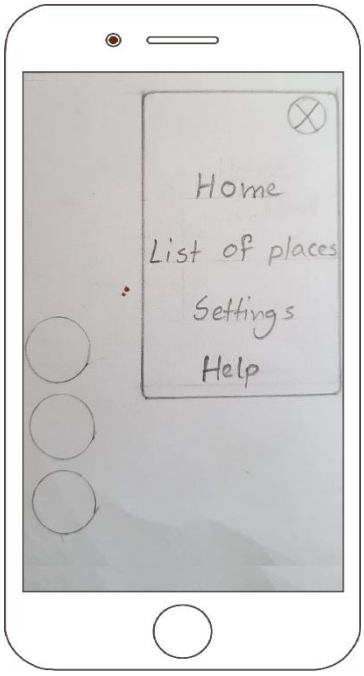

Figure 5. 15: Menu options

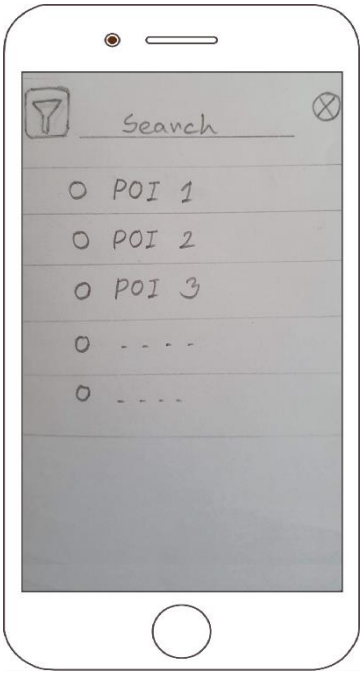

Figure 5. 16: List, search and filter options

5.1.3.2 Choosing color palette

Before designing the interactive version of the mockup, a color palette was ascertained. Color is a crucial element for a user friendly app interface not only for increasing aesthetic values but also for giving the users an idea of the purpose of the app at the first glance. Colors play a huge role in how the audience perceives the information and functionalities provided and to evoke emotional responses from them. The major two colors chosen for the app mockup are blue and white as they resemble the official school colors of TUM and it is a relatable and inspirational factor for all the students and staffs. The color combination being very pleasant and cool-toned, it seemed like a logical choice for a tour app for the outsiders as well. Different shades of blue were used to give the users an easy-on-the-eye feeling. Black color was used for texts to give a proper contrast with the background and it appears to be a standard color for text in maps and applications analyzed in the comparative study (section 4.6.2). Grey was chosen as the background color to keep the harmony among all the colors.

Warm colors were used as a contrast to symbolize different categories of places on the map and in the filter option (Figure 5.27 & 5.33). Since no visible pattern was found for choosing colors for POIs in the reviewed samples, the colors that were mostly occurring in the samples (section 4.6.2) were assigned to different categories. Red being the most favorable color for highlighting important places (section 4.6.2), was chosen for entrance points (POI 1: main entrance) and GPS location on the map. The lecture halls (POI 3: Audimax) were assigned dark blue color considering the department logo colors (blue and white) and contrasting with the background colors. Green was assigned for outdoor spots (POI 4: Inside/out pavilion) keeping a connection to nature and following printed maps. For shops (POI 2: TUM shop), purple color (used in multiple samples for different POIs) was chosen. The other colors: brown, orange and yellow (section 4.6.2) were assigned more freely for libraries, monuments and cafes as examples to complement the color palette and background (Figure 55.31 & 5.32). Considering the novelty and complicated functionalities of the AR environment, the variation was kept to a minimum to keep the interface simple for all kinds of users.

Table 5. 1: Elements used for interactive mockup design

Font used		Color used	
Logo/app name	Bradley Hand ITC	App & map background	Blue, white, grey
Headings, Buttons	Papyrus	Icons	Blue, white
Instructions, POIs, story text, menu options, photo captions	Maiandra GD	POI categories	Red, dark blue, purple, green, brown, orange, yellow
Icons used		GPS/location point	Red
Route button 	Photos 	Text (story and instructions)	Black
GPS button 	Audio 	Button text, labels, popup text	Blue in white background
Scan button 	Video 	Route (AR line)	Blue and white
Popup icon 	Links 	Route (map line)	Red
Go back 	Filter 		
Menu 	Marker (map) 		

5.1.3.3 Data and materials used

The pipeline for data processing for the mockup design shown in Figure 5.17. In order to transform the sketches into interactive mockups, colors, fonts, symbols, texts, images, audio and videos are added to shape the mockup wireframes (Table 5.1).

For displaying the background of the AR view, photographs were taken at the TUM main campus using an Android device[10] to use as an indication of the real-life view of the places through the camera. All displayed maps were styled using Mapbox Studio[11], where the layout, scale, color palette, the amount of details and measurements were executed. Both the maps and the photos were exported and saved as image (JPG) files. The images were edited while experimenting with different values of saturation, opacity, and filters to achieve a better understanding of the displays using Adobe Photoshop. The buttons, icons, logo and story pages for the app were designed using Adobe Illustrator keeping the color palette (section 5.1.3.2) in mind.

Afterwards, the images were imported to Illustrator to add layers of information and icons on the images. The text and photo contents of the story pages were collected from several websites such as the official website of TUM[12], the TUM – 150 years culture of excellence[13] and Wikipedia[14]. Two videos were found on YouTube and an audio file was recorded and uploaded using sound cloud. Additionally, to give the users the feeling of walking in the campus using the app, gif files were created to show the route from one point to another on an online platform gifmaker.me. For this, multiple photos were taken from 2-4 meters distance on the actual routes. All the images were uploaded in the Marvel App[15], an online interactive prototyping platform where the transitions and animations between the displays have been added and the audio, video have been embedded to give the users the feeling of using a real app.

[10] Samsung Galaxy S10+
[11] https://www.mapbox.com/mapbox-studio (accessed on 19.03.2021)
[12] https://www.tum.de/en/ (accessed on 19.03.2021)
[13] https://www.150.tum.de/en/ (accessed on 19.03.2021)
[14] https://en.wikipedia.org/w/index.php?title=Technical_University_of_Munich&oldid=1012771472 (accessed on 19.03.2021)
[15] https://marvelapp.com/ (accessed on 19.03.2021)

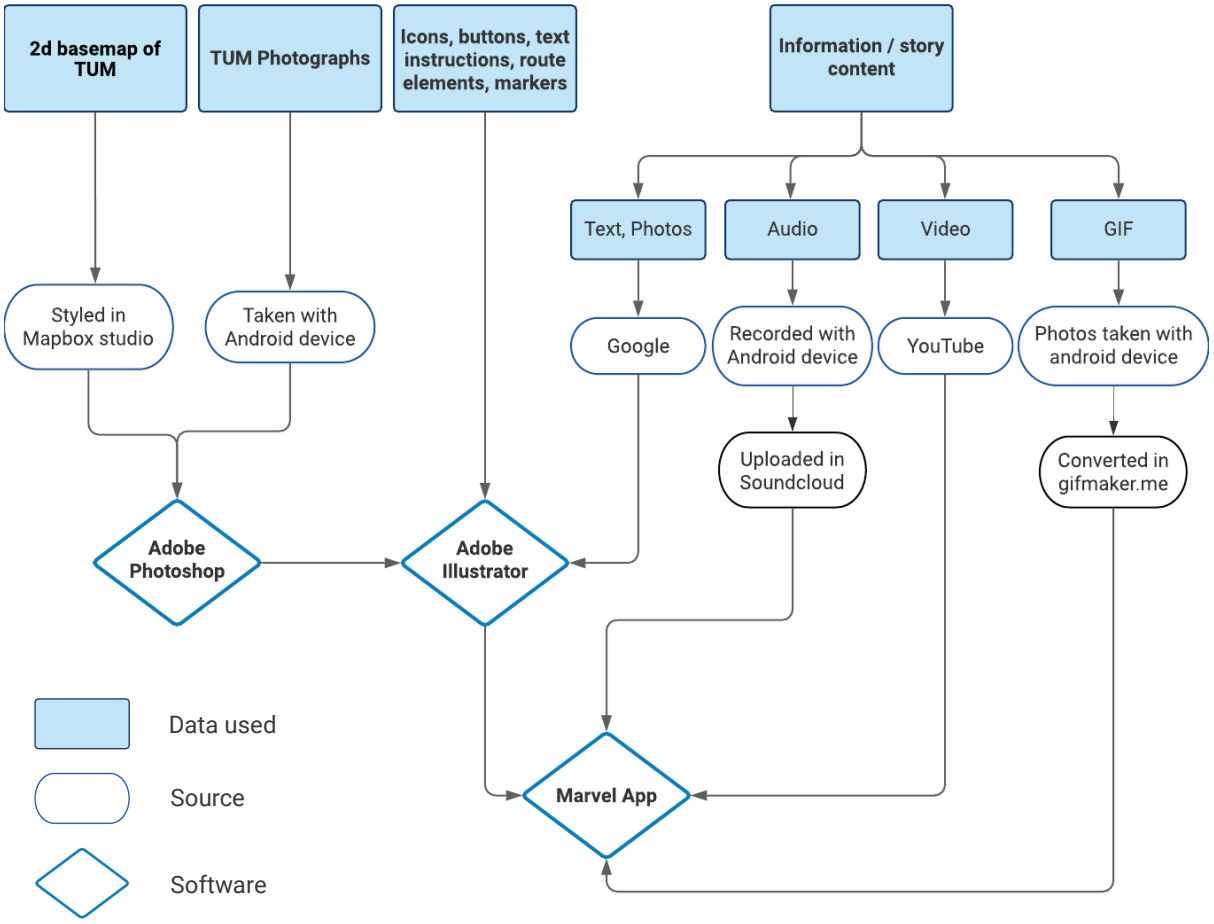

Figure 5. 17: The workflow of the mockup design

5.1.3.4 Mockup design

The narrative structure of the mockup including the displays that users can access and the navigations between them is described in this section. The Marvel mockup prototype consists of 63 screens and can be accessed through the following link:

https://marvelapp.com/prototype/5id96e9/screen/77192298

Homepage

The homepage is the first screen that appears after opening the app (Figure 5.18). The name of the app and the logo are placed on top followed by an introductory text and brief instructions on the buttons below. Two buttons follow stating “Start the tour” and “Choose from the map” taking the users to the guided and self-guided tours respectively.

Starting the guided tour

After clicking the first option, the user can see a static map pointing to the first location from where the tour starts (Figure 5.19). After reading the brief text instruction the user can press “go” to open the camera view. Here, the user is supposed to move their phone for the camera to be able to identify the point of interest (Figure 5.20).

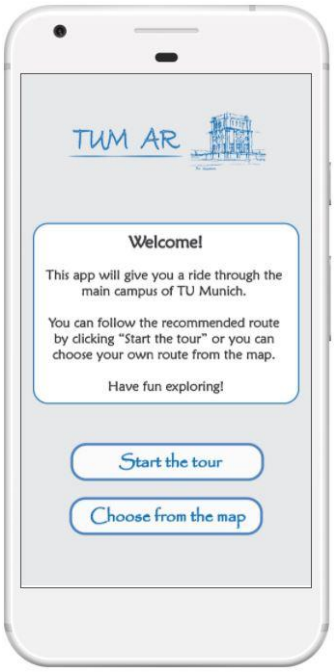

Figure 5. 18: Homepage

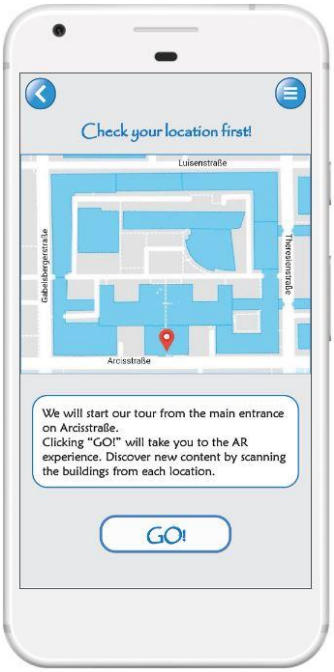

Figure 5. 19: Starting the tour

Figure 5. 20: Camera view

Information page

After the camera scans the surroundings and identifies the building, an icon appears pointing on the particular buildings or POIs. A popup window opens from clicking on the icon consisting a short text introducing the POI to the user and provides an option to learn more about the spot (Figure 5.21). Choosing "learn more" opens the story page of the app (Figure 5.22) where the user can read the text information. They can select the image icon to see photos of the POI. They can also choose to hear the story from the audio option. The other two icons take them to the video and website links respectively. In the image page (Figure 5.23), the user can slide though the photos of the POI from different times and/or viewpoint (inside and outside).

Figure 5. 21: Popup window

Figure 5. 22: Story page

Figure 5. 23: Images

Route button

The first of the three buttons placed at the left bottom corner of the apps turns on the route visualization that guides the user to the next point. It is shown with a gif in the mockup with a blue line with white arrows appearing on the screen giving directions (Figure 5.24). In the real app, the line should be aligned with the actual path shown on the camera view (as shown in the mockup). The user can walk following the line direction at their own pace. The line stops with an arrow pointing to the next destination as soon as the user reaches an approximate distance to the destination and the popup icon appears again (Figure 5.25). Two routes were included in the mockup version from the main entrance to TUM shop and from TUM shop to Audimax as examples (shown in the Marvel App link).

Figure 5. 24 Route (starting point)

Figure 5. 25: Route (ending point)

"Choose from the map" button (the self-guided route)

Choosing the map option from the homepage opens a map with all the POIs pointed with markers and numbers (Figure 5.26). Clicking the markers open the camera view and provides information on the selected POIs in the same format as the guided tour. The only difference between the guided tour and the map option (self-guided tour) is the user has the freedom to choose the points and do not have to follow a linear route. Clicking the route button in this self- guided tour will ask the user to insert the starting and ending points that can either be typed by the user in the search bars or can be chosen from the suggestion list given by the app based on their GPS location (Figure 5.27). After giving the locations the app will start showing the line for the route again on the display so the user can follow. At the same time, a map with an overview of the route and the distance to be covered is also shown in the bottom half of the screen. The map will also show the updated real-time location of the user with the direction they are facing as they move (Figure 5.28).

Figure 5. 26: Choose from the map

Figure 5. 27: Search location

Figure 5. 28: Route with close-up map

GPS and scan button

The second button of the group opens a map showing the current location of the user at any given time with functionalities for zooming and panning and a compass (Figure 5.29). The scan button help the user to connect to the AR view in case of poor connection caused by internet or indoor navigation with GPS (with both online and offline version) and to scan the surroundings again to retrieve information, same as Figure 5.18.

Figure 5. 29: Map with GPS location

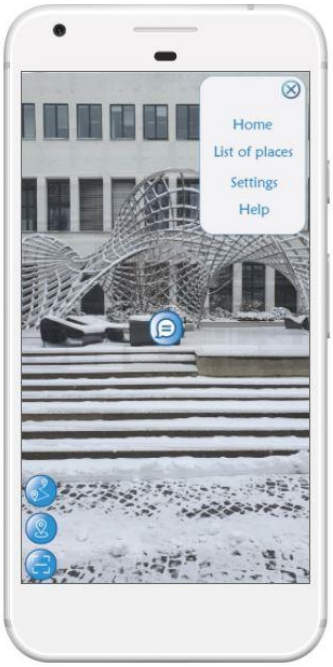

Figure 5. 30: Menu Button

Figure 5. 31: List of places

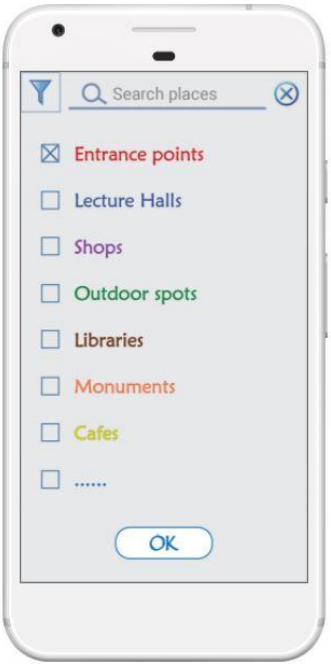

Figure 5. 32: Filter option

Menu functions

The menu button is places on every display of the mockup (Figure 5.30) which consists of the options: homepage (to go back to the first screen), list of places (an overview of the POIs), settings (to customize general app settings and help (to find guidelines to use the app and understand icons and terminologies). The settings and help functionalities were not included in the mockup (although explained verbally to the participants of the user study in the later section) as they are similar in all mobile applications by default. The list of places contains all the POIs of the tour sequentially along with a search bar (Figure 5.31) and a filter option to choose different categories such as libraries, cafes, etc. (Figure 5.32).

Interactivity options and limitations of the mockup

The final step consists of uploading the sketches of all the pages in Marvel App in order to create an interactive prototype of the mockup. Marvel App is an online collaborative design platform for prototyping. No prior coding knowledge is required to create a high-fidelity mockup. The platform offers some automated tools for creating animations and transitions between screens such as clicking and dragging on a specific spot inside a frame creates a design hotspot. The designer can then select another frame to connect the hotspot with. There is a list animation tools provided for screen transition like fade, push right, flip, etc. Additionally actions that trigger these transitions can be chosen by the designer such as click, hover, swipe, etc. as well as a timer can be set for changing from one screen to another. However, some limitations are faced in the Marvel App while making this mockup. The ability for the user to navigate through the map, to zoom in and out, to pan, to see the current GPS location and to move the camera view and scan the surrounding building to get the real-time AR experience was not possible. These limitations needed to be explained in details to the participants while conducting the usability evaluation (section 3.3.2) in the next section.

5.2 Usability evaluation

The usability evaluation was conducted in order to select the visualization elements that are appreciated and required by the users for the AR app to assess the usefulness of the proposed mockup designs for students and tourists.

5.2.1 Materials used

The evaluation was done via Zoom video conference since it was not possible to perform the interviews in person at the campus due to coronavirus regulations. The audio of the conversations were recorded using a personal android device. All the participants were emailed with the information about the duration and structure of the study and asked to sign a statement of consent before the interviews (Appendix D). The interviews were carried out in a semi-structured format including an interactive conversation, answering pre- and post-study questions and mockup demonstration from the Marvel platform using screen sharing in Zoom from both sides.

5.2.2 Interview structure

The interview consisted of four sections (Appendix D) as shown in Figure 5.33. First, some demographic data related to the user's age, sex and location was collected along with their familiarity with the TUM campus and AR applications. Then, a brief discussion was done about the fundamental ideas behind AR technology and to gather some general perception and requirements from the participants' side before seeing the mockups. The third part consisted of the supervised interaction with the Marvel mockups using a think aloud process to record user reactions. This was followed by a feedback session consisting of 8 open-ended questions to collect their opinions and comments on the mockup design.

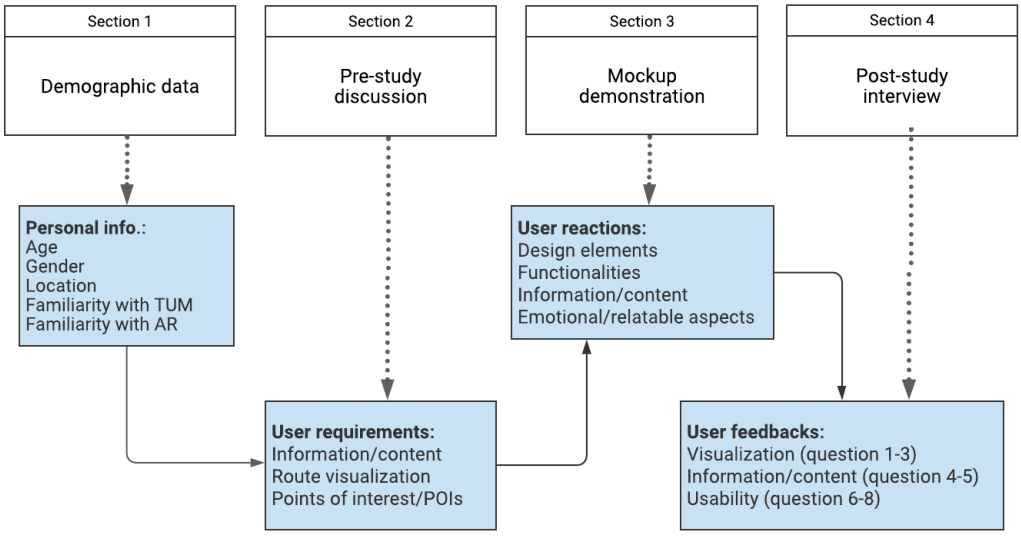

Figure 5. 33: Structure of the user evaluation interview

The feedback session consisted of three categories of questions: visualization requirements (question 1, 2 and 3), information requirements (question 4 and 5), and usability requirements (question 6, 7 and 8). The first category investigates the selection of proper visual elements for the app in general, for the

route and for story visualization. This section is crucial for confirming the effectiveness of the elements chosen from the comparative study to design the mockups. The visual elements should be intuitive and easy to understand so that the information is properly communicated to the users and they can relate to the story. The second category investigates the requirements for content and information to be provided in the application. Since the purpose of the application is to tell a story about the place, the content needs to be comprehensive, representative and meaningful for the user so that it is informative and engaging at the same time. The third category investigates the usability scenarios for the real-life application of the mockup designs. The participants are asked to share their personal opinions and preferences on using such kind of AR applications.

5.2.3 Pilot Study

Before commencing the user evaluations, two pilot tests were conducted. This was important to check the feasibility and to fine-tune the user test before the full-scale implementation. Potential problems and technical difficulties were identified during these tests and mitigated. The tests also allowed to check if the questions and instructions were clear enough for the user and to determine the time required for the interviews.

The first test was done with an expert from the Cartography Chair of TUM who is proficient in AR and highly familiar with the TUM main campus. For the second pilot test, it was necessary to choose a non-expert to represent the tourist group. Hence, the chosen participant was not an expert in AR or cartography and not at all familiar with the campus. The following issues were discovered from the pilot tests:

- The main issues was that the audio function was not functioning in the story/information display, so it was uploaded again and connected to the mockup for the user tests.
- The buttons on the screen (route, GPS and scan) needed to be re-arranged according to their importance or assigned different colors for better understanding which was also done afterwards.
- It was suggested to add a tool tip for the buttons to make them more understandable for non-cartographers as well (not realized for user tests).
- In the second task for the self-guided route from Audimax to Inside/out, the route visualization seemed to be starting too fast to acknowledge. Either a timer needed to be added before starting the route or the time between choosing the destination and starting the route needed to be extended. The latter was adopted.
- It was also discovered that the instructions for each task should be given in the beginning of that particular task so that the participant does not forget the important part such as names of the locations.

The pilot studies took 40 minutes and 52 minutes to complete. This information was used to inform the participants and also for planning the user study, especially on how much detailed information should be given and how to instruct the experts and non-experts during the tasks.

5.2.4 Participants

For the usability test, the participants were initially chosen randomly from two groups: TUM students and tourists. For the student group it was also considered that there were both cartographers (expert group with a high understanding of maps and augmented reality) and non-cartographers coming from different study backgrounds. The non-cartographer group included 2 students of different faculties of TUM and also from outside of TUM. The non-experts or tourist group consisted of people working in various fields. Initially, 26 participants were approached with a focus on their geographic (Figure 5.34)

and professional (Figure 5.35) variation to get a wide range of different perceptions. 4 of them could not join the usability evaluation due to the differences in time zones and scheduling problems. The interviews were successfully conducted with 22 participants from 16 countries who were between 26 and 36 years old.

Figure 5. 34: **Geographic location of the participants**

Table 5. 2: **Demographic data of the participants**

Information		Percentage
Gender	Male	45%
	Female	55%
Age	<26	0%
	26-30	86.50%
	30-35	9%
	36-40	4.5%
	>40	0%
Familiarity with TUM	Familiar	45%
	Not familiar	55%
Familiarity with AR	Familiar	50%
	Not familiar	50%

There were 12 female (55%) and 10 male (45%) participants (Table 5.2). 45% of the participants were familiar with the TUM campus and among them 8 were cartography students from TUM while 2 are from other faculties. From the tourist group, there were 2 PhD students, 1 MSc. and 1 diploma students from other regions and the rest come from different backgrounds and professions. There was an even balance regarding the participants' familiarity with AR with half of the participants (7 cartographers and 4 non-cartographers) having prior knowledge and/or experience with the technology and applications.

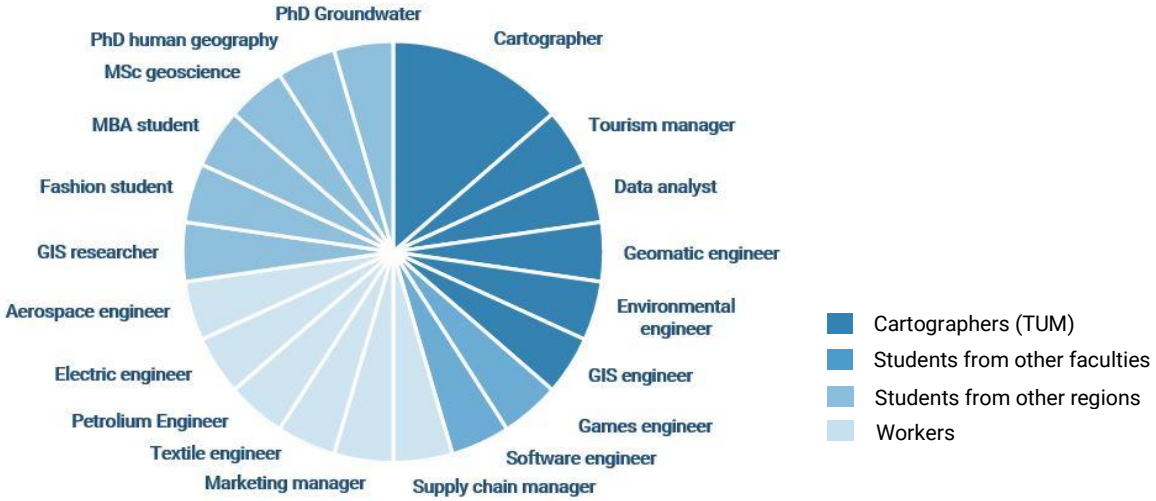

Figure 5. 35: **Background of the participants**

5.2.5 Interview execution

The interviews took place between the 31st of January and 7th of February 2021. In general, there were no major problems concerning the research methodology other than some minor short-term technical problems such as poor network connection and accessing Zoom and Marvel website for some regions, especially China and Bangladesh. As mentioned in section 5.2.2, the research data acquired from the usability test contained four types of information: demographics (results already discussed in the previous section), pre-study discussion, mockup demonstration and recording audio and post-study questionnaire. The complete interview structure can be found in Appendix D.

The introductory information including the limitations of the mockup demonstration was kept the same for all participants. For participants who did not have much idea or experience with AR, were provided with some basic concepts and shown one example, a brief 20-30 seconds YouTube video on the Buenos Aires Travel Guide AR, one of the selected applications of the comparative study (sample no. 37, Appendix A). This part was skipped for the experienced users. After that, the participants were asked about their requirements as a user of a travel or guided tour app in AR. The goal was to collect their unbiased opinion before interacting with the mockup.

In the beginning of the mockup demonstration, the participants were given a link to the Marvel website and asked to share their screen while interacting with the mockups. They were asked to think aloud throughout the process to find out their reactions (both eases and difficulties) about the visualization and then given explanations about each design element at every step. After the demonstration the participants were asked some questions in order to get their feedback. The questions were related to the design elements, story elements and overall usability of AR tour apps. This helped to achieve the research objectives and even provided useful insight for future improvements.

5.2.6 Resulting materials

The thinking aloud of the participants during the mockup demonstration and the discussions before and after were captured in the audio recordings and had provided rich qualitative data. The length of the recordings varied greatly ranging from 30-70 minutes per person. The acquired data from the

recordings were transcribed using *temi.com*[16] which an online platform for automatic text to speech conversion. Due to the difference in accents, background noise and in some cases poor network connections, the automated transcripts were not of a high quality. They were then checked and corrected manually and the data was coded afterwards. The transcription results can be found in Appendix D. User requirements (Table 5.3), think aloud protocols with important actions and errors (Table 5.4), feedbacks and additional suggestions (section 5.2.7.3) were categorized for each test person to organize the collected data for the next sub-section.

5.2.7 Evaluation results

5.2.7.1 User requirements evaluation

The participants were asked to imagine (using their previous knowledge of AR and the given information in the beginning of the interview) what kind of visualizations they would prefer while using an AR app for exploring through a place such as a touristic place or a campus. They were specifically asked about the information contents they would like to have in the app, the visualization of points of interest and the route guidance including the starting and ending points. The categorization of the requirements was determined by emerging themes and verbal expressions from the interviews. The summarized responses are shown in Table 5.3.

The research data were grouped into 5 categories: information/content, POIs, route visualization, starting and ending points and storytelling elements. When asked about what kind of information or content the participants would like to have in an AR tour app, most of them said things that "*it is subjective and there should be all kinds of information for all kinds of users in an ideal app*" and "*it's just nice to look at something that does the thinking for you basically*" which suggests multiple categories or types of tours directing to different user groups. Nevertheless, the top three picks were to see the points of interest around and their types (77%), the route/direction to the POIs (64%) and historical facts about the points (50%). As a visual element to represent the POIs, in total 72% mentioned pointers but 27% specifically mentioned that the pointer should also symbolize the types of the places which indicates icons.

For route visualization the most favorite element was arrows (59%) for reasons like they are simpler, small on the screen and give the sense of right and left. Some of the participants also mentioned having a combination of two elements such as having arrows with a line (14%) or audio (9%) or an avatar (9%). The indication of starting and ending points were somewhat unclear overall as they mostly depended on the participant's choice of route elements. Multiple elements were suggested by each participant for storytelling, text (73%), photos (64%) and audio (41%) being the most popular. Some additional although interesting comments were made such as 3 participants wanted to able to change the language, 1 suggested adding an AR translator and 1 asked to make the app like a game or quest.

5.2.7.2 Mockup demonstration

Before starting the mockup demonstration, the participants were given a brief overview of the whole process. The possibilities and limitations (differences from the real-life application) of the Marvel prototype were explained. Afterwards, a link of the Marvel app prototype was sent via Zoom. The participants were asked to share their screen so that their interaction could be monitored.

[16] https://www.temi.com/ (accessed on 21.03.2021)

Table 5. 3: Requirements mentioned by the participants and their percentages with selected quotes

	Preferred elements	Participants	Quotes
Information / content	Types of POIs	77%	*"to know the type or the category like this a museum or a monument"*
	Direction/route	64%	*"I would like the possible routes and also which ones are the fastest or shortest"*
	Historical facts	50%	*"like when it was established, who has been here, what happened here or what changes it has gone through"*
	Emergencies and facilities	41%	*"tell me the opening hours, emergency places like hospitals around, restrooms, exits, information desk, maybe a restaurant or mosque"* *"I'd look for weather, ATMs, where the closest transport is, where to buy tickets"*
	Interesting facts	36%	*"some small descriptions probably, why is this popular?"*
	Overview map	23%	*"So, first locating them. Because as a traveler, I don't know where is what"*
	Activities	23%	*"what's inside the building, what experience can I have"*
	Names / labels	18%	*"to see the names of the buildings like what it is…but only names"*
	Real-time info.	14%	*"show like how many people are inside, especially with corona and everything"*
Points of interest (POIs)	Markers/pin	45%	*"And they might have some effect, like a blink blink, could be better. Right?"*
	Icons (type of POIs)	27%	*"this is what's coming in my mind that there will be a small button popping up…some key words like, like, there is a temple there"* *"maybe a round shaped neon colored button telling me like it's a museum or so"*
	Audio	18%	*"It can say there is a building to your left in 200 meters or something"*
	Labels/text	18%	*"When I'm close to a point of interest, like any other mobile notification, like getting a message, there will be a blip that you have arrived"*
	Map (points)	18%	*"if I have the map I can just look where are the places"*
Route visualization	Arrows	59%	*"I need the app to tell me whether I should go left or right I'm always confused"* *"I want something simple on screen that doesn't move too much or I get dizzy"*
	Line	36%	*"a simple line on the floor should be enough"*
	Audio	27%	*"The audio one would be less messy for the visualization"*
	Avatar	14%	*"an avatar you can interact with, I think it's interesting so it's not monotonous!"*
	Map (animated)	14%	*"Maybe something like a 2.5D visualization…when I am moving the map is moving with me in the same direction"*
	Distance	14%	*"Like you have 7 meters to go…"*
Starting & ending points	Arrows	27%	*"it can be with line with some arrows pointing…"*
	Markers/pin	23%	*"just like a pinpoint or something!"*
	Audio	9%	*"it could be like okay, you're here or you have reached the destination"*
	Labels	9%	*"the text might give only the name of that point of interest"*
	Search/select	5%	*"I will give the starting point to the app, not the app will give me a starting point"*
Storytelling elements	Text	73%	*"And written forms because, sometimes we want to hear the ambience around"* *"maybe that you can't really find from history books like something only the locals would know that that's special"*
	Photos	64%	*"like that's mandatory, a couple of pictures you can swipe…"*
	Audio	41%	*"because when you are traveling somewhere, it's really hard to just look at your phone and read, it kind of gets boring."* *"the best way I think, to have it spoken in your ear while you, uh, looking through those pictures, with a female Australian accent!"*
	Video	18%	*"for specific (indoor) places maybe a video that I can sit and watch"*
	Timeline	9%	*"So maybe in the bottom of your screen, you could see some pictures and caption with the timeline that'd be cool!"*
	Website links	5%	*"I'd put a link to the official website"*
	Infographics	5%	*"maybe graphs…with some statistics…"*
Additional suggestions	Language	14%	*"if it's possible to have different languages, if you are in a foreign country or so"*
	Game/quest	5%	*"So if I'm In the middle of TUM and the voice says like can you find the building from the 1920s? Walk towards it, walk fast!"*
	Translator	5%	*"you know, I focus the camera there and everything is translated to English"*

All the participants were then given two of the same and sequential tasks:

i) to follow the guided tour using “start the tour” option starting from the Main Entrance (POI 1) to TUM shop (POI 2) and then to Audimax (POI 3)
ii) use “choose from the map” option to go from Audimax (POI 3) to Inside/out pavilion (POI 4)

As the demonstration was conducted virtually, participants that were not familiar with the campus were given a hint of what and where the locations are. The whole process was highly interactive with the author explaining every step of the demonstration. They spent from 15-20 minutes on average on the interacting with the mockup designs.

From the video interaction and the transcribed recordings, the qualitative data were extracted and coded. Table 5.4 shows the strongest and weakest aspects of the mockup based on the reactions and verbal expressions of the participants.

Table 5. 4: User reactions from the mockup demonstration

	Strong aspects	Number of participants	Weak aspects	Number of participants
Design elements	Route visualization (line)	7	Popup icon	6
	AR route (line) + map view	7	**Route button**	5
	Use of maps	5	Text alignments	4
	Story elements (icons)	4		
	Route button	5		
	Color	5		
Functionalities	AR view	12	Identifying route button	7
	List and filter	12	**Guided and self-guided options (unclear)**	5
	Guided and self-guided options	8	Location map (GPS required)	4
	Overview map	8		
	AR route (line) + map view	8		
	Route visualization (AR)	8		
	Popup window	8		
	Audio	7		
	GPS (map)	7		
Content	Story/information	8	Website links	3
	Text	8		
	Photos	6		
	Video	3		
	Maps	3		
Emotionally relatable aspects	Photos (relatable, curiosity)	16		
	Route visualization (interesting / exciting)	9		
	Familiar places	7		
	Color (relatable, soothing)	7		
	Background/story	6		
	Font	2		

5.2.7.3 Post-study interview

To further investigate the user preferences and to gather more information regarding particular parts of the mockups, a post-session semi-structured interview was performed. The participants were asked to answer eight questions, but they were also encouraged to add more comments related and unrelated to the standard questions. The answers of the questions are presented sequentially below.

Question 1

First, the participants were asked about their overall impression regarding the i) overall satisfaction with the mockup design, ii) intuitiveness/clarity and iii) design elements (including positive and negative aspects). The percentage of very satisfied, satisfied and average for overall satisfaction level for the participants were 18%, 73% and 9% respectively (Figure 5.36). About the intuitiveness or clarity, only 3 out of 22 participants said it wasn't clear for them and for 2 of them it seemed "logical" after hearing the explanation while the rest said they could either see everything clearly or they could figure them out by themselves (Figure 5.37). The overall interface design (59%) and route visualization (50%) received the most positive reactions from participants (Table 5.5), followed by having both AR and map versions of the tour, overall use of maps and the options of accessing the story (36% each). In particular, the photos, the color palette, the real-time route visualization in AR and the story seemed to have some emotional effect in the participants (Table 5.6).

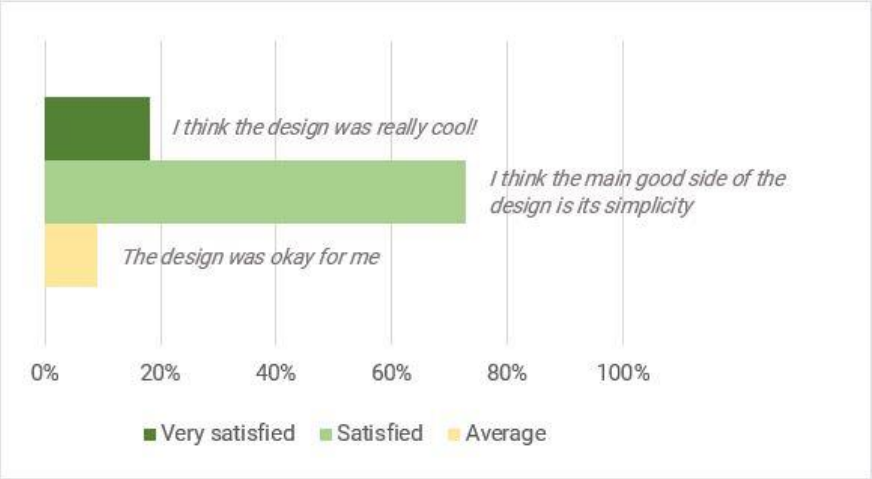

Figure 5. 36: **User satisfaction level for the design**

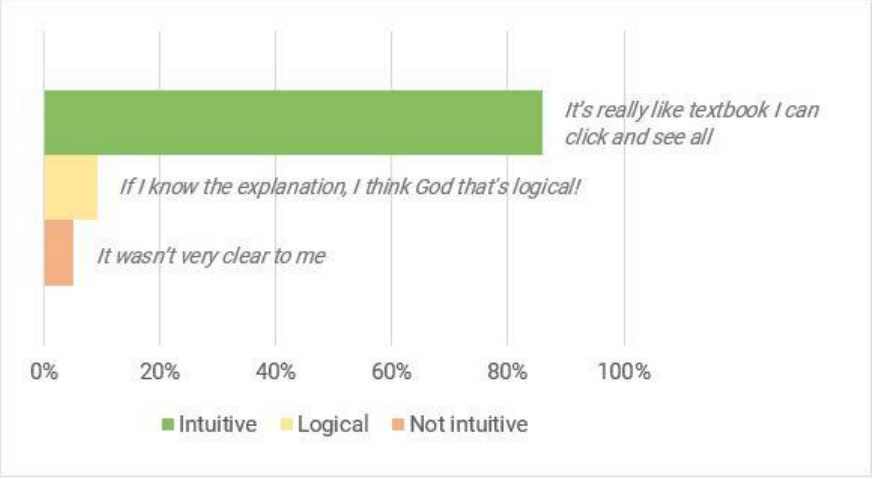

Figure 5. 37: **Intuitiveness level of the interface**

Table 5. 5: **Positive and weak aspects according to the participants**

Positive aspects	User percentage	Weak aspects	User percentage
Interface: simple, user friendly	59%	Buttons (design and placement)	23%
Route visualization	50%	Popup icon (design)	14%
Having tour and map options (Homepage)	36%	Finding route button (visual hierarchy)	14%
Use of map (overview, route, current location)	36%	Tour and map options (difference wasn't clear)	9%
Storytelling elements (overall)	36%	Too many arrows	4.5%
Photos	27%	Fonts used	4.5%
Color palette	27%		
Filter/list of places	14%		

Table 5. 6: **Emotional responses (examples) from the participants**

Photos	*"Many recollection of my life's there"*
Color	*"I see the TUM colors and it takes me back to the campus (TUM student)"*
	"When I see the blue color its pleasant, soothing for the eyes (Tourist)"
Route	*"It can actually get you excited about the route and gets you into it"*
Story	*"After you finish using the app you think now I know everything"*

Question 2

Question 2 was specific to the route visualization. All of the participants said they liked having the route to the POIs shown in the app as it is one of the most important functionalities. 59% of the participants liked having both options for AR tour and choosing from the map and it depends on their familiarity with the place which one they would use. 27% and 14% preferred the map option and the guided tour over the other. With the visual elements (Table 5.7), 17 participants (77%) preferred using "*the line as it is shown*" in the mockup. However, 8 of them (36%) mentioned having multiple options such as line-audio and arrows-audio. Using only avatars or only arrows was mentioned by 3 (14%) and 2 (9%) respectively. 3 people (14%) said depending on the type of place it can vary between a line and an avatar. Moreover, 9 people (41%) particularly liked the idea of showing an animated map along with the line.

Table 5. 7: **Preferred elements for route visualization by the participants**

Preferred visual element	Participants	Quotes
Line as shown	77%	*"It's perfect as it is"*
Map and line combined	41%	*"I like the idea more that you have the map below"*
Multiple options (line-audio/ arrows-audio)	36%	*"It would be better like at the end of the line if it's like blink blink!"*
Avatar (only)	14%	*"like a special character from TUM"*
Arrow (only)	9%	*"in the corner or intersections to show left or right"*
Either Line or Avatar	9%	*"For a touristic place, maybe an avatar but for campus the line is very professional"*
Distance/duration (with line)	9%	*"I'd like to know how long it would take"*

Question 3

In question 3, participants were asked about the story and all the participants seemed to think "*it is very informative*" and agreed to the overall usefulness of this section. In Table 5.8 the first 5 elements are the ones used in the mockups and the rest of the elements were additionally required or suggested by the participants. The results show that photos were clearly the most favorite storytelling element and also the one that the participants (both students and tourists) seemed to connect with the most. Audio (32%) and text (23%) followed next and the participants that chose them were also interested to know more about the place and acquiring the whole information from these which is crucial for the purpose of storytelling.

Table 5. 8: Preferred elements for story visualization by the participants

Preferred storytelling element	Participants	Quotes
Photos	64%	*"I automatically go to the pictures. If I'm still interested then I'm gonna read"*
Audio	32%	*"It's always nice to have someone reading it for me"*
Text	23%	*"I like reading and the information was really interesting"*
Video	4.5%	*"I'd probably like to watch it later when I am sitting somewhere relaxed"*
Website links	4.5%	
Labels	18%	
Timeline	14%	*"You can take more advantage of AR here"*
3D/animated map	14%	
Statistics	4.5%	*"like how many students are there, Nobel prize winners,…"*
Pictogram	4.5%	

Question 4

The participants were if they required any other information or if they were missing any important functionality in the app, numerous opinions came up. Only the ones that were mentioned by more than 1 participant are listed in Table 5.9. Most required were academic information including departments, lecture halls, information desk and opening hours for interested students by 36% participants. 18% wanted to be informed about recent events like parties, seminars and workshops. 14% were interested in more visual representation on the transformation of the campus and about the emergency places. 27% required the functionality to have language options and 14% raised the issue of showing vertical navigation inside the buildings. 18% people expressed unwillingness to add anything else by stating "*there was enough information*", "*don't make it too complicated*" and "*sometimes just simple is better for people*".

