Perspective maps in mobile devices – just style or proper function?

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In most mobile navigation devices perspective map view is offered as an alternative to the traditional 2D map view. This paper describes a map usability test, which studies differences in the usability of both map views, with the result, that no significant differences can be found.

1. Motivation

Navigation systems are popular mobile applications (Raper et al 2008). These systems support the user in his wayfinding task. Usually modern navigation devices offer a perspective map view in addition to the traditional 2D map view. But does this additional map view improve the user's ability to find his way correctly and fast or can perspective map views be only interpreted as nice gimmicks? This question is in line with Zipf's (2003) call for more empirical research on visualization alternatives in mobile maps. We decided to create own empirical data in a usability test in order to answer this question, using a sample size which enables reasonable statistical interpretation of the result.

2. State of the art

According to the definition of the International Standardization Organization (ISO), usability describes the extent, to which a tool can be used by a certain user in order to solve certain tasks in an effective, efficient and satisfying way. In this case effectiveness means the accuracy and the integrity of the work, done by the user by means of the tool, whereas efficiency describes the inserted efforts for that. Satisfaction can be achieved, if the user is not disturbed while using the tool and evolves a positive attitude by using the tool. (Herczeg, 2005)

Considering the usability of maps respectively mobile devices or in common GIS, some important approaches can be identified. Such an approach to more usable GIS is the development of multimodal, collaborative GIS interfaces. (Häussler & Zipf 2003, Cai et al., 2006, Friedmannová et al. 2007) Instead of written words and mouse moves, spoken language and hand gestures are used as input modes to allow the user a more natural communication with the GIS and to enable team work in front of the map display. E.g. Cai et al. (2006) and Cox

(2005) performed a usability evaluation on multimodal GIS interfaces. Further research has to be done in designing the map display itself, as there are new possibilities on digital map display (Ellsiepen, 2005) and also new limitations, like the screen size (Dillemuth, 2007). Plesa et al. (2008) did some evaluation on 3D-Maps for navigation and Coors et al. (2005) even for mobile 3D maps. Nurminen & Oulasvirta (2005) discusses the interaction with mobile 3D navigation systems. Porathe (2007) evaluated different map views for navigation and Kiechle et al. (2007) studied the usability of mobile navigation systems for ski tourists. Klippel (2003) did cognitive research on wayfinding methods.

3. Setup of the Usability Test

The overall goal of this usability test was to figure out any differences in the usability of the 2D map view and the perspective map view. In the context of wayfinding differences in the map usability would result in different times, needed to find the destination, differences in the ability to take the right turn at crossings and different satisfaction rates.

Regarding the user there are three types of information we try to figure out. First, information about the user's behavior, second, about the user's knowledge and opinion achieved during the test and also general information about the users profile.

Therefore we used two types of empirical methods. First we created an online survey to get the participants general profile and to study the participants spatial knowledge as well as their opinions about the given map perspective. Second we prepared an experiment, containing a wayfinding task in an interactive 3D-Viewer, based on the two presented different map views. The 3D-Viewer offered the possibility of logging the participant's track. The log files allowed us to visualize and to analyze the participant's track after the test.

The participants are allocated into two groups: one using a classical 2D map and the other using a perspective map. To both groups a predefined route was presented, which was to be followed in a virtual environment, containing a low-detailed city model (LOD1) of the town of Heidelberg. The system and data were based on a specialized version of the XNavigator 3D client (Schilling et al 2007) from the project www.gdi-3d.de (Zipf et al. 2007). To imitate a real world street view situation, the navigation possibilities of the 3D-Viewer had been modified to allow only horizontal moves and direction changes. Vertical moves, often used in 3D-navigation for gaining an overview were disabled. Therefore turning decisions had to be made only on base of the street network, crossing situations and topographic landmark information, described by the tested map perspective and the 3D-model.

