Using Touch Gestures to Adjust Context Parameters in Mobile Recommender and Search Applications

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ABSTRACT

The design of interfaces suitable for recommender and search applications on mobile devices is a complex and extensive task. Not only does one have to allow for the simple adjustment of filter settings, one also has to cope with technical and physical limitations like the reduced screen size and the lack of comfortable input methods most users are accustomed to. In this paper we consider the scenario of a user looking for a movie to watch at a cinema. To adjust context parameters in this scenario, we present a novel minimalistic interface that is based on touch gestures. We abandon conventional control elements in order to enhance usability and to devote the screen space to content instead of dispensable elements. Eventually, we evaluate our approach by means of a small user study with positive results.

KEYWORDS: mobile applications; recommender systems; mobile search; touch gestures; interface design; context

1. INTRODUCTION

Today's devices can not only accumulate more personal and device-inherent data such as contacts, appointments and photos but they are also increasingly used to access larger external data sets. A soaring variety of content floods the mobile Web. The sheer amount of data requires the user to filter this content for the information currently needed. If not supported by the computer, the user can easily get frustrated in this overburdening process.

To counteract this problem, context-sensitive recommender systems were introduced to filter items that are likely to be of interest for the user depending on his or her context. As [1] point out, contextual information can be obtained in a number of ways including:

- Explicitly, i.e., by directly approaching the user and asking specific questions or eliciting this information through other means. For example, a website may obtain contextual information by asking a person to fill out a Web form.
- Implicitly from the data or the environment, such as a change in location of the user detected by a sensor. The source of the implicit contextual information is always accessed directly. There is no interaction with the user.
- Inferring the context using statistical or data mining methods.

However, the visualization of possibly desired content, be it pre-processed information by the recommender or raw search results, proves difficult on mobile devices. It is subject to limited screen-space and restricted text-input and interaction capabilities which exacerbate the shortcomings of modern (Web) search [5], as to date most mobile interfaces are simple adaptions of standard interfaces.

Although touch screens have existed for decades, it is due to technological advances in recent years that they have increased their prevalence and that a wave of new touch screen-based devices has prompted [8]. With the forthcoming launching of a new generation of tablet computers led by the Apple iPad, the major shortcomings of previous and smaller mobile devices in terms of screen limitations are overcome. Even though tablets are not on par with desktop computers, they allow for enhanced visualization in mobile search. Still, efficient design of interfaces is crucial.

In this paper we review current approaches in interface design for the field of mobile search. We also analyze how extended interaction capabilities and new interface styles of touch-based tablets can be used to better support the user in his search. As we focus on recommenders, this means presenting the user an easy and advantageous interface to control how the recommender operates. We consider the following scenario: A user wants to watch a movie at a cinema. The recommender lists an overview of movies that might be of interest. To narrow down the results, we want the user to be able to conveniently adjust the filter parameters. For that, we have designed and implemented a minimalistic finger-gesture-driven recommender interface for the Apple iPad with proof-of-concept character. This interface requires as little control elements as possible and focuses on the presentation of results. Control is constructed to be intuitive in order to encourage positive user experience.

The paper is organized as follows. In the following section we present some related work. First, we will look into general interface design on mobile devices as well as interface categories for mobile recommenders and search. Next, we present the design of our gesture-driven approach which will be followed by an evaluating user study and our conclusion.

2. FOUNDATIONS AND RELATED WORK

This section of this paper focuses on guidelines for the design of mobile interfaces. As interfaces are defined by the context of the application, we review several areas of research, each introducing individual design aspects.

2.1. Context-aware Recommender Systems

To support the user in our scenario, a mobile recommender system suggesting movies at nearby cinemas can be used. Thereby, it is important to consider the current context [1] such as location and time because movies not screening today may not be of interest for the user, for example. The recommender system can also incorporate ratings of other users and apply collaborative filtering. [14] presents an approach to integrate different recommender algorithms such as collaborative, context- and content-based filtering (e.g. based on the movie genre) by calculating and combining scores for each dimension. However, a user may search for an evening movie in the afternoon. Therefore it is important to provide an interface that allows for adapting the context parameters for the recommender system.

