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Toggle Strategies for the POI selection via the iDrive controller

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ABSTRACT

The importance of spatial and geo-based information has increased over the last few years. The most prevalent example of this kind of information is points of interest (POI) like hotels, restaurants, gas stations, etc. As cars are made for individual transportation, interacting with geo-based information via the In-vehicle Information System (IVIS) should be possible. At present, state-of-the-art IVIS only permit a list based or center based selection on the map, which makes it difficult to handle a high closeness of geo-based data. In this paper, we present alternative approaches for selecting geo-based data with a multifunctional controller. In our work, visual cues help users predict the selection order. An explorative user study showed potential advantages of our concepts.

Keywords

Geo-based information, POI selection, In-vehicle Information System, automotive HMI, iDrive Controller.

INTRODUCTION

Geo-based data representation is gaining more and more importance. Several applications offer possibilities to mark and select points of interest (POI) e.g. restaurants or hotels depending on their position on a map. Especially in portable or in-built navigation systems, users should be able to find places to eat or to refuel in their surroundings or along their planned route in reference to their actual position. Displaying and interacting with POIs implies challenges for In-vehicle Information Systems (IVIS). Some interesting research topics are: how to deal with a large amount of geo-referenced data, how to define filtering methods, and how to select a POI on a map with a multifunctional controller.

Regarding desktop or mobile applications, POIs on a map are selected via direct manipulation by the mouse pointer, the stylus or the user's finger. As common IVIS systems, like BMWs iDrive [3] and AUDIs MMI [1], are manipulated by multifunctional controllers, common direct manipulation concepts are not suitable. Multifunctional controllers normally can at least be pressed, rotated clockwise and counter clockwise [1]. Some can also be pushed in four directions [2]. In actual realizations such commands are used for manipulating the map itself, e.g. zooming by rotating or panning by pushing.

In this paper we present three different concepts that enable users to select POIs on a map. These concepts vary in their visualization as well as in their selection order strategies, which can be toggled through the POIs via the controller. An explorative user study showed that users prefer the concept containing an appropriate visualization of the implemented toggle strategy.

RELATED WORK

State of the art in-car IVIS provide POI selections in a list [3] (Figure 1), sorted e.g. by the distance to the actual position or center based selection directly on the map itself [1] (Figure 2). Especially when selecting POIs within a high-density area, problems with overlapping icons can arise. Choosing POIs near the screen edge, leads to a long interaction time.

Figure 1: iDrive Navigation screenshot. Splitscreen with list and map representation of POIs.

a) b)

Figure 2: Audi MMI Screenshot of the navigation system. a) Selecting a POI on the map. b) Entering the selection for targeting.

We approach this problem by toggling from one POI to another to reduce completion time and the visual demand for hand-eye coordination. The identified research questions are: which are the most suitable toggling strategies and can the usability be improved by a visualization of these strategies?

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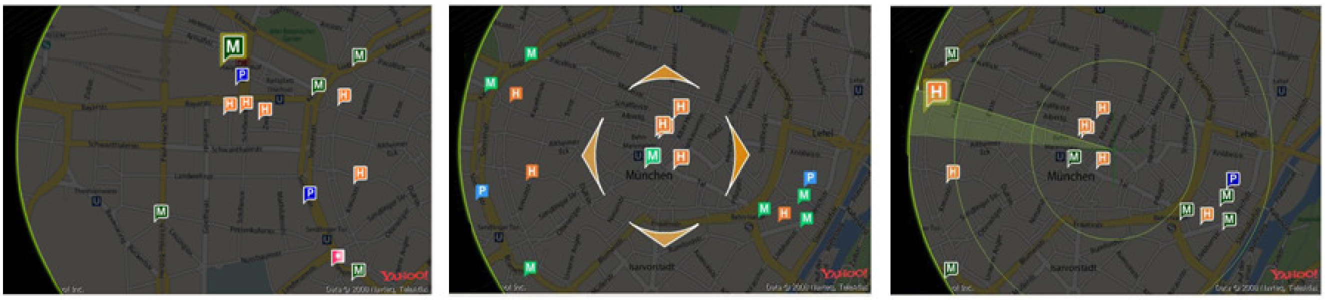

a) Toggle b) Spotlight c) Radar

Figure 3: Screenshots of the three alternative prototypes.