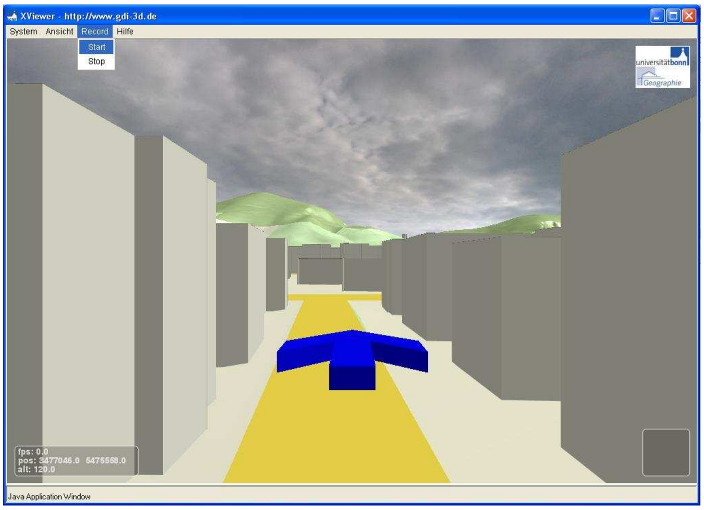

Figure 1: Screenshot of the used 3D-Viewer

This approach of using a virtual testing environment instead of testing in a real world situation facilitates the challenge of observing substantially. User behavior can be measured exactly by using the log-file method, standardized test conditions can be guaranteed for all participants and the time-effort for the test execution is minimized. Nevertheless there are some difficulties occurring using of a 3D-scenery instead of a real world situation. Many people are not familiar with navigation in virtual environments, a 3D model never reaches the complexity and information density of real environment and perception is reduced to visual cues only. Thus mistakes can occur owed to these facts, influencing the test results.

4. Results

The study had 33 participants consisting of students, with a male / female ratio of 26/7. Two of the participants have been in the town of Heidelberg (the testing scene presented in the 3D-Viewer) before, but had no mental representation of this town. This means that we cannot generalize the results to other population groups, but focus on this target group.

Comparing the 2D-map view and the perspective map view, no significant differences could be found. The perspective map did not improve the participant's ability to find the destination in an effective way. The differences in the mean error rate between the both test groups considering "uncertainness", a factor describing the errors made at turn decisions at crossings, and "found destination" are too low as to be significant.

Table 1: per cent of the participants reaching the destination

(results in per cent)	2D map view	perspective map view	overall
destination found	93,8	71,4	83,3
destination not found	6,3	28,6	16,7

Table 2: the uncertainness of the participants (sum of the error types: wrong crossroad decision, crossroad not found and crossroad passed several times)			
	2D map view	perspective map view	overall
Uncertainness	24,94	29,93	27,27

Also the efficiency of wayfinding was not improved, when using perspective map view. No significant differences in the mean "travelling times" and "afford", a factor combining the turn errors at crossings and the time needed to find the destination, could be found.

Table 3: travelling time in minutes			
	2D map view	perspective map view	overall
travelling time	22,9	20,5	21,8

Table 4: afford of the participants (uncertainness multiplicated with travelling time)			
	2D map view	perspective map view	overall
afford	607,3	679,7	641,1

The semantic differentials lead to the same results in both test groups, so it cannot be said, perspective map view would raise the satisfaction with the map.

Table 5: semantic differential for testing satisfaction				
	-3	2D map view	perspective map view	**3**
1	confusing	-0,14	-0,25	clear
2	stressful	-0,29	-0,56	comforting
3	annoyed	-0,21	-0,06	content
4	helpless	-0,21	-0,19	briefed
5	uncertain	0,07	-0,13	certain
6	boring	-0,29	0,13	brisk
7	slow to read	1,07	0,38	fast to read
8	laborious to read	0,79	0,44	easy to read
9	unexpected map design	1	0,56	conversant map design