Question 5

In question 5, the participants were asked if they found anything un-useful for them in the mockups and if they would like to remove anything. 86% said they would not remove anything and that "*everything was necessary*". Three elements were mention by only 4.5% (one person) of the participants each and those are the source to the photos or information, the website link and video. 23% criticized the size and alignment of the text and suggested to have either "*less text*" or to use "*highlights*" or "*bullet points*" to "*show the most interesting facts"* without having to remove them.

Table 5. 9: Additional requirements by the participants

Information required		Participants
Content	Academic information (departments, labs, info. Desk, opening hours etc.)	36%
	Recent events	18%
	Transformation of the building (3d/animated/swipe pictures)	14%
	Emergency places nearby (police station/hospital/restrooms/restaurants)	14%
	Commercials (offers like bike-rent or food menus)	9%
	Real-time data	9%
Functionality	3D indoor navigation map (for different floors/elevation)	14%
	Language options	27%
	Select any 2 locations from the map (current and POIs)	9%
	Select own route (fastest/shortest)	9%
	Customize options (route style, voice, accent, font)	14%
	Save personal info. (covered route, points and duration)	9%
	User contribution (adding photos or personal stories from students)	9%
Nothing required		18%

Question 6

For question number 6, participants were asked if they thought that such kind of an AR would be useful for a campus tour. 82% gave a positive response and the rest replied with "*maybe*" and "*I don't know about useful but it would engage the user more for sure*". As potential users, 77% participants listed new students who are "*in their first semester*" to be the main user group for this kind of an application. 32% also mentioned about prospective students. 27% mentioned of international students who are "*new to the country*" in particular as well as visitors or tourists. The other groups consisted of parents of the students (18%), current students and staff "*who would like to know more about the campus and the hidden spots*" (14%), visiting professors and lecturers (9%) and tour guides themselves (4.5%).

Question 7

In this part, the participants were asked to if they would prefer using an AR app for exploring through a campus or a more touristic place over other forms of guidance for example, paper maps, audio guides, and human tour guides. As shown in Table 5.10, 73% of the participants said that they would like to use the app although 23% of them said depending on the places, they might also prefer human guides or paper maps. 14% will always prefer paper maps and 9% always prefer human guides over anything else. 1 person (4.5%) did not mention any of the options it will completely depend on the places and the environment what they will prefer. None of the participants mentioned audio guides.

Question 8

Lastly, the participants were asked which environments or scenarios they can imagine other than campus tours where an AR tour app (similar to the mockups) might be useful. A great number of scenarios were stated by the participants, museums (59%) and city tours (45%) being the most mentioned. 27% of participants thought it will be useful hiking and in supermarkets and 14% said

historical and indoor places. Figure 5.38 shows all the possible places mentioned by the participants as a *wordcloud*; the places that are mentioned by more participants having the larger size.

Table 5. 10: Preferred medium for a guided tour by the participants

Preferred medium		Participants	Reasons given
AR app	AR app (only)	50%	*""for storytelling purposes"* *"It's pretty much all in one"* *"faster and easier to download and use"* *"more flexible and relaxing"* *"Paper maps and other options are really outdated"* *"It's nice to have something can use 24/7"* *"in a foreign country with a different language"* *"it will be less expensive"*
	AR app or human guide	14%	*"if touring the place only once then definitely a human guide"*
	AR app or paper map	9%	*"might be poor internet connection or run out of battery"*
Paper map		14%	*"It's a personal choice"* *"I'm old-fashioned"*
Human guide		9%	*"I'd prefer human contact more"* *"when I'm in a new city"* *"I like meeting new people"*
Depends		5%	*"It will totally depend on the location"*

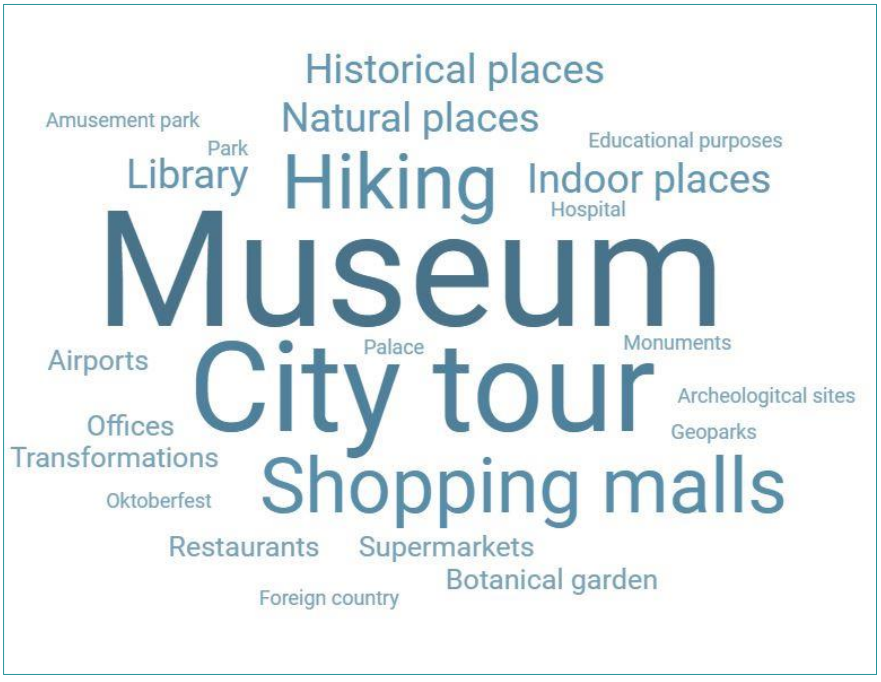

Figure 5. 38: Possible application scenarios/environments for AR tour apps mentioned by the participants

5.3 Conclusion

This chapter has explained the case study phase of the methodology. This consisted of, in the first sub-chapter, the conceptual design development using the results from the previous chapter resulting in the creation of a mockup design of a mobile AR application. The design development process also showed the steps where the design ideas were sketched and wireframed and afterwards given the shape of an interactive mockup prototype. For the second sub-chapter, the constructed mockup design was evaluated by 22 participants to check the usability of the proposed application design. The results were discussed in details highlighting the user preferences for the design elements and functionalities as well as additional comments and prospective usability scenarios.

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Chapter 6
Discussion and recommendations

This chapter will discuss the overall findings from the comparative study and user study in relation to the research problem and objectives (chapter 1) and theoretical background (chapter 2), and finally, provide general recommendations for designing mobile augmented reality applications for location-based storytelling.

This research investigated the design approaches in existing location-based stories in connection with used visual and multimedia elements and how a similar approach can be applied in mobile AR environment. The results provide some insights on the overall usefulness of AR in location-based storytelling and help to propose some general design recommendations for future research.

The results from the comparative study produced a wide array of visual elements used for telling location-based stories in different media. As the sample selection was focused into tourist maps and applications, almost all of the samples contained a series of locations (POIs) with elements like numbers and symbols pointing out their location and multimedia elements conveying the stories. The elements mostly varied depending on the design space and interaction possibilities offered by each medium, however, there was still a pattern for using similar elements to portray a particular kind of information in all three media, such as using numbers, icons and labels to point out the POIs, using lines to recommend a route, and using text and photos as main elements for communicating the story. It is seen that same elements might have different types of interaction in different media, for instance, printed maps only point out the POIs with static markers on them while the same markers can be clickable to open more information in webmaps and AR. On the contrary, audio is only applicable to digital stories. This partially approves the first hypothesis, “all cartographic stories follow a systematic approach in terms of the visual elements used”.

The conceptual development of the mockup designs could not strictly follow the results from the comparative study. For example, the results showed that numbers were the mostly used element for indicating POIs, however, it does not make sense to use numbers in front of a building on the mobile screen. In the mockup, numbers were used only for the map view. Also, there were multiple elements found for the same information category for example to indicate the route 40% and 32% of the samples used solid and dashed lines (used mostly for secondary routes) and 27% had used no elements. The dashed lines were excluded from the design as there was only one type route in the mockup and the no element option was kept as an option to avoid cluttering the screen too much. The color of the application was chosen keeping the university colors in mind and not following the samples. These indicate that the design phase depends on the purpose of the application, and demands more thoughtfulness and creativity than statistical results.

Since the app was designed to give a tour of the campus, a reinforcing storytelling approach (Azuma, 2015) was adopted. The idea of giving the users an introduction first in the popups and text, and then giving the freedom to learn more about the places with different multimedia options seemed to be very useful which also corresponds to Segel and Heer’s (2010) recommendation of stating off with a author-driven (martini glass) structure and ending with reader-driven (drill-down) approach. The storytelling elements received positive feedback from the participants in general although most of them were not willing to read “long text”. The ones who went through the whole content seemed to feel more informed and excited afterwards, which is an indication that being at the real location with more time to explore and using less text with clear headings might make a positive difference to the reactions.

A user evaluation was included in the storytelling process (similar to Lee’s storytelling process and Kent’s communication model) considering the complexity of AR to reduce confusion and errors in the design (Lee, 2015 and Kent, 2018). The results showed a positive response from the participants in general. As the participants came from different regions and professional backgrounds, the study covered a wide range of perspectives. Also, considering the homogeneity in terms of age and gender, the participants represented a user group that is very likely to be interested in using new technologies like AR. The proposed design of the AR application was perceived as simple, user-friendly, intuitive and satisfactory for all of the participants except for one, even though half of them were unfamiliar with the technology. The combination of storytelling and route visualization elements was seen as an effective way to give the users a complete tour of the place attracting both students and tourists as user groups.

When asked about the usefulness of such application design for a campus or touristic spots, all of them responded either positively or indicated that using AR would definitely engage the audience more to the story.

One interesting observation from the user interview was that some of the design requirements of the users differed before and after interacting with the mockup. For instance, most of them preferred arrows (59%) for route visualization initially because they show the directions and do not overcrowd the display, but afterwards they preferred the line more (77%) as it seemed “simple and effective” on the screen. Nevertheless, it was also mentioned by many that they liked the option for turning on and off the route on screen whenever they need.

It is seen that a map-based visualization is preferred by the users, both cartographers and non-cartographers, even with AR. While printed and webmaps in the comparative study incorporated maps as a central component of the story to provide background information, in AR the maps were used as additional features. The camera view in AR works as a realistic 3D map itself making meaningful connections between the geography and geometry of places. Nevertheless, the option to have a self-guided tour with an interactive overview map and GPS was appreciated by the users. Having a small map view on the screen showing the path as they walk was also found interesting (Figure 5.29). Some common suggestions made were to have the option to choose any location from the map other than the selected ones, using offline maps and sharing location with others. Additional maps on different topics like transit maps, elevation maps and historical maps were deemed useful for larger areas.

During the interview, five elements seemed to evoke emotion among the participants. *Photos* were the most effective communicators, especially the old ones, giving a glimpse of the history and evolution of the places. The *color palette* was next as the students found it relatable to their campus while the tourists found it “soothing and relaxing”. The *route visualization* was found exciting primarily because of the new technology and the immersive feeling offered by AR. In spite of being the most important aspect, the *story content* came in the fourth position. This is due to the difference in preferred elements for accessing the story among individuals. An easy solution here would be to give them multiple options like text and audio to choose from. Adding more interactive options, combining different element like a timeline with text and photos or infographics is also highly recommended. The users also mentioned that making a game or a quest would make them engage with the story more. Even choosing the right *font* seemed to be interesting for some people, as using casual or decorative typefaces might “give a poetic vibe to the historical facts”.

Although using mockups for user test have many limitations, such as they don’t offer the same immersive feeling as AR and the participants need to use a lot of imagination, they still proved to be an effective way to test the design and get more insights before developing the real application. The main issues during the mockup demonstration occurred mostly because of the design of the buttons were not clear for every participant, especially non-cartographers. Providing some instructions (graphic or textual) on AR functionalities and tooltips on the buttons and icons would be beneficial for the first time users (Andreas et al. 2007). Combining cartographic symbols with known mobile interface designs would also make them more understandable for every type of user. Another issue that might occur in the real environment is losing sight of the location or adjusting the information in the camera because of the size and distance of the buildings around. The scan button in mockup was an attempt to solve this problem and liked by the users but the button also needed an explanation. An arrow pointing to the nearest POIs or a text notification might also help to adjust the view. For a congested area like a campus surrounded by similar looking buildings, a marker-based tracking might be useful and it will also help to avoid the application overload.

The results point out the second hypothesis “a well-designed augmented reality aided visual story can be a useful method to tell a location-based story” to be true.

In order to offer an enhanced user experience, the following design guidelines for future AR location-based storytelling applications are proposed:

1. Design the application to function as a tour guide combining both storytelling and route visualization elements.
2. Make the interface design simple to minimize distractions that will allow for an enhanced immersive experience.
3. Provide clear instructions and tooltips explaining the buttons, icons and functionalities in the beginning of the app.
4. Adopt known, consistent and intuitive designs for buttons and icons.
5. For storytelling, use a mix of author-driven and reader-driven approach, for instance, present the most important information in the popups and give options to explore for more information.
6. Use short text for the story content, apply meaningful and attractive font; combine text with infographics and photos, and set dividers like headings, paragraphs in the text.
7. Add photos from different times; using an interactive timeline with photos is also a good idea.
8. Provide options, such as text and audio to access the story.
9. Visualize route with simple design elements, such as lines and arrows, and provide more options like audio and avatar considering the type of location and user group if possible.
10. Include a simultaneous map view with the route visualization in AR and an interactive overview map for self-guidance.
11. Provide customization options like hiding the buttons from the screen, location filtering, turning route visualization on and off, changing map layouts and changing the language.
12. Use a soothing and relatable color palette with sufficient contrast with the background that fits the purpose of the app.
13. Use pointers, such as buttons, arrows or text to avoid the problem with adjusting camera view and information loss.
14. Use a marker-based tracking method for congested areas and similar looking spots to assure high positional accuracy.
15. Ensure smooth interactions and transitions between frames/screens.
16. Include user feedback at every step of the design and development process.

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Chapter 7
Conclusion

Chapter 7 will present the final conclusions of this thesis by summarizing the process and reviewing the research questions set in chapter 1. Consequently, the limitations of the study will be portrayed and possible future research directions will be discussed.

7.1 Overview

Augmented reality is one of the latest and most advanced technologies for storytelling and data visualization and it has a growing popularity in tourism. However, the idea of storytelling in AR and combining it with navigation to guide the users through a place is still unexplored. To make the most of the technology and to provide the audience with the best possible experience, the design of an AR application needs careful attention. This study aimed to explore how to design a location-based story using AR following the existing approaches in printed and web cartography and the AR environment itself.

In the beginning, a literature review was conducted to provide a theoretical background on relevant topics including the concepts of narrative cartography and augmented reality. Some application scenarios of location-based stories for tourists with different visual elements were discussed along with their storytelling and navigation potentials. Then the research fundamentals and the methodology adopted for this thesis including comparative study, conceptual design development, usability evaluation and semi-structure interview was described. The chosen methods followed a qualitative approach which included a comparative study of existing story samples and a case study based on developing and testing of a mockup design for an AR tour app of TU Munich main campus.

The comparative study was performed with 38 selected samples from the print, web and AR/VR media which were collected from different regions of the world. The design elements used in the samples for visualizing points of interest (the locations of the story), the story contents and the route direction to these points were reviewed and tabulated. The list of elements were summarized for comparison and pattern identification. Then a conceptual design was developed by generating basic ideas for a mobile AR app based on the findings of the comparative study. The basic ideas were shaped in to sketches to portray the skeleton of the app. Interactive mockups were chosen as a design language for the representation of the design ideas.

Afterwards, an online user study consisting of a semi-structured interview was conducted to evaluate the design. The interview consisted of mockup demonstration, observation and thinking-aloud methods. 22 participants from 16 different countries and from versatile professional backgrounds were interviewed for gathering user requirements in general and feedback on the mockups. Finally, some recommendations were prposed based on the recorded and transcribed user feedbacks to design a location-based AR story app. Some basic principles were outlined considering the user interface design, the story elements, route visualization and the use of maps for the possible improvements in the actual application.

7.2 Addressing research questions

The answers addressing the research questions set in Section 1.2 are summarized as follows:

RQ 1: How are location-based stories for tourists realized in print media, online web platforms and in the AR environment?

d. What visual elements have been used to display different types of tourist information in a story or different phases of a story in each media?

The map review and analysis phase of the comparative study (chapter 4) aided to create a list of visual elements used for depicting tourist information in different media. The information and the elements used are coded into two categories: elements used for delineating the points of interest or POIs (the locations themselves) and elements used to convey description of the POIs (the stories). Ten elements

were identified from the 38 samples for indicating POIs: numbers, letters, markers, symbols, labels, 2D/3D illustrations, icons, filters, lists/legend/sidebar and also no element at all since the POIs are visible though the camera in AR. For conveying story information the elements found were: text, photos, popups, sliders, hyperlinks, ads, graphs, audio, video and scrollbar.

e. What visual elements have been used to display route visualization for tourists?

A total of 16 elements were identified from the selected samples that were used to visualize the route (both recommended and non-recommended) and give direction to tourists which is discussed in section 4.5.2. The most common ones were different types of lines, e.g., solid, dashed, and arrowed, and numbered markers on POIs giving a sense of direction (guided route). Many of the samples did not use any separate element to provide route direction as the streets are already visible on the map or through the camera in AR and the users can find the way on their own (self-guided route). Some of the samples also indicated a recommended route along with other possible routes for the users to choose (partially guided route).

f. What are the similarities and dissimilarities in the patterns of using visual elements among the three different media?

The answer to this question was addressed in several steps. The percentage values of the occurrences of each visual element used to convey the story, route and additional information were calculated. This produced a normalized value for the elements for all three media to make a fair comparison between them (figure 4.4, 4.5, 4.6 and 4.8). An overall pattern was shown in table 4.7 to combine all the elements used for conveying tourist information and additional information across three media. Although there was no statistically significant answer found to this question, a general pattern can be derived from the table. The major similarity lies in choice of elements for specific information category in all three media. The main differences in using the elements stems mainly from the difference in level of interactivity provided by each media. The more advanced the medium, the higher the interaction functionalities, which makes the use of visual, e.g. icons, text, photos, and videos, and non-visual elements, e.g. audio and haptic easier. Moreover, there is a major difference in the interactivity provided inside the maps in different medium.

RQ 2: How can AR technology be used in cartographic storytelling?

a. How can the existing methods or patterns of using visual elements in storytelling be employed or transformed into the AR environment?

The thesis answered this question from a more theoretical point of view. The findings and patterns of the comparative study gave a better idea of the similarities in using design elements among three media and as stated above, the same elements can be used in different media while taking advantage of the added interaction functionalities, such as overview maps with clickable numbers/markers, icons with information popup, etc. On the contrary, some elements that are used in a wide range in the first two media can be replaced by other elements in AR, such as 2D/3D illustrations of POIs might not be needed anymore as AR already integrates real life 3D view of the places. The design elements were selected from all three media based on their frequency of occurrences in one or all three media and applied to the mockup design for the case study to see their actual application and transformation possibilities.

b. What visual elements can be used in AR for making a location-based story more engaging and/or informative?

This question was answered partially in all three steps of the methodology. First, a theoretical concept was built based on the comparative study assuming that the most used elements are the most effective

ones for conveying information. This idea was supported by the user evaluation as there was almost no negative feedback for the design elements selected for the story and route visualization. However, the engaging quality of the elements depends not only on the attractiveness of the elements' design but also from the interaction functionalities and emotional aspects associated with them. Gamification of the application might also engage the users more. Five aspects were identified in the mockup design that particularly made the users connect with the stories: using old and current photos, choosing a soothing and relatable color palette, visualizing route overlaid on reality in AR, the content of the story and using the appropriate font.

RQ 3: How effective is the proposed design?

c. How to evaluate the proposed design concept based on user requirements and feedbacks?
The proposed design was evaluated by creating a mockup prototype of an AR application of the TU Munich main campus and conducting a user study. Considering the qualitative nature of the research a semi-structured approach was adopted to perform a mockup demonstration and question-answer sessions online. The users were asked to share their opinions about the overall design as well as the individual elements chosen for different parts of the application. The comments and reactions from 22 participants were recorded and coded to summarize the evaluation results (section 5.2).

d. How effective is the proposed design and what improvements can be made?

It is ascertained from the results of the user evaluation that the proposed design was well accepted by the participants. Most of them found the design satisfactory and intuitive. It was specifically mentioned by many users that they preferred a simple interface design because of the small screen and complexity of the technology itself. No element or content was found unnecessary. The route visualization, the story elements, the use of multiple maps and having both guided and self-guided tour options were particularly acclaimed by majority of the participants. Some suggestions for improvements included: using less text information for stories, making the maps more interactive, combining the story elements as parts of a whole story and not just as options, adding interactive elements like a timeline, and offering different types of tours of the same places considering different user groups, such as historical tours and academic tours.

7.3 Future outlook

The conducted research is subject to some limitations. First of all, the comparative study was conducted with a limited number of existing samples, particularly for the AR/VR applications. The diversity of the used maps and applications is beneficial, however, collecting and investigating a larger sample would be better representative in the statistical sense and provide additional insights into the designs.

One of the major limitations of the research was that the usability evaluation was performed online with mockup designs. Although real photos and gifs were used for the background and route visualization to give the participants a realistic feeling, it cannot be matched to the immersive experience of AR. The issue of adjusting camera view and tracking could not be tested with the participants either. Moreover, the number of participants were limited and all of them were between 26 and 36 years old. To get more significant results, an on-spot field test with a functioning mobile app prototype involving a larger number of participants from wider age groups is suggested. Additionally, having the users completing the same task under a time constraint and/or testing their ability to recall the information from the story can lead to a more comprehensive evaluation. Including the perspectives of AR experts and mobile app

developers in the conceptual design phase is also crucial to fill the gap between designing and developing an actual application.

Even though selecting the TU Munich campus as a case study area proved to be a good example of a tour attracting both students and tourists, the research did not cover experimenting with designs for different purposes and context. AR stories specific to other locations and different user groups should be designed and tested. Some scenarios are mentioned by the participants in the last question of the post-interview (Figure 5.39). Guided tours of outdoor tourist spots like city tours, mountains or hiking trails, and safaris as well as complex indoor places like museums, shopping malls and airports would be interesting for travelers to know more about the places and to find their ways. Even stories on chronological transformation of natural places like the changes of rivers or glaciers over hundreds of years would be fascinating for geographers as well as others.

Further research could also consider including gaming experience or a quest for exploring different parts of the story to attract more users and engage them more. Experimenting with responsive designs to use the app in different operating systems is also necessary. Broadening the scope of the app to be used for different navigation scenarios other than a walking tour, for example, how an app like this could be used while riding a bike or driving a car in safe way would be a beneficial future research direction. How to design the app to combine multiple places (e.g. multiple campuses or cities), how to combine different types of tours for the same place to attract different user groups (e.g. academic and historical tour of a campus), how to use the design space and tools offered in the AR environment to combine more interactive elements, such as haptics to enhance substantial experiences, are some interesting points that could be looked into in the future.

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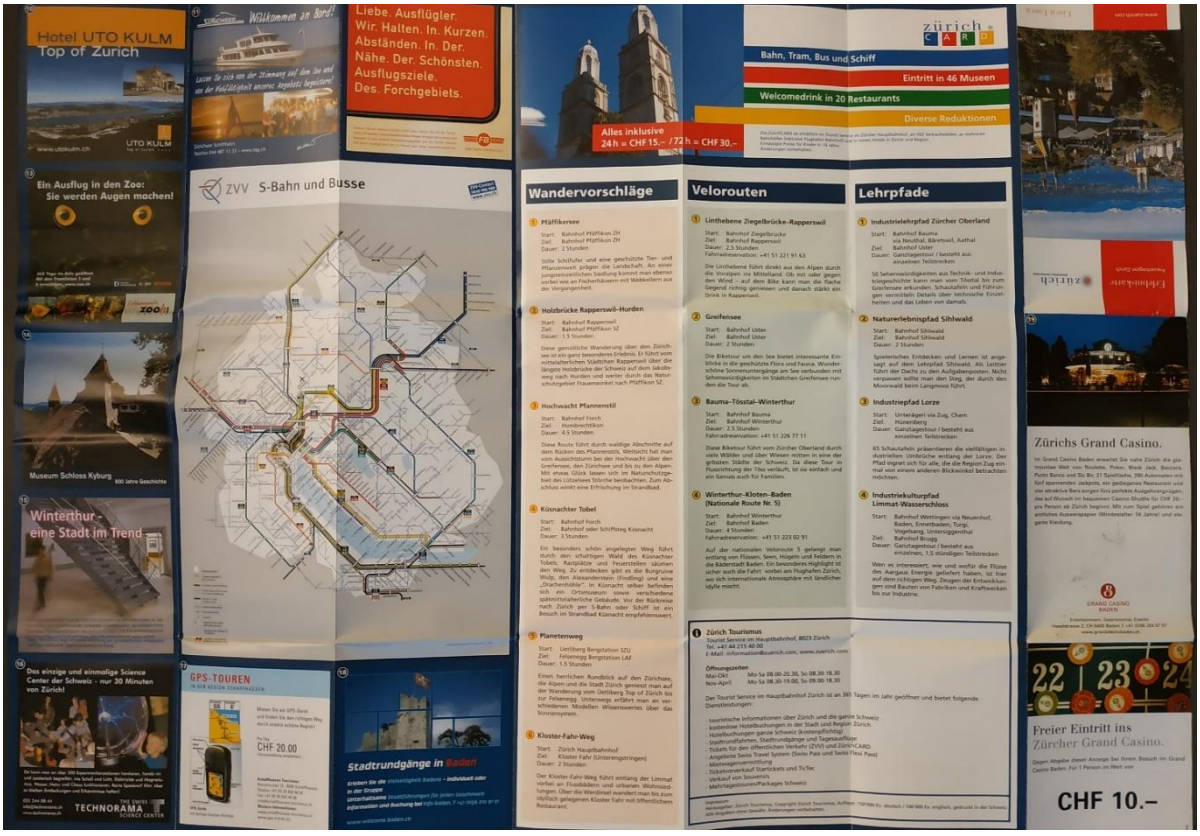
Appendix

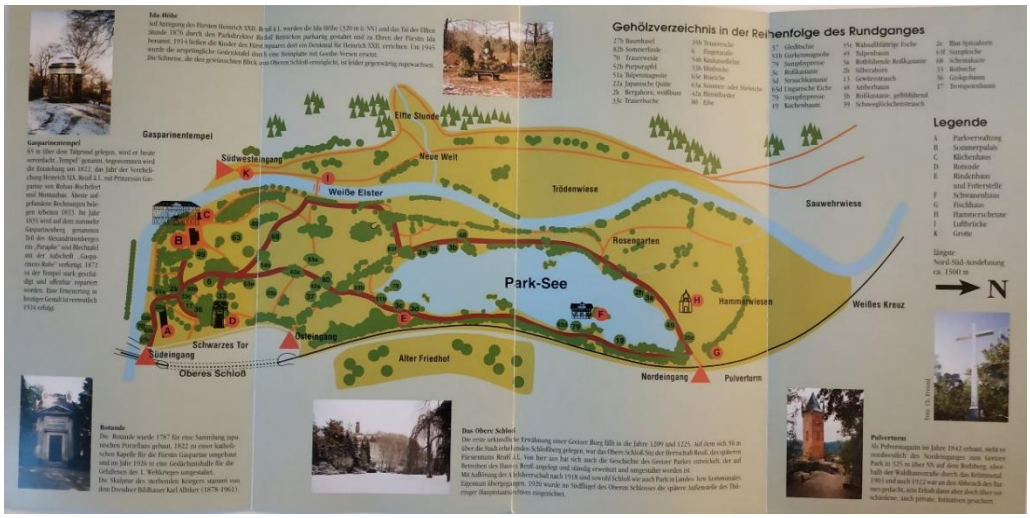
Appendix A

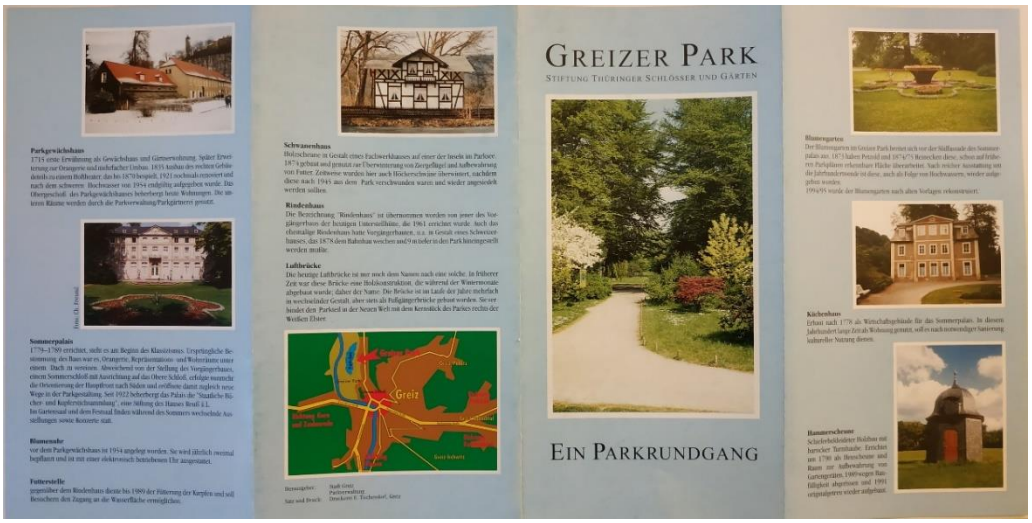
Sample 1: Erlebnisregion Zürich



Sample 2: La ligne touristique Les Cars Rouges

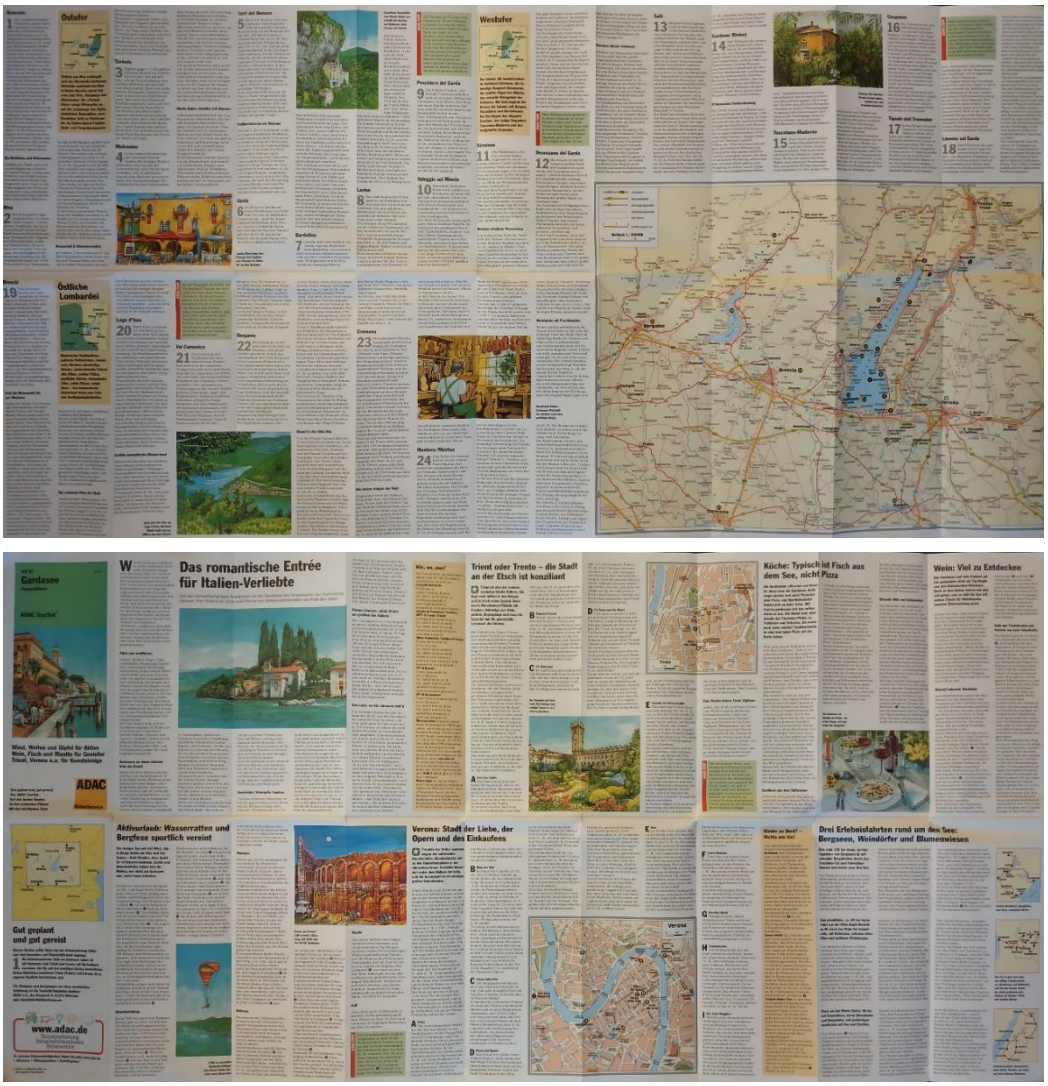
Sample 3: Greizer Park



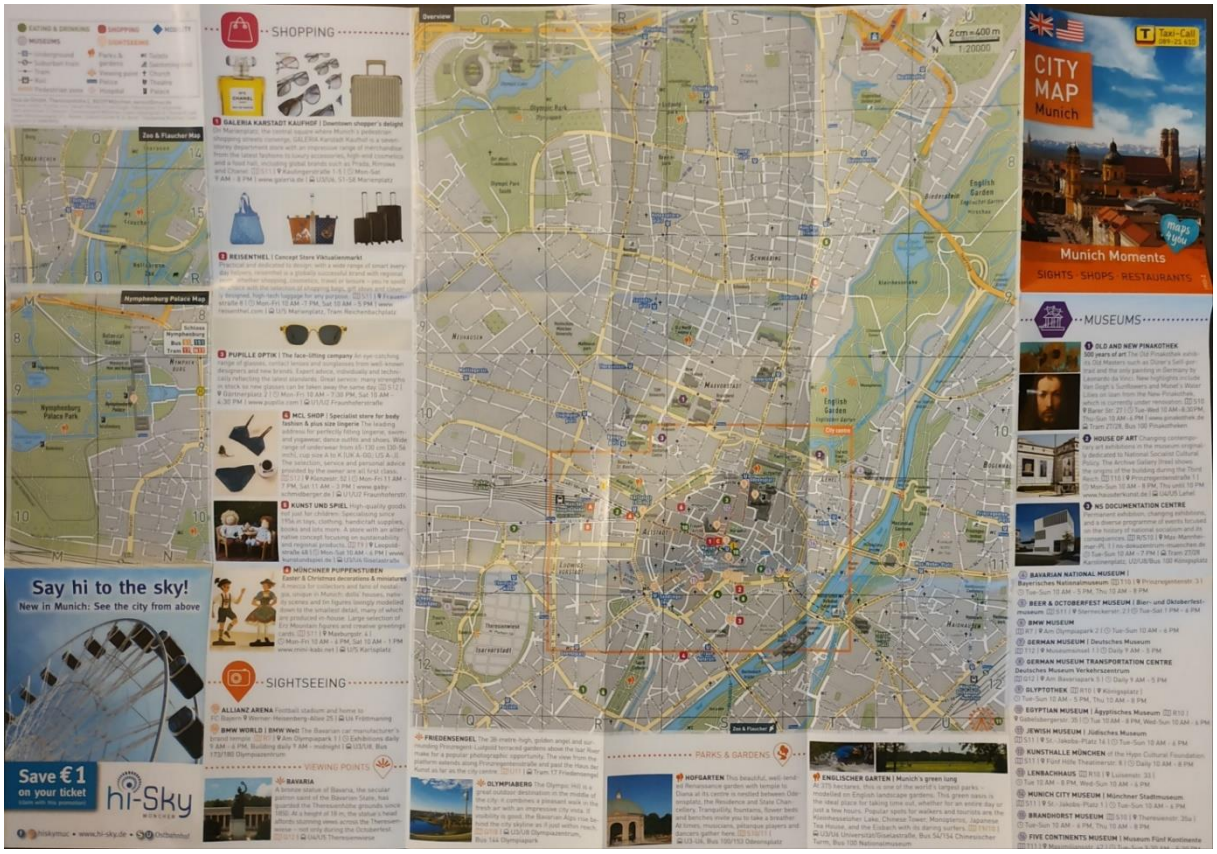


Sample 4: Charta Roma

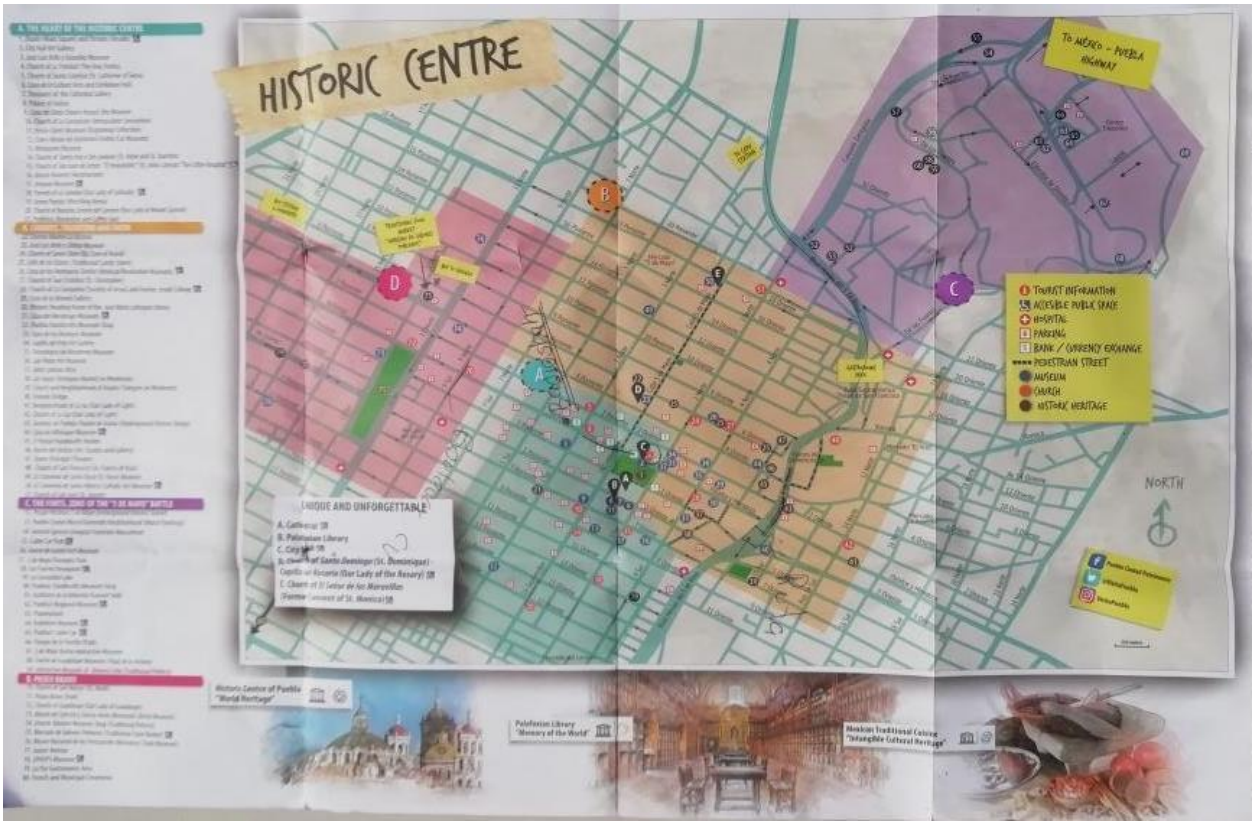
Sample 5: Gardasee Regional-guide



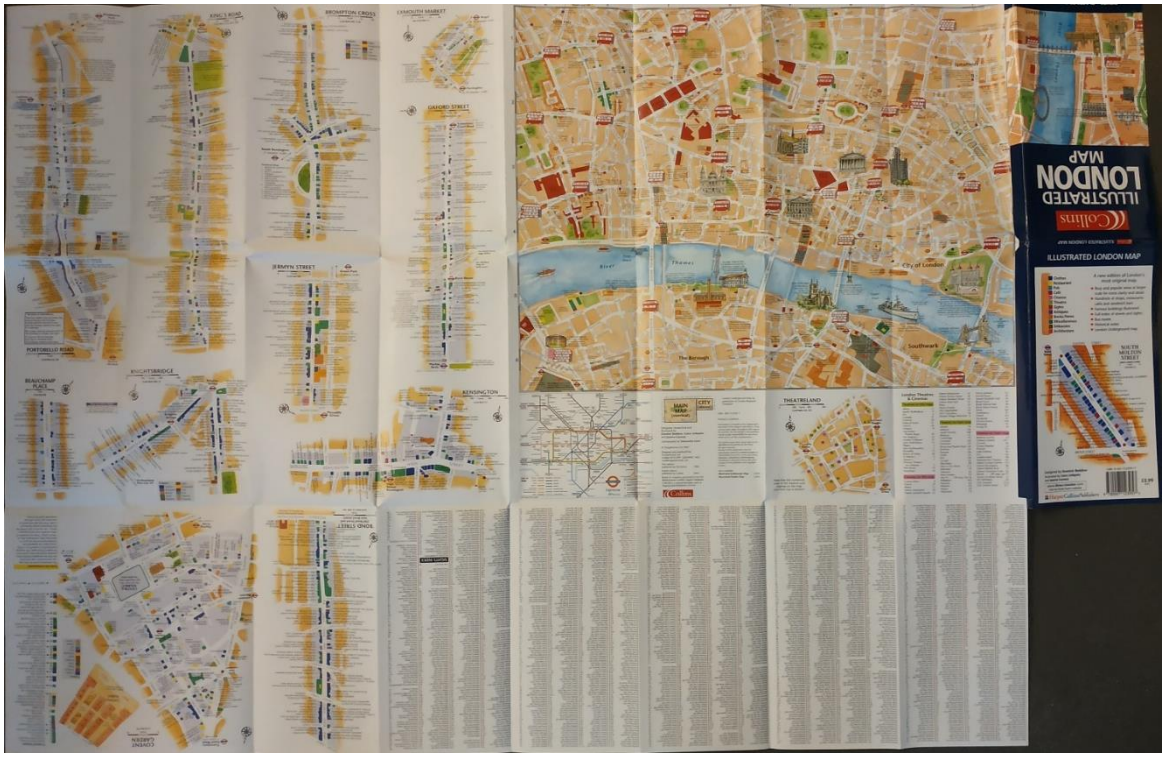
Sample 6: City Map of Munich



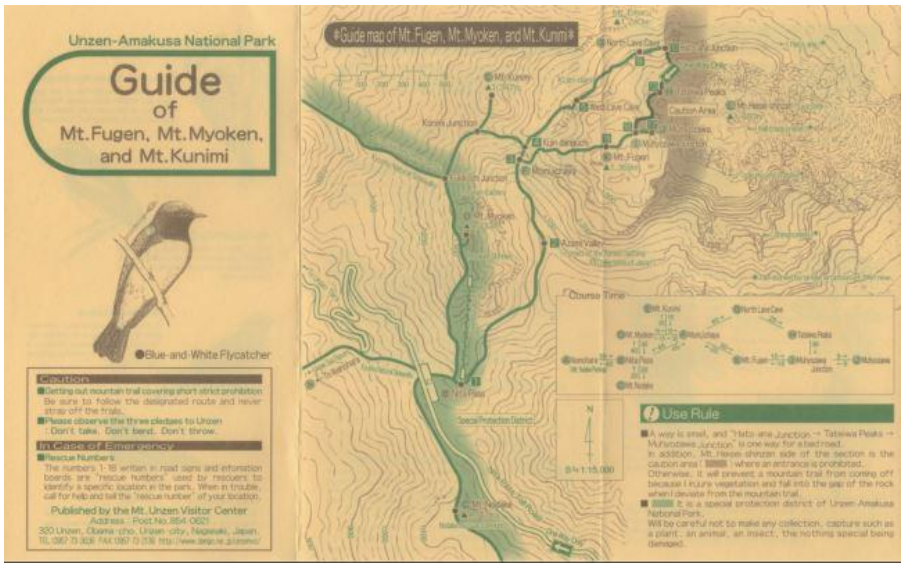
Sample 7: Historic Center of Puebla, Mexico