2.2. General Guidelines for Mobile Interface Design

Based on the work of [9] and [7] we have established some general guidelines for the design of mobile interfaces. This list, however, is by no means complete. It only contains principles we found important in the context of our work.

- Optimized visualization: Mobile interfaces must prevent an overload of information and focus on the essence. A top-down approach is suggested to dynamically determine the granularity of the visualized information.
- Alternative ways of input: Keyboard-based input on mobile devices is laborious, if at all feasible. Thought-out and clever interfaces avoid manual text input where possible.
- Perceptibility: Foreground and background must be clearly distinguishable. Visual effects of the interface related to the functional operation parts should be highlighted.
- Intelligibility & efficiency: The meaning of interface symbols must be clear and understandable, the usage intuitive and easy, that is quick and not complex.
- Information feedback: At all times, the user should be informed about the consequences of his interactions with the interface.
- Dynamic contexts: The use of sensors and other information sources allows for context-awareness.
- Artistic quality and experience: Interfaces have to be aesthetic to enrich the user experience. We design for enjoyment and satisfaction.

2.3. Exploratory Search

A common conception of a search process is motivated by the task to retrieve facts. This classical lookup is mostly associated with a short search query that yields a single precise answer. Most of today’s search systems are trained for this task and perform well, thanks to sophisticated ranking algorithms. But lookups constitute only one form of search activity identified by researchers. According to [13], three general types can be specified (Figure 1). While they are depicted separately, [13] mentions the interplay between these search activities.

Lookup tasks are generally suited to analytical search strategies with two premises: a) one has to be able to formulate a precise query and b) there must be no need for result set examination and item comparison. But what if these premises are invalidated? We imagine another nature of problem, for example the aim to find classical music we might like without knowing this genre and therefore without any criteria for individual preferences - without search criteria. A search like that might be performed with trial-and-error tactics, navigating and investigating search results, then redefining the query and iterating the process.

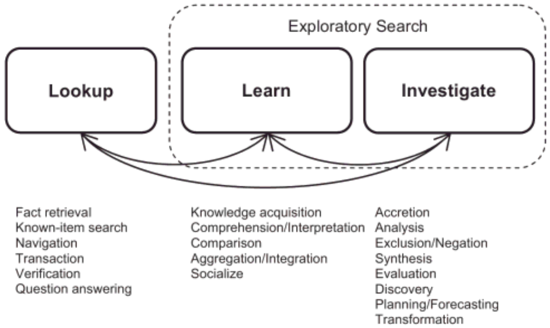

Figure 1. Search activities according to [13]

The technical term for this type of search is exploratory search. It is motivated by uncertainty in situations where: a) the target of the search is (partially) unknown, b) the search begins with some certainty but changes into one unknown and unfamiliar on exposure to new information, and c) users recognize useful information objects by investigation [12].

This raises demands to recommender and search interfaces in order for the user to be able to explore and discover data and iteratively gain knowledge about the domain of interest through both querying and browsing techniques [5]. According to the literature in this field (e.g. [12]), exploratory search systems should:

- use the context of the search activity to reduce uncertainty about the nature of the problem and the information being searched;
- be able to support a diverse range of search strategies;
- provide rich information collections, and
- make use of interfaces that are highly interactive and that immediately update displays in order to engage the user in the search process.

Various concepts and implementations of exploratory search systems have been developed. The integration of temporal information by [2] spawned Timeline-based search, for example. Facet-based hierarchical structuring for image search has been proposed by [15].

2.4. Social Search

A totally different approach to improving search lies in its social side. Using collaborative filtering other like-minded individuals can be included in the context of a user's search. In general, this process can be divided into two steps. We assume that indexed search ratings of all users are stored in the system. First, the system clusters its database into groups and tries to find a group that collectively shares the search ratings of the searching user. Second, the ratings of this group are used to form a prediction for the user's current query. But integration of social elements can not only help rate search results, it can also serve to infer additional context information and, therefore, search criteria. In case of an ambiguous query, the search history of like-minded individuals can be used to determine the context. For Web browsing, [11] introduced this concept as Collaborative Web Search.