DESIGN

All three developed concepts satisfy the basic requirements for selecting POIs with the iDrive controller. In the selection mode we shade the map via a transparent layer to reduce visual annoyance between the map and the displayed POIs. We arranged three categories of POIs that differ in their visualization on the map: hotels (H, orange), motels (M, green) and parking spaces (P, blue).

Our multifunctional controller can be pushed in the cardinal directions, rotated and pressed. Pushing the controller in one of the four directions pans the map like in serial implementations, rotating realizes toggling through the displayed POIs on the map, and pressing in vertical direction selects the focused POI. To label the focused POI it is enlarged to the double size of the other POIs and surrounded by a yellow glow. We thought also about marking the two POIs, which can be reached by one step, by a smaller glow and by a bigger representation but this was more annoying than helpful as informal expert interviews unfolded.

Toggle

In the most basic concept, no visual hints of the selection order are displayed when rotating the controller (Figure 3 a). The selection concept is very simple and toggles through the geo-based data as though one is reading. This means that the POIs are accessed from left to right and from up to down.

Spotlight

The third concept was called spotlight as it displayed a circle in the middle of the map and only POIs surrounded by the circle were selectable via rotating (Figure 3 b). We implemented the same reading strategy, like in the toggle concept, for choosing between POIs inside the spotlight.

Radar

Our radar concept provides a radial selection sequence based on the distance to the center of the map. As additional hints we display circles around the center and a line, which connects the focused POI with the center of the map, see Figure 3 c.

USER STUDY

For the evaluation of the three selection strategies, prototypes were realized in Adobe Flash and ActionScript 2. The interactive maps were implemented with the Yahoo Flash framework. As an input device, an iDrive Controller was connected via a CAN card to our applications. A 19'' LCT screen with a 1280*1024 pixel resolution was used. All three prototypes have a size of 800*480 pixels. For the transition between different tasks, users had to pan. Therefore a map overlay which indicated the next map center of task area was added. Every task is comprised by the selection of several POIs. Therefore a dedicated POI icon was chosen (pink with a star). When the selection was executed successfully, the selected pink POI disappeared and the next appeared (Figure 4).

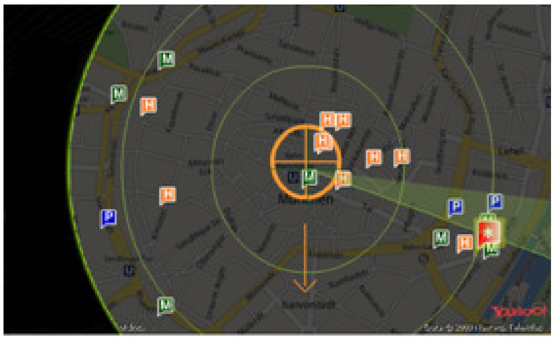

Figure 4: Overlay (orange cross and arrow) which indicates the direction to the next task and selectable POI to participants.

Design of the User Study

To compare all three systems, a within-subject explorative user study was conducted. A Latin square was applied to permute the order in which each participant had to interact with the prototypes. The independent variable was POI selection order strategy in terms of the prototypes (levels: radar, spotlight and toggle). The dependent variables were selection time of the POIs and user preferences.

In total, four different tasks had to be executed. First of all, participants were asked to select three POIs within a group of other POIs (*groupSelect*) followed by a selection of three POIs outlying from others (*lonelySelect*). Afterwards users had to pan to the next task center and select three POIs on a map sector with a few POIs (*fewSelect*). At the end, a selection task with high POI closeness was performed (*manySelect*).

