Method Development for the Visualisation of Bicycle Trajectories and Traffic Related Parameters by a Space-Time Cube

SYLVIA LUDWIG[1], ANDREAS KELER[2] AND CHENYU ZUO[3]

[1]Technical University Munich • E-Mail: sylvia.ludwig@tum.de

[2]Chair of Traffic Engineering and Control • Technical University Munich • E-Mail: andreas.keler@tum.de

[3]Chair of Cartography and Visual Analytics • Technical University Munich • E-Mail: chenyu.zuo@tum.de

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Abstract

To establish the bicycle traffic as a climate friendly alternative to the motorised private transport, a rethinking of city planning in terms of traffic is necessary. The analysis of existing spatiotemporal data from road users is crucial for planning streets and junctions in a way, which fits the needs of cyclists.
In the present thesis spatiotemporal data of cyclists at the junction of Theresienstraße and Ludwigstraße in Munich is visualised by bicycle trajectories in a space-time cube (STC). The data, which is used for the visualisation, is collected by a video camera with a frame rate of 30 frames per second. After converting each individual video frame to an orthophoto, road users are detected using computer vision methods, localised and tracked between the georegistered video sequences (Adamec et al., 2018). For the upcoming visualisation of the trajectories merely the 260 bicycles of a total of 1113 road users are considered, which corresponds to one half of the recorded cars in the selected time frame of 17 minutes and 40 seconds. The raw dataset is reduced and pre-processed into a transformed dataset of reduced memory storage to improve the performance of the further visualisation methods.

To account for a user-defined filtering function and other visualisation options, a graphical user interface (GUI) is implemented in MATLAB. By using this tool, the dataset of the aforementioned crossing can better be analysed in terms of the cycling behaviour. The GUI contains different tools, such as a feature, which filters the visualised trajectories for the origin and destination of the bicycles, therefore it is possible to analyse a specific bicycle stream. Another filtering feature, which is realised by a double slider, allows for the reduction of the amount of shown trajectories. Moreover, one can display the traffic lights, which are switched for the respective traffic flow. The traffic light circuit is visualised by spherical dots in green or red, which are shown as long as a cyclist sees the traffic light, see Figure 1. Two other features are the visualisation of the direction of traffic through small arrows and the possibility to show the velocity of the road users at a specific position, through a colouring of the trajectories. With the help of a colourbar, the respective speed from the colour of the trajectory can be read off.

By using the features of the GUI it possible to get a clearer picture of concrete driving patterns, which are visualised within the STC. Especially, the possibility of a data reduction by the aforementioned filtering features is crucial. It allows the user to keep track of the huge number of trajectories and analyse the behaviour of single cyclists. One specific pattern of the observed road users is the disregard of the red traffic light, which can be seen in Figure 1. The cyclists of the straight traffic flow of the Ludwigstraße, which are ignoring the red light are marked by 1 and 2. After a detailed analysis one can see, that these cyclists crossed the red traffic lights with a high velocity of around 20 km/h. A possible explanation for this behaviour can be determined with the help of the available video material. By using this, it becomes apparent, that the cyclists were not under immediate danger, as there were no motorised vehicles in the field of view. By a further analysis of the available dataset other

patterns can be observed with the implemented tool. One example is the driving behaviour at traffic lights, which can be best analysed by considering the bicycle velocities in the colourmap. This could be useful to help matching the traffic lights to cyclists and therefore to improve the traffic flow for this group of road users. One last pattern, which can be seen in the STC is the crossing behaviour of the cyclists, which is characterised by its diffuse picture. Part of the cyclists choose the possibility to use the same way as the motorised vehicles others the same way as the pedestrians. A special trend, which way is preferred by the cyclists cannot be ascertained.

With the visualisation method of the space-time cube it is possible to visualise traffic parameters such as the time to collision (TTC) and the post encroachment time (PET). In this work, the two parameters were determined using two different trajectory examples. The visualisation of the TTC and PET is quite challenging to automate and therefore difficult to visualise for all the trajectories at the same time.

Besides the analysis of the dataset itself, an expert interview was conducted to assess the usability of the GUI. Therefore, five contributors of the chair of traffic engineering and one contributor of the chair of cartography at Technical University Munich were interrogated, after they had a chance try out the features of the GUI. The experts' suggested improvements can be included for further work.

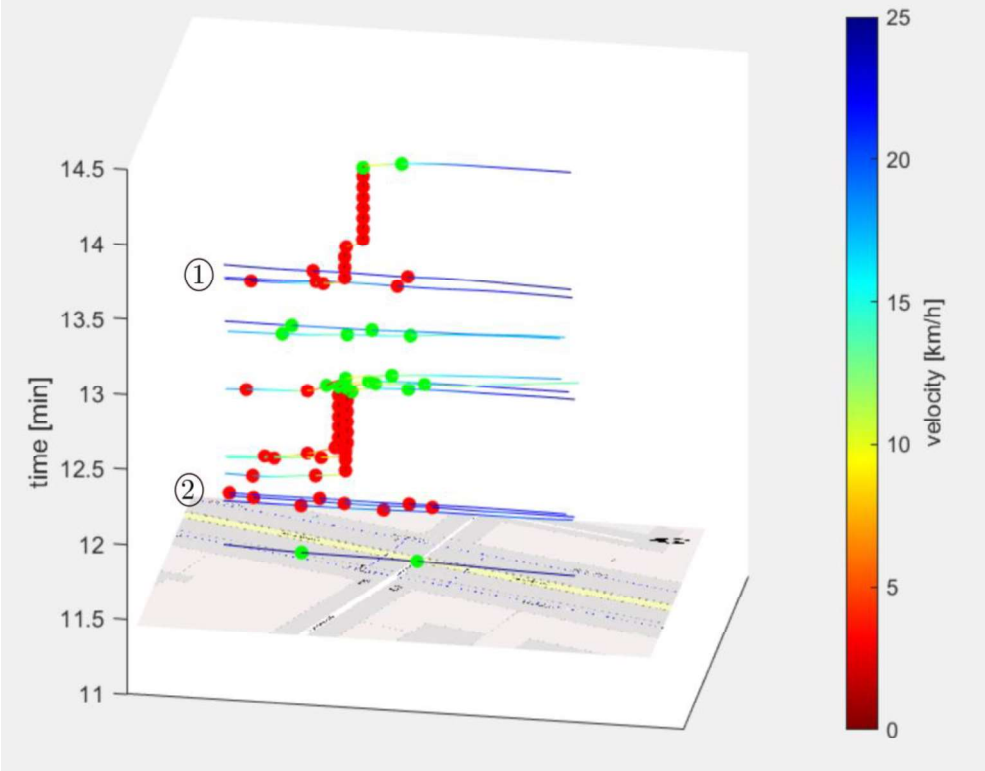

Fig. 1: Disregard of a red traffic light of the straight traffic flow of the Ludwigstraße

References

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