Using social annotations, a concept well known from Web 2.0, information explicitly shared by users can help optimize search results. [4] propose two approaches based on social annotations: On the one hand, annotations provide additional meta-information summarizing a website. Similarity calculations between query and website can be boosted by keywords in annotations. On the other hand, the number of annotations for a website can indicate its popularity and by that partly imply its quality.

In recent time, social networks constitute a novel area of research in the field of information retrieval. [10] state that "a growing body of Internet content cannot be retrieved by traditional Web search as it is not well-connected to the hyperlinked Web" which could be overcome by integrating social networks in Web search and by unifying search methods of both domains under a single interface. Integration can also be achieved the other way around: [5] presents a Facebook application as part of the SocialSearchBrowser application. It lists search queries of Facebook friends along with place and time where and when the respective query was issued.

2.5. Mobile and Location-based Search

Another area of research lies in the search for geographic places of interest, be it a well-defined lookup or a rather unspecific query with a broad range of results. While it seems evident to offer a map-based visualization of search results, a recent user study conducted by Church et al. [6] shows that maps are not the interface of choice for certain information access tasks. They also conclude that hybrid interfaces by means of an integrating view are not optimal as the individual choice of test users heavily depended on personal preferences. Instead, Church et al. propose seamlessly switchable views.

While the aforementioned approaches all account for diversified and improved search that is adjusted to contextual needs of the user, few of them are tailored for mobile use and the inherent requirements for mobile interface design.

Combining location-based search and social components, [3] developed Questions Not Answers (QnA), a prototype application that visualizes queries of other people on a map according to the location of the respective user. This concept emanates from the desire to provide users with an enriched sense of the places they visit.

More recently, [5] presented the abovementioned SocialSearchBrowser project which is heavily influenced by QnA. [3]'s work was extended with various types of filters, additional social elements (Facebook integration) and a more sophisticated touch interface.

2.6. Preliminary Conclusion

In this chapter we presented a variety of research areas concerning mobile recommenders and search. For each area, we listed current projects and interface drafts, the greater part of which was designed for personal desktop computers. To cope with small screens and limited input capabilities but also to take advantage of additional context information, the field of Mobile Search has been introduced. Yet, two observations can be made. First, none of the examined approaches are made-to-measure for a new kind of mobile devices: state-of-the-art tablet computers. Second, all interfaces still dedicate a non-negligible part of the screen space to control elements of the search engine or the recommender. In the next chapter we, therefore, present a proposal on interface design for "hybrid" devices, continuing the pursuit of an optimized and content-oriented visualization.

3. A MINIMAL GESTURE-BASED RECOMMENDER INTERFACE

Subsequently, we present a novel recommender interface designed especially, but not exclusively, for tablet computers. It constitutes a prototype rather than an elaborated interface and serves as a basis for our research on general interface design for tablets and the entailing question of usability, and is customized to a single specific use case scenario.

3.1. Motivation and Design

The major restriction of handheld devices in comparison to stationary computers that comes to mind is usually the accordingly small screen size. As stated before, the launching generation of tablet computers overcomes this cutback with a common diagonal screen size of seven to ten inches and a resolution of 1024x768 or higher.

An additional feature is the touch-based control on the basis of which Apple has popularized touch gestures. Subject to the number of fingers currently touching the device and to the direction of finger movement these touch gestures are interpreted as input commands. The distance of the finger movement can be translated directly to a numerical parameter relevant to the action of the command, be it a number itself or a discrete parameter chosen from an ordered set based on its numerical position in the set.

Utilizing these characteristics we created a gesture-driven interface for a location-based search and recommendation application, the subject of interest being movies and cinemas. Imagine the following scenario: You are out and you plan to watch a movie at a cinema, but you don't have a specific film in mind. In order for a system to support you in your search, it should

- present you with a list of cinemas in the desired location,
- give you an overview of movies currently running in them,
- allow for search refinements by means of filters, and
- make use of as much context information as possible.