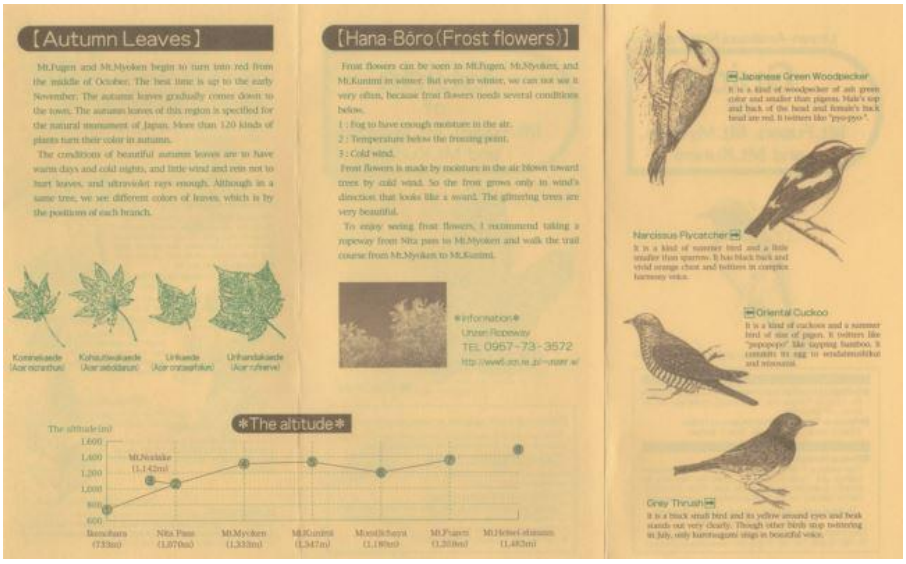


Sample 8: Illustrated London Map

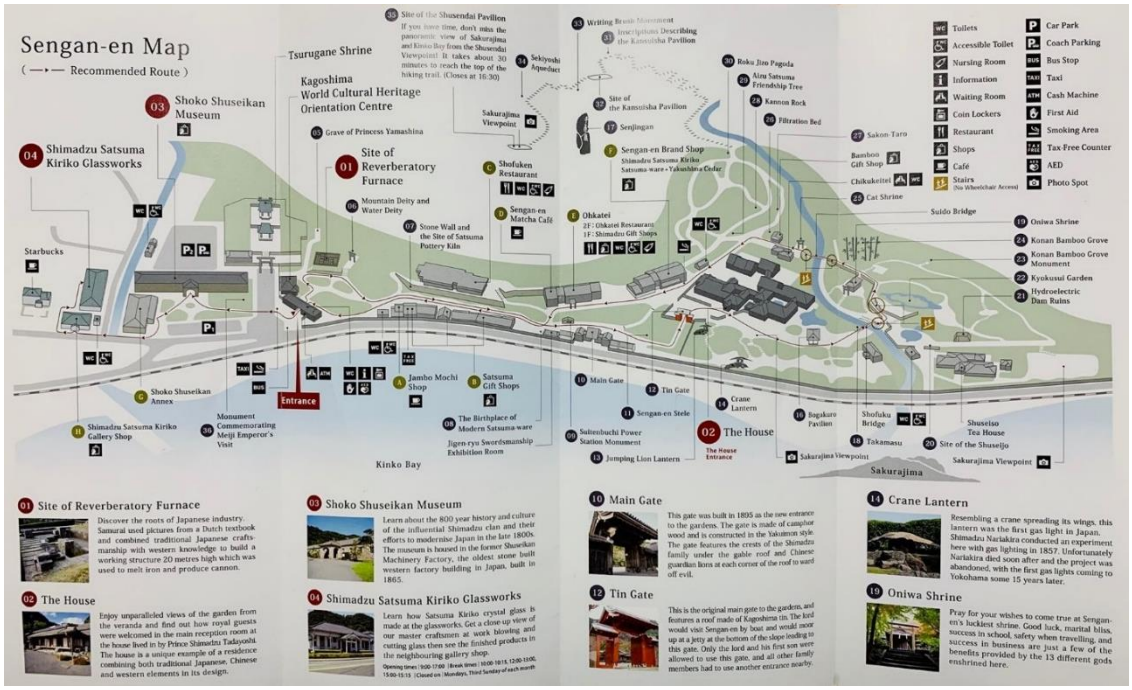


Sample 9: Guide of Mt. Fugen, Mt. Myoken and Mt. Kunimi, Japan

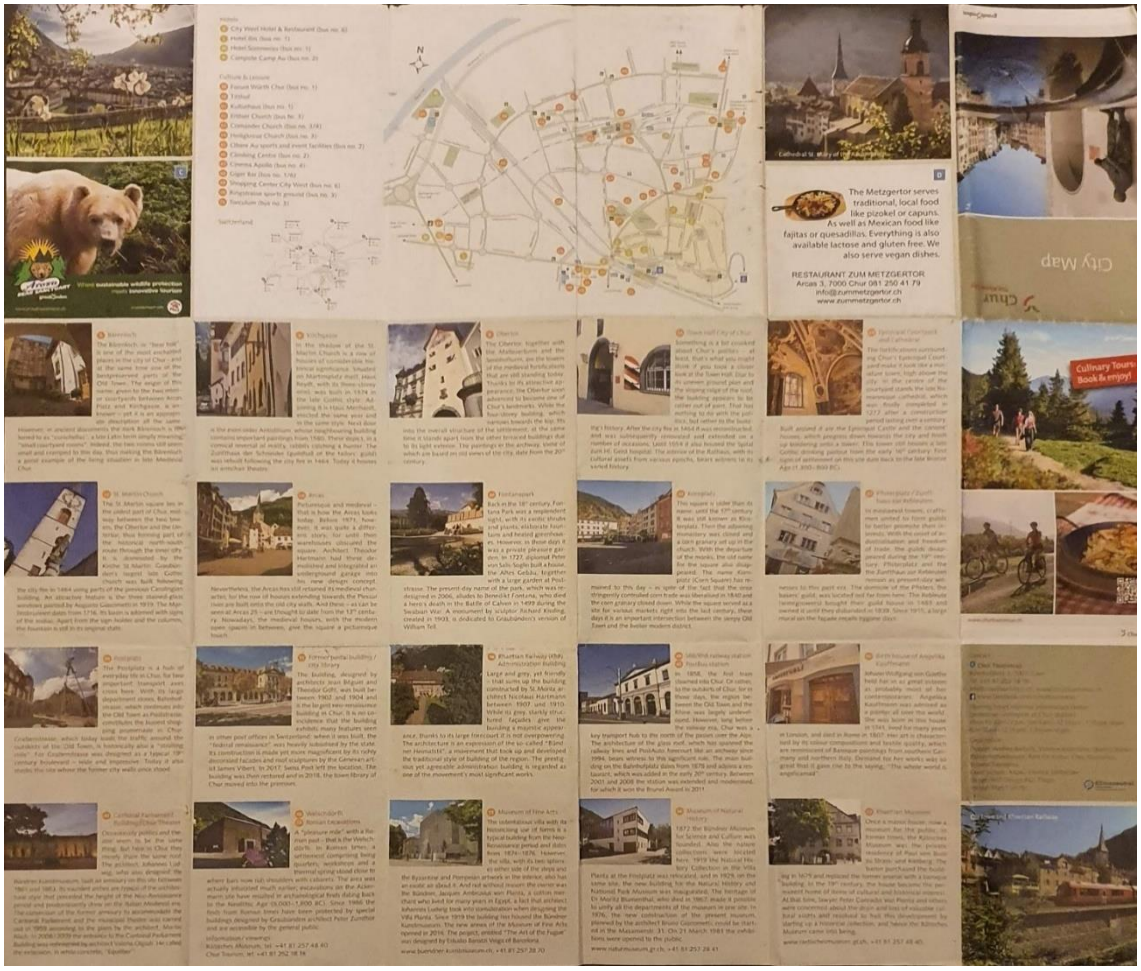




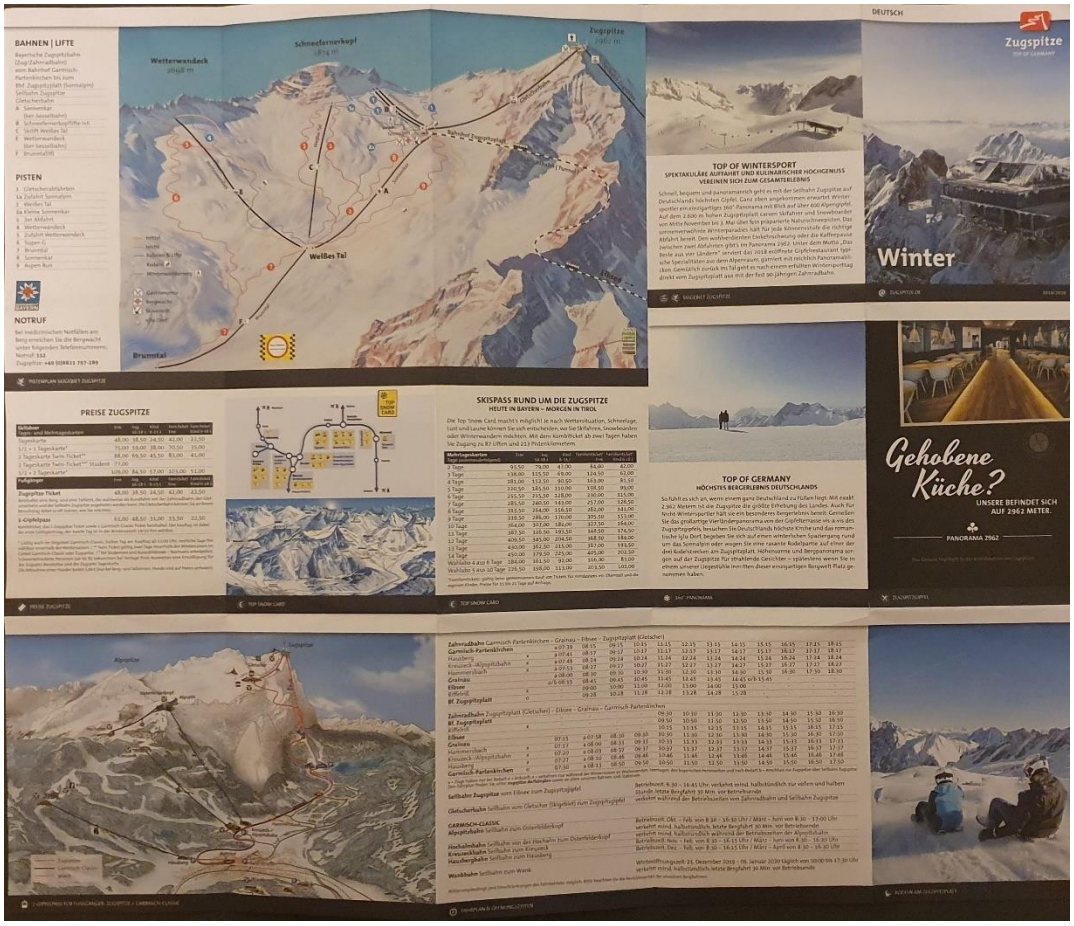
Sample 10: Sengan-en Map, Japan



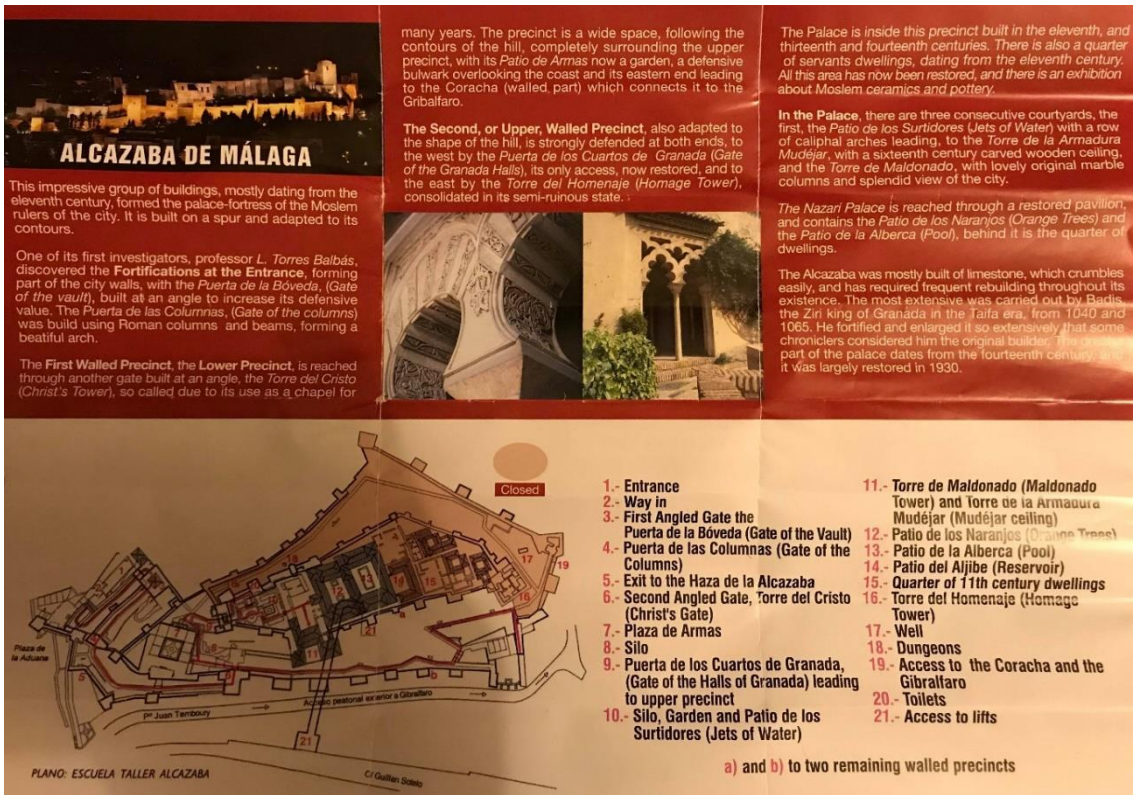
Sample 11: City Map of Chur



Sample 12: Garmisch Classic



Sample 13: Alcazaba de Malaga



Sample 14: Durham City Walk

CIRCULAR ROUTE 1 - 2.8km (1.75 miles)

Leave the Market Place to the right of St Nicholas„ Church and take the pedestrian slope on your left down towards the river. Follow the road to your right under Millburngate Bridge and proceed towards the Premier Inn.

Cross the car park on your left and go over the river via the Penny Ferry foot bridge. Turn left and walk alongside the river. There are excellent views of Castle and Cathedral along this path.

Continue along the path, under Framwellgate Bridge, continuing to follow the river. To your left, as you approach the weir, is one of the most iconic views of the Cathedral.

There is a SHORT STEEP INCLINE in the path leading towards Prebends Bridge. Stop a while on the bridge and admire the views.

Cross Prebends Bridge and turn right following the river, passing the Count„s House on your left before going under the modern footbridge, Kingsgate Bridge.

There is then an INCLINE followed by a SHARP DESCENT as the path skirts round a boat house. Head towards, and then under, Elvet Bridge into the lift lobby area at the bottom of the Prince Bishops car park on your left. Take the lift up to the shops and return to your start in the Market Place.

CIRCULAR ROUTE 2 - 2.8km (1.75 miles)

Follow Route 1 until you reach Prebends Bridge.

Cross Prebends Bridge and follow the road straight ahead (STEEP INCLINE), through the Watergate, and up South Bailey. This is a gradual INCLINE. If you want to visit the Cathedral, turn left through an archway towards the top of South Bailey into the College. Keep the wall on your right for about 100 yards and at end of wall turn right and enter the Cloisters through a tunnel. The Undercroft restaurant and toilets are to your left and the entrance into the Cathedral itself is diagonally opposite where you first entered the Cloisters.

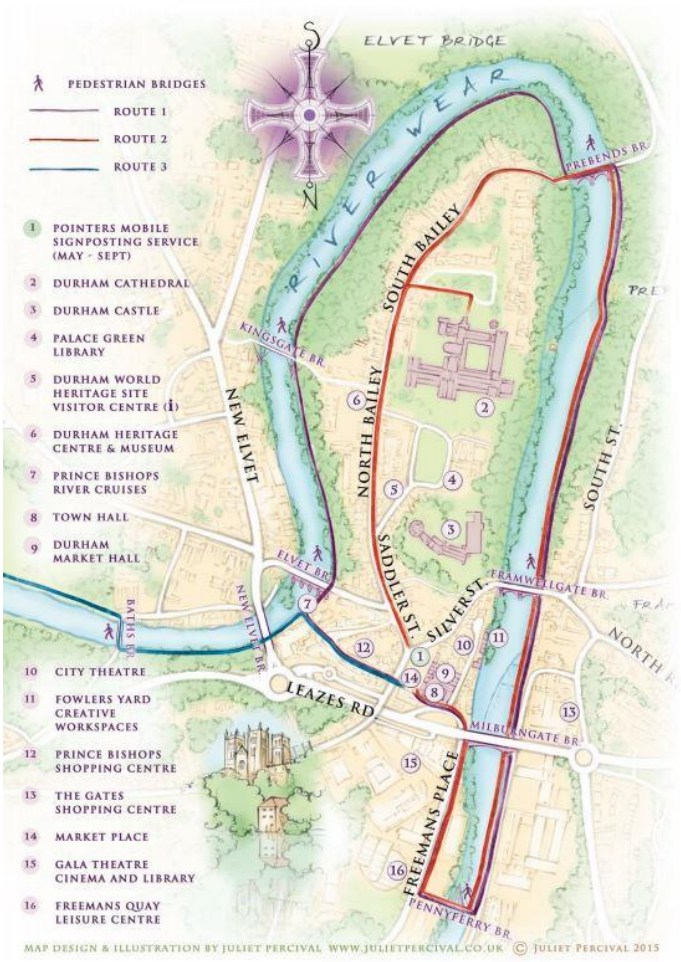
Leave the Cathedral the way you entered, back through the arch, turn left and follow the road DOWNHILL via North Bailey and Saddler Street back to the Market Place.

ROUTE 3 - 1.9km (1.2 miles) return

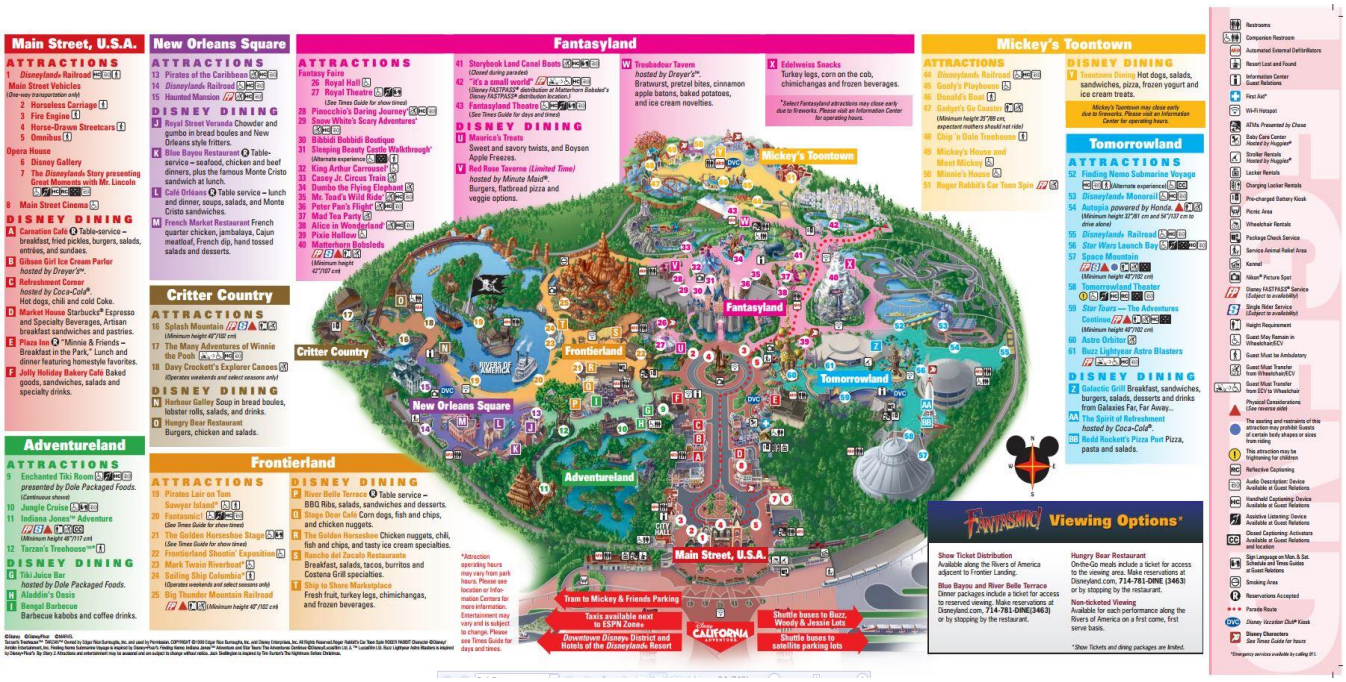
From the Market Place cross the road into the Prince Bishops Shopping Centre. Follow the sign for the Car Park. Take the lift down the ground floor, exit the lobby area and turn left. Follow the river to a pedestrian bridge (Baths Bridge). Cross the bridge and look back at the views of the Cathedral.

Turn left and follow the river with the University playing fields on your right to the bandstand and statue of the Dun Cow on your left.

As you turn round there are stunning views of the Cathedral and Castle. Retrace your route back to the Market Place.



Sample 15: Disneyland Park Map



Sample 16-38 (Web maps and AR/VR applications)

Sample No.	Name	Source	Last accessed
16	A Walk Through Soviet Bishkek, Kyrgystan	https://storymaps.esri.com/stories/2018/bishkek-tour/	19.03.2021
17	Soundscapes of Sequoia and Kings Canyon National Parks	https://nps.maps.arcgis.com/apps/Cascade/index.html?appid=9f33fa32af394a129b0b548429dced01	19.03.2021
18	Aeneid: an interactive voyage	https://www.arcgis.com/apps/MapJournal/index.html?appid=33be151cbe1942d99a300da085884729	19.03.2021
19	London Map	https://www.city-walks.info/London-en/Map.html	19.03.2021
20	Sightseeing oxford map	https://www.citysightseeingoxford.com/interactive-map/	19.03.2021
21	Introducing Munich	https://www.introducingmunich.com/map	19.03.2021
22	From Service to Scholarship	https://tourbuilder.withgoogle.com/builder#play/ahJzfmd3ZWltdG91cmJ1aWxkZXJyDAsSBFRvdXIY-I0LDA	19.03.2021
23	Literary Knox Walking Tour	https://literaryknox.com/story-map/	19.03.2021
24	The 45 minute mystery of Freddie Gray's Death	https://data.baltimoresun.com/freddie-gray/	19.03.2021
25	Black route	https://www.washingtonpost.com/graphics/world/exodus/black-route/	19.03.2021
26	Interactive Map of Wellesley College	http://samples.mapsalive.com/20795/page1.htm	19.03.2021
27	Egyptian History map	https://egyptianmuseum.org/interactive-map	19.03.2021
28	The MET Map	https://maps.metmuseum.org/	19.03.2021
29	African Safari map	http://www.eyesonafrica.net/african-safari-map.htm	19.03.2021
30	Kangaroo Island Map	https://eatdrinkki.com.au/map/	19.03.2021
31	NYC Tour	https://www.youvisit.com/tour/nyc	19.03.2021
32	Dresden 360 Interactive Experience	https://visit.dresden360.com/	19.03.2021
33	Peakfinder	https://www.peakfinder.org/mobile/	19.03.2021
34	Horizon explorer	https://play.google.com/store/apps/details?id=com.arrowsd.horizonexplorer&hl=en&gl=US	19.03.2021
35	Chicago00: The Eastland Disaster	https://www.youtube.com/watch?v=PKJLbi-vzIc&ab_channel=GeoffreyAlanRhodes	19.03.2021
36	Viewranger	https://play.google.com/store/apps/details?id=com.augmentra.viewranger.android&hl=en&utm_source=viewranger&utm_medium=website&utm_campaign=getapp	19.03.2021
37	Buenos Aires Travel Guide AR	https://www.youtube.com/watch?v=-qgR_b11cQA&ab_channel=etipsmobile	19.03.2021
38	Carnuntum App	https://www.carnuntum.at/de/ihr-besuch/carnuntum-app	19.03.2021

Appendix B

Table: Information extracted from the selected 38 sample maps and applications

Map No.	Map Title	Media	Map Type	Theme	Selected Design Elements												
					Information for Tourists				Route					Background map			
					Information provided	Element Used	Color Used	Interaction	Information provided	Element Used	Color Used	Interaction	Guidance	Information provided	Element Used	Color Used	Interaction
1	Erlebnisregion Zürich	Printed	Panoramic map	Interesting touristic spots/ regions of Zurich	Major spots	Numbers	White in blue	None	Main Routes	Solid line	White	None	Guided	Natural landscape	3d illustration	Green shades	None
						3d Illustration	Red & brown		Subway	Solid line	Black			Mountains	3d illustration	Brown shades	
					Spots along the trails	Numbers	similar to line colors		Hiking trails	Dash line	Red in yellow			Built-up areas	3d illustration	Red and brown	
					Tourist services	2d icons	Black & white		Bike routes	Dash line	Green in yellow			River	Polygons	Blue shades	
					Names of places	Labels	Black		Nature trail	Dash line	Black in yellow			Additional information	Transit Map		
					Description of POIs	Photos											
						Text	Black										
2	La ligne touristique Les Cars Rouges	Printed	Thematic Map	The tour of 9 important tourist sites of Paris (audio tour) on the Les Cars Rouges buses and their timatable	Bus stops	Numbers	White in red	None	Bus route (circular)	Solid line	Red	None	Guided	Buildings / blocks	Polygons	Light color palette	None
					Major spots	3d Illustration	Orange & black							Main Roads		White	
						2d symbols	Yellow							Parks/ open spaces	Polygons	Green	
					Other services	2d icons	Blue, Orange							Additional information	Close-up maps		
					Names of places	Labels	Black										
					Description of POIs	Text	Black										
						Table	Multi-colored										
3	Greizer Park	Printed	Pictorial map	Tour of a park showing some interesting spots and vegetation	Park Entrance	2d symbol	Orange	None	Main route	Solid line (thick)	Red	None	Partially guided	Open space	Polygons	Yellow	None
					Major spots	Letters	Black & Orange		Other routes	Solid line (thin)	Orange			Vegetation	Polygons	Green	
						Legend	Black							Lake	Polygons	Blue	
						2d Illustration	Black							Additional information	Overview map		
					Tree Species	Numbers	Black & Green										

						List	Black										
					Names of places	Labels	Black										
					Description of POIs	Photos											
						Text	Black										
4	Charta Roma	Printed	Thematic 3d map	Two maps showing the routes of two different tourist bus services, and pointing important stops and places to visit in Rome	Major spots	Numbers	Red and Blue	None	Bus route 1	Solid line	Red & blue	None	Guided	Grid	Letters & numbers	Black	None
						3d Illustration	Black		Holiday routes	Arrowed line	Black			Additional information	Transit Map		
					Other touristic spots	Numbers	Yellow		Local bus routes	Dashed line	Red						
						Roman Numbers	Red										
						2d symbols	Black and White										
					Names of places	Labels	Black										
					Description of POIs	Photos											
						Text	Black										
						Grid	Black										
5	Gardasee Regional-guide	Printed	Thematic map	The main map tells the story of the northern part of Italy, a large region surrounding the Lake Garda along with two small maps of the cities of Verona and Trento	Major spots	Numbers	Yellow & black	None	Highway routes	Solid lines+bus numbers	Yellow-red	None	Guided	Landscape		Yellow	None
					Description of POIs	Text	Black		Expressway	Solid lines+bus numbers	Yellow-green			Waterbodies	Polygons	Blue	
						Photos/sketches			Main roads	Solid lines+bus numbers	Red			Road distance	Numbers, markers	Blue	
					Major regions	Small maps			Conneting roads	Solid lines	Pink			Names of places	Text	Black	
						Text	Black		Motorway (KFZ-fahre)	Dashed lines	Red			Location	Inset map		
									Waterways	Solid lines	Blue			Information on the cities	Additional maps		
									Routes for adventure rides	Small maps	Red				Text	Black	
									Distance	Text	Black			Additional information	Text	Black	
															Photos/sketches	-	

6	City Map of Munich	Printed	Thematic map	Gives an overview of the Munich city center with essential information for tourists	Major spots	Markers, numbers, letters, icons, symbols	Categorized	None	Main route	Numbers		None	Self guided	Grid	Letters & numbers	Dark grey	None
					Tourist services	2d icons (categorized)	Different for each category		Transportation route (categorized)	Solid and dash lines	Different for each category			Landscape	Polygons	Light grey	
					Description of POIs	Text	Black							Water bodies	Polygons	Blue	
						Photos								Open spaces	Polygons	Green	
						Website links	Grey							Additional Information	Transit map		
						Ads									Text	Black	
															Photos		
7	Historic Center of Puebla, Mexico	Printed		Gives an overview of the important places in the city of Puebla, Mexico	Major spots	Numbers, letters, list (categorized)	Different for each category	None	Pedestrian streets	Dash lines	Black	None	Self guided	Background	Zones/ polygons	Different colors	None
					Tourist services	2d icons (categorized)	Different for each category		Roads	Solid lines	Green			Street names	Text	Black	
					Description of POIs	Text	Black							Open spaces	Polygons	Green	
														Additional Information	Photos/ sketches		
8	Illustrated London Map	Printed	Illustrated Thematic map	The overall map tells the story of the sights, restaurants, shops, pubs, entertaiment spots and buses of London city with several small close up maps telling the tales of intersting streets or areas	Major spots	3d Illustration	Beige & black	None	Bus routes	Symbols + numbers	Red	None	Self guided	Grid	Letters & numbers		None
					Other spots	Symbols	Red, Grey							Built-up areas	Polygons	Orange	
					Tourist services	2d icons	Red, Blue							Open spaces / parks	Polygons	Green	
					Shopping streets	Symbols	Grey							Waterbodies	Polygons	Blue	
					Description of POIs	Text	Black							Street index	Text/list	Black	
														Additional information	Text	Black	
															Close-up maps	Multicolored	
															Lists	Black	
															Transit Map		
9	Guide of Mt. Fugen,	Printed	Topographic map	The map shows the	Major spots	Numbers	Green	None	Main route	Solid line	Green	None	Guided	Elevation	Contour lines	Grey	None

	Mt. Myoken and Mt. Kunimi, Japan			mountain trails		Labels	Grey							Protected Area	Zones/ shades	Green	
					Other spots	Letters	Green							Prohibited entrance	Zones/ shades	Grey	
						Labels	Grey							Additional information	Text	Grey, green	
															Photos/ sketches	Green, grey	
															Graph	Green, grey	
10	Sengan-en Map, Japan	Printed	3d Illustrated map	It tells the story of the house of the Shimadzu lords and the surrounding traditional gardens of Sengan-en	Major spots	Numbers	Red (major four), Black (other)	None	Main route	Arrowed lines	Black	None	Guided	Buildings, monuments	3d pictogram	Grey palette	None
					Other spots	Letters	Green		Hiking trail	Dotted lines	Black			Garden/ field	Polygons	Green	
					Tourist services	2d icons	Black and white							Empty space	Polygons	Grey	
					Description of POIs	Text	Black							Roads	Lines	White	
						Photos								Railway line	Dashed lines	Dark-light grey	
														Additional information	Text	Black	
															Photos		
11	City Map of Chur	Printed	3d Illustrated map	The map shows the tourist sights and services for the city of Chur	Major spots	Numbers	Orange	None				None	Partially guided	Landscape	3d illustration	Black & white	None
						Letters	Yellow							Central area	Polygons	Grey	
					Tourist services	2d icons	Blue, Green, Grey							Openspace	Polygons	Green	
					Description of POIs	List	Black							Roads		White	
						Text	Black							Rail lines	Solid lines	Black	
						Photos											
12	Garmisch Classic	Printed	Panoramic map	The map shows the skiing and hiking routes of the whole Garmisch area and the mountain peaks including Zugspitze	Major spots	2d icons	B&W, orange	None	Skii tracks, cable cars	Solid Lines	Black	None	Guided	Landscape	Shades	Blue and white	None
					Description of POIs	Text	Black			Dashed lines	Orange			Names and altitude	Text	Black	
						Photos				2d icons	Black & white			General information	Text	Black	
						Tables	Black		Rail tracks	Dashed lines	Black & white			Additional information	Close-up map		

										2d icons (train)	Black & white				Overview map	-	
									Hiking trails (categorized by slopes)	Solid Lines	Orange, black, blue						
										Numbers	Orange, black, blue						
									Sledge tracks	Solid lines	Yellow						
13	Alcazaba de Malaga	Printed	Area plan/ map	The map tells the story of the Alcazaba, a palatial fortification of Malaga, Spain	Major spots	Numbers	Red	None	Main route	Solid lines	Red	None	Guided	Closed areas	Polygons	Beige	None
						List/Text	Black							Names of places	Text	Black	
					Description of POIs	Text	White in red							Main buildings	Polygons	Grey, brown	
														Additional Information	Photos		
															Terrain map	Green in white	
14	Durham City Walk	Printed	Handdrawn/Illustrated map	The map shows 3 different riverside routes avoiding steps in Durham, UK	Major spots	Numbers	Black in purple	None	3 main routes	Solid lines	Purple, red, blue	None	Guided	Built-up areas	Polygons	Yellow	None
						2d/3d illustration	Shades		Route instructions	Text	Black			Open spaces/parks	Polygons	Green	
						List/Text	Purple							Waterbodies	Polygons	Blue	
					Names of places	Labels	Black							Roads	Lines	White	
														Additional Information	Text	Black	
15	Disneyland Park Map	Printed	3d Illustrated map	The map gives all the information on the Disneyland park of California	Major spots	Numbers, Letters	Corresponding to zomes	None	Route	Numbers		None	Self guided	Different Zones	Shades	Similar to real park colors	None
						List	Zone color							Openspace	3d illustration	Green	
					Tourist services	2d icons	Multi-colored							Waterbodies	Polygons	Blue	
					Additional Information	Text	Black							Settlements	3d illustration	Multi-colored	
														Roads	Lines	Grey	
16	A Walk Through Soviet Bishkek, Kyrgystan	Web map (ArcGIS Story map)	Satellite imagery	A tour of 12 noteworthy places of the city of Bishkek	Major spots	Numbers	Red	click to see popup info	Main Route	Dash line	Red	None	Guided	Landscape	Satellite imagery		drag to move around
					Description of POIs	Photos								Map scale	Zoom buttons, spread, pinch		zoom in-out

						Text	Black										
						Sliders		move to other pages									
						Scrollbar		read text									
17	Soundscapes of Sequoia and Kings Canyon National Parks	Web map (ArcGIS cascade story map)	Multiple maps	A digital/virtual tour of the two parks giving the audience a real feeling of the environment through real (recorded) sounds	Major spots	2d icons	Categorized by sound		Hiking trail	Solid lines	White	None	Partially guided	Map Layout	Static maps	Multi-colored	
						symbols+ labels	White			Markers	White			Intructions & introduction	Text	White	
					Description of POIs	Audio recordings			Areas divided	Progress bar with buttons				Significant areas, boundary	Polygons	Green	
						Text	White							Navigation	Scrollbar		navigate through the story
						Photos								Map scale	Zoom buttons, double click		zoom in-out
														Additional information	Graphs		
															Video		
															Map GIF		
														Sound library	Audio with icons		click to see location on map
															Overview map		open popup
18	Aeneid: an interactive voyage	Web map (ArcGIS map journal)		A digital storymap telling the mythological & historical story (from Rome to Troy) from the books Aeneid	Major spots	2d Symbol	Black & white		Main route	Dashed line	Red	None	Guided	Landscape		Grey	drag to move
						List / sidebar			Navigation	Slidebar (clickable)				Ancient Landscape	Overview map		
					Description of POIs	Photos/ Sketches	Multi-colored							Map scale	Zoom buttons, spread,double click, pinch		zoom in-out
						Text	Black										
19	London Map	Web map	Openstreetmap	Shows 10 most significant places and 9 shopping streets and meuseums of London city	Major spots	Numbers	Red	click to see info.	None			None	Self guided	Landscape	Interactive map		drag to move
					Shopping streets	£ symbol + numbers	Purple	click to see info.						Map scale	Zoom buttons, double click		zoom in-out
					Museums	M letter + numbers	Black	click to see info.						Navigation	GPS	B&W	show user's location

					Description of POIs	Text	Black								Search bar		find location
						Photos											
						Links		see more details						Stations	Symbols	Red & blue	click to see names
20	Sightseeing oxford map	Web map	Google maps	Gives information about the 20 stops of the Oxford Bus tours	Major spots	Numbers	Red	click to see info.	Main route	Solid line	Blue	None	Partially guided	Map scale	Zoom buttons, spread, double click, pinch		zoom in-out
					Description of POIs	Text	Black		Direction button		show directio n			Places	Text	Green	click to open info
						Photos											
21	Introducing Munich	Web map	Openstreetm ap	Provides information on different kinds of touristic places of Munich	Major spots	Numbers	Categori zed	click to see popups	None			None	Self guided	Landscape	Base map		drag to move
						List/ sidebar	Categori zed	click choose categories						Map scale	Zoom buttons, double click		zoom in-out
					Description of POIs	Text	Black							Search bar			search place
						Photos								Additional Information	Menu	Red	click to open other pages
						Links	Red	click to see information									
22	From Service to Scholarship	Web map	Satellite imagery	Tells the story of the journey of an US Air National guard	Major spots	Markers	Red	click to see story page, see 360 view with arrows	Main route	Solid lines	Red	None	Guided	Landscape	Satellite imagery		drag to move
					Description of POIs	Text	Black			List/ sidebar	choose places			Map scale	Zoom buttons, spread/dou ble click, pinch	B&W	zoom in-out
						Photos								View mode (street view)	Button	Yellow	360' view linked to google maps
						Sliders	Blue	navigate story									
23	Literary Knox Walking Tour	Web map	Openstreetm ap	Tells Knoxville's literary history collected from several literature	Major spots	Markers	Red	click to open slide	Main route	Dash line	Red	None	Guided	Backgroun d	Base map	B&W	drag to move
					Description of POIs	Text	Black and grey							Map scale	Map Overview, Zoom buttons	Grey	zoom in-out

				describing the city		Photos							Inset Map		B&W	
													Navigation	Slider	B&W	move to other pages
24	The 45 minute mystery of Freddie Gray's Death	Web map	Satellite imagery	Tells the story of a 25 old boy's death from the witness' perspective	Major spots	Numbers	Yellow & white	changing color to point location	Main route	Numbers	Yellow & white	None	Guided	Background	Satellite imagery	White	
					Description of POIs	Text	Yellow & white							Navigation	Sliders	White	move to other pages
						Photos											
						Video	White	video player mode									
						Sliders	White	change slide									
25	Black route	Web map	Static map with locations	Tells the story of one family's journey from Aleppo (Syria) to Austria	Major spots	Symbols	Red-Black	point to story locations	Main route	Dash line	Red	None	Guided	Background	static map	Grey	
					Description of POIs	Text	Black							Introduction	Text	White	
						Photos								Additional	Map GIF	Dark Grey	
26	Interactive Map of Wellesley College	Web map	3d illustrated interactive map	Tells the stories of different parts of the Wellesley college campus	Major spots	3d Illustration	Blue-yellow	change color, open information	None			None	Self guided	Background	Static map	White	
						Arrow symbols	Blue-red	change color, open information						Roads	Solid lines	Black border	
					Description of POIs	Text	Black	-						Map scale	Zoom button	B&W	zoom in-out
						Photos								Additional information	Inset map		
27	Egyptian History map	Web map	Static map with locations	Tells the story from different time periods of Egypt	Major spots	Timeline /List	Beige	click to see monuments & open slide	Main route	Timeline /List	choose the places	None	Guided	Landscape	Polygons	Orange	
						Symbols	Grey							Waterbodies	Polygons	Blue	
						Icons	Black	click to open slide									
					Description of POIs	Text	Beige										
						Photos											
						Links		open new website									
28	The MET Map	Web map	2d interactive floor plan	Portrays all the sections of the	Major spots	Numbers	Grey	open information window	Main route	Dotted lines	Red	None	Partially guided	Background	Polygons	White in blue	Drag to move around

				Metropolitan Museum of Art (USA) and tells the story behind the collections		Labels	Orange, blue	open information window						Departments	Polygons	Blue border	
					Other services	2d icons (Hover)	Blue	Hover to see pop-up							Labels	Red	
					Description of POIs	Text	Black							Navigation	Sidebar (floors)	White	choose a floor
						Photos								Map scale	Zoom buttons, spread, pinch	White	Zoom in-out
29	African Safari map	Web map	Series of interconnected interactive maps	Gives a borad and elaborated picture of safaris and detailed tourist information country-wise	Major spots	numbers	Pink, Black	open information	None			None	Self guided	Overview map	Thematic interactive map	Multi-colored polygon	click to open country map
						labels	Grey, Black	-						Country map layout	Polygons	Green shades	
						List	Yellow, black	open information						Roads	Lines	Grey	
					Description of POIs	Text	Black	-						Information	Text	Black	
						Photos	-	-						Navigation	Sidebar	Yellow	select country
						Links	Blue	open other webpages							Squared boxes	White	open regionl maps
30	Kangaroo Island Map	Web map	Static map with interactive elements	The map describes the interesting tourist spots and activities throughout the Kangaroo island and lets the user make their own itinerary	Main spots	2d icons	Categorized	open popup	Routes from airport	Dashed lines	Grey	None	Partially guided	Significant areas	2d pictogram	White, brown	
						Filter button	Black	choose categories	Distance from airport	Text	Grey			Names of places	Text	White	
					Description of POIs	Text	Black							Map scale	Zoom buttons, spread, double click	Black	zoom in-out
						Photos								Search bar	Button	Black	choose POI from list
						Links	Green	open new pages, add to itinerary and see direction						Navigation	Button	Black	find location through GPS
														Language	Menu	B&W	Change language
														Additional information	Text	Black	
															Photos		
															Location map		Interactive maps