Procedure

At the beginning of the evaluation each user had to solve three training tasks. Afterwards they explored the system followed by a rating: 1 (very good) to 6 (very bad). Then, all system functions were explained. In the next step, participants had to complete the tasks (*groupSelect, lonelySelect, fewSelect* and *manySelect*) as described above while completion time was captured. After these tasks, two questionnaires, SUS [1] and AttrakDiff [5], were answered, and once again, a rating of the system's quality was made and supplemented by a rating of the comprehensibility of the system on a Likert scale from 1 (do not agree) to 6 (highly agree). After participants finished the described procedure with all three prototypes in the above mentioned order, each user ranked the three systems based on his or her preferences (1^{st}, 2^{nd} and 3^{rd}).

Participants

For the user study, twelve volunteers were recruited with an average age of 32 years, two of them female. Everyone had a driving license and experience with navigation systems. One left-handed person attended.

Assumptions

Informal expert interviews showed that POI selection order from the radar prototype seems to be faster and clearer. Based on these results we assumed a higher performance and faster completion times with the radar system. Due to the visual representation of the radar system we concluded that participants prefer the radar prototype.

Results

Total Task Time (TTT)

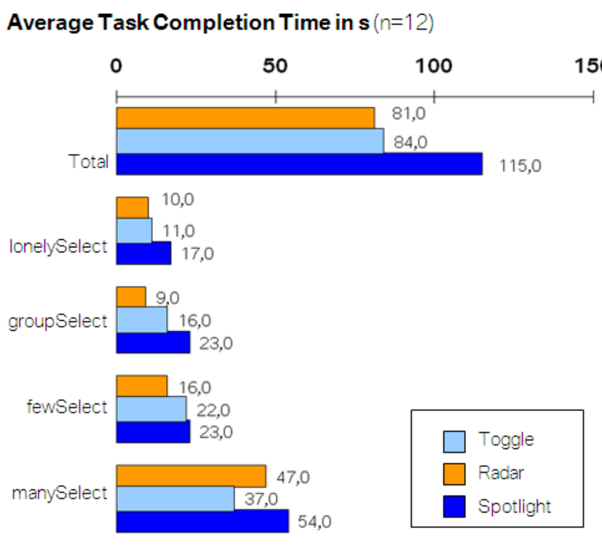

Figure 5: Average task completion time in seconds (n=12).

Each TTT comprises three POI selections. Time was measured from the end of the task instruction to the last interaction step of the third POI selection. TTT for *fewSelect* and *manySelect* contains the additional panning time.

On average, the best overall performance could be achieved under the radar condition (81.0 sec) followed by the toggle condition (84.0 sec). With an average TTT of 115.0 sec, the spotlight system was the slowest for editing the three tasks.

Comparing the different tasks shows a faster interaction time with the radar system except the *manySelect* task. *groupSelect* was finished on average 60% faster under the spotlight and 44% faster than the toggle condition. *fewSelect* was performed on average 30% faster than the spotlight and 28% faster than the toggle condition. Also the selection tasks *lonelySelect* was 10% (toggle condition) and 40% (spotlight condition) faster under the radar condition. The POI selection within the highest POI closeness (*manySelect*) was executed in the shortest time with the toggle prototype (31% faster than spotlight and 13% faster than radar) (Figure 5).

Subjective User Opinion

To retrieve participants' personal preferences concerning the prototypes, two questionnaires were conducted as described above.

The first questionnaire was the SUS (System Usability Scale). It comprises ten questions regarding three dimensions of usability (efficiency, effectiveness and learnability). The result is represented as number between 0 (worst) and 100 (best). On average the twelve participants evaluated the radar prototype with 84 points, the toggle with 74 and the spotlight system with 68 points. Figure 6 shows the evaluation of each dimension. Over all three usability dimensions, users preferred the radar system.

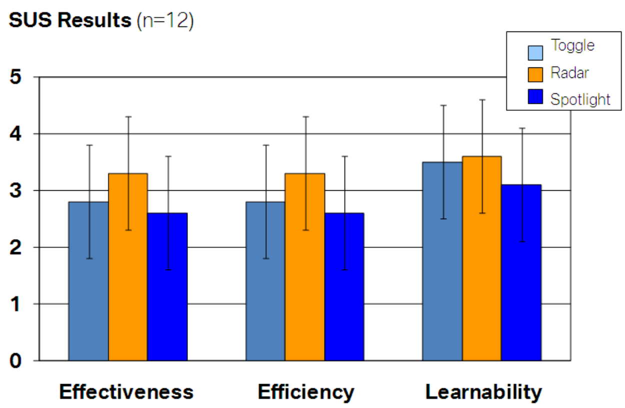

Figure 6: Result of the SUS questionnaire (n=12).