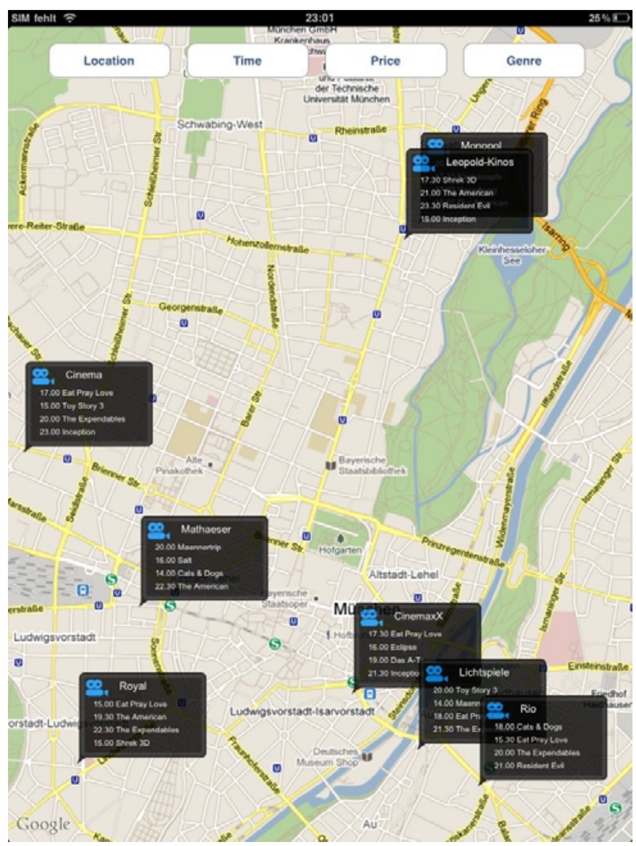

Figure 2. Visual presentation of our movie recommender application

Our application interface mainly consists of an interactive full-screen map that shows relevant cinemas in form of text bubble overlays. Each bubble contains all the movies of the particular cinema that match the request criteria (cf. Figure 2).

In the upper area of the screen we placed four buttons that allow for the switching of the current context. The location context offers common map touch controls like dragging the card, zooming in and out, and tapping on Points of Interest for additional information. The other three contexts resort to our custom gesture implementation. The time context lets the user adjust a numerical range regarding the start time for the movie subject to the current system time. The scale ranges from one to 24 hours with half-hourly stepping. As this setting involves only numerical values, the two-finger pinch is used. The same goes for the price context. Here, the user can adjust the maximum price for a ticket. Only the fourth domain, namely the genre context, requires non-numerical settings and, therefore, the one-finger drag. By moving the finger horizontally along the screen the user can choose from a list of available movie genres. Established filter criteria update the search results on the map in real time. This holds for all contexts. A text overlay informs the user about the adjustments he or she made. Let it be mentioned that the touch gestures work everywhere on the screen not just in dedicated areas.

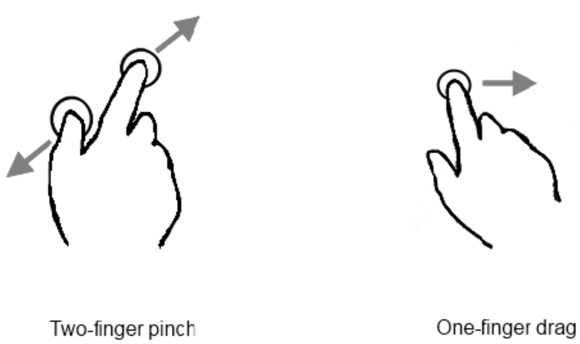

Figure 3. Touch gestures for adjustment of the settings

The draft we created ensures simplicity of use and a visual focus on the functional main element, that is, the presentation of search results, instead of space-consuming control elements. It takes into account all guidelines presented in Section 2 of this paper. We assured optimized, interactive visualization, efficient and intuitive controlling, information feedback, and context-awareness through GPS positioning.