														Video		driving information
31	NYC Tour (Youvisit)	VR/AR	3d Illustrated map, virtual tour	A virtual tour of 11 most significant places of New York	Major spots	360 view		Drag to see around	Main route	List / sidebar		choose location	Self guided	Backgroun d	360 view		drag to see around
						Sidebar		Choose POI		Sliders		go to next location		Introductio n	Video		video player mode
					Description of POIs	Audio		replace narration with text		Markers		choose location from map		Additional information	Illustrated map		click markers to link the tour
						Text	White							Map Scale	Zoom map		zoom in-out, pan
						Photos		choose from multiple									
						Video											
						2d icons	White	Click to open popup pages									
32	Dresden 360 Interactive Experience	VR/AR	Virtual tour	A virtual tour of 11 most significant places of New York	Major spots	Markers	Yellow	zoom to particular area, popup		List/ sidebar		choose a location	Self guided	Backgroun d	360 view		Drag to see around
						Sidebar				Overview map		with clickable markers		View mode	Button	White	virtual mode on
					Description of POIs	Photos								Map scale	Spread, Double click, Pinch		zoom in-out
						Text	Black							Control Mode	Button	White	choose from two different dragging options
33	Peakfinder	VR/AR	AR app for Android	It shows the names of all mountains and peaks with a 360° panorama display offline	Major spots	Label/Text	B&W	see information	None	Camera view		Move camera to navigate	Self guided	View mode	Camera button	Blue	Click to see around
														GPS	GPS button	Black and white	see the view from current location
														Navigation	Fly up button	Black	see bird eye view
															Sliders	Black	set compass, visility range, change time

														Compass icon	Black	calibrate compass
													Additional features	2d bird icon	Black	see the landscape behind mountains
														Shutter button	Black	take photo
														Photo editor	Black	edit, export and share photo
														Telescope button	Black	zoom to a particular spot
														List of visible peaks	Black	see all mountains visible from current position
														Coverage button	Black	add or remove surrounding areas
34	Horizon explorer	VR/AR	AR app for Android	It shows the names, surrounding areas and other information on the pointed landmarks	Major spots	Markers	Black	align to see additional information	Direction to landmark	Drop Marker	Red & blue	Connects to google map	Self guided	Terrain map	3d map button	B&W	see terrain and hills
						Labels (names, altitude, distance)	White							Map layout	Button		change map mode
														Search bar	Button	Blue	display 3D-maps
														Navigation	360		get a bird's eye view
															Scroll		drag the map
														Additional information	Overview map		see the surroundings
															Pop-up text	Black	
															Pop-up photos		
															Links		to wikipedia page
															Menu	Blue	filter information, chage language

35	Chicago00: The Eastland Disaster	VR/AR	AR app for tablet	The app gives users an experience with the history of Chicago using AR and VR on the Chicago riverwalk	Major stops	360 view		see information	Route around the riverwalk	Solid line	Red	Move camera to find location	Guided	Overview map	Button		see the whole area
						List/ gallery	Photos	choose location						View mode	Overlay model	Grey	Drag to align
					Description of POIs	Photos	B&W	swipe the screen						Navigation	Home	White	main menu
						Zoom		zoom in-out, drag, pinch							Compass	White	align the view
						Videos	B&W	Swipe to see more							Info button	White	info. about app
						Text	White	-						Additional features	Camera button	White	take a screenshot
36	**Viewranger**	VR/AR	AR app for Android	The app shows trails for hiking, bike ride, backpacking trip, ski holiday, or outdoor adventure for travelers	Major spots	Label	White	activate additional information	Direction to landmark on the map	Arrowed Lines	Blue	Input destination and see the direction from current GPS location	Self guided	Overview map	Map button	White	see the terrain map and drag around
					Description of POIs	Photos			Direction to landmark on the camera View	Arrows	Blue	Choose destination on camera view and see the direction from current GPS location		Map scale	Zoom buttons, spread, pinch	White	zoom in-out
						Additional maps								Navigation	Explore button	White	open map view of any location
															Location button	Black and white	see current location on map
															AR cam button	Black and white	open the camera view
														Additional info./Features	Hamburger button	B&W	open new info
															Filter buttons	Blue & white	customize activities, route length, difficulty level and check user ratings

														GPS tracking		record tracks and see live stats: time, speed, distance, sunrise and sunset
37	**Buenos Aires Travel Guide AR**	VR/AR	AR app for Apple iphone and ipad	The app gives all the necesarry information for tourists to explore the city of Buenos Aires, Argentina	Major spots	Icons	Categorized	open moe information	Direction to selected spots on the map	Markers		To choose a location on the map and find direction	Partially guided	Background	Camera vieww		see the surroundings through device's camera
														Overview map	Street map		see surroundings and landscape
					Description of POIs	Text	Black							Navigation	Home button	Blue	To go the main page
						Photos								GPS	GPS button	Red	see current location on map
						Links, icons	Blue	see more info.						Map scale	Double click, spread, pinch		zoom in-out
														Additional Features	Filter icons (on map)	Categorized	customize type of place
															Audio		more info.
															Menu/list		sights, shopping centers and restaurants
38	**Carnuntum App**	VR/AR	AR app for all devices	This app lets the user experience seven ancient buildings that were ruined/disappeared for thousands of years	Major spots	Markers		choose AR/VR view	None	Camera view		move camera to navigate	Self guided	Background	Camera view		see and idetify spots
						3d VR models		move camera to see ancient landmarks						Main menu	Buttons	Red	see app information, choose language
					Description of POIS	View mode buttons	Red	choose from AR or VR to see recon-structions							Text	Black	
						List		choose ancient objects							Icons	Red	see location map
														Navigation	Scan button	Red	scan barcode to track spots

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Appendix C

Table: Elements used to indicate POIs in the selected samples

Medium	Map No.	Numbers	Letters	Markers	Symbols	Labels (names)	No element/ Camera view	2d/3d Illustrations	Icons	Filter	List/ Legend/ Sidebar
Printed maps	1	√				√		√	√		
	2	√			√	√		√	√		
	3	√	√		√	√		√			√
	4	√			√	√		√			
	5	√									
	6	√	√	√	√				√		
	7	√	√						√		√
	8				√			√	√		√
	9	√	√			√					
	10	√	√						√		
	11	√	√						√		
	12								√		
	13	√									√
	14	√				√		√			√
	15	√	√						√		√
Webmaps	16	√									
	17				√	√			√		
	18				√						√
	19	√	√		√						
	20	√									
	21	√									√
	22			√							
	23			√							
	24	√									
	25				√						
	26				√			√			
	27				√				√		√
	28	√				√			√		
	29	√				√					√
	30								√	√	
AR / VR	31						√				√
	32			√							√
	33					√					
	34			√		√					
	35						√				√
	36					√					
	37								√		
	38			√				√			

Table: Elements used to communicate stories in the selected samples

Medium	Map No.	Icons	Filter	List/ Legend/ Sidebar	Text	Photos	Popup	Sliders/ swipe	Links/ websites	Ads	Table/ graphs	Audio	Video	Scrollbar
Printed maps	1				√	√								
	2				√						√			
	3				√	√								
	4				√	√								
	5				√	√								
	6				√	√			√	√				
	7				√									
	8				√									
	9				√	√								
	10													
	11													
	12													
	13													
	14													
	15													
Web maps	16				√	√		√						√
	17	√			√	√	√				√	√	√	
	18				√	√								
	19				√	√	√		√					
	20				√	√	√							
	21		√		√	√	√		√					
	22				√	√		√						
	23				√	√								
	24				√	√		√					√	
	25				√	√								
	26				√	√								
	27				√	√			√					
	28				√	√								
	29		√		√	√			√					
	30		√		√	√	√		√				√	
AR / VR	31	√			√	√	√	√	√			√	√	
	32			√	√	√	√							
	33							√						√
	34		√	√	√	√	√		√					
	35				√	√		√					√	
	36		√											
	37	√	√		√	√			√			√		√
	38			√		√								√

Table: Elements used to visualize route in the selected samples

Medium	Map No.	Solid lines	Dashed lines	Arrow-ed line	Dotted lines	Num-ber	Dis-tance	Line + Number	Line + symbol	Map	Text	Symbol + number	Marker	List/ sidebar	Slider	Arrow	No element / 360 view
Printed maps	1	√	√														
	2	√															
	3	√															
	4	√	√	√													
	5	√	√					√		√	√						
	6	√	√			√											
	7		√														√
	8	√										√					√
	9	√															
	10			√	√												
	11																√
	12	√	√			√		√	√								
	13	√	√														
	14	√									√						
	15					√											
Web maps	16		√														
	17	√											√	√			
	18		√											√			
	19																√
	20	√															
	21																√
	22	√												√			
	23		√														
	24					√											
	25		√														
	26																√
	27													√			
	28				√												
	29																√
	30		√								√						
AR / VR	31												√	√	√		
	32									√				√			
	33																√
	34												√				
	35	√															
	36			√												√	
	37												√				
	38																√

Table: Elements used to communicate additional information in the selected samples

Medium	Map No.	2D/3D Illustration	List/ legend/ sidebar	Text	Photo	Grid	Overview map	Additional map	Transit map	Close-up map	Search bar	Menu	GPS	View mode	Zooming	Panning
Printed maps	1	√							√							
	2									√						
	3						√									
	4					√			√							
	5			√	√		√	√								
	6			√	√	√			√							
	7			√	√											
	8		√	√		√			√	√						
	9			√	√											
	10	√		√	√											
	11	√	√	√	√											
	12			√	√		√			√						
	13			√	√			√								
	14			√												
	15	√														
Web maps	16														√	√
	17			√			√	√							√	
	18						√								√	√
	19										√		√		√	√
	20														√	√
	21										√	√			√	√
	22														√	√
	23						√								√	√
	24															
	25			√												
	26						√								√	√
	27															
	28		√	√											√	√
	29			√			√									
	30	√		√	√						√	√	√	√	√	√
AR / VR	31						√							√	√	√
	32											√		√	√	
	33		√							√			√			
	34									√	√	√	√	√	√	
	35						√						√		√	
	36						√				√		√	√	√	
	37						√					√	√	√	√	
	38	√	√	√	√		√					√		√		√

Table: Distribution/occurrence of elements used for POIs, stories and additional info. in the selected samples

Elements Used	POI			Information on POI/Storyline			Additional Informaiton		
	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)
Numbers	13	7							
Letters	7	1							
Markers	1	2	3						
Symbols	5	6							
Labels (names)	6	3	3						
No elements/Camera view			2						
Icons	9	4	1		1	2			
Filter		1			3	3			
2d/3d Illustrations	6	1	1				4	1	1
List/Legend/Sidebar	6	4	3			2	2	1	2
Text (long)				9	15	5	10	2	1
Photos/sketches				6	15	6	8	2	1
Popup Window					5	3			
Sliders/swipe					3	3			
Links				1	6	3			
Ads				2					
Table/graph				2	1				
Audio					1	2			
Video					3	2			
Scroll bar					1	3			
Map grid							3		
Overview/inset map(s)							3	5	5
Additional map(s)							2		
Transit map(s)							4		
Close-up map(s)/button							3		2
Search bar								3	2
Menu/settings button								2	4
GPS button								2	5
View mode (Map/Camera) button								1	6
Zooming								11	6
Panning								10	2

Table: Percentage of occurrence of elements used for POIs, stories and additional info. in the selected samples

Elements Used	POI			Information on POI/Storyline			Additional Informaiton		
	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)	Printed Maps (15)	Web Maps (15)	VR/AR (8)
Numbers	87%	47%							
Letters	47%	7%							
Markers	7%	13%	38%						
Symbols	33%	40%							
Labels (names)	40%	20%	38%						
No elements/Camera view			25%						
Icons	60%	27%	13%		7%	25%			
Filter		7%			20%	38%			
2d/3d Illustrations	40%	7%	13%				27%	7%	13%
List/Legend/Sidebar	40%	27%	38%			25%	13%	7%	25%
Text (long)				60%	100%	63%	67%	13%	13%
Photos/sketches				40%	100%	75%	53%	13%	13%
Popup Window					33%	38%			
Sliders/swipe					20%	38%			
Links				7%	40%	38%			
Ads				13%					
Table/graph				13%	7%				
Audio					7%	25%			
Video					20%	25%			
Scroll bar					7%	38%			
Map grid							20%		
Overview/inset map(s)							20%	33%	63%
Additional map(s)							13%		
Transit map(s)							27%		
Close-up map(s)/button							20%		25%
Search bar								20%	25%
Menu/settings button								13%	50%
GPS button								13%	63%
View mode (Map/Camera) button								7%	75%
Zooming								73%	75%
Panning								67%	25%

Table: Occurrence and percentage of elements used for route visualization in the selected samples

Elements Used	Printed Maps (15)		Web/online Maps (15)		VR/AR (8)	
	Total	%	Total	%	Total	%
Solid lines	11	73	3	20	1	13
Dashed lines	7	47	5	33.3		
Arrowed lines	2	13			1	13
Dotted lines	1	7	1	6.7		
Numbers	3	20	1	6.7		
Distance			1	6.7		
Lines + numbers	2	13				
Lines + symbols	1	7				
Route maps	1	7			1	13
Text	2	13	1	6.7		
Symbols + numbers	1	7				
Markers			2	13.3	3	38
Timeline/list			3	20	2	25
Sliders			1	7	1	13
Pointers/arrows					1	13
No element(Web)/Camera view(AR)	3	20	4	26.7	2	25

Appendix D

Cartography M.Sc.

Usability evaluation for the TUM AR mockup – a semi-structured interview

(Approximate duration ≈ 1 hour)

1. Introduction

- Greetings
- Briefing about the interview (duration, recording process, steps of the interviews…)

2. Collecting personal information

a) Name:
b) Gender:
c) Age:
d) Nationality:
e) Profession/background:
f) Are you familiar with the TUM campus?
g) Do you have any experience with AR apps?

3. Giving information on the topic (if necessary)

a) Introduction to AR
b) How an AR application works
c) Showing an example from the collected samples

4. Asking for user requirements

Q. What kind of information would you like to have in a campus tour app and how would you like them to be visualized in the context of…

a) Points of interest (POIs)
b) Route: visual element for route direction, starting and ending points
c) Story: content and visual elements

5. Mockup demonstration

A supervised demonstration of the Marvel mockup where the user has to navigate their way through the campus to finish the following tasks while thinking aloud. An overview of the campus will be given to the tourist group before starting the tasks.

Tasks:

I. For the guided route –> go from the ***Entrance*** to ***TUM shop*** to ***Audimax***
II. For the self-guided route –> go from ***Audimax*** to ***Inside/out***

*The reactions and opinions while navigating the mockups will be recorded

Usability evaluation for the TUM AR mockup – a semi-structured interview

(Approximate duration ≈ 1 hour)

6. Post-interview questions

Since the questions are open-ended, the sequence or the follow-up questions might be different for each participant. The general structure of the questions are given below:

A. What was your overall impression on the application design (the interface, navigation, visual elements, etc.)?

   I. Positive aspects:

   II. Negative aspects:

B. How helpful was the route function in the mockup? Would you prefer any other way (e.g., avatars, arrows, audio, etc.) to visualize it?

C. How did you feel about the storytelling elements (e.g., texts, photos, videos, and links)? What would you add/change?

D. Would you prefer to have any other kind of information/contect included in the app? If yes, what?

E. Do you find any information/content not useful for you in the app?

F. Do you think an AR app would be useful for a campus tour? When and for whom?

G. Would you prefer this kind of app over other forms such as paper maps, audio guides, human guides, etc.? Why or why not?

H. What other kind of stories/tours would you like to explore with such kind of an application? Where else do you think it might be useful?

Consent to Participate in the User Study (TU Munich)

Thank you for finding time for the user test, which is conducted by **Nuzhat Tabassum Nawshin**, master student of the Technical University of Munich. It is organized within my work on the master thesis with the topic **"A Systematic Approach to Designing Cartographic Stories in Augmented Reality (AR)"**.

The test will be in the form of a semi-structured interview that consists of three parts - an introductory section, the task (exploring the mockup designs), followed by a short questionnaire to be answered and discussed in person. The aim is to perform an exploratory research on the usability of the created mockups to evaluate the applicability of AR into cartographic stories. For these reasons, the conversation and interactions will be recorded. You are kindly asked to think aloud during the task to provide a better understanding of your interactions within the test.

Confidentiality and Rights

This study is anonymous and is not aimed to collect or retain any personal information. All the records and data gained from the test will be anonymized and used only within the work of the master thesis research. The decision to participate in this study is entirely up to you. You may refuse to take part in the study at any time. You have the right to ask questions about this research study and to have those questions answered by the student before, during or after the research.

Consent

• I have been informed on the procedure and purpose of the study and my questions have been answered to my satisfaction.

• I have volunteered to take part in this study and agree that during the study information is recorded. This information may only be used for research purpose with the possible subsequent publication of the thesis on a conference or in a journal.

• I understand that my participation in this study is confidential. All personal information and individual results will not be released to third parties without my written consent.

• I understand that I can withdraw from participation in the study at any time.

Subject's Name: _____

Subject's Signature: _____ Date: _____

Interview transcripts

Participant 01

31.01.2021

(Textile engineer, Bangladesh)

Good evening and thank you for taking the time to participate in my user study. This is a part of my master's thesis on designing cartographic stories in augmented reality. The interview will be in a semi-structured or guided interview format where I ask you some open questions and you will interact with some mockup designs with screen sharing on. The whole thing should take about 30 to 40 minutes.

So first, I will need some personal information from your side: your name, age and profession […]

And are you familiar with the TU Munich campus?
No, I'm not.

Do you have any prior experience with augmented reality applications?
Umm… I don't think so.

Yeah, so I can give you a brief idea. So, in augmented reality, you get to see your surroundings, the real world view in the background. But there's extra information added on that view. So for example, you can use your camera, in your phone, so you see the real environment through the camera view. And then there will be some layer of digital information on the screen. It could be texts, photos, graphs, videos and so on. So it combines the real information and augmented or digital information on the same screen.
Oh okay. I get it.

If you want, I can show you a small example, it's just a glimpse of an app (https://www.youtube.com/watch?v=-qgR_b11cQA&ab_channel=etipsmobile) […]

Now if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus what type of information would you like to have there? How would you prefer to see the starting and ending points? How can you imagine the route to be visualized on the screen?

So since we already have Google maps in our phone, location can be tracked from there anytime. So it would be really great if in the app I can put the name of the place I want to visit, then the app shows me that. Okay, so the, your preferred location, or it can like pop up in the app that, okay, you're two minutes away from your destination. Then when I'm at, I am at my destination, it can tell me that. Okay you have reached or something.

What information I want to have? I mean, the app can automatic ask. There can be a button like if I want to know when it was established I can or something else. Am I on the right track? I'm confused.

There's no wrong track here.

Okay, I mean, If I click on when I'm on the destination in front of the gate, I can see when it was established, and then maybe I can get inside and get a map. Like, if you go right, then you will find the library. If you go left, there will be a cafeteria like this, then I can choose from a small map where I want to go first.

So, okay you'd like to see an overview map I see. With the camera view though, how would like to see the points?

So like the video you showed, this is what's coming in my mind that there will be a small button popping up on the monument or anything? Yeah. And as I said a map would be useful to tell me what's in the left or right.

Maybe it will be more interesting if I can just see a photo of the place. Or if it's too much in the screen, maybe just arrows or something like an avatar flying like follow me.

Which one you would prefer more like a line taking you to the next spot or just arrows in the intersections on the road, or an avatar like it's always in front of you and you're just following?

An avatar sounds interesting! But it I mean, not everyone will prefer that.

About the story or the information to be shown on the locations… what kind of information would you like to get about the place? And in what format? Would you like to have some texts, or some other form?

Photo options should be available there. And written forms. I mean, sometimes we want to hear the ambience around us for that voice can be destructive for that place, like I want to hear the crowd and so, written form will be better for me. But also, sometimes I want to ignore the crowd too. So there should be options. And in written form too much information will not be interesting, it will be better if there is some key words like, like, there is a temple there. So, you mentioned the name of the temple like that.

So you just see the name of the places, and then you choose something like that? So labels, I would say.

What other kind of information would you like to have as a tourist, what would you want to know about a place in general?

I'd like to know the history, when it was established and maybe some highlights.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs of a tour app […]

Okay, you're now seeing the first page of the app, you can read through and tell me what you get from here.

So the first one is the tour, then check your location first. Then started from the main entrance to the name of the street, where you should start. Okay, so this is where I move my camera around to find the place.

And when it identifies that this is the building, this is the next screen that will come up.

Now, the middle button is for me to write something?

Not really. It is the icon for the information.

Oh. Okay. So I see some text and some icons over it. Oh okay! I can read the information. Ok. The first three icons are very clear but for the i I was confused. Maybe you can use smallboxes with names on it.

So if you want to know more about the place there is a link to a video. The second option is for audio like you said it. If you don't want to read through the text. This is for additional information, this will take you to the University website or some other relevant page about the location. Here you can find some photos.

Oh, I see some old photos. So I think here you can have small boxes with names of the icons like in photoshop. Some icons are obvious. But if you want to use more options, you can use that. So, like for I was confused here, what does this i mean? The first three was very clear. But this icon is like chat icon, I thought that I can click here and get to write something. But it's given me information.

Okay, About that… would you like the option to write something in the app?

If I want to write something, I think that will that will that should not be authentic. I mean, the app should not allow this because different people can write different things. And if everything I mean is saved in this app, then the information might get violated real information.

Okay, let's see the other options here.

There could different options for me to click and choose like history, map, famous items, popular places, different types of options for information to choose.

In the top, this is a menu… list of places, settings.

Settings would be for the general app settings there, help for any terms or any buttons that you don't understand. The list of places, is for you to have a list of the places and you can choose from that list that okay, I want to get the info from there. You don't have to use a map or you don't have to wait for the app to take you there. You can use the filter to find specific type of places like cafes or monuments and so on.

Okay. That's useful! Okay. I will start with this.

This one is taking you to the next stop from the entrance. So you understand what happened right now?

You can see you're entering the building and it stops in front of the shop, the TUM shop. So the layout for the information is the same as the first one. So there's no confusion with the buttons and everything. This is just shown here as a GIF. But in real life, you will be walking through the paces, and you saw the line that was taking you. So was, do you think that would be useful? To follow through?

To guide? Maybe an avatar would be good!

Okay. So this line is not working for you.

Lines, okay. But Avatar will be more interesting for me.

Okay, here on the bottom, the second button. You see, yeah, this is to show you your current location. Yeah, so this is the map of the whole building. so you know where you started from you saw in the previous map, you were on the street in the middle, at bottom, and now you're in front of the shop. So you have covered this part this way.

So it's like Google Maps, you see your GPS points, like now I'm here, only that. Okay.

And then you can close it. And the last button here, it's just to help with the connection, so if you want to recognize the building again you can always scan again and you get the information back on the screen. So now you go to the next step. You remember the route button?

Umm…route button, this? No.

Okay, so one difficulty found! This button is not very intuitive for you?

Well, Maybe you can make it bolder so it's more visible.

Okay. And now you're at the third location. You can see the info, it's in the same format

Yeah, I see. It's a lecture hall. The photos from inside! Oh this is very large!

So this was the first option, the guided tour. For the second, you can go back to the homepage. For the second option you can choose the places.

Yeah. So I can interact with the map?

Yes, of course. So here, you can choose from the map here directly where to go and get the same info as before. And here you can choose the route button. In the app, you can search for the places. Here, you can click and select. So from Audimax to the last one Inside out. And you get the route again.

Ah so the line and there's a map too!

Yeah, and that's pretty much it. So, this was just an example. You can imagine what the rest of the app might look like.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

I like the options that you have kept in the app like the voice guide, youtube, the written form of information as well. And also the pictures. I was having some issue finding the map, I mean the route. Could be my screen or you can make it a bit more visible.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

I think it's helpful but I'd prefer an avatar. It's more fun.

3. So about the storytelling elements, like the text, photos, videos and other options, would you like to add or change something?

I think there were enough options and that's enough.

4. Would you like to have some other kind of information included in the app, about the campus, or some functionality?

Specifically, for a university, I think it was quite enough. But if it was another place like a museum the requirements might be different. Like there, there could be different kind of information. You can put different icons, like for history, there could be a specific icon, there could be another icon for the departments. I mean, if I click somewhere, there could be three, four options. And I can choose from there, what kind of info I want. So the app is working for me as a guide, right? Yeah. It can show I mean, history maps, famous items, popular places like this.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, I think they were useful.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Yes, I think considering the structure, it will be useful for students.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

So personally I prefer more human contact than technological help. First, I'd like to find something on my own. I'd like to find a paper map or a human guide. But in case I don't have any of those then this app might be really helpful.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

For a tour to a big museum. Or like any place to visit like a lake and if I can get more info on the lake and this kind of places it will be very useful. Also, in remote places like if I go for a hike, and there is a chance I might get lost then this kind of an app would be really helpful.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 02

31.01.2021

(MSc. Student, Geoscience, USA)

Thank you for […]

And are you familiar with the TU Munich campus?

No, I'm not familiar with your campus.

Do you have any prior experience with augmented reality applications?

No, no, I have no idea. Can you please enlighten me?

Okay, do you have any idea about virtual reality?

No.

So basically, augmented reality is, imagine you're using an app on your phone, where you're using your camera. So, you can see everything around you through your camera. But you can also see some additional information about those places on screen. So, it will be like, an extra layer of information that's overlaid on the real-world information.

Is that going to interfere with the personal information and all? Like, is it going to cost anyone's privacy issues?

No, of course not. For example, your Imagine you're at the Eiffel Tower and you point your camera towards the tower, and it will recognize the structure. You, will get some additional information, for example, when it was built, or its history and activities that you can do around it. So those kinds of things you'll see on your mobile screen.

So, you can see the surroundings, enjoy the view. And at the same time, you get to learn? That will be helpful for anyone specially tourists. Okay I get the idea. So.

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

I would definitely want to see the history behind it and also what other places I should see and also the attractive places in around.

Okay, so if it's a guided tour, for example, the app is guiding you to a place. So, there should be a starting point. And there should be an ending point like the destination, the place of interest. And you, you will definitely want the app to take you to that location like it should give you a route. How would you prefer the app to show you the route like go to that direction? It could be lines, labels, arrows, avatar, maps anything?

I would prefer navigation icon or something? Like, when I move my hands, it can show me You should go this way. And that way. I think that would be great. But I don't like any avatar, actually. Because I don't want any, any cartoon character? I don't think so. So, yeah, definitely prefer an arrow or navigation icon, maybe a line, perhaps.

And another thing, like for the starting and ending point, Like this is the point where I should start from, and that's the building that I should be looking at it there should be some kind of pointer. Yeah. How would you imagine that?

Like a pinpoint or something? It should work. It will be like handy, I guess.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

I think an audio. Audio will be great, because when you are traveling somewhere, it's really hard to just look at your phone and read all the passages and it, it kind of gets boring. So I think I would prefer audio, to any other. And Maybe some photos? Videos is going to be lengthy I guess. I think photos and audio tools is perfect.

Mockup demonstration

Okay. So we can move to the next section, I will show you some mockup designs […]

So yeah, you can see the app display now. It's the first screen.

Yeah, yeah. Should I start the tour or choose from the map. Okay, I'm just clicking the first option I'm getting that is a guided tour. So, yeah, I'm taking it. Okay. So, yeah, I am under impression I should click the go option or something?

Okay, here your camera will start working automatically and it will say that move your camera to find the spot. Now when it identifies the building, then it gives you this display. So you can look through the options from the top.

Okay, this option, the arrow thing. Yeah, it can move me back? Oh, yeah. And. Okay. So, this icon I can find on my right, right most top it is suggesting something. So yeah it is the menu, homepage, places and settings and all. Is there a chat option that I can find in the middle?

No. This is actually supposed to be the information icon. Like you said, Oh, when you see a place of interest? You need you need something to pinpoint that. Okay, this is the place and you get information about this place.

Okay. Yeah, you're entering TUM. One of the leading universities of Munich and establishing. Oh, so, yeah, information…I can hear an audio? Okay, video option.

And if you want more information, you can click,

I can always learn more from it now. Okay,

Okay, you on the top, you have some options you know, like images?

Okay. Yes. And, I can hear it from the audio, right? I got it ok. And what is the play option?

That's a video link, you can click on that one.

Okay. A video about the university. This is from YouTube here. I think it's five minutes. So I'll skip. And what is this information? Okay. Do I have to read the whole thing?

No, you don't have to read. It's just to give you an idea. So this is taking you to the university page where you can get more information about the campus.

Okay now back? Okay This one. I can find an arrow option here. Yeah, it is taking me to the hall.

Yes, and… as you can see, it's taking you to the next stop.

Oh, yeah. This is a shop.

This is the second location. So, you understood what this button here did?

Yeah, Yeah. Took me to the next point?

Yeah, exactly. And the one below there, that one. What do you think?

Oh, yeah, its saying me that I am in the next position right now. That that is my current location.

Exactly. So if you ever need to align your camera with the view, you can use that Scan button. So, you can click to the next location again.

So in the real app, I will be walking through this hallway. I see a cafe there. Oh so this is the third location. It's the lecture hall. And yeah, the information layout is the same. I think it's okay. I think I can see some images of the lecture hall in there. As you have mentioned earlier, so, yeah. Got the idea.

Okay, so this was the guided portion of the app. Now, you can go to the menu again.

To go back to the menu, okay. Yeah. Okay. Just from the map. Okay, here,

You can see all the four locations that are shown inside the app. Just for example, you can click on one, two or three.

Okay, I'm clicking two. Oh the TUM shop. Okay, got it! It's not taking me to the place?

Not from the map, but here on the top, you can again find the root button. Second one. Yeah. And from here, you can choose so here in the app, you can write it, but here you can click and choose.

From audimax, okay. And here are the last one.

And now you see how this one works. So it will take you again, showing you the route.
And it's also showing the map. Yeah. So it's really handy. Actually, the app will be like a guide for someone who's new to a place. So yeah, I find it really fascinating.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

I like the options that just pointing me where I should go is really handy. And also, the historical background and images that is providing me. And yeah, that is really great. I think, for someone who's new to someplace it's really handy. And the negative aspect is really hard to find. Because I think everything is, like great the way it is now. I can say that there. No, I have nothing in mind to find out as a bit negative aspect. Maybe the icon…It looked like a chat option! But the whole design of the app is really great to me. It's really like a textbook. You can click and see everything. Really friendly for a first time user.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

No avatar, I guess, because we are not playing Pokemon Go here. I think the arrow is really great the way it is now. And everything as it was, it is really fine, I guess. And it is really, really handy. It can show you that you're on the right direction or not. It is not required o change something here. So it is really great. I think.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? And you add/change something there? Like the format?

I don't think so. Because There are enough options I think. Any other format… doesn't come to my mind.

4. Would you like add anything? Any other information? Like, content wise?

No, I think everything was enough. When someone go to a place as a tourist, they want to just enjoy that place. Not thinking about the graphs and statistics? No. No, I think it is, it is enough the way it is.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

It was useful for me the whole thing. So, No. I know you want a home option. And also you need to see the picture options and all I think it is all necessary.

6. Would you think an app like this would be useful for a campus tour?

Yeah, I think it is. It is really, it is going to be helpful for the new students and their parents to just see a campus because most of the universities just encourage people to see their campus. And it can be handy I guess, for both the parents and university students and the students they are want to get enrolled. So yeah, I think it is good for a campus. Because you don't need a professor just to show you all the places all the time.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Those are like really outdated options, paper maps. So, people are more likely to like, think that they are having an app on their mobile. So yeah, I would recommend the app over paper maps. Yeah.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

I think most of the tourist locations, like city tours and also, the historical places or museums, it will be really helpful for them, because most of the times tourists require a guide. So if they have an app on their mobile, so it will be really less of a problem or anything. So, I'm just thinking about USA tourist spots or Washington DC and monuments, Abraham Lincoln monuments so this will be handy for those who are new to those places. So they can learn the history and all and also explore new things. It will be really time saver for them.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 03

31.01.2021

(PhD student, Groundwater and Global Change, Germany)

Thank you for […]

And are you familiar with the TU Munich campus?

No, I'm not.

Do you have any prior experience with augmented reality applications?

If I have understood what augmented reality correctly, then we have seen the 3d animations in different museums or cinema halls where we can see the 3d version of everything wearing glasses. So if that's augmented reality, then I think I have that experience.

Yeah, so what you've described for museums, that could be augmented reality, or that can be virtual reality. So in a virtual reality experience, everything you see is digital information, everything is computerized. In augmented reality, you get to see your surroundings, the real world view in the background. But there's extra information added on that view. So for example, you can use your camera, in your phone, so you see the real environment in camera view. And then there will be some layer of information on the screen. So it combines the real information and augmented or digital information on the same screen.

Ah! Maybe I have seen that… umm with Benedict Cumberbatch… in Sherlock Holmes! He was wearing…umm no not wearing but he was thinking and everything was the information of the photos were coming side by side.

Okay!!!

If you want, I can show you a small example, […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

I would say that the name some important buildings or monuments. So it's first just locating them. Because I as a traveler, I don't know where is what exactly. So then it could be like Google Map, where you can see the direction. So first, they will give you some direction… suppose you are in Louvre Museum, and you want to see the Mona Lisa, art, but you don't know exactly where it is. So this app can give you direction. And maybe when you are following the direction, you can also see some other famous or important art, just around like, you can see, okay, this is Michelangelo's statue. Because you of course, you don't know everything. It could be something you are, you are not familiar with.

So, you would like to get an overview of the whole area first?

First of all, yes, an overview.

Would you imagine that with a map or some other way?

I would say as it's working with the reality, so the exact same structure or the image, not the map version, it could be a real image, but then on the real image, it will give the prediction and also the name of the important stuffs.

How would you prefer to see the locations? like the starting point? And the point that you're directed to? How can you imagine them to be visualized on the screen?

I suppose I will start, like I will give the starting point to the app, not app will give me a starting point. So the app, we already have all the information of that building or of that area. So whenever I'm starting the app, and when it's matching the location, then automatically it will say that this is my starting point. Now show me around. So it's not like totally the way museum exhibition happens like they will give you certain direction that okay, go in this direction. It will be like, it's up to me, wherever I want to go.

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

I think it can use vocal or audio part, instead of showing directly on the map or on the image. The audio one would be less messy for the visualization because if you have lots of information on one image, then it will be very messy and you will not be able to catch the important or interesting facts. So I think it will be easier if the audio works at the same time the visualization works.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

First of all, if can be based on the purpose of the app, they will ask you some questions regarding your interests. Based on that, it can show you some selected point of interests that might be interesting for you.

Then, I will say, the text might give only the name of that point of interest. Just the name. And then if you click on the name, then it can start telling you the audio version, the details, the history. But on the map or in visualization, I suppose that would be easier if you have only the names.

What other kind of information would you like to have as a tourist, what would you want to know about a place in general?

I think I will go for the history. It's personal choice. And then I think with the history, you'll cover almost everything who has been here or whatever, important events have taken place here.

You would like to have that in audio format?

Yes, in an audio format.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Ok.

So this is the first screen of the application. I see some instructions. So now I have to choose between these two option?

Yeah, so the first option is where the app is guiding you to the place. And the second option where you can choose your starting point and where you want to go. Yeah, you can start with the first one.

Okay. I can see the map and one building and the roads. And I'm standing in front of the entrance of the building. Here I go.

This is supposed to be our camera view. And it should tell you that you can move your camera to identify the building when you point in the right direction and it knows that this is the building, it will give you this screen with information.

So "you're entering one of the leading universities of Munich". So learn more will give me more information?

Yes. You can click.

Oh! I don't want to read the text. What's this? Oh, the audio! There will be lots of people like me who are lazy, who doesn't want to read. There's some old pictures. A video. The website… Okay.

Yeah this would be specific to the POI. If it's a dept, you can go to the university pages, or if it's a monument, and there's an article about that monument somewhere, it will direct you to that website.

And what's the point of this menu button?

This is to navigate through the app. So this will be available in every page in the app. So, there will be an option to go to go back to homepage. Settings as general settings for the app, and help will be there to explain some terms or some buttons that you might get confused about. In the list pf places, you'll see all the stops of the tour and you can find the info again from there. You can also try filtering.

Okay. That's useful! And then… this is the route to try?

Yes, this is where you're walking to your next destination. The gif is to give you the feeling of movement a bit.

Ok! And the information again? And what's this button, ah, your current location?

Yeah so you don't get lost, you will always know where you are.

And this scan button?

So, when you move your camera too much the connection might get lost sometimes, or if you want to go back and see the info again you can click this one.

Ah so I scan the real building and then it will come again? Ok. The information in the popups is the same format? Ok.

Here you can see the website of the TUM shop, you can do some online shopping. Next, you can go to the next stop. So the idea is pretty much the same.

Okay, so I just walked through the whole building?

Yes, now you're in the yard. This is another building. And this is the outside of a lecture hall.

Okay, so I see the photos from inside.

So this was the first option, the guided tour. For the second, you can go back to the homepage.

Yeah. So I see the map from here. And I can choose?

Yes, If you don't want to start from the main entrance, you can take any other entrance and you can choose from the map here directly where to go.

But I don't know where are other entrances.

Yeah, here, it is only showing the selected places for the mockups. In the app you can see your location and choose from other entrances and any other spots.

Okay, so I have only one option to use just for now. So with the map, there will be these options to zoom in and out?

Yes, it will be an interactive map with all these options, so kind of like Google Maps.

Okay. So when I click on one of the points, it just takes you to the same info page?

Yes, the difference is you are choosing the spot now, but the information are all put in the same layout.

Yes, yeah. And what about this on top?

This is the route button same as before. But here you can put your location manually. You can type here directly. So you can choose a starting point. And then if you click on inside/out, yeah so you will see the camera is showing you the route again. And also with the map. You can see your GPS location moving.

Ah so this is the last spot?

Yes, that's pretty much it. So, this was just an example. And you can imagine what the rest of the app might look like.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

For me, it was quite easy to operate. And it looks also nice. Like when I see the blue color, it's pleasant for the eyes. And all the options are also pretty much easy to find or understand. So I think it's very good.

The White and Blue combination I used, it's actually the color of the university. So, did you have any difficulties?

No, it was quite easy.

2. How helpful do you think was the route function?

Yeah, it's, as I said, I will prefer this one. In my earlier talk, I said that I want the directions to be on the map. It's showing from which side to which side or left side right side, where I should go? So I think it's helpful.

So you like the version with the map below, showing you're going through this route?

Yes. And also, like, the first one where the map or the app is telling me the starting point. Here, there you can use showed the tick marks or the predictions in blue color. So that's also a root function, I suppose. So I, that was helpful. But I like the other idea more like you have the map below. And there you can see from which direction to which direction you're going.

And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

Depends, as an educational institution, I won't prefer an avatar. An arrow would also work without the line. But for museum or for any other place, fun place, I will suppose an avatar would be nice. So it depends on the purpose of type. For this app, I think line is okay. Like very professional.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

They are also very informative. I found them interesting. I can't think of anything else.

4. Would you like to change anything or add anything? Or any other information?

No, I think everything was there already. There were text, audio video and different forms of information. And the website can give you the rest. So I think you'll have a lot and I don't think any other information is required.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, maybe I was not very interested to click the link below the photo. Where is the source of the photo? But maybe some people find it interesting to find the source. Other than that, no. It was nice.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Yes, of course. For students! And when you don't know the language properly, then it's obviously needed. And the app should have the English version, wherever the university is. But it should have an English language options so that everybody can use that app. Okay so maybe in the settings, there could be an option to change languages.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I will say, it's totally my personal opinion, it's not related to the app, the negative aspect of this app would be if I don't have internet, can I still use this app?

Well, it can work with GPS or the images or models of the buildings. So, yes that is possible.

Suppose you have no smartphone with you, you are a traveler, then obviously you cannot use this app. But I would say nowadays, it's very helpful. Because, or in Europe, it's helpful. Because we have fast internet or connection is very good. But in other places, it might not work very well. So depends. Depending on the location, I would prefer, the preference will change.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

As I said, museums, this could be very good option. And maybe some natural point of interest, not artificial, natural one like lakes and mountains, If the app can work without internet, so maybe hiking during hiking, I can check that but for that, maybe you'll have to take lots of photos and information which might be difficult. But you never know, maybe in future someone will work with that.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Maybe one thing… it could be useful for personal use if you can save the route you followed in the app and the duration. So, no one will see your information but if you come back later and see again where you have been to the last time. So like… just on the map like an overview with the points where you have been and so on.

Participant 04

31.01.2021

(Marketing manager, Educational institute, Japan)

Good morning and thank you for […]

And are you familiar with the TU Munich campus?

Not that much. I've heard about it.

Do you have any prior experience with augmented reality applications?

Not really, in our profession we actually don't use that.

So do you have any idea how it works?

I don't think so.

Okay, so let me give you a brief idea. So imagine you are walking through a city. And you can see everything around you. And if you use your camera to take photos or videos, you can see the same view on the screen. Now in augmented reality, there's extra information added on that view. So for example, you can use your camera, so you see the real environment in camera view. And then there will be some layer of digital information on the screen. So it combines the real information and augmented or digital information on the same screen.

Sounds like a Pokemon game

Yeah. Exactly like that. It's the same technology. You have played it before?

A bit yeah, just one or two times. Okay. Now I realized.

Okay!!!

If you want, I can show you a small example, it's just a glimpse of an app (https://www.youtube.com/watch?v=-qgR_b11cQA&ab_channel=etipsmobile). You see […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a university campus, something like that, what type of information would you like to have there?

I have a question, the app you are right now developing, is it a offline or online one? Like, do you need internet access?

Umm, I am only developing the mockups but the actual app can be used both online and offline.

So, I mean, if you think about Japan, it is the kind of place where a lot of mountains are there. And then it's surrounded by the sea, and it's in between a lot of islands. So during weekend or in summer, we visit mountains for hiking, and when you go to these places like you don't have access of using internet and you know, like you go up and down, it's a bit difficult thing. So you need a kind of a map to see how you can get out or get up or down from the mountain, which way is better, which way is shorter. So I think like, it could be better if you put kind of a offline map where you can see the way and you can check like okay, there is a place where you can take photos, okay, there is a shorter way, or a place for emergencies like a shelter if it's raining, toilets, the metro lines nearby, this is the place for the shorter route etc. So I think it's can be a better one for foreigner tourists to use.

So, you would like to get an offline map to show you the direction?

Yes, for the mountain top, where no internet available.

About the route… how would you like to be directed? I mean design wise, if the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

Like, if I start from the beginning, like, this is the starting point maybe I would like to see the whole map having those information. And when I start going further, I can see like, okay, there is a building, maybe it's, it has history that I should know. So maybe on top of the place there should have kind of “i” like, it means info, right? So if I press, so it can show me the information. And that's enough for me, I think.

How would you prefer to see the route or the way to that place?

So in Japan we use voice supporting app, that whenever you walk, it will tell you okay, in the right side, you are seeing that the building, which is has the history of 100 years and if we go further, maybe 100 meter 200 meter in the left side, you will see that building. But for foreigners, maybe you see a map and the turning points like left or right in arrows on screen or an avatar that you can interact with…I think it’s also interesting so it’s not monotonous!

Which one would you choose from all these options?

Maybe avatar is better for both type of travelers I think.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

Written guideline, including voice, I think it's better for both types of travelers, sometimes reading is not enough, they would like to hear maybe both are better like a combination.

What kind of information would you like to have as a tourist, about a place in general?

I think the history, the ways, the emergency exits and places… and interesting points!

Mockup demonstration

Okay. In the next section, I will show you some mockup designs of a tour app. […]

So… I can see the two options. So can I choose map option?

Well… you should check both of them. So I’d recommend to start with the first option. So here the app is guiding you to the place.

Okay. This is the map of the campus? The red point is where I am?

This is where you should be if you are taking the tour from the app. So, like the starting point.

Ok, let’s press go.

This is supposed to be our camera view. And it is telling you to move your camera to align it with the building and identify the building and when you point in the right building, it will show this icon and the information pops up.