After the SUS, the AttrakDiff questionnaire was filled out. This questionnaire is a semantic differential for evaluating the users' opinion. Normally pragmatic quality, hedonic quality-stimulation, hedonic quality-identity and attractiveness are covered by this questionnaire. We only asked the questions concerning the attractiveness. As exhibited in the illustration in Figure 7 participants favor the radar system.

Regarding the comprehensibility of the three systems, participants preferred the radar prototype. On a 1 to 6 Likert scale, where one stands for very bad and six for very good, users evaluated the radar system as a 5.2 (n=12). The toggle prototype was judged as a 4.9 followed by the spotlight (4.0) (Figure 8).

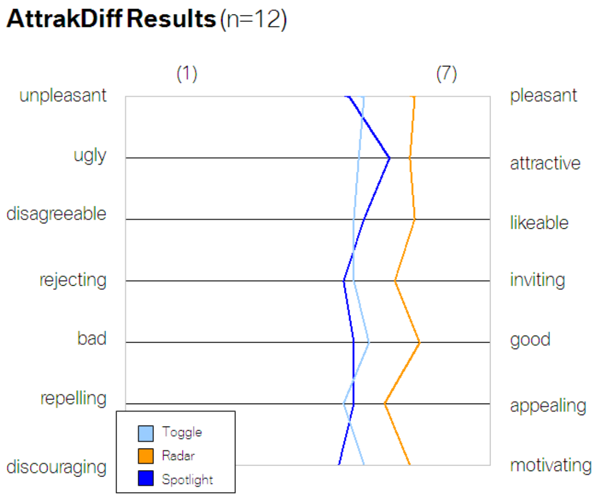

Figure 7: Results of the AttrakDiff questionnaire (n=12, dimension: attractiveness).

The grading of the three variants concerning users' preferences yielded to the following result: radar 2.1, toggle 2.8 and spotlight 2.8. Also the ranking showed that all attendees preferred the POI selection via the radar prototype (Figure 8).

Result Summary (n=12)

	1 Radar		2 Toggle		3 Spotlight	
SUS	83,95	+	73,75	●	68,3	−
Comprehensibility (1-6, Likert scale)	5,2	+	4,9	●	4,0	−
School Marks (1-6)	2,1	+	2,8	●	2,8	●
Ranking (1st, 2nd, 3rd)	1,3	+	2	●	2,7	−
Task completion time (sec.)	81	+	84	●	115	−
		+6		0		-4

Figure 8: Summary of subjective and objective user study results.

CONCLUSION AND FUTURE WORK

Our explorative user study showed the tendency that different strategies for the POI selection can influence the user performance as well as the attractiveness of a system. We compared three systems in terms of prototypes. The toggle prototype, which implements the reading order without any visualization, the spotlight prototype with a center based selection order and the radar prototype, which realizes a radial POI selection order combined with an appropriate visualization.

Except the selection in a very high POI density, the shortest task completion time was achieved with the radar prototype. Based on user input, the main advantage of the radar prototype seems to be the predictable selection order and a less disturbing change between the POIs. This could be ascribed to the visualization.

According to the opinion of the participants one reason for the higher completion time within many POIs could be the tail, which is supposed to indicate the turning direction of the iDrive controller. Five people mentioned that this tail irritated them.

Concerning the spotlight prototype eight participants mentioned the pre-selection in the center of spotlight as main advantage of this system.

For the design of future systems a combination of the mentioned advantages could make sense. For example, a pre-selection of POIs via a spotlight combined with a radar-like toggling is a possibility. Another issue for future work will be the validation of these systems in a more realistic driving environment. Therefore a dual task evaluation method will be applied. Either under simulated conditions or a realistic driving study could be conducted.

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