3.2. Implementation

We implemented our concept on the Apple iPad using the MapKit Framework provided by Apple and Google. Unfortunately, the iOS gesture recognizer implementations cause problems when used with view classes based upon UIWebView, that is, MKMapView for our case. Hence, we had to realize our own solution: On top of the map view we put a transparent view layer that intercepts touches on the screen and processes them subject to the current context. If the context is set to location the layer passes on the touch event to the common handler. For any other context it captures the movement of the touch gesture, calculates the distance and interprets the gesture type based on the direction of movement and the number of fingers touching the screen. The distance of movement is then translated into a context-relevant numerical value. An exception on the gesture interpretation by interception is made for the four buttons. Any touch on a point over the area of a button on the transparent layer is considered a click on that button and passed on as such. A semi-transparent label provides feedback on the current setting (cf. Figure 4). The cinemas, their geo coordinates and the list of movies were hardcoded for this prototype application.

Figure 4. Implementation on the Apple iPad

4. USER STUDY

It was the central research question of this project whether the innovative capabilities of tablet computers could enrich user experience by means of novel and well-thought-out interface design. Therefore, we carried out a user study in form of hands-on presentation and a questionnaire.

4.1. Participants and Procedure

20 participants took part in our study, approximately equally distributed between the sexes. Age, background and technical expertise were highly heterogeneous. While some participants were recruited from the computer science domain and the scientific world, others had never used a touch-controlled device. Before conducting the survey, we provided all participants with an iPad running the interface presented in Section 3 of this paper, and shortly instructed them on how to use it. Then, we established the following scenario: The participants were asked to find a movie screening in Munich they would like to attend within the next 24 hours. All other parameters, like genre and price, were to be determined by each participant independently. Following that, our participants filled out a 14-point questionnaire that can be found as Appendix in this paper. It contains eleven "Likert" questions, subdivided according to subject-matter, and three freeform questions for a more general feedback. Everyone was asked, beforehand, to evaluate the functionality of the application under the premise of real, productive use. Subsequently, we outline the results that can be found in Table 1.

Table 1. Questionnaire results

Question	Mean	Mode	Frequency				
			1	2	3	4	5
Q1	3.95	4	0	2	2	11	5
Q2	3.60	4	0	3	4	11	2
Q3	2.40	2	2	12	2	4	0
Q4	2.90	3, 4	3	4	6	6	1
Q5	4.50	5	0	2	1	2	15
Q6	4.40	5	1	0	2	4	13
Q7	2.95	2	1	9	3	4	3
Q8	4.05	4	0	2	2	9	7
Q9	4.25	4	0	0	2	11	7
Q10	3.60	4	1	4	2	8	5
Q11	2.35	3	5	6	7	1	1

4.2. Quantitative Results

The first two questions covered general acceptance and overall usability of the interface. 80% of our participants generally liked the interface, only two people had reservations. Yet, only 65% found the interface to be intuitive.

In the second block we opposed gesture-based control to common distinct control elements. Only 20% stated that they preferred classic control elements over gestures. Interestingly, 35% of all participants were under the impression that control elements allow for more accuracy in adjusting settings. 35% argued the converse and 30% adopted a neutral position.

The expectedly enhanced usability through the comparatively large screen was the subject of interest in the third block. Only a single participant did not share a favorable or noncommittal perception. The visual richness had appeal to a majority of 85%. Two of the questions referred to the matter of portability of touch-driven mobile recommender and search applications to smaller devices like smartphones. The exact half of our participants doubted an equally enjoyable and productive use of the application on such a device. In general, however, the prevalent opinion was that for smartphones gesture-based interfaces are to be preferred over control elements.

In order to evaluate the presentation of search results, the last block comprised three according questions. Not a single participant particularly disliked the visualization in form of bubbles on a map and only 10% would have wanted a different form like a text list. The information content offered by our visualization style was considered satisfying or greater by 75%. The residual 25% had wished for additional information.

4.3. Qualitative Evaluation

Through three freeform questions we elicited positive impressions, criticism and suggestions.