So this is the information? “you're entering…”. Wow! I think the icon should be different. It’s more like a message icon. Yeah, I can understand but maybe an i icon will be better, so everyone can understand it.

Okay.

Oh! I So then…Learn more? Ok, I get the text…the history...So yeah, that's the audio version, okay, that’s good! And this is a video, okay, understood. Oh, that's the i I was looking for!

Yeah, if you want extra information, it takes you directly to the university page. The links will change with every location.

And yeah, so it all looks good. Maybe this description should be a little less. Okay. So there are a lot of informations here. So some people may lose interest to see all those informations anyway. In the audio version, maybe you can add more information because they don't need to read right? But in reading information, maybe you can add less information so that the screen looks neat and clean, so that it can be easy to read.

Okay. So now you can check the button on top first.

This is a menu button?

Yes! This is to navigate through the app. So, you see an option to go to go back to homepage, general settings for the app, and help will be there to explain some terms or buttons that you might get confused about. In the list of places, you’ll see all the stops of the tour and their information. You can also try filtering.

Okay. I can choose the type of place? This is nice! Okay, let’s go back. What else?

Yeah, the next buttons in the bottom. What do you think? All three, you can check.

So, these are not all clear for me. I mean, of course, there are visual buttons, but maybe it would be better if I drag the mouse here, they could show what is all about? So like this one I understood, okay, the information, this is menu, this maybe the current location, but these what I don't understand, I need to click for that.

Alright! So yes, this is the current location, you can see your gps location at any point. The first one is the route direction to the next spot. So when you click… this is now going automatically as it’s a gif, but when you're using the app, you're actually walking through the cmapus, and the line is in front of you. You follow... And then as you saw, it will stop here pointing to this direction so you know this is the stop.

Okay, I have to check the information again?

If you want. It’s put in the same format as before.

Okay, Yeah, it was the same as before. And okay, I know I have to click here go to the next one.

This is a hallway a big hallway in the main building, and now you're in the yard. So it's taking you to another building here. And yeah, now you're in front of the lecture hall.

Let's, let's take a second look. Okay, I am on here right now. So I was… my starting point was here and then right now I'm here. Understood. What this button does? Yeah. Okay. Location, right. And then next button is kind of a scanning button maybe. Let's see. Yeah.

Yes, the scan button is when you lose the connection, or if you want to go back and see the info again you can click this one, see the camera view? Right?

Okay, done! So the map now?

Yeah, you can go back to the homepage.

Yeah. So I see the map and four locations. So let's see number three. Oh, the same thing I see! So I can get the direction here?

Yes, you can see with the map, there's a route button.

Okay. Yeah.

So here, you have the option to choose from where you want to go and to where. So you are at Audimax, that was the lecture hall, to the last location. Exactly. And you're again, seeing the camera view, you're following the line. And you see in the map also, you're moving? Do you see? You can see your GPS location moving.

Yeah, I understood that. Okay. Ah so this is called Inside out?

Yes, you're at the last location now. You can check out the information. And this is the basic idea of the whole app.

Post-interview

So now I would like to ask you some questions.

1. First, I would like to ask you what is your overall impression about the design? Like the interface, the visualization, navigation… what did you like in particular and what not?

Okay, so it's pretty easy, also showing the route in an easier way. And you can repeat it again, how you came in where you are right now…Looks good. Yeah, I don't have any complaints. Just the buttons, like it could be like, it could be better if something pops up and say current location or to say point and A to Z or something like how to say entry point exit point. I think this is the only thing I would like to see. But if it's not here, that's still fine. Because it's visual so people click it and find what it is. They look pretty neat and simple. Easy to use not so complicated, I guess.

2. How helpful do you think was the route function?

It's quite easy. And you can repeat the route again and again so that you can know where from where you started and where you have ended it. It's pretty good.

So you like it as it is shown with a line or would you prefer any other kind of option like avatar, audio or something?

Oh, it's simple, if you're considering about that campus, maybe this is the easy way. Because there are a lot of routes and it might be helpful to find the easier route so a line is better. But if you're considering about a wider version, like a mountain or something like that, maybe you can put avatar or arrow in a few places where it's confusing, like intersection or something, not everywhere. But a few places. Yeah.

3. How did you feel about the storytelling/information elements like the text, photos, videos and other options?

That is pretty good and informative. And also there are a few photos, historical photos I saw. And I think it's better. I don't think you need more information here. Maybe less information. Yeah, like when it's all about the text, I'm seeing it's a mobile screen, right. Or maybe it's an iPad screen. So the screen is like, smaller than, like a computer screen or laptop screen. So as if you put less information while writing, then it could be much more neat and clean. While it's an audio one you can hear more, you can have fewer information written here.

4. Would you like to add any other information here about the campus?

Don't think so. Because my intention to go to the university is to see. And the basic information. I would like to know that already here. So I don't think I need more information here. All I need is the info the route and where to go. Maybe just the translations if it's in other language but English is fine. So that's all.

5. Okay, do you find any information or element that wasn't necessary for the tour or for the app?

No, I think it was pretty enough. No need to add or remove anything.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Like in the university, you definitely need it because as a fresh student, maybe it might be helpful for them. Even if you consider some historical places still you need that kind of app to guide you. In the beginning.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

The use of paper map, you cannot replace it anyhow, like it's from the long time and people are used to that paper map. Even though you have that kind of easy application. Still, they will keep that map. Because you know, these are these these are devices it might run out of a battery or something like that and you will need a manual one as well. But I think like how to say like the app is a digital version of everything. A kind of easier version interactive version of the whole place. So I think it's an interesting one. And I think like for myself, maybe I will, I will take a photo of the map and then keep using that one.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Maybe like indoor places, museums and mountains…a place with lot of points of interest, maybe for hikers, in shopping malls when you're looking for a particular shop or brand. And supermarkets… Yeah, and one thing you can do If possible, like if you're considering about, like music museum or like a sightseeing place where there are a lot of points of interest, you might add a favorite verse favorite button where you can just save your favorite place so that you can take it and you can go again, they can get the route or get the details just for that place. Not everything. Okay. Did you understand? Yeah.

Okay, I understand. Well…then. Thank you very much for your participation again…

Participant 05

01.02.2021

(Electrical Engineer, England)

Thank you for […]

And are you familiar with the TU Munich campus?

Not at all.

Do you have any prior experience with augmented reality applications?

Not that I think so. No. But you can fill me in.

Yeah off course. So basically, it's a technology where you can combine your real-world view with some computer-generated view. So, for example, you're using an AR app in your phone, and you can use the camera to detect your surroundings. So, you will be seeing the same view, as you see in front of you. And on your display, there will be some digital information overlaid on the real information. So, information enhancing in a way.

Is it quite similar to VR?

Yeah, but in VR, everything is computer generated. It's not real at all. But in AR the background information is from the real world.

Oh, okay!

If you want, I can show you a small example, […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

Okay right, can it be any place? Or it has to be historical one? Or it can be any place?

Any place that you usually like to visit, where you'll need a guidance. And the thing is, how would you like to see the information?

I usually look around the fun places and that's all. Probably with some text or pictures? I don't know really difficult to say, because I never used something like that. Maybe with text, pictures, videos, or even if it can be helpful with different language options… like that.

And how would you like to identify the places that that are the point of interest?

Icons or something like that, to use. Like, you know, those markers they have in that video, something like that?

Probably some lines on a map.

Okay. So you would prefer to use a map, like a map telling you where you are and where you should go?

Yeah.

But for example, with the camera view, when you're seeing the places in front of you, do you still need a map or you would prefer something on the screen telling you that go this way?

That will be helpful if I go to any historical places, or any museums or things like that. But you know what I was thinking about sightseeing places, like closer to nature. So I was thinking about the map only.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Just bear with me, one moment. So should I start the tour? Okay, let's explore your campus, we will start our tour from the main entrance. Click go?

Now you were asked to move your camera to align it with the building, when your camera identifies the building, it will give you this information

You are entering TUM, one of the leading universities of Munich that was established in 1868. Nice information! Learn more. Oh, wow! there's a whole lot of information. So it has a picture from 1868. More information. Okay. Right. It also has an audio option, should I play the audio? It can be very helpful for blind people. They will prefer this. There's one video also. Oh, is that available? Do I have to watch the video?

If you don't want to, no. If you get the idea, then it's fine.

Okay, I will look for some other stuff. Just back. Right? Okay, so it's fine.

Right, so that you can check them, I would suggest you check the menu button first.

That's great. Yeah, and the home is it will take you to the start. Settings, help…

You also list of all the locations that are available and you can just choose one of them.

That's great! What's that one?

Yeah, this is just for when you're moving your camera, you might lose the information. Because it's AR it's only recognizing one building and giving you the information. So if you lose that you can use this button to scan again.

The second one?

What do you think?

Map? My location?

Yeah, that's it.

Okay, Now can I see this again? I just followed last time. It just looks so cool, wow there's snow!

That's because you're walking in a yard now. This is put in a GIF format, to give you a more realistic idea that this is how you will be holding your camera and walking through the campus. And now you're in front of the lecture hall. Yeah. So you're not much interested to read. You are happy with seeing. You can check out the photos if you want and inside the information.

Yeah. You are now in front of audimax. Oh, that's the lecture hall. And it has a picture, can I find you here?

Umm, No.

Oh, okay. right. What next?

And now you can go back to the homepage so we can explore the second option.

Yes. Okay I will move slowly now.

We don't have lot left, so don't worry!

So choose from the map.

So here, as I said, in the app, there will be many more names on the map, but I'm showing the four that I'm using here. So for example, you can click one of these one, two or three buttons and the markers on the map. Yeah. So now you can go to the map again. And here you'll find another button on top. It's the same route button.

The cool one. My favorite one. Yeah. Okay, do you want me to click that in?

Yeah. This is to show you a different approach, can choose where you are, and where you want to go.

Okay, this is the audio Max, that you're in front of the last stop,
And you can see how it's taking you to that there. And you can also see in the bottom on the map how you're going. Yeah. So yeah, and then the information are pretty much in the same format.
You can look more, or we can directly talk about what you think.

Post-interview

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

First of all, it was very interesting. And probably you already know which one was my favorite part?

Yeah you mean the route button? Did you understand it's telling you it's it will show you a route?

Yes. It was okay. I mean I seemed like two points and then I clicked and then it was clearer. All of those, icons or buttons, whatever you have used, like for camera, or maps. And if it was me, then yeah, I would love to have both of them start the tour or choose from map because the first one gives you overall idea of your campus. And one could be just where I want to go. I like both the options.

You didn't have difficulties understanding anything or you would like to change in the design?

Not really at the moment, but if you want to do something about my favorite one, I'd love to see a more improved version.

If it's your favorite one, then why you want a change?

No, just if you would like to add more routes like that, I'd like to see.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

No, The lines are fine. That's perfectly good. It it's a avatar I start looking for my Pokemon.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

I think it was interesting. And you had options for videos, or for audio, that's really good, because that can be helpful for a lot of people. Some probably prefer video, some probably prefer audio. So you have all the options, which is wonderful.

4. Would you like to add any other information in the app?

No, I think it has enough information. I don't think I want to add more. Yeah, it has enough information. And I mean, all the basic information we need to know to start with, so that's perfectly fine. quite informative. I want to add something. Nope, that's fine. I feel like if it was more than it's going to be, I don't know, too complex, or too much information. Sometimes just simple is better for people.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, I think everything that was there was necessary to have and they are all quite important ones.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Maybe, as I didn't use it before, but it looks something promising. So could be. Sometimes it's useful for the new students. They are new in a country, coming to the campus on their very first day, but they are not very confident in the language. So, this sort of app would be really helpful for them. Good helping hand.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Yes, of course, I would prefer to use this sort of app, than the guided tour trust me, because they talk a lot. I have the experience. So yeah, it's very helpful. It is.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Oh, yeah, why not in museums or palace tours? You know, places like that. That would be useful. Like, in the UK we have many palace tours. These things are really useful, because sometimes they are very huge, and you need to find through it. So if there are some information selected, that would be easier to take the tour.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 06

01.02.2021

(Cartographer & Data analyst, TUM student, Kenya)

Hello and thank you for […]

And are you familiar with the TU Munich campus?

Yes, I'm familiar but I might have forgotten one or two things.

Do you have any prior experience with augmented reality applications?

yes, yes, but not on a professional level.

So have you used an AR app before?

Yes, like traveling up. I have not made one or designed one in that perspective. But I have definitely used one.

Okay, so should I explain it more or can we go to the next section?

I think we can go if you think that my knowledge is sufficient. And so yes, I have used as a user. If that's sufficient, then you can go ahead. But if you think I need a knowledge of how things work in the background, then no.

No, I think that should be enough. So, what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a university campus, something like that, what type of information would you like to have there?

Yeah, yeah, definitely I do want to have, a routing application. For example, I'm finding my way to see the library, right. So I definitely want to know the direction to that library. And the direction in terms of if they're going to use arrows, and if I get like a picture, or an image or a photograph, that will go a long way. And additionally, like to have a voice like the back where it's possible for me to switch it on or off. Because in some cases, I don't want to be constantly looking at my phone. But in a scenario where I'm assuming I don't have my earphones, then I will expect to have either just the symbol or like some writing, but not too detailed writing, you know, just give me turn right and left. Additionally, I'd say if it's possible to have different languages, for example, if it's a German speaking country and I'm a foreigner, say I speak English. So the language, the directions, the sound, and also the clarity in terms of, maybe yes, you can show me things that are around the library, but not too crowded, like just show me the basic things that will lead me to that place. Because sometimes it can say walk 200 meters, but I'm not sure how I'm going to be estimating 200 meters, like in terms of distance, 200 meters can be relative to the eye. So I think they should also give me instructions in terms of when you see a big tree or you know something more permanent like a yellow building or so, something that can sort of give me a visual understanding of where I am, apart from just the distances and the measurements, not everyone has that capability of telling this is a 500 meter. And this is 200 meters. Okay, speaking for myself.

About the route… how would you like to be directed? I mean design wise, if the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

This kind of tricky because I'm thinking, both visual and the sound. If they told me if I have reached and then of course they're measuring that they're using the GPS to take my position and they they have rejected average the library. So I'm thinking the best and the future will be where you're like next to the point and they tell by, that's the most realistic the most straightaway, because if they use image and the other options, I would say it can be I have reached there, but I'm behind the building and the image is in front of the building.

That's interesting. Now, about the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in what format? Would you like to have some texts, or some other form?

I think a mixture of both text and like I'm thinking, 3d visualization of the place where it maybe turns with me, you know, it shows me if I'm walking, you know, the way when I'm facing and I'm walking in a certain direction, it's working, it's moving in the same direction. To me that is more that is more realistic. So I definitely prefer visual, a visual representation, either 2d or 3d. But that is able to, to move with me as I move, it also moves and shows me, you know, the direction I'm going, I'm facing this direction. If it's a building a library if they're able to show me visually. So it's not necessarily 3d to like, look at the volume of the plane, I think that will be too complicated. Really, if my goal is to get to a place, you know, I'm not wanting to be entertained and to know the volume of the room. So maybe, maybe 3d is not the right word to do, or 2.5, d 2.5. It's like an animation, animation of a 2d map actually make more sense. So that it's moving with me. You see, there's that animation where they've input an image of a person who is moving and I visualize myself. I'm like, I'm this person moving. Okay, I'm entering the door. It's also entering the door. So yeah.

I think I got the idea. Thank you. That was a very interesting one.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs of a tour app. […]

Okay, you can see my screen. So from my knowledge, just knowing my university colors I think I'm already liking the color choice of your app, and then I like the fact that it's not so many, you see three colors, kind of gray, white and blue. And I think it's a very wise way of choosing the colors rather than a yellow or red. So I'll be like, where are we? What is this about? Yeah, so if I am student here, and I know this is our color, so already identify, I connect, I connect with this app, I'm like this is home.

So welcome… Yeah, I think that's also clear, not too much information, not too little. I'm already guided that I have two choices, the first button and the second button. So I choose whichever I want to go. And from the creativity point of view, I also like the fact that you've used a variety of font types, but not exaggerated. You see, it's interesting, it's not just boring, the main information, of course, I'm getting it in a kind of late laid back font, but the two buttons the design is beautiful. So from the word go, I think I like the introduction to the app. So am I supposed to choose one of the options? Or do you want me to go with the first?

I would recommend you start with the first because we will come back. And we will see both of the options, of course.

Ok. Check your location first. Okay, so this is my location. That ensures that to make sure that you're at the right spot, because it's a guided tour. Okay, let me reveal our tour from the main entrance on arcistrasse, click go take you to the AR experience. So first off, I think just the fact that I have this red pin, and it's attracting even before I read that and I know that this is where they want me to start. I'm supposed to be here somehow even before you read instructions down here. Okay, so can I click go? Yeah.

So so far it's when I move my camera, I pointed to a certain direction. It gives me the info of that same building I'm pointing to right? Okay, get it. And this options, the options I have here. Are they working in this?

Yes, all of them are working. I would recommend you start from the top so you can see all of them. One by one.

Ok, nice! Okay, the first impression that I'm getting is that this, if I click on this, it will give me maybe information about this building, maybe to tell me this is the library or whatever. Looking at it I feel like maybe I'll want a visual hierarchy of giving me a priority. If, if this is going to give me information, I actually consistently should start with this? So it could be a bit bigger or different color? But I get the point that it's very clear that this to me, even without clicking on it, it's going to give me some text information about this building. That's my assumption.

Okay. Yeah. The popup is alright. If you want to learn more, you can click on and giving you a history of a background story. And you have some options, also. A background and then I have nice, images, I can get the sound, I can get a video, can get information. I think yeah. I like it. I like the fact that I'm getting, I'm getting more options of stuff. And even the representation of those options. It's straight to the point, I see this as it's an image, I feel this is its voice.

So you have the video, but I'm seeing the video is coming from YouTube. So in case YouTube brings the video down. Is there another option of getting a different video or is it it has to depend on that particular region?

Depends on the developer, I would say and where they're getting the link from. They can decide to put their own video, for example, or from some authentic source, it could be YouTube or if there's something on the university page that would be more appropriate, I would say.

Yeah, that's good. And then this is more information, it takes me to the websites to get more information. So from here to go back, I think I have to use this. Okay, that's different, but it makes sense that this is the default Android, you know, the way the phone looks like, because this is just a part of the app, it's actually taking you to another website. So it works out.

I would say you can check the menu button first…

So this is the menu? With home, list, settings, help…ok so general information?

Yes! This is to navigate through the app. In the list of places, you'll see all the stops of the tour and their information. You can also try filtering with different categories.

So this is if you are moving your camera and you lose the information, you can always click on that and it enables the camera view again and you scan again. It's only for that.

Okay, the second one a map of the place and it shows me where I am and the direction that I am heading to. All right. Interesting. I'm used to the more traditional compass. So imagining as a cartographer, having a traditional compass will be more easier, but yeah, it's still it still does work.

Yeah, then this is the route button. So this is taking you to the next stop. So my question is this, I'm using this now. Do I have to be using this button every other time or this is just in case I lose connection?

Only if you lose connection as it's a new technology, it still need to be stabilized. Sometimes it happens.

Yeah, yeah. For sure. I think that's nice. And by the fact that it's only for recovering in case I lose, then then I think that's really that's brilliant. Check this one shop now.

That's interesting. And then as you get more information about the TUM shop, I'm assuming in case this app goes live, there'll be more information about this shop? Yeah. So this is just this is not this is just how can I say? It's an example of the information that's in the table?

Yes and no. The text should be concise, I think, for the app to get the story, but a short story about that place. And you have these options to see pictures are here in that information, you can get the link of the shop. So the important information, they're provided in sections.

Right. Because I wanted to comment on the structure of this, the text. I mean, I have understood that this is just like a prototype, but I will say that we could still make the text a little bit more interesting. And also, you can separate the paragraphs, trying to get them cut, making it as simple as possible. So maybe paragraphing is justifying and using visuals, blue to highlight some of them to highlight the if one paragraph is talking about what he found in this shop, the second paragraph is about something highlighting the main point of that paragraph.

Yeah, so I'll go back to the road.

You remember this place?

Yes, yes, definitely. We had lots of classes. And then the dining area, the cafeteria. This is the Audimax! And then again takes me to the info. The images…oh nice! From inside…it's already exciting me. I am planning where to sit here! I think the image idea is really nice! From outside for me it's like so boring but when I see the photos I'm like wow it's beautiful!

Yeah, now you can go back to the self-guided tour in the homepage.

Yeah. So I'm thinking if this home button could be outside the menu like an icon with a building, it could be another feature to go automatically and not click on the menu.

So now I can choose from the map?

Yes, you can see with the map all the locations but for now there's only four for example.

Okay so I get one point straight away and the information? Right. So this is good if I have already seen the campus so I can just directly go to a point. This is brilliant.

So here, you have the route button again. It's the option to choose from where you want to go and to where.

So I choose the Audimax and Inside out… okay this is really nice with the map and all. Did you take the pictures when it was snowing?

Yes, so if you were at the campus now you'll see it like this!

Yeah that's nice! So you can also have pictures from different seasons and from different times…

Post-interview

So now I would like to ask you some questions for your feedback.

1. First, I would like to ask you what is your overall impression about the design? Like the interface, the visualization, navigation… what did you like in particular and what not?

Okay, so my first positive is the colors are already connecting me to being a student of TUM. The color balance is good as a cartographer. I like the two options in the beginning, it was a brilliant idea I think. If I want to save time and go to a particular place. I also like the different

options of communication the text, and audio and pictures. I like the fact that it's simple, not too confusing or crowded on the screen and not too much information. There's a summary and also the option to go the website for more. Also, the idea of using the AR and the camera and getting the info. And the option to type a place from here to here, so sometimes I don't know the names but I can see in the map and choose so it's good nice aspect. And the main aspect, the map and the line was taking the center stage on the camera and those small icons were on the side and still visible…so for a normal person it's good to use it.

Yeah, for improvements… the text can be highlighted to see the main points. The home page can be accessible with a button. So basically that's what comes to mind immediately.

2. How helpful do you think was the route function? So you like it as it is shown with a line or would you prefer any other kind of option like avatar, audio or something?

No, I think I prefer the way it is. I feel like it did it's work. It led me, it was interesting. So this one is good.

3. How did you feel about the storytelling/information elements, so you said you liked the photos but does something else come to your mind, some other kind of visual elements that could be interesting?

I think it was okay. But if you want to make it more complicated, so if you click on a building and it shows you how it looked in the past. So with images maybe…it can take me to the history with the images but with time.

So you mean like an interactive timeline or as you saw some old photos at the entrance? Which one do you prefer?

The timeline would be much better, I think. But not too detailed or not with too many pages but only a photo and some necessary information.

4. Would you like to add any other information here about the campus?

So maybe the opening hours for some places like the library or the cafeteria… not for all places but some like this.

5. Okay, do you find any information or element that wasn't necessary for the tour or for the app?

I don't think so. I think every option was necessary they have to be there for using the app well.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Absolutely. I think the world is moving towards AR. And being in a campus you have many new students from different countries. It's a place where you can really get lost. I think it's really useful for a campus setting where you have so many things and you have classes every day and so many rooms and libraries. I think for finding a room or to solve some of these problems it's really useful. Even having a map is confusing there like I don't know where I am going.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

100%. So when I am using this app it takes me to that place and I am turning to left or right I see the places. With paper maps it's just the way but the app is moving with you. I think someone guiding me would be the best but it's not practical that someone will be available all the time every day. If I am touring the campus for one time, then definitely a person.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Yeah, tourism in a city. But maybe it's not the best because I'd also like to see around and not look at the app the whole time. Maybe in a hospital, if it's too complicated. To me, the places that are coming to mind the not places for leisure. It's where you have to find a place and do something, to get to a certain room or a patient….like a mall, a shopping mall. So I want to get exactly where I want to. In summary, yeah, hospitals, malls, a complex…yeah that's all.

Okay, I understand. Well…then. Thank you very much for your participation again…

Participant 07

01.02.2021

(Cartographer, Netherlands)

Thank you for […]

And are you familiar with the TU Munich campus?

Of course!

Do you have any prior experience with augmented reality applications? Do you know how it works?

Yeah. So it's a mix between things that are actually happening and things that you can see because you have these glasses on, or phone or whatever you have on. So it's an extra on top of what you can normally already see him.

Will you do it from the tum campus?

The design is based on TUM campus. So it's a campus tour kind of, um, yeah.

But before we go to the mockups, I'd like to know something from you, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

So, like walking through Berlin? And it's about the second world war. I would maybe like to see how it was before, uh, before like bombardments or so, so like, it would probably like to see the year and then see how it was like so most interesting information. And it's easy to remember cause you are here or you come back, you can choose between a few years and say, how did this look in 1600? And then you can maybe see it idea.

Would you prefer like to see some photos from the past or you want to see like in a 3d version or a timeline with the history?

Um, and then, uh, the way the timeline could be good. I just said that you can choose between some years, but that could be in a timeline, of course. So maybe in the bottom of your screen, you could see some pictures with the timeline and then you can, I don't know how, but we can choose for one of these pictures that is according to yeah.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

Yeah, depends if I'm doing a tour and there's a guide, that's nice if she just talks about it and you can, meanwhile, look at the pictures you want to see, but if there's a, if it's just an app on your phone, then it would be nice to have some information and the best way I think, to have it spoken in your ear while you, uh, looking through those pictures, the ideal for me, like the least amount of assets you can choose. I want a female with an Australian accent. That would be the best.

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

So there's no external guides, it's the app. That's everything. Um, it could be fun too. So if I'm in the middle of the tum campus, they, the voice that beautiful Australian voice says look around, can you find the building from the 1920s? And then when you found it in your eyes, vision, and it's okay that they check if you've got it right, then, uh, she says, walk towards it, walk fast. And afterwards go left. We see the next building, which is demolished by the Nazis in the 1940s center, maybe in that way. So it would be kind of a quest.

So make it very obvious. Of course you can do arrows in the screen, but if you want to, that's not really a game anymore. So it's a question between, do you want a game or not? Maybe that's could be an option, like a game. Yeah. Well, if you want it easier by just following the arrows, arrows under roads, or do you want to experience your surrounding more and hear the voice telling you where to go? Meanwhile, seeing these buildings and taking up information about, Oh, it's demolished. Well, if the person has the phone and the arrows are on the phone yes. To watch his phone all the time. Whereas if you listen to it, then, uh, you can follow well looking around, I would definitely prefer option two. And of course you can do both so that if you're confused, you look at the screen and then you get extra mixed maybe.

And what about the points of interest? Like how would you like to identify them on the camera?

If you want some selected places, you could give that the places that you have information about, you can add a little, I, uh, I mean the letter, I, for information box, like a tiny box so that, you know, that's a building, I could get more information on, but I'm, I'm always in favor of, uh, people that, that I'm led through a route. And then it has the options yourself to choose if you want every single point of information from every single DOI or that you say, I want to be more quick. I know what I want. I, that was the last building, and then you can choose how fast you want to go.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

So I will need you to start from the beginning… You're very active!

Well, I know start should start the tour, I'm curious what in the map is. That's why I, then I see, ah, I can, so now I'm thinking it might be that if I did start the routes that I would start at entrance to TUM shop then throughout your marks.

So in the beginning, it's, it will ask you to check your location. And this is your camera view. So you have to move your camera to identify the building. When, when the camera detects it, you get this information on your screen, You can talk about all the options or buttons, whatever you're thinking.

Um, I thought it's a very little information, but good one though, but I see how much more there is. Um, and then, because I'm not really interested in the entrance, I, uh,

It's like some pictures. So that's why I choose the pictures. So good. It's a good, uh, pictogram I think not so good that it's in the first one,

These will be different for every spot.

Ah! Yeah. I was actually thinking of when, when this is here and then you have her timeline below with those pictures, because now you see how it, well, it should be a bit from further, but as you can see it from now, and that's in the bottom, I think it's pretty hard to make, but, um, to see, uh, what time it was now, how it was some time ago, and then you could maybe click on like a picture of 1816 to read if you think, ah, that's an interesting picture. What's the information with that.

And there is an audio option!

Yeah, I am still looking for an Australian accent for you!

Nice. Very good. And is also from the, uh, is from just plays the accent. Ok, not that many options as well.

And more infos, That's the, the, like the least important. The interesting one, I would, I would put this, I sign like just as a link down below. Uh, yeah, of course. There's more information, but, uh, it looks like you're kind of going out of the app and this is, uh, yeah. Yeah. I like these three because it's image sounds view like three important things. And then the i is a bit, this is maybe not really a fight of the big three.

And the color from the, maybe that it is blue and white. Right. So TUM colors. Great!

So menu, home and settings. Ah a list, I think nice, oh the filter is good so you can save time. I want to go to the next.

So with the three button on the bottom, what do you, what's your first impression about those?

Um, not completely clear. Like I want to go to the next, so I know which one to choose, but I think this is scanning something…

Umm this is sometimes you might need to, um, uh, identify the building again. So yeah, it will come back in a second. you can always go back and scan again.

Yeah. But there's nothing if you just don't want your phone to be pointing towards this building and you just want to read those texts and these pictures, just like you normally have your phone in your hand, right. Pointing towards the, I was just thinking about if you dealt with them physically.

It should work in a wide range. Like you, you shouldn't have to lose the information unless you're too far. But for example, you just want to go back to another place. You just missed something. You want to see it again so you can directly go there and just scan again. Yeah.

Ah! I think first one is for going to the next, and then this one is to show your current location on the map.

Yeah. And this is my direction. Yeah. No, I don't want to go to the shop.

Haha, ok you don't have to go in!

Okay, just a couple of photos. When did you take the photos? With snow!

A couple of weeks ago. So it, it will look like this. If you're, if you're here.

Yeah. My favorite place to find a free food. This is focusing on the lecture hall, and then you can find the cafe behind.

You can separate this, this, this whole text in the smaller pieces would be easier to start like, Oh, okay. I'll read one. Okay. It says old as we are. It's just too much without any, uh, um, white lines.

Oh yeah. Yeah. It, it will face which direction you're facing.

Now you can check out the map, uh, in the beginning. So at the homepage.

So you can choose any place from here, not for now the other three. So if you don't want to start at the main entrance, you might click there and it will ask you to find again, and then everything is the same.

Another way would be from the map. So when you go to the route, yeah, here you can, you have the option to type or search for the places.

Yeah. Also the map, you did this? Nice! It was good edits. It fits on one page. That's also…and I got to learn something about the structure.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

It's quite simple. So, um, you can basically finished by like reading everything. And so after you used the app you think now I know everything! You do it to get some information. And then this is the most efficient way, I guess.

Maybe only then from the starting screen I didn't under automatically understood what the buttons were for. In some apps, you have a starting screen, which has this like four, four or five or so, uh, buttons. So maybe that's possible. You have to have the, um, pictogram of route and pictures that you have and put them in a list with the explanation.

Uh, so far, the buttons aand the icons, were they understandable for you?

Yes. If, I know the explanation, I think God, that's logical. If I don't yet know what it is, then I have to find out. And I like more than one that I have to find my own way or the one that is already made for me.

2. How helpful do you think was the route function?

I think it is good. I think most people would want to see the map and see, If people have never been there, the route is better. If people have been there, the, you can choose yourself. Option is better. But then I'm mainly focused in what I want to know. You're really open as someone who's in a new city as well.

And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

Yeah, I would say kind of voice but if you do a voice, you shouldn't say, go on, go left. But, uh, do you see this, uh, this is a shop where you can buy stuff? And if people don't understand that they can always watch, the screen. Yeah. But I think it was a good one. The arrows.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you add/change something?

Yeah, I would think I would put the four that's personal, but I would put the images first and then a pictogram to the text, maybe, uh, the text, uh, combined with the, sort of the picture with some texts we need, but to have just the text as the main start. Yeah. For me, I automatically go to the pictures. And if after I've seen the pictures, I'm still interested, then I'm gonna read, first the least intense, uh, job. And then, uh, yeah, for me, ideally it would be you open this. We don't see only texts, but you see this timeline, um, of maybe a few pictures and then you can click on one of those to get the story.

I think that's a, it's a bit hard. I think you have to then do it for typically to have maybe three pictures with maybe only the year. So you have the auditorium in the 1907 and in 1950 and 2000 or so, and then you can choose what you're most interested, interested in. Depends on the information you have about it, but to give more priority to the images is maybe interesting.

4. Good. Um, so my next question is in general, would you prefer any other kind of information or any other kind of functionality included in that?

How hard you can make it? Yeah, so, also that you, uh, look at a building and you can also see it in a different time. So the, the AR glasses, for instance, they change what you see in the building. And it's really strange.

Like a 3d illustration?

Yeah, yeah. Right! The 3d… that would be amazing. And then you put how it was on top of what it is now. Um, and maybe you even have a button and, uh, if you push it, you see how it was. And if you just leave it the way, um, you just see how it now is. So there's some kind of filter you can put on them.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Uh, only the thing for the extra information could be very down below, below the text. Um, it's a bit more clean with only three in the top. Yeah. The rest is okay.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

I didn't know if it would be more useful, but it would be more, um, it would engaged the user more. Um, so they're, they, they would be more willing to work with it. I think it's a good sell. So this idea of something new, something they maybe haven't experienced yet, we've all seen them on a phone and push the buttons to see the actual information, but to look around and see things pop up. Maybe that's still kind of a new thing for many people.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I have to say, I always prefer paper maps, but I think, well, it's, this is, this could practically be an audio guide, but with an extra. So if I walk around and this beautiful voice says do you see this building and I can see them I'd like that.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

A tour with a lot of history maybe, that's number one. But you can also do it something geographic. So, maybe you are in a place and the thing is not there anymore, buildings change very frequently, for example how river changes…it takes hundreds of years so maybe you won't have pictures of this. So maybe yeah everything in a city. So it would be good to know how different something was. For hiking trails, you can see the names and heights.

So if you have not one but many places, because when you have an app you don't use it once you use it 100 times. So if you can fit the whole Alps for example. Oh, this last question got me thinking. So this app you need to be sitting or walking? There should be something for cycling! But that could be difficult!

But it's not a good idea to look at photos while you're biking!

Yeah, true. But I can then listen! It's a long shot!

Yeah but good thinking though! Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 08

01.02.2021

(Cartographer, Tourism manager, Serbia)

Thank you for […]

And are you familiar with the TU Munich campus?

Yeah. I know it. Specially Mensa!

Do you have any prior experience with augmented reality applications?

No, I don't think so.

Uh, you, you have seen any apps or have you used any apps before?

I think, uh, I mean, I've seen yes, but I didn't use any, no.

Okay, I will give you a brief idea […]

Okay, so it comes like popups on screen, yeah, I get.

Now I'd like you to imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

I would imagine it as a map. So like maybe with, um, where I am at the moment, like inside the building, or the town that I'm visiting, for example, then I will want, I would like to see a map with the location and maybe like points around me, for example, like what is around. And then I can just like, yeah, with specific symbols, like museum monument to restaurant something like this shopping center, and then maybe I can just like click on like a symbol and then, uh, this will be a pop up with like information about like maybe yeah.

How would you like to, um, the app to point it out to you that this is one important place to see?

Like in this like app? Well, um, maybe like the best idea is to be like, uh, marker, but uh, designed like that, like the building, maybe like, um, like for example, if it's like a city call, then it will be a marker, like city hall, then you can get like some kind of, uh, uh, like association, kind of, the icon of, uh, that it's the same as the actual city hall.

And if you are getting a route direction from one point to another, how would you like that to guide you to that location?

Well, first, like the whole route to be on the app, like from point A to point B, like the closest route and there'll be like a line, um, how to say like in the Google maps, that's like pretty, okay. That shows you the direction of your phone. Like kind of a compass like this. And then when you move, it moves out so that you're facing something like this, and then you can, um, yeah, just follow the line.

About what this kind of information would you like to get about the places? And in, in what format? Would you like to have some texts, or some other form?

Maybe some kinds of like a short description, because I think that, yeah, especially for an app, you don't want to read all that. maybe some kinds of interesting, like fun facts or some legend that is like associated with that place or pictures. Like that's mandatory, a couple of pictures just like to see, and then you can just like swipe it, yeah. And maybe if you're more interested in this place, then maybe you can, like, there's like some kind of a link to maybe like the official website. Or, um, for example, if it's a museum like a visual websites, maybe like the working days, working hours, something. That's mandatory for the athletics for museums, for galleries, for like opening hours.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

So this will be the first page of your app.

So I go start to tour, right? Let's let's go… adjust your camera. So, um, this is the path

You're actually walking through the campus and it's showing you the direction.

Okay. Yes. I remember this shop. Um, so it was this, this is a location where it's like the campus is there and your current location. And this is to scan something?

So this one is, if you move your camera or you lose your building, you can always try to go back to that spot and scan again.

Oh, okay. Yes. So recognize the building. And yeah, the popup… I mean, this is like the history of a little bit. Yeah. Pictures…with source.

The second one is supposed to be an audio file. So if you don't like to read long text it will read for you

Video… And this is like, this is the website.

Now you can move to the next spot.

I have to wait. Yeah. Okay. I'm walking. Yeah. This is to pictures. This is again the website. This shop. Okay. Okay.

You can buy things online here. Now the shop is closed because of COVID.

No it's closed? I can go to the next one. Okay. Let's go outside. I remember these doors. So this is like the, I cannot move. Uh, I can't. Yeah, it's just a picture. Okay. So this is the location. Um,

I kept the format, same for every location. So it's easier to understand.

Yes. It was like the, again, the explanation. Oh, it looks nice, I've never been inside of the Audimax! Um, yeah. And this is like, the end.

No, you can go back to the first homepage. Yeah. This was a guided route example. So you can see the next option. Um, I have a question Do you understand why there are two options?

What, what do you mean? Yes. Like, like I understand the tour and I think it's just like, um, I can choose from a map where I want to like, like just the locations and I will be there. Right. Something like this.

Yeah. so here, if you can click one, two or three and just to have an idea that,

Uh, so that will be, the place again

You can go back and there is the route option again. So year you can put your origin and destination to find your route in the app.

So, That's the end. So he will take me like, uh, like it's like a tour again.

Yeah. But it can be from any of the locations to any of the other locations here. It's just one example.

Oh, I didn't know. This is the name of it. Inside out!

Oh and you can also check the menu. The settings and help options are, self-explanatory kind of, so it's about the app settings. Um, what, like for the app in general and help is if you don't understand any options or any terms, you can check there. Uh, the list of places you can see all of them and choose to get the information from the list on one spot or something. And also filter…

Oh, yeah.

Post-interview

So now I would like to ask you some questions.

1. First, I would like to ask you what is your general impression about the app? Like the interface, the visualization, navigation…was it intuitive enough? what did you like in particular and what not?

I think it was, it was okay. Like, it, it wasn't difficult to use. Um, what else? Um, yeah. first, like just have like a tour. This is like a great thing, for example, for like new students or like for, parents. So they can like see the university and like it's guided, like the app is guiding them. That's really nice. Um, uh, what else? Uh, information, I think it's, it was too much information like this it's a very large text, I think, because I mean, it's an app. I don't think that someone will likes to stand there and just like read everything. So maybe like a short term, like maybe two sentences for you. or like some kind of points, like some like very short, it will be great. Uh, what else? Um, yeah, like, yeah, the, uh, the map was okay. Uh, there's also like a North arrow, zooming, That's also good. Pictures. Yeah. That's that's okay. And the website for more information, like I said in the beginning like that. Yeah. I think mostly it's. Okay.

2. How helpful do you think was the root function? Was the line okay or would you prefer any other kind of visualization like avatar, audio something like that?

I think the line was okay. Well, for me it was okay because I already know the place, so I was like, I already knew like where I'm going and I know the, like the entrance and this big hall and the shop. So for me it was okay. Uh, maybe for example, it would be great to have a map somewhere in the corner to also see where you're going, like on a map.

Okay. Like in the second option, um, from automates to inside out, uh, when you were going…

Yes. Yes, yes, yes. Yeah.

Uh, the voice voiceover, it maybe even better, there'll be like a recording and then maybe you can listen instead, because I mean, we all have headphones already, so maybe there'll be some of like, you can just maybe like, if you go and your points with your camera, then also like the recording will activate and then you can actually listen.

So, if you have to like choose one or two elements, which you would choose the line, or, voice or,…?

Yeah. A line would be fine. And maybe also, yeah. And maybe also arrows would be also great. Maybe arrows that would be like maybe easier, if you cannot find yours yourself, like in the map, in the app, then with the arrows, you can say, aha, I'm going from here to like the location.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

Well, I already said there are all nice. Yeah. Maybe it is just kind of a stupid idea. The Navy should be like, uh, is there like a radio or something in the campus? Like maybe you, like when you walk around, like you can listen to music, for example. Yeah. And, yeah, maybe also there could be also some kind of, because I mean, it's still it's university. Maybe it could be like some kind of stories about like alumni or like some student life. And like, they could be also like some kinds of commercials. Like there is a student party tomorrow. Uh,

Okay. The events?

Yeah. Like some kind of commercials, like, when you walk around maybe like a campus then like, like for example, if you get to us certain spots, then it would like, the recording would like, the audio would activate and there'd be like some kind of commercial or I don't know, something like that. And maybe it could be something to make something funny, like, uh, like what, like watch out or something like this! Or when you get close to that doors that open it, like you just like, don't touch the door, they're open, like what out of the ghost or something!

Okay. Okay. Interesting!

Yeah. And also because there is a, this, a Stucafe and Menza maybe that there can also be like commercials like today on the menu is you have like this! There can be like in, uh, in numbers. So for example, like there is a fish and chips in stock number two, and then you can go to two, and then you can click and then it can guide you to took. or maybe like they can, uh, present in something like, the specialty of the day maybe. Like, I mean, TUM makes its own beer. So maybe like, if you're interested for a beer come to the. Or, or maybe it can also be a commercial for like a shop. Like we sell today. This, this the prices there's like only four 99 euros or 99 cents. Just to make it like more interesting.

4. Okay, so I think we already covered if you'd like to have more information here.
5. So next is, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No. I think everything is okay. Like everything is, I mean, it's necessary for the app, so I think everything is useful, like all information that you need.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

In the beginning, maybe for new students that could be like very useful for, like I said, parents wants to visit or, but mostly for students, it will be great because I mean, it's a big university. It's a big campus. So maybe it can also guide you to like some classroom that can also be very useful.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I am really old fashioned. I prefer paper maps. Like I like maps and I know how to read them. So for me it's easy. But for someone who is like, not very, um, how to say, doesn't know how to read properly the map and for someone who wants to learn something more about the campus, or like, like I said, doesn't know how to find, uh, the classroom for students or like something like that, then it can be very useful. For storytelling purposes yes, this app will be like great because yeah, from the paper map, then you have to Google things, you have to find on the internet and stuff. And with this app, you already have everything covered.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Yeah. Yeah. Like city center, for example, for tourists, like from Karlsplatz to Marienplatz for example, like their whole streets can be covered, and for like conference or for business trips, maybe it will be easier for people to like also find the way. It can be used maybe for, for schools. Like for example, like, uh, children can visit someplace where like, there was like some kind of a battle, like 200 years ago and then maybe they can make some kind of like, there's some kind of this app where you can just like, again, like, it will be like an audio and then you can just go around the place where there was a battle. And then here was where trenches here, where, or like cannons, yeah, here where here was the King with his, like, like an army, something like this,

Good idea like that. You mean like reconstructing past events?

Yeah. Yeah. I like the location where something happened. There can be points like points of interest and then you can go from one point to another and then there'll be some kind of a story, some explanation. And maybe it can be some kind of like video also. Yeah. Something like this, like for educational purposes, maybe it can be great.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 09

02.02.2021

(PhD student, Human Geography, Australia)

Thank you for […]

And are you familiar with the TU Munich campus?