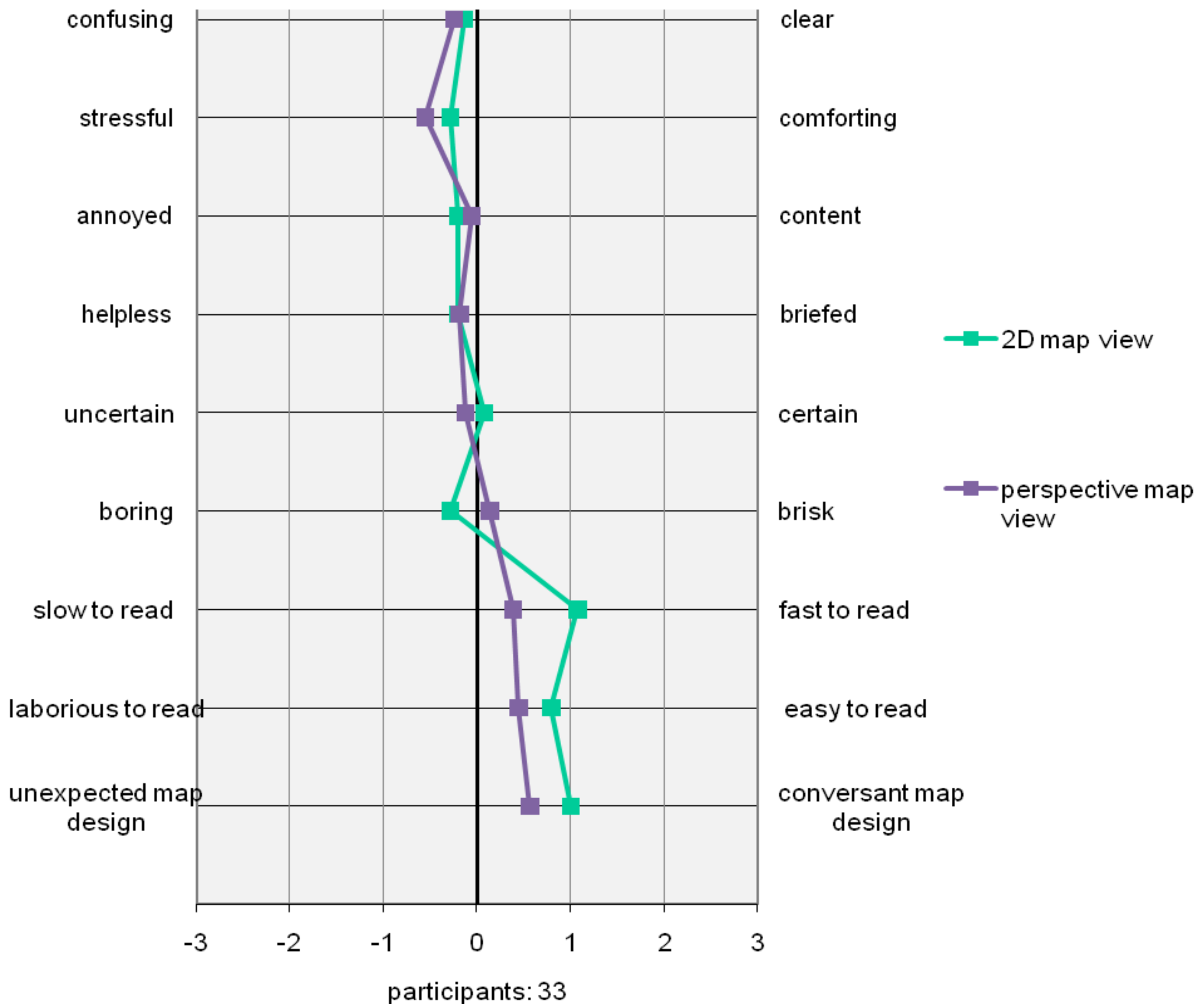

Figure 2: results of the semantic differential

The analysis of the failed turning decisions per crossing however showed significant differences between crossings where the user should go straight on (23.16%) and crossings where the user had to turn left or right (76.84%). But then comparing the two groups and their respectively failed turning decisions revealed, like the other data mentioned before, no significant differences between the two map perspectives.