In general, the participants liked simplicity and intuitiveness of the interface. Several people explicitly expressed their enjoyment of the gesture control and the ease of use. One participant stated: *"It is nice that the control is becoming more intuitive in the very sense of the word: Doing something like you would do in real life, instead of the more common perception: 'It would in no way whatsoever do stuff like that in real life, but yeah, the interface is easy to use.'"*

Also, the majority mentioned the cleanliness of the interface due to missing control elements. The only elements we used, the context buttons, were regarded an adequate and easy way for switching context dimensions. In addition to that, the possibility to use gestures anywhere on the screen was favorably received.

Above, we listed a perceived lack of information content reported by 25% of the participants, several of which have provided more detailed remarks. The criticism on this matter formed the main complaint regarding our application. A commonly criticized point was the feedback on adjusted settings. A lack thereof was noticed for all contexts not currently selected. As the label overlay (cf. Figure 4) only shows the setting for the current context, people were missing a display of previously established settings, i.e., for the other contexts. The same goes for the missing highlight of the selected context in order for the user to identify which settings he or she is adjusting at that moment. Also, the feedback label with the current context setting is only displayed when the user performs a gesture, not automatically after selection of a context. The fixed central positioning of the label reportedly caused it to be blocked, at times, by the hand or arm performing the gesture. Another information-content-related point of critique concerned the unavailability of a visual overview over non-numerical options, that is, the movie genres.

Alongside these points one participant picked up on the question of intuitiveness. A small on-screen tutorial on how to control the application was suggested, in addition to the instructions all participants were given before the study. Three remarks were made on gestures themselves. For once, it was suggested to divide the screen and to dedicate the partitions to certain contexts in order to get rid of the buttons. Each gesture would have its according space on the screen. Second, a participant recommended rotational, clock-like gestures to adjust the start time in a more intuitive manner. The third statement concerned the granularity of the gesture-based control: “Gestures did not always set the properties with the desired granularity (i.e. small movement of the fingers resulted in a big change of values).” Admittedly, the implementation of a linear scale could be dismissed in favor of a logarithmic one.

5. CONCLUSION

The design of interfaces suitable for mobile recommender and search applications is a complex and extensive task. Not only does one have to support the user in properly adjusting context parameters, filter out irrelevant search results and visually present them, one also has to cope with technical and physical limitations like the reduced screen size and the lack of comfortable input methods most users are accustomed to. Latest technical advancements that manifest in the current and upcoming tablet computer generations now have rendered possible novel interface types that allow for an enriched user experience and a visual focus on the presentation of content instead of intrinsic controls. In this paper we have availed ourselves of these capabilities and have presented an approach that is mainly based on touch gestures. We almost completely abstained from conventional control elements that dominate most user interfaces. The benefit of our approach lies in the resulting content orientation. As recommenders cope with an excess of information, control elements draw off screen space that could be used to display results. Our interface does not present the user with an abundance of items unrelated to his or her actual interest.

A more elaborated visual feedback is something we will keep in mind for future work on the topic. We will also consider a diversification of gestures for further control element abstraction, be it in form of particular gestures for different contexts or in form of screen partitioning as proposed by a participant. Overall, our evaluation yielded confirmative results. It indicates that our approach is an improvement over conventional interface design in terms of usability, proving our hypothesis that omission of control elements enriches the user experience.

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#	Question
	Likert
Q1	Overall, I liked using the recommender interface.
Q2	The interface was intuitive.
Q3	I prefer distinct control elements (e.g. sliders, radio buttons etc.) over gesture based control.
Q4	Interfaces with control elements allow me to adjust settings more accurately.
Q5	I was able to easily read the text on the interface.
Q6	The bigger screen of the iPad in comparison to a smaller smartphone screen enriches the user experience.
Q7	The same application would be exactly as good to use on a smaller smartphone.
Q8	Screen limitations aside, on a smartphone the gesture based design is to be preferred over control elements.
Q9	I was pleased with the visual presentation of search results in form of text bubbles on the map.
Q10	The visualization gave me all the information I needed.
Q11	Controls aside, a different presentation of search results – for example in form of a text list – would be preferable.
	Freeform
Q12	What did you like about the interface (i.e., gesture controls and visual presentation)?
Q13	What didn't you like about it?
Q14	Do you have any remarks, suggestions or other feedback?

Appendix. Questionnaire