No.

Do you have any prior experience with augmented reality applications?

I haven't used it. I read about it, uh, one once or twice, but it would be nice if you can explain a bit to me.

Okay, I will give you a brief idea […]

Okay.

Now I'd like you to imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

Well, if it's, um, a university campus, um, my expectation would be a bit different than if it's a touristic place. So if it says university, then I would like to get the main information desk where I, I can get the information regarding the departments and also some emergency places like, uh, if you need to go to the hospital or if you need to go to the mosque or if you need to go to the canteen. And if I go to a touristic place, then I would like to get, the easy way out from that place, the history, And I would like to get the location for restaurants where I can get different kind of food.

And if you are getting a route direction from one point to another, how would you like that to guide you to that location?

Nice. If I can see the arrow option and then I can find the left, right, because sometimes in Google map we find difficulties, we need to turn left or turn. Right. So it would be nice if we have a specific, uh, kind of arrow.

How would you like to, um, the app to point it out to you that this is one important place to see?

Maybe the name of the place. And also a round shaped, a neon color button. That would be enough for me. If they just tell me the name, then maybe it's a museum or so…

About what this kind of information would you like to get about the places? And in, in what format? Would you like to have some texts, or some other form?

Uh, for me, audio is not, uh, helpful. So I would prefer to get a combination of text and visual representation. So I will see the place, um, 20 or 30 years ago, maybe pictures, if it's a historical place and also the text there. And if it's a university, then for me, the text is text will be enough.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Yeah. Uh, is the instruction here. Yes. now it's clear there are two button. So I will click on the start. Okay. Okay. So the next thing is we would start our tour here and press go. Okay. Um, it's understandable, but it would be better if you can mention something more like you are here.

Okay. Now you can click, go here. Uh, your camera view will be on, and it will tell you to move your camera to find the nearest point of interest. So when you're moving your camera around and, um, it identifies the main building, then the information will pop up on your screen.

Uh, one, one thing is that, um, point of interest. So not everyone will understand that. So you should mention this one as well. I think would be a bit different one, because it seems like it's message. So I think the sign should be a different one.

Okay. So this screen here with that, uh, icons and buttons. So now you can tell me what, what's your impression?

Okay. Well, this one is the direction button. This is the map? Yeah. That one is the back page and the other one is options.

Yeah. Uh, the menu, you can click on the menu if you want, just to check the options that are available.

Yes, home, settings, help. What's the list?

I thought if there were, if it was a complete tour, it will be like more than 20 places, at least. So if you get a list view, and you can choose from there and see info, okay. And you can filter too.

Uh, you can check the information icon. Now you see a pop-up window with some texts and yeah. If you want to learn more, you can also click,

Okay, well, it's the background story of the university. Yeah. In this page, the audio version and the video, the pictures. And so the audio, website… nice!

Now if you close the popup and check the route or direction button

The direction one I'm getting into, oh it's moving fast!

This is to give you an impression like how it will actually work. So you will be walking with your camera down through the place.

Um, okay, a shop. Information… don't forget to grab your…okay.

Okay. Now you can again, choose the route button. So it will take you to the next destination. This is the main hallway you're now leaving the building and you're in the, in our yard. You see a cafe in the back, and so you're in front of, um, a lecture hall. It is from the outside, but you can check out the photos.

Okay. This is inside.

Okay. So now, uh, this was the end of our first option. It was the guided route. So you saw like the app will take you to the next location. Um, or you can go back to the homepage, you know where it is?

So here…

You will see all the locations that are included in the app. And you can choose one by one, if you want. So you don't want to take the recommended path. You want to go from some other entrance. You want to start with some other place. You can just go there and check it on the map. And when you click there it's will be the same. You can try one, it gives you the information in the same style. Another option you have here, um, go back to the map and you also have the routes button here on top.

So I can click on? From… audimax. To this? Ok, the line and you can see a map. So it's also showing the route where you're going…this one looks better with the movement.

Um, yeah, so that was the last location for the mockup. It was the basic idea behind the app.

Post-interview

So now I would like to ask you some questions.

1. First, I would like to ask you what is your general impression about the app? Like the interface, the visualization, navigation…was it intuitive enough? what did you like in particular and what not?

The navigation that detection, uh, direction part was really interesting because I never saw this kind of, uh, arrow kind of moving from one to another. So the navigation part was really nice. Uh, I was a bit confused about the information, uh, information, um, but I already, I already mentioned it.

2. How helpful do you think was the root function? Was the line okay or would you prefer any other kind of visualization like avatar, audio something like that?

It was comfortable to see the arrow, but avatar would be interesting. If something is in front of me and I can see and follow that that could be interesting.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you add or change something?

It looks quite nice, but you can also mention the history of that place. You already showed me the old pictures. So it actually makes me more interested to see the pictures. If you can show something like how it was 20 years ago and how it's now it will be more interesting. And then actually I can visualize when I see the pictures. You already include audio files, video files, and text. So, uh, the difference of the features, like how it was before and how it's now.

4. So next, is there something you would like to know more about something about the campus?

Okay. As far I saw, uh, the, the given, uh, explanations were enough, uh, for, for someone who, who, who started to know the university. So for, for me, it was enough because I'm, to be very honest, I'm not gonna read a lot of text when I'm entering to a building. I will just read two or three lines. Okay.

5. So next is, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

You, you mentioned the four or five elements in, in your app. So all of them were quite, uh, quite helpful for someone who's new to, uh, to a place. So for me, I don't want to remove anything. Okay.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Sure. I think it's quite helpful because I already struggled a lot when I went to a university. I didn't know where is the library where are the lecture halls. So for the newcomers, or even mostly for the internationals, it's quite helpful to get this kind of apps when they're new to a university. And it was really nice that you made this app in English because it's an international language, so everyone can use this.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I think I would like to use the app because depending on other people for information is quite landed. So I would really prefer to get this app instead of getting someone to direct me. No, I think the app is better because, uh, for the paper map you have to collect it or sometimes you can lose it, but the app will be always in your phone. So it's helpful.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Okay. For me, I really like to explore new places to eat. So for me, the restaurant for the restaurants, this kind of app app would be helpful. And, uh, I'm from a very different culture. So I prefer to get halal food. So if I can get an app, which shows, which show me where I can get halal food and as, uh, as I'm a student. So I also prefer to get, um, a reasonable, reasonable food. So if an app can show me this kind of information, that where I can get maybe South Asian food, Chinese food or food or reasonable food. So that would be really great. Like if I click on the info information button, I will get to know what kind of food or the menu. And also when it was actually established and basic idea, which includes like five or six sentences, not a lot of details.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 10

02.02.2021

(Cartographer, Greece)

Thank you for […]

And are you familiar with the TU Munich campus?

Yeah, exactly!

Do you have any prior experience with augmented reality applications? Do you know how it works?

Yeah. I used an app in Spain and we have the glasses and you can see through the, through the coast. I mean, you can go through the city through the screen and you can still see some people there, um, some streets and some, some houses. And they also think that there are different types of houses. So I think that's, uh, uh, they focus on architecture of its time. So you can see the different architecture types of houses, something like that.

So was it Augmented reality and not virtual reality?

I think Augmented, cause you put the glasses and you see the houses around.

Okay. That was pretty easy. Um, so then next part for me is I would like to ask you if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

For example, in the campus? I think it's important to define the location of each room, for example, uh, I think also if they were occupied or not, I don't know if this is important. And then, uh, going to the information desk, I mean, to see the main, parts of the buildings, but I think the most important thing is when you want to find the halls, I mean, for, um, for a lecture and also to visit the library, for example.

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

Um, I think if it is possible with a line and I mean on the floor, I think it's easier.

Cool! And what about the points of interest? Like how would you like to identify them on the camera?

Maybe not so much as a line, but of course it's a second level of, yes, it would be nice just like, just like a popup window. Like, I don't know if augmented reality could be a popup window, but you know.

So you'd like to have a pin or a marker on the building and you click there and there'll be a pop-up or something like that?

Yeah

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

I think a combination, not too much text, of course, some keywords, but a thing that when you are outside and you want to go from one place to another, it's important…direction and some keywords of the text.

Mockup demonstration

Okay, nice. So, in the next section, I will show you some mockup designs […]

So, um, so this is the first screen of your app with both of them, right? So to start with the first one, for example, I'm just reading the text information. So, I can click the go button. Okay. So here, your camera view will be on automatically?

Yeah, it will tell you to align your camera with the building. And when it identifies the entrance, it will give you this screen,

And this for example, are information?

Yeah. And you can click on, learn more. Also, you see a text version of the stories on the history. On top ou have some other options.

You can have audio? And you have many photos? You will have more in the app?

Yes.

Okay, The video? Ah it's in youtube! And here, you will be directed to the university website here?

Yeah, any website related to the spot.

Okay. Now, back? What is this button?

You can go back to the pop-up page and I can show you there. Okay. Now you can close it.

Uh, it was like the main button, okay. So this is the menu button.

Yeah, It will be available in every, every, uh, display, uh, you can click on.

Um, yeah, so the homepage. Okay.

So, in the list of places. So you will see all the locations that are provided. And you can choose a category also.

Oh nice!

The settings is for app settings. So if you want to change volume or language or anything else in the app, app settings, and with the help, you will get more information. If you have trouble using something or understanding something, it will get put there. But I thought it's, uh, these are general instructions for apps. So they're pretty much the same.

So, uh, in the bottom, three buttons. Yeah. This mean the location? Great. Uh, you can start with the middle one. Yeah. Great. So this the point, that's the point. Your location right?

I'm glad you understood that. I guess that's the perk of being a cartographer! So, It's like your GPS location. Uh, that third option here, the scan button, if you lose the information from your skin screen, you can scan it again to find your location, find the building, or for example, you want to go back and see someplace again. You can just go there and turn on your camera and scan it again.

And the first button here, the pointer, this is the route?

Yes, this is, it's taking you to the next location.

So now going through the campus and the line Yeah. Okay.

So yeah, you can, if you want, you can stay through the information here. It's put in the same format.

Okay, it's the same.

And okay, now you can move on to the next location again.

Ah the Audimax! I missed, I'm sure you have photos. Yeah. I've never been inside. So I really like the photos! And this website?

This is an event that happens every year inside audimax.

This was the first type of guidance. It's the app guiding you. Now you can go to the homepage.

Yeah, yeah. Um, the second option here, like if the user don't want the whole tour, you can choose one? And the information in the same way. And the map functions are there. Zoom in, zoom out, see your GPS location and the compass.

Yeah. It will be more or less like Google maps.

So if I go here, ah I'm in front of the TUM shop. Okay. I want to see information on this one. Do I have to work here?

No, you can go back and use the route option again.

Uh, the route button I know. Yeah, I use, okay.

This is the option where you can put the locations.

What's the… audimax. And then… inside out? And it shows that path again in the camera. Uh, yes, I think we can go, right? Yeah. Okay.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

First of all, I think, so it was a nice experience. So, uh, I like the colors, I think it's so, so combined with TUM. So, I mean, I understand that, many recollections of my life there. So I don't know if another person doesn't know that. Maybe you can explain that. Um, so I already like this one, um, according to the buttons, for example, do you remember the main button? It was the first thing that I didn't really realize. I mean, so maybe you can make it more clear. The main as this one with the three lines, it was like links to homepage, I think. Yes. In the first page it was okay.

Yeah. So this one, and I guess that you, maybe you can use a frame on the map. Then you have, uh, in the, in the lower levels. Can I say legend, for example? So maybe to have a frame between the map and the legend, just like for, for artistic creations, not for something practical.

And maybe the button of the navigation, maybe to be more clear, uh, in the second part the location button, just to be the same as the, in the previous, I think it was different or not.

Yeah. So I've seen it's just by default, they use this design in the map. That's why I put it like that. But yeah, it should be similar in the app too I guess.

If you just like have more options, if you have like more roads, if you have more photos and I think that would make it, but, uh, from this part, just like, um, try to improve these things that I mentioned and then see.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

I think that the line was okay. Um, I don't know, maybe because I know the buildings and I know the route, so it's easy for me. So if it is something that I don't know, maybe it would be helpful to have arrows or to have something more, but I mean, as a user, I don't have any problem maybe because of that. So I'm not sure about that, but with the line, it was okay. It was clear.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you add/change something?

No, I think it was okay. Maybe to have less text because it was an app on a mobile phone and maybe too much text. Um, it's not appropriate or maybe to make an overview of the history, for example, or maybe to have bullets. Probably it will be more helpful just for the reader, because you're just going from one place to another and then you'd have to focus on that. Yeah. Maybe bullets are better.

Um, so, would you, like personally, some other kind of visuals that would pique your interest or something, or was it, the options that were provided were enough for you?

It were enough. Maybe you can have all deals like this is this place, like within a, the name of a place. Okay. Labels. Yes. Or maybe some key works for that.

I don't know. I mean, I really like those photos or maybe have some combination photos, like now a day and in the process going through the seasons, because now we have snow, maybe if that was spring photo. Yeah. Just to make known for people how it is in the sun!

4. Good. Um, so my next question content wise, would you prefer any other kind of information or any other kind of information about the campus included in that?

Yes. Maybe if there's some, um, events that's there, uh, organizing events. I mean, nowadays they think it's impossible to do always, but I mean, for example, um, an event like a party and event, like information day for going somewhere or the opening hours of the information desk, for example, maybe it would be helpful.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Not really. I mean, if you, um, if you have like the text in a list or just like, make it like an overview, I think rest was ok.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

I think it would be useful, especially for students, um, that, um, who come from the first time and for the first day or the first semester, um, it will be helpful or maybe also will be helpful for tutors, um, and assistance, um, that they're visiting the university, just like for two or three lectures that are visitors like from other universities. And they don't know the main campus or the main facilities. So I think it will be helpful for them.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I think that is my first option. And then, um, but also combination, I think when you have like, uh, uh, someone that knows the place and then you have the app or combined both of them, but I think that the app is enough for the first time.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

And the library? Probably. I mean, you have to know the main, um, the main entrance or the coffee place, or where is the area for a reading or for borrowing books and that stuff. And I think also in this direction of museum. Yeah. Um, and in general, I think, you know, these big buildings that you have, like, uh, in companies and businesses that you go there and you don't know where to go, but I think museums and libraries are more, um, more useful because you have a lot of people that they want to visit them.

Yeah but good thinking though! Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 11

02.02.2021

(Cartographer, Environmental Engineer, Ecuador)

Thank you for […]

And are you familiar with the TU Munich campus?

Yep. I hope I can remember.

Do you have any prior experience with augmented reality applications?

Experience… Yes, but as a user, a couple of them.

So you know how it works?

Um, Yes.

Okay! Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

Especially as a tourist?

Yeah. Also as a student or as a cartographer in general?

Well, it depends on my goals on the place, I would say it would be easier when you have some directions to the addresses that you are looking for exactly where to go and numbers or signs on the things that are surrounding you. Like, what is exactly here, there what's happening? Um, what are, Hmm, well, it doesn't come to my mind, so many things though.

So imagine you're in, inside the campus, um, and you're navigating with an AR app. Um, then what kind of information would you like to have?

Yeah, actually I remember probably most of it, the names of the, the floors of the numbers of their rooms or which side of the building I am like this kind of a semantics or what numeration is the word. Yeah. And yeah, to have names of, uh, important professors that are in the area or places that I am searching for. Okay.

As a tourist, from the university would be nice to have like, um, I don't know, stuff like, um, too, you can play with time and the, yeah. The timing on the building, the changes that it have suffered or something like that.

So the history and the development with time?

Yeah!

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

We probably will with the signs of the direction, which one would be taking me more or less time? I mean, the time, for example, if I go up. Well, exactly like Google maps show you, but with signs. Yeah, like arrows or text. And I can imagine which elements do I have to go through. Maybe also, like if AR can show me, I can go through stairs to go up, which what's the name of it ah a lift! that makes it easier to go shorter.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

For me, it be good in short texts. Short ones and probably some, a couple of photos, but not too much. And, uh, I can have the chance to close it and open it to whenever I can. And also like, to not have too much information at the same time, but just like, if I go one step, I can know what I have two steps forward. Probably. But it can go as updating, updating, and I always have what I have in my next two, three steps, something like that.

Um, and other than texts and photos, uh, any other visual, elements come to your mind? uh, like you were saying about a timeline before…

Ah yeah yeah! That would be really nice! Yeah. Timeline is the word. And if it showed me more or less how it will be the path. So I don't know, probably or something like that, but I can control that part of the app. And then it can show me also if I, for example, if I have some food in the, in the way also somewhat a restaurant, whatever.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

So this is the first screen of your app. I guess. Yeah. So for the first one, the app is giving you the tour. And that's a map? You can search?

The second one, you can choose your own path.

So you see the map and your point. Now move your camera, to identify the building. Okay. So you click the middle icon? Ah the pop-up okay.

Here you can also learn more if you want, you can click there.

So it's audio, you have a video? Yeah. Okay. I guess, can I click here? You have links to websites. Okay.

Yeah. Now you can check the menu button if you want.

Okay. Yeah places and so you can choose your own too…good. And, see, similar places that's helpful for me.

So for home, settings and help, uh, it will be similar with any other Android app.

Yeah. This is to show your current location? Yeah.

This is if you lose your connection or if you want to go back to a place and see the information again, you can always scan with this.

So Now this one? okay, this was your route to the second location.

Yeah, and next one… Audimax! Cool. Okay. Yeah.

So this was the first route. I mean the first option with the route, and now you can, um, check the menu and press home.

You can just check one location or something? I am supposed to be anywhere here and then I can choose the goal, which would be any one of these?

Yeah. And if you want to choose your route, you can use the route button from this page.

So to the inside out, for example.

And it turns on the camera again and also shows you in the map where you're going. So this is the end of the mockup demonstration.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Um, I actually really liked the fact that, it was simple because it's not something that we're really used to and it can get confused. And I think that the design was for a really beginner user. So it's really friendly and it can actually get you excited about the route that you're doing and get it really gets you into it. And yeah, I think it was the really practical also. I think that also a positive thing is that each, um, the concept is not too probably heavy maybe that it can get the, the app really gets slow, like to make the app slow, which would be also a problem in AR.

And yeah, I actually, I think that's the part from the choose, and it was actually not the first part of the interface in that option, but I actually liked the, you can have the whole map and kind of know where to go. I don't know if it was easy for me because I am kind of familiar with it. But anyway, for me, it was a surprise to get the front two option.

Yeah. I like two of them. But I am specifically talking about the second one because when you press it, the first thing that you have is the maps with the options. So it was a surprise for me because I expected them in the front in the beginning. And it was like something after like one more click or something like that. I like it, it was easier for me to get to know the whole idea.

But I think that you can also, if you're in the map, you can select like a point or something…Like you can select the two points with a click. that could be a good idea. Yeah. But the rest, I can really think it was nice. I really like the simple symbol of the design.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

Really. I actually prefer the way you did it. Uh, I also, when you started with the history part, I thought also about another part, like something like a special character from TUM, but for myself, I think it's real practical an arrow. Like the actually the way you did in that arrow, it can take less elements on their interface, I think it's more friendly.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

I like it, but I think that in that part, you can take more from, to reality now, more advantage, because you can actually play with, uh, with the picture and the, for example, in the first one that you are outside the building and you are in front of the entrance and for example, instead of using, uh, image in slide shows after on the click, you can actually see the, the old, uh, stages or the look of the building.

In an image format. Or are you saying like a 3d model or something?

Yeah, Is there like a 3d model, like actually an augmented reality thing that can show you something more? I mean, that's a really good advantage. For example, the things that I showed you actually in here is something happened.

4. Okay, now, um content wise, would you prefer to have any other kinds of information about the university maybe?

I think it was a really good, uh, for first time in the building. But for example, I can imagine if I can try to use the up a little bit more frequently, I would like to choose, for example, my goal and click, as I told you the best route to go there.

5. Did you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No. not actually. It was really nice. I really liked the part you can divide the screen and you can get it on or off to have the line or not. I really like that.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

For sure. I think it's really useful for me, for every outsider, as I told you, it's easy and it really gets you in through find some specific points that are not that easier to find. So probably in TUM and yeah, I think there are a lot of users that can be included there actually new students are also visitors.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I did prefer these ones. For example, some of them are also used in museums. Um, I remember I did once and I really liked because I can control the places they want to go with the place and wait for climb as much as I can and stay there and enjoy as much. So I think like for visiting or something like that, and I prefer to this one, it takes you to the interaction and you can also take the time on the tool, your own time on the tour.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Yeah. Museums for sure. Um, Well, I am thinking about an activity that you walk a lot because you are in a lot in contact with the screen, so you can not be writing or something then. Yeah. Generally museums, I think it's really useful also for, I don't know the name that the things this place is that I even forgot the name in Spanish, but for these kinds of museum for plants. Yeah. I think it's really useful to have it because go on having your screen sort of details, some sort of order pictures about the details of the plants.

Like a botanical garden, or?

Yeah exactly! I think it's also in zoos, for example. Okay. Yeah. Yeah. In general, also for the occasional purposes. Yeah, also probably to find some shops or to find some other areas in the shop when they are maybe yeah. Not for myself on that. But I would say that people can use it. I also like the one with walking tours, where you can play with the history… Oh yeah and also in the mountains! I forgot that one. And could be good have in archeological sites, like to have the real AR feeling with the 3d models or something, yeah that would be amazing, like also on the glaciers! To see the previous view, like historical glacier in life!

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 12

03.02.2021

(Software Engineer, Bangladesh)

Thank you for […]

And are you familiar with the TU Munich campus?

No, I don’t know.

Do you have any prior experience with augmented reality applications?

Uh, not that much. I just know what they are on a very basic level. So, um, I don't have any firsthand experience. I've seen some of the videos from YouTube and, um, there was a holographic image and, um, like, uh, user interaction using some sort of, I don't know, um, motion and motion detection, things like that. That's all I know.

On a technical level. Uh, yeah, but you get the idea like, uh, in the app where you see the surroundings through your camera and then you get some, uh, computer generated information as a layer.

Yeah.

Okay. So that's enough for me. Um, so I would like to ask you, um, as a tourist or a traveler, uh, if you're visiting some place and you're using an app like that, uh, uh, that should guide you around that place. Um, what kind of information would you prefer to have in an app like that?

It can help me with navigation, for example, I'm looking for a place and I, um, hold my camera to a direction and, um, it would be good if the app can tell me which way to go, uh, or I can like, uh, hold the camera, um, on some monument or building. And, um, it would be nice if it could tell me what it is or, uh, give me some additional information about it.

What kind of additional information do you mean?

Ideally, any kind of information I want, uh, for example, I, I can, uh, it is a very subjective matter because when, uh, someone can look for, uh, some historical perspective, someone can look for something fun. It depends on the person. So, um, ideally I guess in a good app, uh, all kinds of information should be there, but yeah, uh, with a brief overview at the top, then if I look for further information, like, uh, the history of the building are what's in the building. Um, this information should pop up too.

Okay. And, uh, as you said about navigation before, uh, like you would like do have the direction, um, to a place. Um, how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

For me? I should be happy with, um, arrows, I guess. Um, I'm not into avatars or something. Uh, so I should say arrow and, uh, maybe a marker of the destination I want, uh, in front of me so I can navigate.

And about the information, like, the history or the additional information about that place. And what form would you like to have that, for example, there could be texts, in any other, uh, visuals something else that comes to your mind?

Uh, I guess whichever, uh, works better. I mean, if I look for an overview, then it should be best. Uh, if there is an audio in vocal, because it's difficult to read text, uh, outdoor. So, audio, would be nice. And, if I look for something specific, like what's inside the building, what experience can I have then, uh, photos or videos would be better in that case.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. You kind of want me to think out loud while using it?

Exactly. Okay. Um, you can, um, see the first page on your screen?

Yeah, okay I understand it.

I click the start the tour option.

So this is, uh, you can see the map of the building. And since you don't know the campus, this is the main building and you can see where the main entrance is.

Yeah.

We can wait a few seconds where you imagine that you're scanning the building.

Okay. Okay. So the first, Uh, there, should I click it? Yeah. That's the menu.

Yeah, so the home button should take you to the first screen and you can check the second option.

There's a setting and help…

Yeah that’s typical for any app you know.

Uh, list of places? So these are the place to see?

Yeah, So you can also choose from here. You can search for places. Yeah. that one, you can also get, ask for a filter.

A filter! Can I click?

So if you go back, so now you are already in front of the main entrance.

Nice. What is this?

That's the marker… it will give you the information.

Yeah. There's a brief history, I can see options there, a play, info, picture? Yeah. This is an old version of the campus. Okay. So the second one is it's supposed to be an audio version?

Yeah. Getting the audio version.

Yes. The third option is a video. Okay. I'll skip it. And this is the info button?

This will be websites related to the current spot. Now for entrance it's the main university website.

Should they click on this?

Okay. do you understand the icon here?

Not entirely. Okay. So this is supposed to be next location?

Okay. So this one, this one was for, if, if you go back to someplace you can always go to the camera.

Um, Yeah.

This one is for your current location.

So it will show you your GPS location?

Yeah. So now you imagine you're walking inside the campus. Of course, you, you are following the line

To a certain destination?

Yeah. And this is the first destination. You can check the information if you want to know where you are.

Yeah. Ok a shop. And…yeah. So, next

Now you're in the inner yard and it's taking you to another building. You can see a cafe in the background.

Yeah. Okay, here. And this is a lecture hall audimax largest lecture hall of the campus.

And, um, for all the locations, you get the information in the same format.

Of course.

So for the second option, you can go back to the homepage,

The homepage,

I put it in a landscape firms because it will be otherwise very tiny on the screen, but you know, you can always rotate your camera.

Yeah, yeah. And this is a basic map function. Like you have those zoom and, um, uh, GPS options and you can navigate through the map?

Um, this is because if you don't want to follow the instruction from the app, you can always choose which location you're at or where you want to go. So for example, if you want information on one particular place, you can click on one of the markers and it will take you to the same,

Yeah I see.

Here you can. Um, in the app you can either write your location where you are, or you can click there and it will give you a suggestion.

So last one Audi max, the lecture hall,

Again, you're following your camera and direction. And you can also see in the map that you're moving.

Yeah.

These one is my favorite spot in the campus.

Is it like a relaxing place? Yeah.

Like you can sit under this structure and you can relax. You can work, you can do whatever you want.

That's nice. It looks nice.

If you get the idea, then we can stop with the mock-up now. And I will ask you some questions for your feedback.

Post-interview

1. First, I would like to ask you what is your general impression about the app? Like the interface, the visualization, navigation… what did you like in particular and what not?

Um, so I shouldn't comment about the design, um, there could be much more design in future if it comes to production, I can understand. So, uh that's okay. Um, uh, the experience now using the app, I should say it has a, uh, it has a simple and easy to use user-friendly, um, interface, not too many options. Uh, I just want to go somewhere. I click on the place and put it in the right direction and it will take me to the destination. That's nice. And then the visual, uh, information. That's nice. I should say. Um, and yeah, uh, if I'm not willing to read, there's an option for someone to read it out for me. So, um, and what should I say? Um,

Um, you can talk about that design, if you want, like what can be improved

This buttons, I should say. Um, this buttons can be sort of hidden when I'm navigating, uh, could be some way when I want these buttons or out again, physically helpful. Um, and, um, I think than that, uh, I guess, uh, the main, uh, good side of this app is simplicity. So, uh, I like that part, so yeah. Uh, and the icons, the icons could be, um, I mean, there's room for improvement for the icons, but I guess for that, I think that's not an issue, so, yeah, everything's fine.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

I guess the lines are a very intuitive way to do it. Um, because, uh, if someone tells me I could tell me left and right go forward, uh, 50 meters, that it's little less intuitive as you say, but, uh, the lines, if it can be implemented, uh, for real, then it should be very nice, I should say because, uh, all I have to do is just, um, I mean, hold up my phone and see which way I have to go and just using a line. That's nice. If I have to take a turn left, from the lines, uh, taking a bend like that. Right. So I guess it's perfect.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

There can be some, uh, interactive, uh, if it can be possible. I mean, I was thinking about, um, like, um, interactive remains feature, like, uh, I hold up my camera and there are, different buildings in front of me. Uh, then I can click on one building and the app will tell me what it is while I navigate. Uh, it's not, uh, it will be like, uh, I am going, uh, to a destination, but, uh, I'm not only caring about the destination. I want to know the surroundings while I'm going. So maybe, uh, while I'm on my way to the auditorium, uh, or the conference hall, maybe there is a building that I like, and I want to know what it is. So I hold up my camera and I click on the building, then it should pop up some information. Yeah. This would be helpful.

4. Would you like to change anything or add anything? Or any other information?

Um, I think, um, there can be some more contemporary information, like, uh, not only in form of video, uh, like, uh, maybe the app can tell me that there's a nice event that's going to take place today, so it can inform me about that. So, uh, it kind of like a newsletter, uh, but, um, according to the user's taste, I should say, so maybe some user is looking for a good seminar or a good talk. Some user can be looking for some cultural event or some sports event. So whatever I'm looking for, maybe the app can let me know.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Um, for me, I personally don't like to like take out my phone that much, so, uh, it's a little bit, uh, awkward to, uh, hold out my phone while walking all the time. Maybe I won't be like holding out the phone and follow the road blindly, maybe, uh, I'll take an idea then put it down and walk. And when I come to an intersection and I pull up my phone again and yeah, they'll be which way to go, I guess it will be nicer. Maybe, uh, if I'm not using the navigation system, maybe I'll be using it for the newsletter or are things like that, or if I'm lost somewhere and I need to find my way out. But for new students and tourists…Yeah, of course. Why not?

6. Would you think an app like this would be useful for a campus tour?

Yes, of course. For students! And when you don't know the language properly, then it's obviously needed. And the app should have the English version, wherever the university is. But it should have an English language options so that everybody can use that app. Okay so maybe in the settings, there could be an option to change languages.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Because this, this will be much more, um, smart, I should say with this app. I should say very fulfilling and that I don't have to depend on, some other person. So, uh, it should be enough, uh, by myself. So yeah, it's, uh, it will be helpful.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

It can be used in, uh, cities, that's where people get lost. So, and I feel curious, like, beautiful building or beautiful park and I want to know about it a little more. So yeah, in that context, this app can be helpful. Uh, apart from that, I don't know if it can be done, but, uh, when, uh, if you go on a, like a trekking or a mountain climbing and, uh, it happened to me, I lost my way, uh, and it costs me like a half an hour. So in that place, if there is an, uh, guiding system, uh, using this kind of, uh, it would be very much helpful to find my way. So there are people who, uh, don't want to go to place, uh, with a guide with them all the time. So for those this would be very, very helpful. And, um, in the, in the recent time, I should say that, uh, Google maps has been very, very, um, widespread and people use it all the time. And, uh, if it can be done in a proper way, this app can be even more, um, intuitive and user-friendly than Google maps.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Is there any kind of real app that's already in the market like this?

[…]

Participant 13

(Product Operation Specialist, Germany) **03.02.2021**

Thank you for […]

And are you familiar with the TU Munich campus?
Yes. Um, I actually wanted to apply, but I couldn't.

But have you ever been there?
No.

Do you have any prior experience with augmented reality applications?
Not really.

Okay. But do you understand what it is or how it works?
I have actually, I have a little idea, but I just don't want to be wrong. So maybe I would want to know more about it.

Yeah, so I can give you a brief idea. So, in augmented reality, you get to see your surroundings, the real world view in the background. But there's extra information added on that view. So for example, you can use your camera, in your phone, so you see the real environment through the camera view. And then there will be some layer of digital information on the screen. It could be texts, photos, graphs, video and so on. So it combines the real information and augmented or digital information on the same screen.

Is this also an example of augmented reality? The zoom call we are in right now?

Uh, no, because, it cannot identify my face. It cannot tell you who I am or anything about me. But if you saw a pop-up window telling you my name, my information on the screen, like floating texts. That would be augmented reality.
Okay.

If you want, I can show you a small example, […]

Oh, it's kind of, uh, like information on the spot.

Yeah, exactly.

So, but there's also, you need to have internet.

Well, sometimes yes. Sometimes no, it can also work with your GPS location or it can work with models. For example, if you're in the mountains, there is an app that, um, already has the 3d models of all the mountains. So you can use those models and align them properly, according to your location. And then the information just matches the screen. Yeah. So there you don't need internet.
Okay.

Now I would like you to imagine that you would actually use an app like this and you, you are somewhere. I mean, you can use your imagination, you, you like traveling to places. So, um, if you're somewhere like this in a new place, a new city could be a museum or anywhere that you like to go. Uh, and you're using this app, for example, what kind of information would you look for in that?

Uh, the first thing would be weather because it is unpredictable. And, also I would like to know, if I'm, for example, I'm going to visit some museum and, if the information is not available in the internet, maybe using such thing can help me get all the information and to know when it is open and also you know, the next train that we can catch, from the place to get back home. So I'll go with like a train station and all the bus station links, and have some good hotels.

Okay.

And history of that.

History? Of the place or of the hotel?

You know, if I'm going to like the museum, like also a little bit of history of it, what's the reason what's the reason that the museum was built and what are the special things that we can find inside the museum. And why is it so popular? Why is it so different and yeah. Such as kind of information.

Cool. And, okay. So how would you like to get this information? Like, in which form would you prefer it, for example, you can have texts. Would you like to read through, um, a lot of texts or would you prefer any other kinds of visuals, like photos or videos or any other form?

I will go with visuals. I would go with a video and a little bit of explanation on it, rather than just reading it, you know?

Okay. Um, and if the app is guiding you from one place to another, so like, if, if you want to, um, go from one building to another or one monument to another, something like that, and the app is guiding you, like how to reach that point, how would you visualize it? For example, it can show you arrows that go this way, or it can give you the names of the streets, or you can hear it, like audio instructions, or, um, there could be an avatar on the screen, like it's floating around and you're following it. These are some options.

Um, I would like, like I said, I want to have it like visual form and also somebody explaining it. So I would want, like the one we have in Google where the kind of says, like, you know, we're walking along and then it says, turn right. Turn left. So I would want such kind of thing with arrows or something that somebody's explaining.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. All right. So I'm here, as you can see, there are two options provided. So I thought it would be better for every kind of user, um, that you have a full tour of the campus. So the app will guide you from one place to another, and you will follow the app. Uh, you cannot

choose where you want to go. And for the second option, there will be the option that you can choose, where you are, what you want to see, where you want to go. So it will be on the user. Uh, okay. I will send you the link, uh, here, and you can click on this, uh, on the link and start sharing your screen with me. I'm sending you here in zoom.

Do I start the tour?

Yeah. You can like, tell me what you're seeing right now. And if you understand the instructions, okay.

I'll just make it bigger. Should I read out loud and explain from my side how I understood it?

You don't have to read aloud the test, but you can explain what you understood or if it's clear for you.

So, okay. So I just came to an app that will give me a ride through the campus TU Munich and I'm going to start the tour. Then I need to check my location first. So we will be starting from the main entrance. From Arcistrasse. Okay.

You can see on the map where you should be standing. Here you wait a few seconds. So this is where you move your camera to find the building. And when it identifies that, okay, this is the entrance. It will give you this screen.

Okay. So I just clicked the button. That's just above the entrance door. So, it's kind of saying you're entering TUM. One of the leading universities of Munich that was established in 1868.

You can click learn more if you want. You don't have to go through the whole text, but you get the idea. Like you can see some history about the university here on top. You have some options.

These are the four tools. Okay. This, uh, the history. Are these professors?

So the first alumni is I think, uh, the organic chemistry department.

Oh, the teacher. I will just cross this.

Well, there will be an option. So if you don't want to read everything, you can also listen to an audio. It's the second option.

And that's, that's what I wanted.

Sorry. It's not working right now.

So this is the information?

Here you will get extra information. So you'll be directed to some other website where you can get more information about the place. And you saw there was a video in the third option.

Yeah. Okay. Is this also the website of the university?

Here? This one is, yeah.

Yep. Okay.

Um, with the other buttons here, I would say you can, yeah. You can go with that one first.

Landmark?

This is your GPS location. So if you want to know where you are at that moment, so you don't get lost inside, you can always check where you are.

There's a high chance of that.

When you close it, the, uh, the one in the bottom. It's for, if you want to. Um, yeah, if you lose the information on the screen, somehow, like you're moving, you're walking and you don't see the building anymore in front of you. So you want to scan again to get back the information it's because of that.

Oh, this is the scanning button. Yeah. Okay.

And, uh, first you can check also the menu before you move. Yeah.

Okay. So many places.

So this is where you will get a list of all the places that you're going to visit with the tour. And you can also, I mean, in the actual lab, you can choose one of them and you can just see the information window directly and you can also put some filter. So if you want just the cafes or just libraries or something, you can check here and it will only show you the filtered information.

Yeah. That's great.

So you can cross, and now the most important, but you already said you don't like the idea. That's the route button. You can click on that one. Oh no, these settings and help, these are the same as any other app. So if you want to change the language or volume or something that that's the settings option for and help is if you need to understand one button or any term specific term that you don't understand, it will be for that.

Guidance. Okay. You told me to go to which one? Oh, this one, the first one.

So now you started the tour. You, you were starting to walk through the campus. It's going too fast here because it's a GIF, but when you're there, you are actually walking and following the line and it takes you here, the second location and yeah, that information layout are the same

Should I click again on this button?

Yeah. So now you will be walking through the main hallway. So this is the main building, and then you go to the, inner yard outside. It's snowing. And On the back, there's a cafe you saw, and this is a lecture hall. That's the third spot. So this is the end of the first route. But if you want to check the information you can. That's okay. If you want to see some photos from inside, you can check it out.

Oh my God, it's huge.

It's the largest. it can accommodate, I think 1100 people.

Oh, cool. Okay.

So this was the first option, like I said, and there, I mean, it's up there supposed to be many more from here to other locations. It goes on this way. And uh, now you can go back to the homepage. And you can check the second option.

Ah, this is very tricky because I am very bad with directions.

But if I put it this way, it will be a very tiny map. That's why I used it like this. So the idea is you can click on any of the markers from the map and it takes you directly to that location. So if you don't want to start from the beginning, maybe you want to start from the shop or somewhere else, you just click there and it takes you there. You scan and you get the information. And for the route you have this button, the same button on top.

This one here?

Yeah. Here, you can actually choose like where you are now and where you wish to go. So you can choose the Audimax, the lecture, this is the lecture hall we were at, and you can choose the last location. And this will give you again, a direction that you can follow this route and walk to the next point.

You know, I think this is one of the best tool for those people and for the new, you know, new in town, because I have experienced of being lost in some building. Especially you know, uh, like initially, you know, when I was new and I was just learning the language, it was pretty difficult for me to catch the pace, you know, where exactly I need to need it to go from which direction. I was hanging there for like, I don't know, 10 to 15 minutes, which way to go? So this is like really cool idea. I mean, for the newbies, I would say.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Um, initially, like I told you, I was a little bit like on the, I will not say negative side, but I was not wanting to go with this. Um, but I guess in some aspects of our life, it is really helpful. Um, because, um, it kind of gives you a confidence to go to any new place and then not feel lost. So, um, it is actually the best tool I would say for now, you know, it's like Google app as well. We do use it because it has helped me. It has helped through a lot of struggles, I would say just to find a place. Um, but with this one, with all the information, it's really helpful. A negative aspect I would, and I don't know, like a lot about, like, to detail information about this augmented reality. Um, so I am not sure if somebody can track me with the information. So because it's like kind of tracking your location, so I'm not sure if it's good in that sense.

But I, I don't think it will be any more, uh, not secure as, um, than Google maps or any other kind of maps or navigation tool that you use on your phone. It's supposed to give you, um, a way, like to give you a direction, but if you want to save your data on your phone, that's up to you. I mean, that could be one functionality of the app. Also, you can use it offline, so there will be no way for someone to track you.

So, in lot of the cases, like with Google apps as well, I mean with Google or Alexa, the terms and conditions because of which we accepted and that's how they actually track us. And I mean, they would Google with not use, uh, also like, I don't know, for the negative or for some false information. So I'm just eager, I would say to know if using such apps also we have to sign certain towns and conditions, you know, like privacy thing from my side.

Do you have any comments about the design elements? Like if the app, um, if the design was okay for you? It was understandable?

Yeah. I mean, it was really clear, loud and clear. Um, I found no difficulty actually finding things. Yeah. Customer convenience.

2. How helpful do you think was the route function?

Um, well, previously I used in different context, maybe, uh, it will be like, I could see as well, but there were also times where actually I would not want to hold my phone and just, you know, just see on the, on the floor and then walk. Um, like if I'm really, um, um, like in a new place, I would really want to give my a hundred percent concentration. So I would just go with the lining. It gives, it kind of makes you easy to follow and then just go to the place without even losing time.

3. H What did you feel about the storytelling elements? So the information that you got about the place. There was text, photos and videos. Would you like to add some other kinds of information? I mean, um, some other visuals in a way, um, I don't know, it could be a 3d illustration or, um, timeline or statistics or something like that. Some, some different elements that you would like to have?

No, just go with 3d. 3d would be much better because it kind of gives you the feeling of understanding and seeing the reality, you know. 3d would be the best one, I would say. Okay.

Um, I would remind you that with the camera you're on, you're actually seeing the place through the camera. And also you're there already when you're exploring. So with the 3d, you would expect, like to see the whole campus altogether, like to get overall idea, or do you mean like something from the past, maybe like it used to look like this in the past?

Um, no. I mean to say, like, whatever we kind of, like when I entered the main door, there was this like button kind of explained a little bit about the university. Um, so in such when they're telling their they're, uh, trying to give some information about the university, along with the script, maybe a 3d animation or something would add more effect, I would say.

4. Would you like to change anything or add anything? Or any other information?

I think I want to just go with the nearby police station or something where I can get like your help, you know, if anything happens, you know, the nearby police station or emergency number or something like that. Yeah.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, no. Everything was okay. Yeah.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Perfect. You know why? Because I was also thinking, you know, because I'm also working in a company, I would say, I'll just take the example of my company that I'm working is really huge. And, um, so there are like a lot of departments and a lot of things that's happening. So you, as like me as a newcomer, I was really overwhelmed, you know, like seeing what people are doing, certain things like this app would really have a visual impact like if this department is doing certain kinds of things and this department is doing certain kinds of things and here was this, so it would be really helpful. And, um, so I would also say like when somebody is new in a university, this thing would really help.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Uh, it depends like when I'm going to a new place, like moving to a city, uh, I would definitely want to go with a human guide because it's more fun and interesting. Um, because there are certain, there are a lot of things where a person can actually explain. Um, but in terms of education, in terms of, um, work, I would just go with this app. This is really helpful.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Airports? Is it okay if I say that?. Yeah, because with airports, it's like really confusing sometimes for me, uh, because sometimes, you know, if the system is not working properly, like, which you need, you need to go and it's kind of, it's too much. Yeah. You have to catch like the flight in an hour and then things are not working and then you have to panic. But if, I guess if there are certain things in the airport like this, that would really, it would be convenient. I think it's museum is really nice because there are a lot of things that, uh, like I said, I mean, certain things, uh, human minds are really nice. I mean, you know, it's really nice to hear from humans, but also in like, history things that a lot of things that a person cannot put things in their head, especially when things like you go to museum. And there are a lot of things, you know, which a hundred or 200 years old, um, for certain things I would want to have such app or maybe something like that. Yeah. To give the background.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

No, it was really interesting. Actually, this one I never heard of this before, until you brought this up and thinking slowly, it's, it's kind of useful for our society. You know, I don't know if it's, how much does it, how much does it help? Like if somebody is lost and then maybe we can track the person overall, like with the educational point of view. It's really nice.