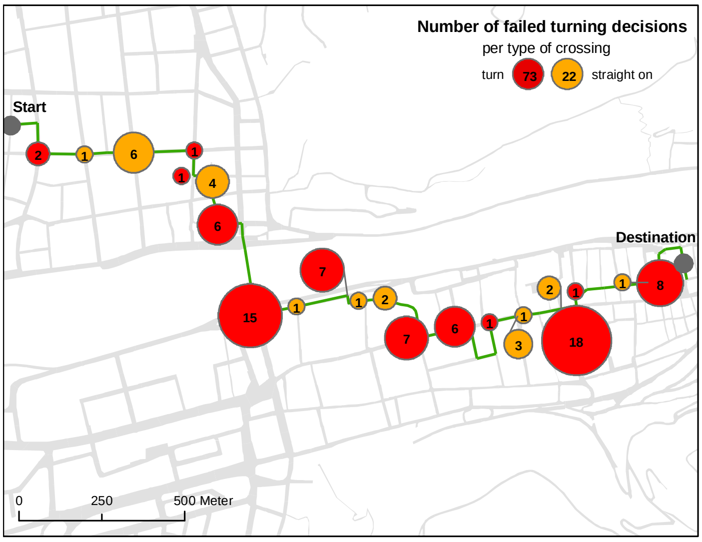

Figure 3: wrong crossroad decisions per type of crossing

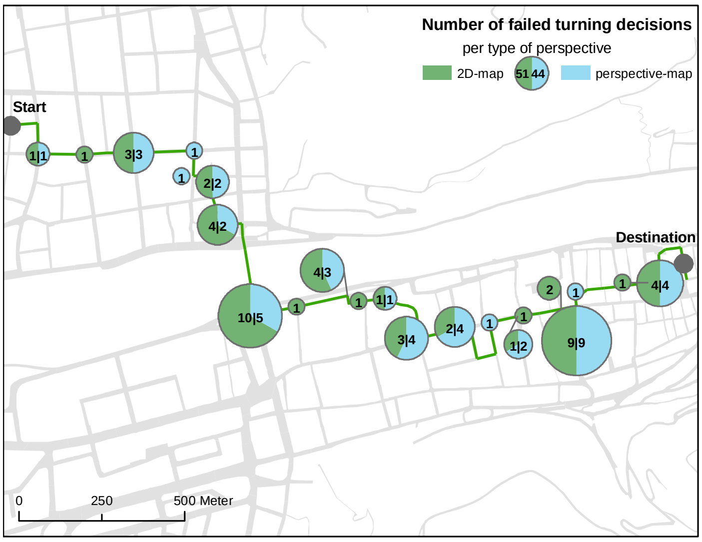

Figure 4: wrong crossroad decisions per type of map view

The lack of differences between these two types of map view points to the differences in map view. The possible advantage of the perspective map view, showing a greater area on the same map size, does not have an effect on the map usability. Overall, there is neither a proven advantage nor a disadvantage for a user to use the perspective map view instead of the traditional 2D-map view.

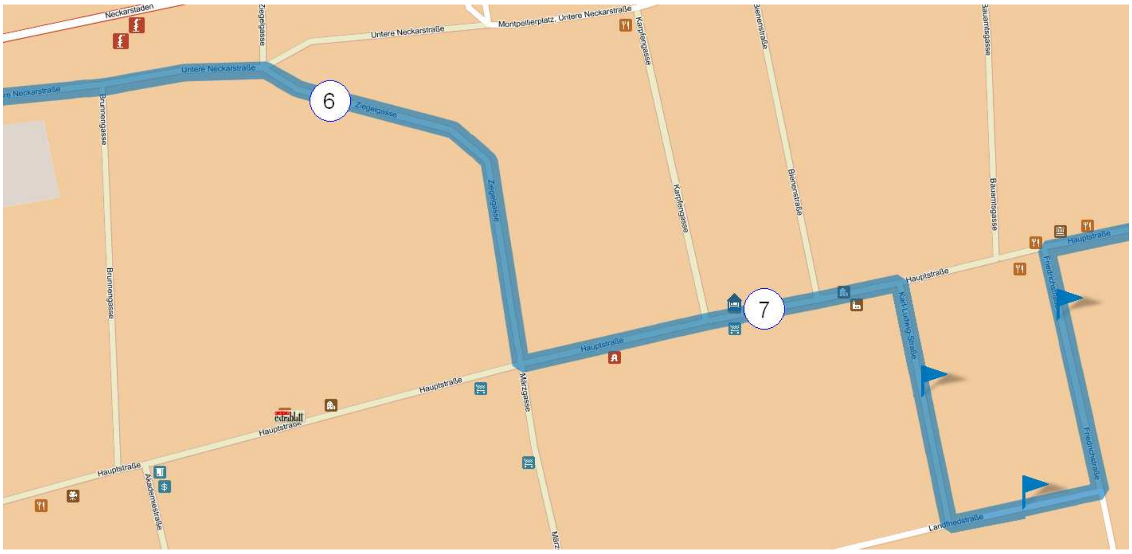

Figure 5: Example of the 2D map view; source: www.map24.de

Figure 6: Example of the perspective map view; source: www.map24.de

5. Conclusion

Our first results seem to implicate that the initial question can be answered with perspective map view being just a nice gimmick for navigation services, at least for this user group. But before branding a relative wide spread map view type in car navigation systems as a feature that is more relevant for marketing, than for usability, further research has to be done. Of course we need to investigate the possible effects of conducting the study through simulating the physical environment in contrast to actually walking or driving through that environment. A further issue is the proper use of landmarks in 2D and 3D scenes for navigation. The 2D case has been a major theme in LBS research for quite some time (e.g. Elias et al. 2008), according to Coors & Zipf (2007) also the topic of landmarks in 3D mobile navigation systems is considered. In the future individual influences like sex, age or experience with navigation systems will be studied. Further the usability test will be repeated with a bigger sample size.

Another topic we want to point out is the use of virtual 3D city models in our evaluation. The participants showed no major problems in using the city model instead of driving in the real town of Heidelberg. Therefore we hypothesize that w3ds-clients are not only useful for traditional application areas like urban planning or city marketing, it can also be used in psychological experiments. Unlike acting in real world, the environmental conditions can be exactly controlled. Further research will be done to proof this hypothesis.

6. Literature

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