Participant 14

03.02.2021

(Supply chain manager, Australia)

Thank you for […]

And are you familiar with the TU Munich campus?

No.

Do you have any prior experience with augmented reality applications?

Uh, not really. Uh, the closest I've come to is virtual reality. Um, would I be wrong in assuming like things like Google glasses or something, uh, is augmented reality?

It's similar, but, uh, the difference with virtual reality and augmented reality is that, uh, with VR, what you see around you is not the real world information, it's all computer generated, but with AR you can see the real world information in front of you. So through glasses, or you can use your phone and through the camera, you see the surroundings, um, the way it is in real life. And you get some extra information, additional information on the screen, which is, um, computer generated. So it's a big difference.

There was this helmet that basically had, I think, yeah, I, as you just described, for people who ride motorcycles. So they had a camera in the back. Uh, I forgot the name of the company. So as you went down with the helmet, um, now, I mean, you ride a motorcycle you can't

see behind you. I like this one because it had a camera at the back. You could see the real thing on the side, but you can also see things like maps and you can yeah. Basically by planning of routes and stuff like that, or give you traffic information, give you weather information. Um, and you can basically tap on the side of the helmet to, I mean, it's basically like wearing an iron man helmet thing. Like, so, yeah. That's yeah.

Okay I think you have enough idea or or some imagination already! Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're traveling or exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, what type of information would you like to have there?

Um, well, you mentioned traveling, but I think if I go back to say, um, my example of like, uh, being a motorcycle rider, it'd be nice to have that information in front of you. So you can see things like, uh, uh, basically traffic conditions ahead or on the road that you're taking the names of roads. Um, actually combined the traveler thing, as well as the motor thing cause you'd have like points of attraction, points of interest, um, hazards, um, things like weather conditions, um, depending on the complexity, but basically the probability of rain forecast. Um, and also if there was ways to integrate that with the systems of your vehicle, um, should be like fuel consumption, your speed. So you can have all that information right in front of you instead of like looking down and looking down at, you know, the speedometer, fuel gauge or whatever, and things like gears…

Um, but then, yeah, if you're user on the foot, um, very similar, like once again, weather conditions, places of interest, um, maybe crowd sizes. Um, so basically like hypothetically here, they're looking at, um, let's say a museum. I would like a little, uh, little sidebar or something that says, okay, like this is famous for this. Here are some reviews that someone, how much it costs to enter the museum. These are the prices. Here's a quick picture of whatever. I knew I was getting like way too advanced, it's just nice to look at something and it does the thinking for you basically. Yeah. So that, that would be nice.

I mean, face to visit if, what are the key things to see in Munich? Um, points of interest, uh, socially, uh, and, uh, maybe like, if you look at a bus stop or something, and it gives you like a timetable or something on the side, uh, possible routes, uh, where you buy tickets or like, uh, stuff like that. Um, maybe if you're on the road, if you're driving, maybe it be like things like, um, like gas stations or restaurants or something on the side, um, fastest possible routes, um, traffic conditions and stuff. Even if you are a pedestrian, I guess that would be handy. Um, like I've given place like the ideal time to visit those spaces. Um, what else would be useful? Um, yeah, stuff, that's it? I guess.

So is the app is giving you the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

Um, yeah, I'd prefer an audio guide for sure because I could still, you know, switch off visually and just taking the sites. Um, or he just had like a voice in your head kind of telling you it'd be like listening to a podcast or something.

One more thing I'd like to ask you about the story or the information on the locations… what kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

I think information it depends, right? Like, so if I'm looking at, say a restaurant, I don't want like the restaurants, food and stuff described to me, I'd like to see pictures of the things they'd be like, and maybe like a quick rundown of the prices. So I think in that case, it'd be the show. But if I'm going to say, I dunno, like, uh, something like a historic site, that's like a Ruin or something, you see old pictures, let's say, for example, if you're looking at the ruins of like, uh, like a, like an old Roman bath house or something, you probably already know what the thing looks like. It's kind of like that extra bit of info. Uh, and that background info that yeah.

A show you could get from a tour guide or a, or a book or something, but it'd be like that little, you know, when you, when you select like something to watch on Netflix, it gives you like a quick rundown on like who's in it. And like a little bit of background trivia to while you're watching the show. And they're like, you know, information like that about the site. Um, yeah. Um, that you can't really find from history books like something only the locals would know that that's special about it and looking at that, that information like that. So in that case, so I think it's like contextual.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

All right, let's start

You understand, it's showing you your current location, where you should be starting from

Yeah, Go! So here you will be… move the camera to find the nearest point of interest.

Moving your camera in the real view. And when it identifies the building, you will see this screen.

Yeah, here should be a text, um, uh, all that text… […]

Wow, you read really fast! Most of the participants just skipped the text!

I was just curious what the text was about. And oh there's also audio? Okay so it's like the information part and it takes you straight to the information, and um, different version of it. So back and oh the pictures of the thing. Oh, and Oh yeah. That's the, that's the background pictures back in the day. Yaaay! Oh yeah. That's cool. I like that!

You also have a video inside. You don't have to do the whole thing, but okay.

You can check the menu button first before.

Uh, the home, uh, you know, already, it will take you to the first page again. Um, and the list of places, this one you can,

You will see all the places that, that, uh, tour is going to take you to, and you can also choose one of them from here, you can also put some filters, uh, on top, you have the filter icon, so you can choose.

That was pretty cool. Yeah. So going back. I wanna check these buttons.

Yeah. I, it would be good if you start from the bottom. Yeah. So I can explain better.

This one will take you, it will show you the place, the camera thing.

Yeah, the second one is for your GPS location.

Was it, also have like zooming and panning options. So it will be like Google maps or something?

Yeah. Sort of. So now you're S you see a line and you're, you can walk following the line to the next destination

Oh that is, that is quite a fast walk.

I know. I mean, it's, just for the demonstration. I cannot give you the real tour, but it depends on you. Like, you can walk slowly with the app.

No, actually, can I go back? it was fun! It was almost like holy crap, it's cold outside. And I run straight inside and get me out of the cold, slammed through the doors straight up. That's fun!

Oh there's a lot of text, I wanna read that! And oh information oh information!

It's a website on the shelf. If you want, you can buy something online.

Yes. Let's see. Uh, shop. Cool. Cool.

Okay. Now you can move to the next stop. You know how,

Yeah.

Another fast walk and you're going through the hallway. This is the main building and you will go to the main yard. That's like the middle of the campus, and it's taking you to another building. So on the back, you see a cafe and you will stop in front of this building. This is a lecture hall. If you want to see the information you can. Okay.

So this is audimax……

And this is the annual function that happens every year.

Uh, the, um, uh, PICTURES, uh, ah the graduation day! Um, professor um,

We didn't, uh, we don't get our, um, graduation ceremony in here. We all, we all hoped it but they don't do it.

Okay I wanna run to the next place!

But, uh, this was the only two locations for the first one. Sorry. But you have another, another option left. Um, you can go back to the homepage.

Ah, from the menu.

And, but again, this is just going to be one short route.

No, but you still have like four places, that's really nice. As, as, as a tourist or traveler, this would be so handy. Um, in, in like a museum, especially if it's like really big museums and you'd be like, ah, like I don't give a crap about like Europe, for example, I want to go straight back to the Asian section. So you don't have to walk around. Oh, all the shortcuts, the site, man. And IKEA!! You'll get all the shortcuts! Man! I don't wanna follow their arrows!

Okay. So the last thing here, um, if you click on one, two or three, it will take you to the same places that you already saw. Um, just move your camera and you get the information as before. But the difference is now you're choosing the place. The app is not telling you where to go. And if you go back, um, you also see that route button on top. Um, yeah. So that's another option for you to choose which route you want to see.

So for example, the lecture hall already and choose the last location. A very fast walk. Yeah. This is like a relaxing place?

Yeah, so in summer, everyone is sitting there working, eating, just sleeping.

And it will give you the shortest route. Of course. I would love it. As long as I get this transcript. […] innovation and technology and BOOM PLAY. Is that wasting your time?

I can send you the link if you want. You can relax and watch.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Okay. Well, I really liked how easy to use pretty, um, pretty easy to understand. Um, I mean, honestly, if people own a smartphone, they could figure it out randomly clicking buttons, um, simple color palettes, not too hard on the eyes, soothing colors. So it doesn't blind you in your opening screen instructions and you have the option of the audio and the visual, um, pictures as well, which is very nice, uh, pretty straightforward on how to get from point A to point B or, you know, in between points and make a fastest route as possible.

Um, um, maybe, maybe instead of like linking it straight to the website or the mobile version of the website. Because I feel if I'm focusing only on the screen, and I'm using augmented reality. But if it takes me to the mobile, the mobile version of the website, it kind of takes you away from that. You have to experience through browsing. So, yeah, I like the app, I'll use it.

I could easily see its application in multiple places. So not just in a university. Use it in a museum, use in a stupid big shopping centers where the bloody hell is a food court? and they always put it in the top level! I wanna go there and skip all the nonsense shops. So that's really nice.

And probably like, no, obviously you've gotta update and stuff as you go along, so then I get all this popup, kiosks for example they're like temporary, you know, appear and disappear. So one moment it's like a mobile place. The next time it's like a sushi place. And using this app like it no nonsense. Fastest way to get from point a to point B. I like the pictures, also everything.

2. And you already said the route function was straightforward and and helpful… And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

I think it would be nice to have different options. Then you can customize the lines the arrows the style. You can have different tones, different voices, different accents, yeah. But if I have to choose one, I'll prefer the arrows. Cause the place might be crowded or noise already!

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you prefer having something else?

No, I think, there were enough options.

4. Would you like to change anything or add anything? Or any other information?

As a first time user, maybe live data… how crowded it is, basically things like how many people are in the library… Maybe it's not the goal of the app but if you could see like if there was an emergency or something. Like someone was trapped in a building or something… You already had the history, that's good. If you have special offers like you could rent a bike or something, parkings…transportations, oh yes, maybe the fastest route form the lecture hall to the bus stop, for students I mean.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, I really liked the options, maybe add those silly things but nothing to remove, no.

6. Would you think an app like this would be useful for a campus tour?

Yes, new people, it'll be useful for first year students, it'll be useful for people giving guided tours in the campus. During orientation tour for example. What else? Parents and other visitors. Like checking in on their children like where are you now? Haha.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I think I'll prefer the app, cause if you're used to Google maps and well, it doesn't have everything, but app does. And depending on how much time you have, so like, if you're in a relaxing mood you can take time with the app and all.

8. I think we already covered my last question that is what other kind of tours/places would you prefer to explore in the AR environment? You already said museums, restaurants, shopping malls and IKEA! Anything else you'd add?

It can encompass entire cities, like large scale, with all these points of interest, or these museums, like places like mazes where you need the shortest way. Not so much in parks maybe, I mean it's a park! If you don't know how to move in a park, I mean…. Yeah that's all.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

No, just good luck with your thesis and let me know how it goes…

Participant 15

(Aerospace engineer, India) **04.02.2021**

Thank you for […]

And are you familiar with the TU Munich campus?

Umm, no. Um, I know of TU Munich, but not very familiar. I know of it because, um, there was a masters course that I was looking for. That was interesting, but in the end just didn't apply.

Do you have any prior experience with augmented reality applications?

Um, yeah. it's with a few applications on the phone. Um, I don't remember the name of it, but I think it's a few games where you, you see something on the table and then you have to take some actions and you move around stuff using your phone. And, uh, the other one was with the Google glasses, I believe. Uh, it was, um, at a university fair where you could just, you know, see stuff and figure out some stuff to do with it. And one of the more interesting ones for me was, um, in a conference in Bremen where, um, uh, one of the people in the conference where the participant, they came up with an augmented reality set where you could, um, feel like you're in a space elevator

and you see yourself going up in, into space, but it can get more exhausting because you're climbing up constantly and then you're in a confined space. You're not actually confined to the confined space of course. So, yeah, it was just interesting.

The last one you described, it's more like virtual reality.

Oh yeah, you're correct. So, because I had the glasses on and everything. Yeah, that's true. It doesn't come with augmented. Yeah. Um, so augmented reality would be something you see in front of you, but in real time. Right. But virtual reality would be like, you know, you're in a virtual reality itself as the name suggests.

Okay! So, as I see you get the difference pretty well. Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

Yeah, I think, um, firstly that the obligation will be most useful for me in terms of directions. Yeah. For navigation because, um, a lot of times, like every time I use Google maps, every time I've taken a wrong turn because the arrows aren't pointing correctly or it just cannot process the correct direction. So in, in the sense that like you're walking real-time and then the arrow points, you take a right. Um, uh, I think for that, that's like an amazing navigation capability that, uh, this application would bring for me, for example. And, um, another thinking about it, like while I'm navigating through the application, if it pops up, for example, let's say that we've got a new city, I want to explore restaurants or some, some monuments or some touristic attractions, you know, and it just, and a lot of times I do that by just walking around the city. So from walking around, let's say it just pops up on the glass thing that, Hey, this is, um, something you might be interested in, like a restaurant or a touristic attraction. You might want to check out that way. I would find it extremely useful.

And, uh, like you said, you'll use it for directions and navigation. Uh, how would you like it to visualize to you, like with arrows or, um, align or an avatar or what would be useful?

Um, in my opinion, simplest would be just like arrows to go right or left or take a U-turn or whatever, because I think, um, and the reason I would prefer that as, because they are kind of the norm, even when you're going on the road bike, you see arrows everywhere. So it's coming from that aspect or it's coming from that habit that I would like, uh, the app to use arrows.

One more thing, about the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

Uh, that's a very good question because, um, I'm assuming, um, it's my phone and I'm going to be holding it and going like this. Um, I don't want an all work information. I want very, um, uh, as little information as possible, but with most description, for example, if it's a restaurant, I just want, rather than having an X on top that it says it's the restaurant or a hotel, you know? And, um, the other thing, um, the probably would be classification. if it's a tourist attraction, what sort of tourist attraction is it? Is it, is it a church? Is the monument, is it, um, a museum? Um, and, um, yeah, um, I'm thinking in terms of icons, because that's the most descriptive, but probably like if it's a restaurant, we'll just say a restaurant icon with Italian or something like that already food choice choosing.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Sure. What does this mean TUM AR?

That's the name and logo. tum is the name of the university and AR and that's the shape of the main building here.

All right. Awesome. So I start the tour. Now, check your locations first, press go. All right.

Now it's telling you to use your camera to identify the building. You can wait a few seconds while you're, I mean, you have to imagine that you're trying to find the building with your camera, and then you see the pop-up.

Okay. I'm going to click on this one because it really wants me to! So okay, established in 1816, actually. Um, this one, for some reason, I, I, um, my, um, it was not catchy enough for me. The learn more part, uh, like for example, when I go here, this is intuitive that I'm supposed to click on it. Like, there's something when I click on it, I see it. But somehow does learn more, um, I didn't realize it, it gives me some basic information and there is more.

Okay, noted. Now, you don't have to read through all of it if you don't want. It's fine.

Yeah. Um, this one gets as well, which is nice for example like how you can have different options on the screen, this gives me images, which is what I kind of expected as well. So let's show what it does. It seems like it would read the thing out, but I'm not sure.

Yeah the audio, It's supposed to…

Okay. And then this information takes me to the website. Right. I feel like this icon, um, like this one, this one, and this one are quite intuitive. Um, I feel like that says I would get more information for me to a website instead. So, uh, yeah, this is a bit misleading in that sense. Yeah. I feel like it should just give me more information because there's me know some symbol for information. Okay.

And you can check the, yeah. This one.

So menu, Home is, it will take you to the first page. Wait a second. Um, can I click that? Yeah. Okay. So, you will get the overview of all the places that your, um, the app will take you to.

And there will be an option to search for any particular place, if you want. Or you can try the filter to, if you only want to see some kind of places like restaurants or something,

The numbers here, I don't know why it feels not conventional to have numbers here, you type something, and then everything pops up here and then you just have front desk numbers.

Okay. So no numbers. yeah, this is nice just in general settings.

Sure.

Uh, here, or you can check the last two buttons first.

Yeah. Yeah. So this is, like, um, turn on the camera mode and scan again. Oh, okay. Okay. All right. Yeah. That's nice. Um, this is the map again

To show your current location. So like a GPS location, you will know at any point where you are in the map.

Interesting GPS based location, you can have inside the library as well?

Yeah, should be.

Yeah. Now this. All right.

And this will take you to the next location.

Oh, okay. All right. So we're now walking inside the campus. Yeah. And you're, you are following the line on the screen, so it's not, I mean,

This is not moving by itself. You're walking and moving it.

Yeah. Of course. So again, the information pages. But, um, I see the options will be the same.

Yeah. Now you're in the main hallway and you leave the main building. You'll be in the, in our yard. It's snowing outside. Yeah. And yeah, you see a cafe in the back, so you will have, that's also an example. Like you will see popups of different locations around you, but it's taking you to the next spot that's, um, assigned in the tour.

Awesome.

Okay. This was the first option. The guided tour. Now you can go back to the homepage and yeah.

So the second option here, choose from the map.

This is more like, if you don't want to get the whole tour, you can choose by yourself. So the user has the freedom, you can click and just check the layout.

And so this is a map, So yeah, you can click in one of these, um, points and it will take you to that. Yeah. So you only have three selected locations, is it, can I, for example, go at a location that is not selected as well?

Of course in the, I mean, in the application and there will be all the important places available.

You know, this is the bottom floor area. Yeah. And if there's multiple flows outward, what if you want to go up or down?

Good question. So, um, when you, uh, asked for the route, and the line appeared, so it, it, it can take you up the stairs.

Okay, cause that's needed inside the building.

So now the route option is also available here. If you click the route button and so you have to choose the places like where you are and where you want to go.

So that's the, uh, lecture hall or the max, and the last location.

So you see, you have a map view and also the line on the screen. So when you follow this, it can take you, so if you want to go up or down, the line will also give you direction like that with an arrow. And, yeah.

Okay.

So yeah, this, I told you, this is just a basic idea and how the app could look like, like as a design.

Yep. Nice. And, um, all this is generated on the go, is it? Or do you have it pre-programmed somewhere and it just displays on your phone?

Yeah. You'll get the map and it will be like Google maps with your location tracking. Like you can zoom in and out. All of those interactions will be available. Yeah. And it will be updated information. Yeah.

Yes.

It's not possible to show here because it's all static on the yeah. In the platform. So, uh, now I'd like to ask you some questions for your feedback. Um, yeah, you can. Okay.

Okay. Awesome. Very good. Okay. Thank you.

Post-interview

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

I think in general I have a positive opinion about the app. I would use the application, um, in, in my opinion, um, most of the stuff was very intuitive. I think there's a few tweaks that you have to go, maybe get like a bunch of feedback from people. And then I guess that's when you move on what is more intuitive for users to click on. So there's a little bit of work in progress, but as a general feedback, I think there's

a lot of thought process as well on what the users would need or what the users would like to have. So you've got the basic checks with them, I will say.

2. How helpful do you think was the route function? And instead of line, would you prefer any other kind of visualization like avatar, audio something like that?

Audio is not for me and avatar as well because, um, then you just have too much going on. I still want to be able to see my surroundings, you know, simple line is very good for me because I can see other stuff popping up on the map. With avatar, there's chance that you get distracted in the middle and you don't know what's happening, becomes a little too interactive. You will not notice the surroundings. So for me it was perfect. Like the way you had it.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you add/change something? Other than the information icon?

Um, I'm using it as maps. So in maps you can have some 3d but I don't want to crowd the systems in a real life scenario. So maybe I will not go for 3d maps and stuff like that. And, uh, what was the other thing you said? Okay. Historical perspective. I mean, it's an interesting feature, but I'm not sure if I would use it because I'll get, it depends on the application. For example, let's say if I'm using it specifically for the purpose of exploring the city, but if I'm using it, for example, to go to navigate through the library, then I'm definitely not gonna use it. Uh, at least not that often, maybe I use it like for the first time and I'm like, okay.

One general feature I think might be worth adding is how much time it takes from point A to point B. so if you're targeting users that are walking you can mention it will take you 10 minutes or 15 minutes by walk.

4. Would you like to add any other information, I mean content wise, about the campus?

Um, maybe classes like you could have? Um, for example, a lot of times when I had to find a class, it was almost impossible to find from one point without having any information where this thing is. In our library they have something similar like they mapped the whole library and it gives you information on how many spots that are in each particular area, for example, and especially that's useful when you want to use the computer at the library, because there are limited number of spots for the computer. If there's a spot available only then you would have library. So that, that could be a handy feature if you target only let's say the university, the campus. Yeah.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Hmm. Um, I think most of the things were basic, so it's nice to have although, honestly, I don't think I'd use a lot of the features again and again. So, uh, even this information texts, obviously I won't click it every single time. But overall I think it's a nice to have, um, because you know, it gives you a nice experience, it's all digital, so you might as well see it on the app. So, yeah.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Yes, definitely. My personal experiences. I've, been late to classes a number of times because I just couldn't find a classroom, um, in the university. I think it always helps to have a guidance and navigation, and it hasn't been good exploratory features as well. So, you know, just walking around is nice to be over the top.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

No, personally, like, because I think this was a personal preferential question, I believe. It's always nice to have something on you that you can use 24/7 and walk around when you want that's good. No extra effort needed. SO I think the app is the way to go.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

I think in indoor places where you have many floors and you have different things in each floor. So like my office has 10 floors and I always get lost. So if you can have an indoor map of the area it will extremely useful. These places like the shopping malls find a shop of food court. I don't know, I think, maps like these are always useful. You see the point, go and come back. Yeah, that's it.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 16

04.02.2021

(Petroleum Engineer, Germany)

Thank you for […]

And are you familiar with the TU Munich campus?

No.

Do you have any prior experience with augmented reality applications?

No.

Do you know virtual reality?

Like the google glasses and you see different places…

So the difference between augmented reality and virtual reality is in the virtual reality environment, what you see in the glasses, they're all digital information. Like nothing is real there. You're in a virtual world. And with augmented reality, you see the real places in the background with some computer generated information combined. You, you can use the glasses or you can use your phone camera, you actually see what's in front of you. But then you get some more information about those places on your screen. So that's the augmented part.

If you want, I can show you a small example, […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

On the phone? Um, probably for like ATMs, um, like restaurants, supermarkets, like opening hours, uh, camera on the supermarket and information pops up like open or closed, like museums or attractions. Um, what else? Uh, phone, uh, onto the, like a bus station. So like number of routes or like possible destinations, um, yep.

How would you prefer to see the locations? The point that you're directed to? How can you imagine them to be visualized on the screen?

Uh, the number of the buses or metros, um, and the route of course. The important places for tourist, like, you're in a random city and you want to go to an attraction, uh, you can get a line to an amusement park or a touristic square like you can set the mode for tourists or locals or…

And about the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that? Like with a line or audio or avatar or text or something else?

Like, not the audio. It's like give you like a noisy place rather like arrows like in video games pointing like an arrow pointing to someone, something like, I don't know, like a bullet or marker blinking. Like any object that you can use. Like a different color. They are brighter. You can use it or you can see that object and you can go, you know!

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

In a nutshell. Like few items, like in the video, small icons like I for information, like click it and put information in to tell the most important things. Maybe texts. Not the audio. There's street and lot of noise, like traffic. So rather like click on the i and a menu pops up. First of all, that the main or the most important information. Um, for example, you have like a museum and you click on the I and see the opening hours, price. Um, what else? Parking lots. Like pictures of the museum and parking lots. Yeah.

Mockup demonstration

Okay. Now, I will show you some mockup designs […]

I can see it's cool.

So this is the starting page. You get what the options are for?

Yeah. There are instructions.

You can follow the recommended route by clicking the first option, or you can choose from the map.

Okay. So I start the tour. The location.

This one will be a static map just to show you the location, where to start from.

So not the route or anything?

No, just telling you you need to be here for starting the tour. Like a guided tour, you get a meeting spot, like that.

Oh so not where I am but where I need to be?

Yeah.

Now, when I press go here,

You will be asked to use your camera to align yourself. You, you see the main entrance and the, when it identifies the building, the information comes up. You want something to be blinking. That should be the middle icon. It's not blinking at the moment, but it might.

Like, Oh yeah. So it will be on the live building?

Yeah. When you're pointing your camera, uh, to this building, you will see the icon in front of you.

Okay. All right. See the info… so if I want to know more I can click learn more?

Yeah. So you don't have to read everything if you don't want. And so the idea is that you get some text information here. If you want to know about the place, or you can choose the options on top, there is an audio option. If you don't want to read the text, you can also listen to it,

Uh, the second one is the audio. The third one, there's a video inside. So I am directed to a youtube video?

It will be a different video for every spot. If something is available in the university website or YouTube or any other, uh, website.

Okay. Um, I have some more information, I guess. Yeah.

So it's a link to another website. If you're at a different spot and you will be directed to the website for that location.

There are some photos…old ones! So you'll have only historic photos or more?

For now I put some historic photos, but you can have different pictures because you can see how the building looks now in front of you. So it doesn't make sense to give you a recent photo, but maybe from different time in the past or a different time of the day or season.

Yeah. Okay. Main page.

And you can check the menu button here.

Um, so the homepage uh, okay like any other app. You can change the configurations?

From the list of places. You can click on that one again, it's just an example. Like it will show you all the places that the tour is supposed to take you to. So you, you know, like where you are going next.

And yeah I can choose from cafes or libraries?

Yeah, if you're only interested in cafes, you can filter from here and it will only show you those places where you can eat or drink something.

Okay. So now.

From the last three options, uh, the first one is the most important. So I will, I will save it for the last. You can check the other two buttons.

So this one is a GPS? Okay. Will this also show the starting point?

No. This is showing you where you are right now.

Oh okay. So it will be moving all the time. Like every time you click on it, it will show your current location. Okay, the last one… so to scan the building? Ah okay. Then, this one?

This one is taking you to your next point. Imagine you're walking inside,

So I am going in…

And you get the idea like you, you, if you click in the icon again in the middle, it will give you the information.

So this is a shop…photos from inside. The I has a information of the shop? Ah website. So I'm walking with the phone, right? If I point right or left what do I see?

You see the rest of the hall. Only with the points of interest you see the icon to point.

Okay. Now you can move on to the next location.

The arrows are moving again.

In real you can move at your own pace. Now you're in the, um, in our yard, you're going to another building. You see a cafe, you will see other spots. If it's on your way, they will pop up like this. And this is the next stop.

So this is audimax? Um, the information. Video, website again…

So that was the first option. Um, like you get the idea how the tour is going to be.

Yeah.

Now, uh, you can go back to the homepage.

Yup.

And you can check out the other option, choose from the map. Here, I only chose four locations, but in the actual app, there will be a lot more like all the important places in the campus.

Yeah. There is a route?

Yeah. On top the same route button.

Yup.

Here you can choose, like you can type the places where you are, where you want to go. Or if you click here, it will give you some suggestions. So you're in front of the audimax.

So yeah from the audimax to… inside out I guess? I haven't seen, yeah!

So this is the route I see. There is a map too! Nice. It looks like the roof of a stadium! Okay.

This is the basic idea for the app. If you're done with the interaction, I can, we can move to the next session where I ask you some questions for your feedback.

Okay.

Post-interview

1. First, I would like to ask you what is your general impression about the app? Like the interface, the visualization, navigation… what did you like in particular and what not?

Um, okay I like the app. You kept it simple, easy to use. The menu button, the three button down below,

like the button to the next place I thought it would be showing you the route on a map and not the next station. Yeah.

Well, okay. Um, with the navigation and like other options, those were intuitive. I didn't like the design with the arrows, like too many arrows, you can put one or two.

2. Okay. Okay. Less arrows. Okay. Other than that, was the route function working for you? Or would you prefer different kind of visuals or pointers?

The way it is right now. No avatar, for me. It would be childish. Um, depending on the kind of people. Yeah. There could be like options..avatar or no avatar, or for audio too.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

Like apart from audio or text? Um, I'd do less text, only the most important information for example, when I was at the main entrance only when the university was built. Okay it was already there and the option to have more. Yeah, it was okay. On the homepage when you, when I pick from, start the tour and there was a 2d map? But it could be like a 3d.

4. Okay. All right. Um, so my next question is more like content wise, if you are using this app for an, uh, for a campus tour, like this, what other kinds of information would you like to have about the university or about the places? What would be interesting for you to know?

Like where the faculties are. Library? Mensa of course! clubs or pubs that are run by students. Student parties…

Like recent events?

Yeah. Maybe it could be in the clubs' information.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

I think it was all useful, yeah.

6. Would you think an app like this would be useful for a campus tour?

I don't know. Uh, it could be for like, for first semester like on their first week. Yeah. So like a tour for the students, it could be nice.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

So, um, If I'm in China or Russia, like the country, I can't speak the language and where the alphabet is different, then the app will be very useful. But when I'm in a country, like when I speak the language, I'd like to use the Google maps that would be enough for me, or normal map and I can talk to people. And I'll only use the app for additional information.

8. My last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

So a foreign country, inside buildings or emergencies…so if there's a fire it can tell you fast where to go, where the exits are. Anything else? Uh, could be an amusement park! For the attractions, where they are, how many people are there like how long you have to wait for the roller coaster or yeah!

Like Octoberfest?

Yeah Octoberfest, of course!

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Umm… Not now.

Participant 17

04.02.2021

(Researcher, GIS and Physical geography, Bangladesh)

Thank you for […]

And are you familiar with the TU Munich campus?

No.

Do you have any prior experience with augmented reality applications?

No, I don't have an understanding about augmented reality.

So, uh, AR is an advanced technology where the real world information is combined with computer generated information. So for example, if you are going somewhere you want to explore around, you can use your camera see around you and in the app, you will see your surroundings but then there will be some additional information on the screen. There could be some pop-ups some photos other elements, like videos, audio information, you can have website links, uh, and so on. Like, um, you understand like digital information will be overlaid on the, um, real life information.

So, the camera acts like a active feature. I don't have to take pictures just open the camera and point?

Yeah. Let me show you a small example, […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

There are many purposes like traveling. When I visit a new place I want to know, um, my first difficulty is to know the transportation system of this area, like the apps will use, um, the camera function, right? So while I open the camera, the camera can show me, uh, the available transportation. I can read the price level of this transportation in this area. Second, I, uh, like to know the distance from, uh, a point to another point. Like when I open the camera, I can draw a line from one point to another point and the point, um, uh, gives me a distance from between the points. I would like to know the tourist place in this area, like I, I like opening a map I will draw a radius on my point and it will give me the tourist spots in that area. So, um, it could help me to, um, plan, uh, where I can go visit places. So I'd like to know which would are at every level in this distance. Another thing I wanted to know, uh, the elevation pattern of the land surfaces, when I am walking the the road or a mountain I want to know elevation pattern. I think this is enough.

How would you prefer to see the locations? like the point that you're directed to or the point of interest, how can you imagine them to be visualized on the screen?

Like the popup, I'd prefer the initial name showing on this structure, like this is a restaurant. If I want to know about it I will click on that. Not just a marker, initially I want to know what is this place.

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

I can get this like Google maps. So is there anything special you were thinking about this apps, um, about routing?

For example, it can show you live route because you're seeing in the camera. You can actually see the road in front of you, so it can show you that, okay, you take this road with some pointers, it could be an avatar, could be a line on the real road you see in the app. It could be just the names of the streets. It could be audio instructions. Or it can have a map like Google maps included or just arrows or you can think of a different idea.

If I'm driving on the door and my camera is running. So I like information like a warning, or notification that this is something to see or another vehicle is coming at me. And the other thing is like the driving speed on the road.

Okay. And if you're walking, like in a small distance.

If I am walking, one point to another point? Yeah. It can be line, with distance.

Mockup demonstration

Okay. Now, I will show you some mockup designs […]

Okay, this app will… I can choose anything, yeah?

But it's better if you start from the first one, because we will see both of the options.

Yeah, yeah. So this is my GPS location right?

So not as a GPS point, but it will show you where you should be to start the tour. Because this one is a guided tour.

But it can show both like my present location and where the tour starts.

Yeah, actually!

So I click go.

So now your camera's on, it's telling you to move around. So you're standing in front of the building. And when the camera recognizes this place, that this is the entrance, it will give you this icon.

In the middle, here? Let me see. Yeah. So how will I know the direction?

Yeah. That we will see. But before going to the next spot, uh, you can see the information for the first spot here.

So, it will tell me which places are open?

Yes that too.

So how do I go?

Uh, first I would like to check the information box, uh, the one you already click the pop up. Yeah. And you can go to learn more.

Learn more? Okay. I click this this is photos. And what kind of audio?

So instead of text you can hear the story. Or additional information.

It will be in English right?

Yeah, ideally. But could be option for different languages.

Yeah, that would be better. Then? Video… okay, then?

The fourth option is for links to other websites. If you want to know more, so it will take you to the university website and so on.

Yeah. Okay.

You can close and now you can check the menu button.

The home is the first page? And what else?

You the settings and help are in general.

What is list of places?

You can click on that. It's also an example. Like it will show you all the places that the tourist supposed to take you to. So you have an overview of where you're going next. You can also search for places here. If you already know, like, I want to go there or you can filter.

So there will be options, like cafes, libraries, monuments. Okay. I just want to see some images with this.
Okay. So you can choose from the pictures that I want this place to see?

Yes.

Okay, cool. Now you can go back and let me tell you about the other three buttons. So the one in the bottom is for if at any point you lose the information on the screen, you lose the building that you wanted to look at. So you can always click on that. And the camera mode will turn on and try to find the building and scan it for you.

So if I want to back and see something this will help?

Yes. The second one is your GPS location. So you have this map.

This will be a secondary map? Like Google maps or something?

Yeah, yeah. And now the most important button is this one you are looking for a route to the next place. Now you're walking inside the campus. Okay. And you enter the main building and then it's showing you to go,

Go right? So it will take me to a particular location? Will I see other locations like there is a library in my left?

Yeah. yeah. It will be like a pop up with the name or icon. Okay. So you can, if you want, you can see the information here or we can go to the next location.

Okay.

So yeah. You see the cafe in the background. This was inside your view. That's why it popped up there. When you move the camera, you'll see also other pointers like this and yeah. But the arrow will stop when you reach the location. So again, you see the same buttons on the screen, the same popup. You will get the information the same way you can.

You are now in front of the Audimax, the largest lecture hall oh! So it will show me the places that are already in the app? If its not in the app then I will not get any information? If I want to have a coffee in that café, it will say?

Yes. But of course not for all the rooms, just selected ones. Now you can go back to the homepage. Yeah. Okay. So the second option, choose from the map.

So, the same places?

Yeah. but now you don't have to follow the app. So, um, you'll have the usual interactions. Like zoom in, zoom out. You can pan, you can see your GPS location, you have a compass.

Is there an option like you can go in a group and see your friend's location where anyone is…like, like Uh, location sharing? We can see the location of each other?

So I haven't thought of it, but it could be a good idea, I guess, add it in the recommendation. Yeah. That would be a nice thing. Yeah.

While I'm clicking this particular point, will it show a route then? Like, uh, I am here now, so I'm clicking this, uh, particular places. Uh, so it would pop up like this and it can really show the route from my location to this place?

Not directly if you're somewhere else and you're clicking some other spot then no, but that can be another idea to show on the map. That would be possible. Or, um, yeah.

I want to know the route from my present location to this when I am clicking that will be nice.

Okay. And that, um, there is a route button on top. You see?

Yeah.

So when you click there, for example, that's one option you can choose your place, like from, and to, and you can have your own route, like you're in front of the lecture hall. Now you click on Audimax, you can either type it, you can choose it from the list or, uh, in the bottom, you see a map.

Will it also show me the suggestions?

Um, it might, yeah. Depending on, depending on your GPS, it might show the locations, the closest ones. And where you want to go to, and then again, on the screen, you see the line and you also get a map view.

Yes, this one is really nice.

Okay. So that was basically the idea. So now I would like to ask you some questions.

Post-interview

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

I like the last, last option. Like I see the line and the map at the same time is the first thing I liked the most. The second thing, the, the list of places that I can choose. But if I get the direction from it, from my location that will be great. Yeah. So, I think the apps is great, uh, but, the visualization can get better. But it is a great idea to have an apps like a guide with maps.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

Yeah. The line is good. And I think you can see the, um, distance also with the line and, while turning like a right or left, maybe you can have curves and not sharp edges. It, could be in a color with, um, say like, less opacity.

Okay. So not too bright or not eye catching?

Yeah. I want to add another thing. if there is another place on my route, I want, to see the name on top of the route.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you like to change anything or add anything?

I think this information is enough for all kinds of apps. Like the background and some images…it's enough.

4. So for a campus tour do you want to have some other information included?

In a campus tour I want to know like university information like what kind of department is there, academic information, student information. So for students there should be academic information.

Is there any option that I can, add there some images, uh, some videos and a background text, like I can add in the Google maps, I can upload the picture of this to this app's data server? like I will add the image through this app?

It can be, of course an option. To tell your own story. Yeah.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

No, I think everything there is is quite useful.

6. Would you think an app like this would be useful for a campus tour?

Yes, like I said for students and visitors also.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

First of all, I will prefer maps but as different technologies are upgrading we will use more screen based media. If we get all the information, in one apps, like we have some restrictions in Google maps, if there's apps that can combine all the things together, then it will be more useful.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Uh, it could be anywhere like cities, tourist places, anywhere. Could be in airports when you are new and don't know the ways and rules, it will be useful.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

No, no comments from my side. I would like see the apps final apps developed. It is a great app and it will be helpful for people, for tourists so it will be nice.

Participant 18

(Cartographer, Geomatics Engineering, Mexico)

05.02.2021

Thank you for […]

And are you familiar with the TU Munich campus?

Yes, I did. I am because I did my first semester, uh, there for my master's degree, so, yeah, I pretty much know.

Do you have any prior experience with augmented reality applications?

If I have understood what augmented reality correctly, then we have seen the 3d animations in different museums or cinema halls where we can see the 3d version of everything wearing glasses. So if that's augmented reality, then I think I have that experience.

Well, I think I used them one or two times, um, well, like for two minutes or just a presentation or so, but I've seen it.

Um, but you know what AR is.

I do know what AR is.

Okay. So then, uh, I will skip the part where I explain it to you.

Okay. You can skip it. Because I know.

So I would like to ask you as, um, as a user of an augmented reality app, if you are exploring through a place, so you can think as a traveler, um, what information would you like to have in an app if the app is guiding you to a place?

Well, it's pretty much depends. Uh, what's the focus of this application, because it's not the same to get you through, for example, the campus uh, or a museum, or like, uh, I don't know, like some open area, like, um, it totally depends on what you see. For example, in a museum I would like to like, separate things that, uh, actually make you feel that your inside, however, for example, in the capitals, I would like to see, um, some guidance, some things that helped me through my way, uh, or help me to get through some, some place, but totally depends like what's the focus.

Okay. So, uh, if you imagine, um, getting a campus tour using this kind of an app, then what can, which information would pique your interest?

I think it's really important to, to manage, to put that the things that help you, uh, help you out to get familiar with the campus. It's not only to have a, like a 3d view but also to not like some details or some stuff that make you feel like you're there, but that they're actually there to help you to recognize that places like where you are, for example. Like usually users oversea, some details they usually don't pay attention to those, those details. However, there's some objects that are that are really important to have them there to make the experience like real and natural and you're actually there because I wouldn't like to see, like, if there's like stop or like some texture that for me maybe not useful.

Okay. Um, so if you are moving through the campus and you're being directed, like you get some direction how to get to the next spot, um, how would you imagine it to be like, how, how can it be visualized in the app?

Um, I would like to have it, like the way you walk to a place, not really fast, but not super slow that actually gives the perception of the reality the place

But for example, you can have a line or avatar or audio instructions or some visuals on the screen which element would you prefer?

In the campus, if I want to get into a place, I actually want to have, a line, but not going like straight line only to have a line. I mean, when I have to turn over, like to go to the right or to the left, maybe it will pop up like some arrow through these place. Or maybe if I, I want a classroom, maybe if I tap or I click on that, I get some instructions in the classroom, uh, the name is, blah, blah, or this is the office or whatever.

Okay. Uh, so for the points of interest, like you want to see, okay, this is the office, or this is the lecture hall. Um, would you like to see it as a marker, uh, pointing you to that place? Or how would you like to identify?

Actually, like, I think it will be good to have like, uh, like you help you a line that it's guiding you and maybe like only, um, at the door, it will, you will have, like, for example, the line that it's, um, lightning, or like showing you that this is the place you were looking for, um, when you were using, for example, your mobile phone.

About the story or the information on the locations… Would you like to have some texts, or some other form?

Say when you were working with your phone, you actually have a, like really, really small space. So having a lot of texts, um, keeps you out from the augmented reality is just like, um, like, uh, you stopped paying attention to the details to actually read through information. Uh, I think it's better, like, when it was like, in my personal experience, I usually have my headphones, uh, with me and I'm listening to whatever. And so if I hear it's like the instructions, or if I hear some information for me, it's like more useful than when I like, because it keeps me in like my attention it's out of, I'm meant to be able to, if I see some texts, then I'm not paying attention to it and like anymore, um, like you

can actually like combine it to some other devices. Like your phone usually can connect to other devices, for example, your, um, your watch, if it's like a connected to it, maybe the information can be central to it, or like, as a message or something like that. So, I can look at my watch to whatever information my name, my application has given.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. Okay. So, okay. I think I have two options. Um, Hm. Um, okay. I want to see what's in the first one. Okay. Um, start from the main entrance and will take you to the school.

This option is a guided tour. So the app is guiding you now you're scanning with your camera to identify the building. And when it knows that, okay, you're at the right spot, it gives you this information.

Okay. Um, entering to the TUM, uh, one, um, uh, this gives me the perspective that it, maybe it's not for students. Like, usually if I'm, I'm looking for a place like, a lecture hall or any classroom, I mean, for me at this information, it's not helpful. It's for someone who's visiting the campus for the first time. For students or for visitors.

I understand here that the icon in the middle that is to give you more information.

You know what, I will put it like some additional information, maybe somewhere like there, as a teaser! If you want to know more about the campus click here. Just to bring out your curiosity.

Okay. You can click on that now. Yeah. So here to give you some example, like you can have different options. You can read through the text, or there could be some recordings as you see the second icon. so you don't have to read everything. One is for pictures. So you can see some old photos or photos from some different time, how it looked before. Um, you know, a little bit more about the history you can, um, you have some video.

Hmm. Okay. I think that's enough. I'd say, I think it works.

Yeah, you get more information here. For the entrance, I put the university website, like the main one, but it might, it will vary according to your location. I would prefer to check the menu button here.

Okay. I understand.

For the list of places. Um, you can click and it's what you will be seeing in the whole tour, which places you will go to have an overview.

This is for mention, I might, I might not have it here because like, um, I think they will have it like outside, like to get to know like the information, which place is, this is going to take me through, uh, because for me, this menu is like, would be only for this, home, settings and help. And I wouldn't relate it. I wouldn't, uh, at first look for the list of places here. Like at first, like when I click go, like, or maybe here, like, um, to have like markers in the maps or so.

Okay, you can also search there and, you know, um, filter if you are only interested in one kind of place like cafes or, um, monuments or departments, you can choose like that.

The second one here the one you clicked is supposed to be your GPS location.

You know what I'll do? I'll put what these buttons are in the GO.

Okay! You can click on that and see.

And the first one, like with the icon, pointing that is supposed to take you to the next location?

Yeah. So when you click, you see the line in front of you on the screen and you keep walking and it will tell you that, okay, this, this is your next destination. You see the popup again, and the line disappears. So if you want, you can see the information or we can move on to the next place up to you. Okay?

Okay. I think I have already seen. Um… yeah. So to the next one.

So with that, um, you saw the label, stucafe. So other places will also pop up like this around you when you move.

Yeah.

Okay. Now you can go back to the home page and you can choose the second option.

This will be an interactive maps with the locations. So all the locations will be there and you can choose one. If you already know that I'm here and I don't need the route, you can click on the markers and you get the information right away.

Okay, it's fine.

You also have an option to get the route on top.

Yeah.

Yeah. You can type the places like I want to go from here to there, or you can choose it from the map or you'll be, uh, when they have already a GPS, they will suggest you list like this and you can again, follow the routes.

Fine. Yeah. Okay. So

Post-interview

So now I would like to ask you some questions for your feedback.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Okay. The design is fine. Uh, it's really friendly. Um, the only thing that I will add, like it's some more information, what it contains inside the button. I like the design of the buttons and everything. Uh, maybe I find the one with the information a little bit different from this one. They don't match together like completely. Uh, but the colors like the shade of the buttons I liked them actually.

I put blue and white because it's, you know, the color of TUM.

I know. Yeah. Maybe I would have done this one the same way. Yep.

And also maybe the fonts. Uh, I really like these ones. I really like the start the tour, choose from the map. They actually look really cool. Maybe I will do them like somehow a little bit different from this, to get to know that these ones that are buttons and this one is not. Like, I don't know what to add. Maybe some shades or some other color or something, or they be different like to distinguish. So not just the font. Maybe use something, um, not so standard. Uh, we're having here are really cool font, but I really like that. Like maybe it's not that I wouldn't use like traditional font, but maybe I will use like some, some fonts that is with these same design. Um, the map, uh it's, uh, it's really understandable. The thing is we don't need that much information there. So I wouldn't add like more, I think like, only with the streets that are like in time, it's like important to find your location. It's okay. I'm guessing there will be different designs for the vertical and horizontal view on your phone.

Otherwise I think, um, like that's everything from my point of view.

Maybe like a button to say like, uh, which places are very checked out and which ones are missing, maybe that will be useful to see, okay. I already went to this one and this place and it's between this one and this one. The text maybe I will align and have it like a grey color or like you're reading a poem or something, in that design because you're reading the story of a really old school!

Um, otherwise I find it really well, yeah, definitely. I think those will be all micro ones.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

For me, I think the line distract you less from what you're seeing, if I'm looking for a place, I also want to pay attention to what I'm seeing, where, where I'm going. And if I have something that catches my attention a lot, maybe, I would lose what I'm seeing just to see this other stuff. Uh, I will have only the avatar when I'm stopped not moving, uh, the line, I think it works for you. Well, I that's the same way that I'm using it in my car. Uh, I wouldn't like to have any other kind of, um, guidance. And maybe just when, when you have like many, many exits or different entrances, maybe might have like some arrow to tell you this one, you will have some pop, but the line for me, it's enough.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

No, I think it's already giving enough information here. Like some pictures, um, maybe I will only put a really nice font here as title and or maybe I will turn it like the other map. I will have it, like in complete view. Um, yeah, otherwise I, I think that this is enough.

4. Would you like to add any other information in the app?

As a student, for me, for example, I would say like, this entrance, uh, takes you like faster to this department. I think it's, um, when you see it, like from many points, like these entrances closer to these labs or these rooms I think it's like for students that will be irrelevant.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Well, I, it's, not that there are so many buttons. I think those are enough and useful. Um, now, otherwise I don't have any other recommendations. Like I actually, these apps, like for the phones, shouldn't have that much information. So I don't want more.

6. Would you think an app like this would be useful for a campus tour?

Yes, right now as it is done, it's useful for tourists. For students it could have some other information. It could have profiles for like am I a student, am I a tourist or am I a teacher and have relevant information there.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

I personally I will need to try different ways of guidance first. Because I am not used to AR apps to guide me through places. But I think if I start using it, I think I can get used to it really fast. I think I would prefer it more than traditional ways, uh, because it's, uh, easier and you can get to uh like faster. Yeah.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Well, any place that needs a guidance. Even if you are outside and you are going somewhere in walking distance. So I will not recommend it while you are cycling or using a transportation because it can be dangerous uh, you are looking at the screen. But, it will be useful for outdoors, it will be useful for museums, I think, it's like, it could be useful for any plave that people like to visit for any, any reason.

Participant 19

05.02.2021

(Fashion student, France)

Thank you for […]

And are you familiar with the TU Munich campus?

No.

Do you have any prior experience with augmented reality applications?

Not really.

Do you know how it works?

Umm, not really.

Okay. So basically the idea is that, uh, the application, um, combines real-world information with digital information. So you can use your phone or you can use a VR glasses, and you can see what's around you. It's just like any other camera view. But with the background, you will see some additional information about the place or the object that you're seeing in the camera. So have you ever played Pokemon go?

No.

So let me show you a small example, […]

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

Um, if I'm traveling as a tourist, um, I think I'd like to know a bit of history. If I'm visiting like, um, a new city, I'd like to know a bit about the history of the city. I'd probably want something in an app that will help me translate everything as I go. Like if I, um, I can always type in the translator, but sometimes I see photo and sometimes there is like, um, in script, or something. And I would like to know what it means. So if I have something that just, you know, I focus the camera there and everything is translated to my own language or maybe in English that would be nice.

And if the app is guiding you from one place to another, like it's giving you a direction, uh, how would you like to see that? Like, um, for example, it can show you a line on the street or arrows or audio instructions or maps or an avatar.

Which really tells me whether to go left or right. Because that's, that's one thing that I actually a bit confused with when, uh, while I'm using Google maps, sometimes I don't understand if it's like, if I'm supposed to go right or left and I do not understand how the arrow works sometimes. So, um, I think yes, audio, um, or they would be nice telling me to if I shouldn't go right or left. And then see like pointers that this is a place worth checking out or something.

Okay. And how would you like, uh, the information to to show on this screen? Like, um, if you're wanting to see the history or if you want to know about that place, would you like to have it in a text form or in some other forms?

Um, text, uh, text would be nice. I like reading and, uh, also like to see some photos as well from like, like old photos from like before how it looks like, for example, if I'm like, when I, when I saw the Eiffel tower, I was very curious to know how it looked like, you know, when it was made. So that would be nice to see a photo from the beginning.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. You can see it now. Uh, what do you think you understand?

This is the first page of the app and two buttons. Okay. So basically, uh, it says you follow the recommended route by clicking the first option, or you can choose your own route from the map.

In the second one, you can have the freedom to go from anywhere to anywhere. So, yeah, when you start

Okay, start the tour first, okay, where you're supposed to be to start the tour.

And when you click go, it will start your camera view. And this is the basic idea behind AR like, you have to move your camera and when it identifies the building, it will give you the information on the screen.

So now on, you're seeing the building through the camera, so you see an icon on the middle, so you will be like, yeah, exactly. So that's intuitive. Great. Okay. Learn more… So yeah, some text information. I think this for photos. And audio? And I think the next one is play.

Yeah it's a video.

Okay. So in the photos, I like them.

And with the more information here, you're directed to the university website. So you get more information from there. That's that one is also specific to the location.

I go back, this is a manual button top? Ah, you can go back to the homepage. You have a list? And settings and help. So the list is to get an overall idea and you can also choose from here and you have a filter option.

So if I want one kind of place like cafes or libraries or monuments, I can filter here? Uh, this one is supposed to give you this, um, camera again?

So if you want to go back to a place and scan again, you can always use this option. The second one here, um, then you guess what this, yeah. Okay.

So this is uh, like, a GPS location?

Yeah. And the other one?

I have no idea about, I see two points, so maybe next point or something?

Yeah, exactly. So you walk with the camera on and you'll see a line in front of you and you're following it and it stops in front of the next location. So here again, you'll get the information. It's a shop.

You can buy your own souvenirs and stuff. So these, these are taken like, uh, recently?

A couple of weeks ago actually. I mean, if you're here now and using the app, you will see this view and the campus.

Yeah. So next one. This is a lecture hall. Largest lecture hall of the university.

And if you want to see just, there are some photos from inside, because you cannot always go in.

This is good. You can see and decide whether to go in.

And now you can check the next option from the homepage. So choose from the map. Okay. So you are using a phone now it's easier for you to see.

I will see all the locations. It will be like google maps but just for the campus?

Kind of, yes. And the last option here, this is also the same button, the route button.

Okay, I cannot type.

So you can choose from here,

Okay, I'm here. Okay, this one.

Uh okay, so yeah. This map is good. It's facing where I am?

Yeah. And so you see the information here.

Okay, then.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you, what is your general impression about the app? Like the interface, the visualization, navigation… what did you like in particular and what not?

Um, I think it's interesting. I'll definitely use it for sure. But obviously without using it for in real time, it's definitely hard to actually criticize, if I'm traveling to a new place I'll use it that's for sure. And, um, design element, it's simple. That's what I actually liked about it the most, because I'm, I'm not very technologically developed person. I can actually call myself technologically challenged. So for me the simpler it is the better. So I thought it's very easy to understand. So I think, um, it should say don't make it complicated.

2. How was the route function? Would you prefer it this way or some other way I mentioned before?

Well, if the line is showing like that. If, I mean, I prefer the audio because there is like no line like google maps, but like if there is a line that is actually showing me where to go. I think I, I mean, either it has to be audio or a line like this one, so either is fine. Okay. But no avatars.

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

Informative, and I really liked the audio, uh, option because sometimes maybe I will, I'm not in the mood to read, so, but I still like to know. So if I'm like, you know, there is an audio option, I will just play the audio. I just hear whatever is written. So that's helpful. And the photos, they're fine. I wouldn't change anything.

4. Would you like to add any other information about the place?

Yeah. Like where I can find light food around as a tourist. It's very important. The translation, uh, it's already in English, but just in case if it's in other language. Yeah. I mean, it's already, it already has more than I use in my entire life, so.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

I was thinking like probably the video personally, I probably not going to use it. Like I would like to see photos, but video is like, it's, it's a bit time consuming. I'm probably not going to stand somewhere and watch a video about that place. I'm not saying it's not useful or interesting, but I'm probably not going to watch it right away. You probably can put videos in a different section. Like, you know, you're giving a tour about TUM. So rather than putting the video in the, um, in, you have put it right now, you probably can put it in a different section where someone can watch later, like when you go back home. Yeah.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Yeah. For newcomer students. Definitely. If the university is big, definitely. If it's small like the ones in Paris, no, you don't need an app for that, but, um, in big universities, I mean, especially with the one that you showed me, they can definitely use it. Definitely for, um, potential students who are coming to the university to get admission or to just know about the university and definitely professors as well, it could be very useful.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Um, the app is pretty much all in one, so I probably would prefer that. It's much easier. I mean, there, I don't have to ask anyone. I can just do it. I'll just put my phone, so, okay.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

Museums and big libraries and big malls. They can use this app. I think it's easier because sometimes like, you know, when you're in a rush and you're in a curfew and you have to shop in like half an hour, and you go to a big grocery shop and you have no idea where to go. So if the app is showing you, okay, like you put in the app, like, okay, I'm looking for pasta, the app will tell you.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 20

06.02.2021

(GIS Data Engineer, Cartographer, Mexico)

Thank you for […]

Okay. And I know that you're familiar with the tum campus. And do you have any experience with augmented reality applications?

Hmm, I think I do. Yes. One application, I think. Yeah. From the mountains. Yeah. That one that you put your phone and you look to the landscape, and then you have the name of the, of the mountains and the peaks.

Yeah. Peak finder. Yeah. Okay. So you know how it works, augmented reality. Great. So that saves me the time to explain to you what it is, how it works. Okay. So now, um, I would like to ask you as a geographer or as a traveler, if you are, um, exploring through a place and you're using such kind of an app, what functionalities would you expect to have or what information would you like to be provided with?

Well, it will depend on, on the kind of app that I am using. Um, I was really excited about this, uh, peak what's the name? Peak finder. Um, because I am usually not that good reading maps, so it's hard for me to find the peaks and that is something that I would like to have in my country, you know, to put the phone and to know the name of the peaks. Uh, so basically I'm interested on that. And also maybe like, if you're going to a city that you can know the name of the buildings, because you usually you're walking and you see such beautiful buildings, but you don't really know what are those buildings. So I would like to now with the name, and of course, maybe there's a small, a very brief description of the building. Maybe like what it used to be, and now what is it, you know, maybe a library or for whatever that will be interesting. Um, or any interested kind of things. And, and maybe, yeah, maybe if you're going to a city, maybe it can show you the, uh, where to go, like a way. So like a route, you know, like you have the building here and you know what building is, but then it shows you which direction to go and which other building to face it. Yeah, that would be cool.

Great. So from the design perspective now, how would you like the route and the building to be pointed out to you? For example, in peak finder, you see some labels showing you the names of mountains, but if you're walking in a city, would you have it with labels or would you just like a pointer or something and also the route, how would you prefer it, the app to show you the route? It can be with arrows or an avatar that you can follow or lines or something like that?

Um, yeah. Um, I usually have problems with, uh, with, uh, pictures that move fast because I really get, um, dizzy, like for instance, Google maps that you click and, you know, you go like you move forward or backward and that kind of movement, uh, like so fast, it makes me sick. So yeah, I would like to have something that it doesn't move that much. For instance, if your labels for your buildings are, I think it's a good idea and the brief, uh, description on that low part, the screen, um, maybe for the routes, um, with a line. I think it's easier to follow a line that follow, you know, like separate arrows. So if you put the phone like this, you just follow the line and maybe in the corner, you will see that the line is turning. So that will be easier for me to, to follow than an avatar or something. It's like the simplest for me, it will be the best. Like not, not too many things on the screen because yeah, that will make me confused.

And, uh, about the information, like you say, you would like to have small text or something. Any other kind of, uh, information that you would like to see on the screen? Like it could be photos, videos, or audio, or some statistics, some, some even say 3d illustrations, anything.

Yeah, it would be cool. Maybe a picture of how it, uh, I mean, if it's something historical, how it used to look like before, like an ancient or old picture now, how, how it looks now, that would be cool. I'm really excited about those kind of things. Like comparing like the before and after. And what else can it be? Well, maybe if there is some kind of service that, for instance, I told you at a library, maybe they're opening hours and the closing hours, um, if you have to pay a ticket, maybe the price of the ticket. Um, yeah, I think that will be pretty useful.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

So maybe this is the first, so when I click on the app, this screen will show. Okay.

Okay. Um, I think it can be more, um, colorful or, I mean, it looks nice because it looks like very minimalistic. But may be some, something with more color can make more attractive. So I will go with the tour.

So this is a static map to check your location. Like a meeting point. The tour will start from here.

Okay

This is your camera view will tell you to identify the building. So when you move your camera and the camera detects that this is the entrance, it will give you this screen.

Okay. If I click learn more then I will have. Yeah. This is for audio. That's cool. And then you can keep looking to the building. Yeah. So this is a video. Okay. I'll look at the video. Okay. So here's more information. You know what I was expecting? Like, if I take information, I will get this. Maybe you can change it to something that represent the internet or something, maybe there's an icon with three Ws. So there are also pictures. Ah, yeah, this is what I was saying. Okay.

Uh, now you can check the menu button because it's working in this page. You have the option to go back to the homepage. Settings and help, these are like more general functions. Um, the list of places you can click, this is also like giving you the list of the places that the tour will take you to, all the places. You can also choose one of them. Also, you have an, a filter option or search option. Yeah. So if you're only interested in cafes or libraries, you can check.

Yeah, this is cool. Okay. Because if you don't know which, I mean, I am not familiar with the building. then I can filter here. So I guess this is a tour.

Yeah. But before that, let me explain that other two, that's easier this way. The second one, and the bottom, this, uh will show your GPS location.

Okay. So while you move, you will see where are you? You know what would also be cool? If this map, while you walk, uh, for instance, I know this one is the Audimax. So maybe you can label this so you can have more or less the idea if you, if you're walking here. I know is that you will get the picture here, but maybe you can get some, some idea for it.

Okay.

Okay. So if I click it they disappear. Okay.

And the last button, this one is, it will go back to the camera version and it'll tell you, okay, you can move your camera and identify the building. Yeah. Now comes the dizzy part. Yeah. Okay. Because you're going inside, I mentioned you're walking really fast. It's snowing outside.

Well, you are moving, you will see the arrows, but it will tell you, like, that you are in front of an, uh, POI? It will tell me, like you were in front of the shop or a stop here or something?

Yeah at the end, it will point you to the door with the arrow. And when you reach, it will detect that you're in, in this location, the arrows will stop. And you'll see the icon again with the information.

Like this one, right?

Yeah.

So I continue and end up here?

Yeah. Uh, in the information button of the TUM shop, I put the online shop link. So you can also buy something online.

Aww. It's so beautiful. So again…

Yeah. You saw the label, at Stucafe in the back

Okay. Uh, okay. So I think that you will, you can also label here.

Okay. I will put that. So this was the first example, uh, how the guided tour will be. Now, if you go back to the homepage.

This one over here?

Yeah. This is going to be an interactive map like Google maps or something you can zoom in out and you'll see all the locations that are like, that should be in the app. Uh, so from the map, the idea is you see the names of the places you can click on a marker and it will turn on the camera again.

Can I click any one?

Yeah. See you scan it and then you have the information.

But it doesn't show me how to get there. Uh, I mean, what if I, um, wait how do I go back? Okay. So for instance, I'm here. I want to go to Audimax. I won't show me the way?

Uh, you, you can click on the route button on top, and here you can choose. You can type here. Yeah. You are, you get some information from the GPS when you click, it will give you some suggestion.

Okay but when you see that I'm here, you click on a spot because not everyone know the name. So that should be another option, I think. And also if you're not in a POI, maybe you're just walking, then where am I? That would be easier.

Okay. For now you can, um, see one route from the Audimax to the inside-out.

The Audimax. Okay. Uh huh.

So again, you see the line, you see it on the map and you're following it. And, uh, you see here the arrow, like when you reach there, it will stop showing you the route and give you the information instead.

I don't know if that's, that's possible just to make it more interactive. Do you think it's possible? I don't know how hard this can be. Like to point, to the building and then with, um, I don't know the name of the tool, like to sweep the picture and to have, uh, an older picture behind?

Like on top of the building you see a picture of another time?

Yeah. Like two pictures and you swip like the before and after version. I think that would be cool.

Oh I know what you mean. I made a story map once online and I had this function included. Yeah.

Yeah, I think that would be more interactive.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Like there when in the screen, when you can see two screens, maybe I will like to not to double-click for instance. Well, here when you click for information and that you have a brief description. Um, I think I would like to have that, um, maybe immediately when I, I get to the place, like I don't have to click. Um, maybe just an icon of, of the information you want to learn more. A brief description, that's fine. But I would nothing to popup. Yeah. I also mentioned about the labels when you arrive and, um, what else? I also like the filtering places. I like that, because that will be much easier. If you went to find a cafe or something, you don't have to go through the whole list. See the cafes. What else? Hmm.

You mentioned about the color in the beginning? Like you'd like it to be more colorful?

Yes. Maybe. I mean, this looks, in my opinion, it can be more attractive. I know that you are using the blue color because of TUM. Yeah. Maybe it can, it can be more, attractive. Yeah. I also don't want too much information or too many buttons in the screen because that's pretty confusing, but yeah. I think the buttons can be more, more attractive and also the description can, can have a different layout. I don't really love the design to be honest. I like the functionality, but not really the design.

Okay. For the information page or the whole thing?

Yeah. In the information. I mean, I don't like the popup. I mean, the functionalities is very important.

2. And what did you think about the route? instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

Maybe you can have two options. I like the line, uh, to be honest, when I, I, I use Google maps, I never use the audio. I usually look at the map and I say like, Oh, you have to turn right. Or left or whatever. Uh, but maybe if you are walking like, yeah, if you're doing this like a guide, you can just put your earphones and just follow the instructions and like turn left, turn right. But if you don't want it to use the earphones that you just can follow the follow the line. I liked the line. Um, maybe I wouldn't put the arrows too, too close to each other. Um, I mean, it's very small details, but I do like the line, I prefer the line. It shows me that I am following the right way.

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you like to add something?

Like I said that the swipe with the pictures, that was very cool. You can use some statistics, like how many students, or like how many nationalities you're coming from or whatever. I like, I like those kinds of information. You know, like very brief.

Yeah. Maybe you can have more, small beach or whatever, uh, with the statistics like to choose, um, in this case it will be from the whole university. But if we're talking about like, as a guide through the city, of course it will be different statistics from the different places. Also something that I, like you said, you can go to the website. Um, Oh, well in this example, if you want to go shopping through their online shop, but I mean this can be something else. Maybe if you went to buy your tickets with the entrance online or something, I think that's very useful just to go directly to the website. That's a good idea.

4. Would you like to add anything any other information content wise?

I don't know if it will be too much, maybe in there, if you go to the cafe, maybe you can have the menu. It would be cool, but that's like extra information. But in general, no, I mean, I think I already mentioned that it will be cool to have just like, um, the description, but just like lines, not the whole text. Just to make it faster to read. And because I'm more interested in like, on small details, like, you know,

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Hmm. Let me go back. No, I think there is not something that shouldn't be there. I also like, um, the video, the video option. If you want to read, then you can look at the video. Um, no, I don't think there is a unnecessary functionalities or information. And it's easy to use.

6. Would you think an app like this would be useful for a campus tour?

Yes. It can be useful. I mean for this campus. It's a small one, but it's hard to find a way sometimes. Um, not only as tour, but also it can be very useful if you're a student there. I sometimes have problems getting to the places I should go. For instance, uh, the lab there was kind of hard to find a way. They're very big universities. Yeah. I can think about the one in Mexico. It's enormous. It's almost city. So this will be perfect for that kind of places. Yeah. I think it's useful.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Having someone to show me around the place. It's always nice. Yeah, I will prefer it. If I have these two options, I will prefer going with that with a guide. But I don't know if you have more AR options. I only know the ones that you have used and the peaks and all.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

A city of course. Also in a museum it will be very useful. Um, I don't know if in a mall it will be very useful. Well, maybe to find the way would be way easier. My sister has an app, that can identify the plants. She takes a picture of the plant and it gives you the whole description of the plant. So it will be cool if you had something like that. Because you have so many plants. So you have a small description and you have the scientific name and regular name. But if you can have more information of the plant it would be cool for this kind of app. You know where it would be great to have an app? In the Geoparks. This is an idea from UNESCO. The geoparks are areas where you can find geological heritage. It would be great that if you point with a camera to a geological object you can get the whole description of it. Its like the peaks app but with rocks and fossils and volcanoes.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

No I have already said it. I like the functionalities. They are very useful. It's what you need. There is nothing extra. I like the option that you can take a tour or you can choose from the map where you want to go.

Participant 21

07.02.2021

(GIS and Cartography, China)

Thank you for […]

And are you familiar with the TU Munich campus?

Yes.

Do you have any prior experience with augmented reality applications?

Augmented Reality? Um, sometimes to use some AR applications, just a little bit.

So you understand the concept and how it works?

Yeah yeah, the concept.

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

I would expect a navigation tool. Like it might show me the, route to give me the instruction of where I should go or, um, also like maybe like, uh, additional information of a object or some point of interest that I can get like read more information, like if they can pop up from, from the object and then it would be cool I think. That really depends on like what kind is the app, like what purpose, the app serves, I mean. If AR app is a navigation one, then it might have a, a direction arrow, like, lead you where you should go. But if it's an app for a museum, like it might show you more text information or audio information of a, uh, history, uh, subject.

If it's giving you a direction, how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that?

Like an arrow in a line would be, would be okay. And if it has a audio, uh, explanation, then it would be a better, right? Like tell you, like, there's like seven meters to go and turn or something like that. And they might have some, some effect, like a blink blink, like could be better. Right?

Yeah. I will remember the blink blink! Okay.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

Like maybe a graph, right? It can give an overview. Like a picture or visual explanation. I mean, yeah. That'd be better.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. Then we get started, um, okay, I should start the tour.

Oh, this one is a static map. Just to show you where you should be to start your tour.

Yeah.

So now you wait a few seconds, so, well, it will tell you to move your camera. You see the surroundings and when you find the building, you get a pop-up.

Oooh, so now I cannot move right? With the phone I need to move.

Yeah, cause it's online.

Yeah, I know. But okay I see a icon.

You can click learn more. So can you see some options?

Yeah, you have a text. There is an audio option. You have some photos. A option for video and more?

And you have links to other websites here. I put the website for TUM.

Yeah. Okay.

Uh, you can check the menu here. So you have these options and settings help you.

Now. They're pretty standard. A home will take you to the first page, um, list of places?

Like you will have all the places that the tour is supposed to take you to, you get the idea. You, you can search for any place or you can filter, um, you can click on the filter. Yeah. So if you want to see only some selected spots you can choose from here. That's the general idea. So if you select cafes, it will show you stucafe, a Mensa and other eating spots around the campus.

Okay!

Um, now, uh, with the last two options. The second one is to, uh, show you your location, GPS location. It will be interactive in the actual app. You'll see where you are inside the campus. Um, the scan icon is to it only if you want to go back to a place, or if you lose the connection, you can get, you can scan again.

Okay. This one is where you see the route to the next.

Yeah, so I put it in a Jiff format so you get the idea, like, you'll see a line on the screen and you'll follow it. So you will be walking inside the campus, following the line. Yeah. And the information is put in the same format. You see the icon. So, um, yeah, the layout is the same for every location.

I should buy something from the shop!

Yeah, me too!

Now you can go again to the next, so yeah, this, you can turn on or off whenever you want. So it's not too cluttered on the screen.

How, how did you add this, this arrow on this gif?

With images. I have to edit the photos and then make the gif.

On them all?

Yeah. I wanted to give people an idea of how it can move. Like if I'm only using images, that's really hard to explain to everyone who has never used AR before.

Okay. Audimax. Okay.

For this, this option. This is the end point. I'm only showing you an example. So yeah. I didn't want to make it too long. And you can go to the homepage. So now you can check the second option.

So the map should be working, you know, um, there'll be an interactive map?

Yeah. You'll have all these points there, um, all the important points and where you can go, you can click on one of them and then scan with your camera again and have the information back on the screen. And if you go back, you have a route button on top.

Yeah. So I can also choose from here. Like I can type the places in the app, um, or it will give suggestions?

Both can be there.

Perfect. Okay.

So yeah. You saw the line and there was also, it was also showing you in the map help with a red line. So, that's it. It's not the whole design of course, but, uh, yeah.

Post-interview

So now I would like to ask you some questions. And you can stop sharing if you want.

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Yeah, I think, yeah, the idea is pretty cool. I mean, in terms of the, the idea of the whole design that it has, all the POI is right. And all the, um, the route planning, because you can like, when you're really between like places that place like you want to go, you know, uh, I'm thinking, that probably you can add one more, um, uh, function, the biggest for now you can plan the route between different places. Right?

But you cannot plan the, uh, the route between the, um, POI and your current location. So, so that might be interesting, you know, like, I don't know where I am but I want to go to audimax. So it might be interesting if I have this function I can use to directly give me your route. Right.

I like the features, um, your camera really helps to find a way, because, um, sometimes like, I think this spatially in the indoor scenario, it's more helpful. Like, because you can see that this is the cafe, or this is the automatic, so you can know like where I'm, but in the building, you really don't know like, like where are you? Because like the things in front of you, our surroundings are all the same classroom, the door. like outside, you have more things can help you to locate your location. Like references. So I think this AR is really helpful. Um, it's really helpful to use, uh, is partially in the, in, in the building. Like how can this AR help you to navigate? Um, you'll know like how mass our, our, uh, our room number, like two rooms per se, stuff like that. That was horrible. But I have this idea that if you have a AR or you can use your camera, then it can recognize, the room number. And then the app itself can calculate, Like, you don't do remember all of them. So, once you can scan the room numbers, so the app can actually know where you are, then they can give you the correct route for your route planning the idea.

You know your GPS location works so poor in the building, you know, like GPS, accuracy, uh, it could be, could be good in terms of longitude and latitude, the height, the elevation really is worse than the horizontal. So for a indoor navigation that is really tricky there. So you cannot know which floor are you are, because the accuracy is so poor. You don't know which floor you are, but if you can scan, if you can scan the room number, then they can tell you exactly where you are, like, which lower, which people being, which floor, which room like, learn like in, from health. So it can give you a more, uh, accurate route plan. And so this was the idea.

2. How helpful do you think was the route function? And instead of line with arrows, would you prefer any other kind of visualization like avatar, audio something like that?

I think arrows is cool. I think it works great. And yeah. Um, like I said, it could be better if it's like blink blink blink right?

3. How did you feel about the storytelling elements like the text, photos, videos and other options? Would you like to change anything or add anything?

Yeah. I think the information is helpful. Yeah. Yeah. Because it gave you all the information you might want to know and you don't need to search for like Google for it. Yeah. It could be helpful. Uh, yeah. Yeah. And also the pictures, the photos is perfect, I think. Yeah, because you can, you can actually see it before you go there and if it's boring, then you don't want to go there. Yeah. I think it's pretty good. Yeah.

And you were talking about graphs before, like, do, can you think of any other kind of visual elements?

I think this is another thing, because this graph I'm talking about is more like the storytelling map. You see this is like, you wanna make a big thing out of this small object. But apparently that involves like more designs, right? Now you have this text thing, a photo, a video and all. But I think if you're using a storytelling thing, then it must be a mixed thing. Then you have this all in one page. Like text information, gifs, maybe like an SVG like a moving thing all together instead of having all these different forms, like separate ways. Yeah. I mean, this might be interesting for like certain important places like the most popular place, right? Yeah.

4. Would you like to have any other information about the campus here?

I think if this is a school or university, um, navigation app, and then I'm thinking the, the, the user might be more interested in like all the labs, or the professors, or like Nobel prize winners, or, I mean, all this academic related things, you know, like, because they might have a purpose of one day, I want to study there instead of here. So, so I think it should like involve more, uh, academic, uh, things like labs. Like you, you want to introduce like how fancy our labs are, how incredible, uh, equipment or how good is our library. Yeah.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

Um, I think I might have a thought about the two options on the home page. So we have two right. Okay. Okay. So, so the first one is like, it shows, gives you a, like a standard like tour, right? The second one is more like serve the purpose of navigation. Yeah. But my idea is that these two, uh, functions my not be equally important, um, on the home page. So in terms of the design, the navigation, might be more important and the tour one, you might make it like smaller one or on the side. It's just, my idea.

The last three questions are more in the general direction.

6. Would you think an app like this would be useful for a campus tour?

Yeah, certainly. It could be so helpful. I mean, nothing even university, I mean, cut short. Like TUM should have one. If you have a cell phone, that would be great.

7. Okay, would you prefer this kind of app over other forms of tours, for example, people use paper maps, or an audio guide, or just someone giving you a tour of the campus or any other option?

Personally? I think if I'm in a museum, I mean, if the purpose is to exploring is to visit, then I would choose the app. But if I'm in a campus, I want to find a place like a lecture room or a lab, then I would prefer, just ask someone, just ask people. Um, yeah. Yeah.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

I mean, not only campus, I think for things like tourist places and museums also should, have one. Yeah. It's very cool. Because now, like when you go to museum, you can buy the audio guidance. Right. But, if you have a phone app, you have this guidance and this AR a guidance that could be a market, right? Yeah. Because now you need to pay, for the audio service so you can have that one, then you can make lots of money. Um, I mean, commercial value.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…

Participant 22

07.02.2021

(M.Sc. student TUM, Games Engineering, Germany)

Thank you for […]

And are you familiar with the TU Munich campus?

Uh, sort of familiar because I don't really have any classes over there. I just went there for the registration and maybe one or two exams.

Do you have any prior experience with augmented reality applications?

I would say I have a decent amount of experience. I actually had a project during my master's course where I had to develop an augmented reality application. It was basically a game based on AR.

Now what I'd like to know from you is, if you imagine yourself using an app like this, when you're exploring through a place or getting a tour of a place, maybe be a touristic place or a campus, something like that, how would you imagine it? What type of information would you like to have there?

I think whatever the app is, I think it should be something similar to Google maps because right now I find Google maps to be the best way to travel around wherever I go. And so the main thing that I use in Google maps is like the navigation system. So right now the navigation system in Google maps is like, you have to just follow the lines in the map, actual map. So if I'm using AR to do the same thing in that case, what I would assume is the lines would be in the real world or something like that. Like, I would want to go to a place. I would try to have the directions and when I want to see it in the phone, uh, somehow I get some directions using AR to go to the same places. So maybe that's the main thing giving directions through AR. Other than that may be, I would prefer to get some information about the places, but I don't think getting information would be too much uh, important to me because I could just Google them. But the navigation part might be important, I think.

About the route… how would you like to be directed? So the app can shows you you're supposed to go from point A to B, how would you prefer the app to tell you that? Would you prefer to have the direction or the, uh, like navigation with the line on the screen or, uh, in any other way?

What kind of other ways? Right now, I can't really imagine anything other else than a line.

Like just arrows or, um, text or audio, uh, guide or an avatar running through the screen and you're following it.

I don't think anything other than the line seems reasonable for me because like, in case of audio, I can't always use a headphone and in many places, I cannot listen to the app out loud because of traffic noise. And also people always doesn't like hearing noises from others. So, I think the line would be the one I would prefer.

About the story or the information to be shown on the locations… what this kind of information would you like to get about the place? And in, in what format? Would you like to have some texts, or some other form?

Information? I think I would prefer text.

Just text?

Uh, yeah, like in most cases if I had the choice between different options, I would probably opt for the text.

You'd like to read a lot. Okay. And yeah. And, um, how would you, uh, like to see the point of interest, um, how, how would you like to the app to point them out for you

From personal experience, what I have seen before, uh, when I was traveling in other places, in most cases, what I would do is uh, Google that most important places to visit. In most places, they were certain, uh, personalized points of interest maps made by other people that can be shared in Google maps. Those are then overlaid top of the Google map. So those places are shown on the maps and I just can navigate through them. So in the AR app, I would most probably prefer it in the same way. Like I would be able to see whole map and the position of all the points of interest. And if I want to navigate to some place then I could just tap on the location and the app would somehow show me how to go there. And so when I'm trying to navigate through the places that AR app would probably show me the direction to how to go there. And when I suppose reach a point of interest, there would be some kind of maybe notification saying that you are close to a point of interest or something like that. And then in that case, probably I will be able to move the camera to find that place, in my view. And when I find the place in my camera probably related information could be shown. And I think that would be preferable.

So you want notification that this is a point of interest?

Yeah. When I'm close to a point of interest, like any other mobile notification, like getting a message, there will be a blip that you have arrived. Then after that, you can look through the camera to find the actual place and then near the actual place, maybe see some information.

You really like texts a lot.

Mockup demonstration

Okay. In the next section, I will show you some mockup designs […]

Okay. So I guess this is the home page of the app. I see some welcome information and there are two different buttons. What's the difference between the start the tour and choose from the map?

Yeah, so the first option is where the app is guiding you to the place. And the second option where you can choose your starting point and where you want to go.

Let's start with the first one. Okay. So this seems kind of like the Google map. Um, “you will start off on the main entrance”

This is a static map, but it's only to make sure that you're at the right spot.

Uh, so this one should be my location? I mean, is this where I should go or is this my current location?

Where you should be. Bu maybe if you can see your GPS location here it be easier.

Uh, yeah. Like, so in that case, this should be the starting point and there should be another point where I am currently now, maybe, you know? Okay. So first of all, I have to arrive at this position to start to right? Okay. When I come over here, I press go

Okay

Oh, this is like the tour.

So now you are moving your camera. You’re looking for the building.

And so when I find a building, uh, I will be able to, um, find the information like this. So I guess this button is for the information. Yep. So learn more. Okay. A lot of texts and this. Okay. Is there like a video over here?

Yeah. Also have an option for the audio.

Oh, it plays a video from YouTube. And which is for the audio?

Which one do you think?

This one?

Yeah.

So this button seems to be for more information oh, okay.

This is just a sketch here to show you an example.

So in the real case, what should happen when I pressed it, press this button?

It'll take you to a website that's relevant to that location where you are.

Okay. And press learn more to learn more.

And you can read more

All done. So this goes back to the previous page. So these two buttons both seems to be related to maps. What's the difference between them? Should I try to press them now?

You can press the second one maybe first.

Okay

So this will show you your current location at any point.

So this is like a live map of my current location. Okay

And I recommend to press the first one later.

Okay. And what’s the last one for? Okay. I think, uh, now I have to again, find a point of interest to calibrate my camera. Okay.

So that's, if you lose a connection at some point, or if you want to go back to a place and scan again, you can always,

Okay. So this looks like more menu stuff. So let’s press this one. Okay. Home. It goes back to the main menu. I suppose. A list of places. Seems interesting. Let's try that. Okay. So what am I seeing over here? These are obviously in different places in the campus.

Yeah. So the points where the tour's supposed to take you.

Okay. There's a filter here. Okay. And different types of stuffs, uh, specific places I can filter out. Okay, cool. Let's go back now.

Now the most important button

Which is this one? So what am I seeing now? Oh, okay. I'm walking through the campus? So this would be my navigation line if I was actually using it. Right. Okay. So I walked up to the TUM shop.

Oh, you know the place already.

Yeah. It's just beside the registration office. So I have seen it when I went there. So I think clicking this will give me more information. Okay. I haven't actually been inside the TUM shop, I guess this is how it looks like inside. And so more information. Yeah. Okay.

Yeah it’s the website for the shop.

So in the actual app, I would probably be able to buy stuffs from here. So let's go back. So I think these two things are just like before. So let's press this one. Okay. So this is showing the route to the next place. Okay. So pressing that button just starts at my route to the next destination, right?

Yeah. So if we'll show you the line, but of course you will be walking at your own pace and you will be following the line.

Uh, I think I find these two buttons a bit confusing. Like I couldn't really understand that pressing this button actually meant going to the next place. It kind of just seems like a map showing uh, route between different places in the whole map. So more information. So this is the Audimax right? Uh, I haven't actually been in there.

Nobody has.

Uh, okay. So more information, learn more, so, more information about Audimax, I guess. Pictures of audimax.. So let's see more information. So this is a website related to the Audimax?

I think academic seminar or something that happens every year in there.

Okay

Okay. So this was the last spot for the guided tour. You can go back to the homepage and check out the next option.

So for going back to the homepage in the actual app, maybe I will be able to press the back button then go back.

Or you saw the option before

So back to the home screen. I finished the tour. So should I now check the choose from the map?

Yeah. This is to show you the map in a better way. Otherwise it would be too tiny.

So again, uh, will this be like a live map or just a static map?

Live map. In Google maps, you can interact, you can zoom in out to see your GPS location. You can also click on the points. So for example, if you click one, anyone, you can just be in front of that place and get the information directly.

But suppose I'm in front of the tomb shop and I press a RD max, in that case, what would happen?

So it will, uh, turn on the camera so you can, um, scan the place again.

Uh, so basically whichever place I click on the, uh, app, it will just turn the camera on. So maybe in that case, I would prefer to have a single, uh, option to scan the, uh, places, a single button to start the camera, to scan the places because the camera would be able to maybe differentiate between the places by itself. I don't have to say which place I am in. I think it gets bit confusing this way, maybe. Uh, so in this map I just prefer it to be like a normal Google map where I can just see the places and when I click on them, I just see more information about them.

Um, so you mean like just pop ups with the name?

Yeah.

Yeah. So it will be like just an overview map. Okay.

I was actually talking about something similar in Google maps. Like in Google maps, you can make your own personalized, um, uh, travel routes. You can share with other people. So other people can see that map and you just see those points of interest in the map. So this is kind of like Google maps, but in a smaller scale, obviously Google maps doesn't cover a single building. It just covers a large places.

Yeah.

So I guess this is for zooming in zooming out. And this button is for finding my, my position and the main, just like before. And so we have two options on the top, I guess this goes back and this is similar to the button that I saw before. So let's press this one.

Okay. So here you can put the locations, like I want to go from here to there. Here you can click and choose. Okay.

So, uh, um, so we will have fixed number of places over here and I will have to select one of them.

Or you can type.

So I guess selecting wouldn't be the better option if the number of places is really high, but in this case, since I have just like three places, maybe I could use a drop down menu over here,

But maybe it could be like Google maps, like you start typing and it gives you some suggestions of similar names or if it's possible, like I'm not completely sure it attracts your GPS and gives you the locations around like the nearest location, a suggestion that could be an option that might also work.

And what is, this map for? This will show my current location?

Yeah. Well, and you'll see with this, it also gives you, um, like close up map and it shows you a movement. So you can, you have both ways the camera view and also from the map.

So the bottom map was kind of like the Google maps and a top one was like actual view. Okay. So I followed the route to the new place. Okay. So in and out. Oh, okay. Inside out. And just like before I can see more information pressing over here are more pictures. Looks better in the summertime. And this is like the joints of the structure?

Yeah. That's the specialty of the structure. How it's constructed. Okay. So that's basically it.

So if I want to go back then from the menu.

Post-interview

1. First, I would like to ask you what is your general impression about the app itself? Like the interface, the visualization, navigation… what did you like in particular and what not?

Mm. I think the technology is cool. But um, it, if I'm talking technically I think it wouldn't be too easy to implement right now. I haven't seen such apps yet, so it could be a challenge implementing it, but if it's possible to make it, I think it will be really nice. The only downside I can see about using AR is like, you have to keep your phone on, all that time. So it would drain a lot of battery from your phone since you are it continuously and on top of that using AR. What I have seen from my experience um, developing my games, you can't really play that game for a lot of time because it drains the battery a lot. So small tours might be okay, like in case of universities, it seems like a good, uh, way to visit all the places because you won't be, uh, covering a lot of distance, but if you're covering larger places, it might be a problem.

Yep. And involved the design. You have any comments?

No, I think design is cool. Uh, I think you selected the colors because of the colors of TUM. So I think it makes sense. And the button for going to the next point of interest, like I said, it was a bit confusing, but other than that, I think the other design choices were nice.

And how would you, uh, put that button? How would you show it? Like, from one point to another?

Like easiest would be to show some text, like 'next location', but obviously that won't be too attractive. In case of images, I'm not totally sure what an image would be appropriate for that.

2. How helpful do you think was the route function? Like, did you like the, do you, would you prefer it to show with the line or like I mentioned before there could be other options?

No, I think the line is the best option for me

3. How did you feel about the storytelling elements like the text, photos, videos and other options?

No, I think it's okay. There's enough text and enough photos and videos. If a person wants to see the videos or images he can, and if somebody wants to ignore them, they can pretty easily. So I don't think there's any change needed over there.

4. Would you like to have any more information in the app?

No.

5. Okay, do you find any information or element that was not particularly useful for you? And that wasn't necessary for the tour or for the app?

I don't think so. Nothing like that.

6. Would you think an app like this would be useful for a campus tour?

For campus tours at start of your studies? Tours like that are usually conducted by real people. And I think I kind of prefer them over the app because the overall experience, like talking with the new students, that's a really fun part. I think I would prefer that because if you're using the app over there, you would be by yourself and you wouldn't really be able to meet other people. So in case of tours, campus tours, I think I would prefer it over the app.

7. Okay. Actually, that was my next question. You already answered it. Like what would you prefer personally.

8. The last question is what other kind of tours/places would you prefer to explore in the AR environment, other than a campus tour, which places can you imagine, where you'd like to use this kind of an app?

I think museums are the most obvious choice, like there's so many tours in the museums and in those cases, uh, if I'm trying to take a guided tour by from person, cost becomes significant. So in case of museums and other tourist spots, like city tours, I think I prefer the app over actual persons.

Okay. Any other places?

Nothing I can think of right now.

Okay, then. Thank you very much for your participation and if you have any other comments or questions…