

Usability and UX of a Gaze Interaction Tool for Front Seat Passengers

Evaluation of a Gaze Controlled Optical Feedback System in a Car

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ABSTRACT

Input modalities generally as well as in cars are evolving quickly regarding their spread and reliability. One possible input technique is gaze interaction, a topic still being researched. What are the front seat passengers' feelings towards gaze interaction, are they comfortable using it and do they think it is necessary? A laboratory experiment was conducted with 13 student participants, using a driving simulator, eye tracker, lamp and a driving wheel. Qualitative data was collected during and after the experiment through observation and a semi-structured interview. Quantitative data was collected through questionnaires (ATI, CTAM, SUS). The results were that the usability of the system was high but participants did not feel well using it.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Interaction techniques**; *User studies*; *Usability testing*; *Laboratory experiments*.

KEYWORDS

gaze interaction, front seat passenger, human computer interaction, usability testing, ux testing

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1 INTRODUCTION

Many systems and functions are researched and implemented for car usage for drivers (e.g. [6, 7, 12]) and front seat passengers. Front seat passengers have the freedom to shift their focus on such tools and applications. Research focuses on navigation as a collaborative task between the driver and front seat passenger (e.g. [1, 10, 11]). This paper aims to contribute to automotive user interface research by introducing and evaluating a system in which a front seat car passenger can light a lamp with gaze input. By controlling the lamp, the front seat passenger could assist the driver and direct his attention towards attention needing situations. This is just an example application, since the aim of this paper only is to examine the usability of a gaze interaction system as well as the front seat passengers' user experience with it, not to evaluate the function or value of the application itself. The following evaluation of this system is based on an experiment in which test persons serve as front seat passengers. Through interviews and questionnaires, qualitative and quantitative data concerning acceptance, usability and user experience will be collected.

2 RELATED WORK

Additional to the works cited before, relevant papers for the topic examined in this paper are, among others, the following: Kern, Mahr et al. [7] inspected a gaze interaction system for drivers, discovering that gaze input is faster than speech input, but also more distracting and slower than touch input. Trösterer, Gärtner et al. [14] visualized the front seat passengers' gaze direction in order for the driver to see it, by lighting regions in a LED strip placed horizontally beneath the front window and current gaze of the front seat passenger. They also examined the implemented technical setup [15]. These examples show that gaze input for front seat passenger is an actual and a current problem. Research is conducted on how front seat passengers can help drivers,

how gaze input can be used in the car and how the gaze of car passengers can be visualized. Furthermore, ambient light in cars is also currently researched (e.g. [8, 13, 16]), but will not be focused on in this work.

3 METHOD

A laboratory experiment was conducted by two researchers, in which qualitative as well as quantitative data was collected. There were two preceding tests to validate the test design including the task, the technical setup as well as the adequacy and comprehensibility of the questionnaires.

Participants

13 student participants, including 8 men and 5 women with a mean age of 24.77 ranged from 21 to 31, were tested. The participants in the preceding tests, two male probands aged 23 and 31, are not included in the total amount of 13 experiments discussed in the following sections.

Procedure

At the beginning of the experiment, the setup (see figure 2 and 1) as well as the input technique were explained. Every participant then had to trigger the lamp a few times by looking at the designated area (speedometer). This procedure also served the purpose of making sure that the utilised eye tracking glasses were well calibrated and a look at the designated area was clearly identifiable. In a next step, the participants were instructed to light the lamp whenever they felt unsafe during the ride. Following the introduction, a 15-minute car

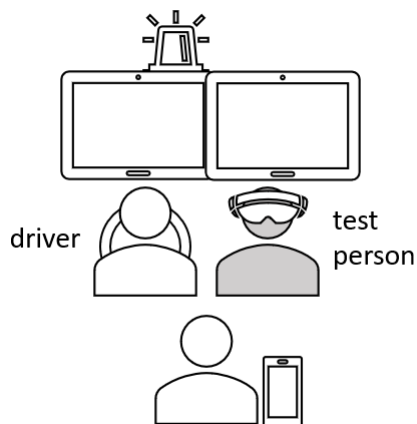


Figure 1: Experimental setup

ride was simulated. After this test drive, the participants were asked about what they liked and disliked about the system in a semi-structured interview. In a last step, they had to answer/complete ATI, SUS and CTAM questionnaires.

Technical Setup

Each participant was seated on a chair – resembling the front seat of a car – next to the test driver and given eye tracking glasses (SMI Eye Tracking Glasses). In front of the driver and the participant were a driving wheel, a gear shift (Logitech G25 Racing Wheel) fixed to a table as well as two monitors. In addition, a camera was placed on the monitors' left side for recording the experiment. The driving wheel and gear shift, both real objects, were used by the driver. A LED lamp was fixated with duct on top of the monitors. These monitors were connected to a PC on which the driving simulation "Drive Megapolis" was running. On both screens parts of the car interior and the view through the front and side windows of the simulated car were shown. The second test executor sat behind the driver and the front seat passenger, holding a remote control for the LED lamp as well as a smartphone showing the eye tracker live image. The exact area looked at is marked with a circle (see circle on top of tram in figure 2). When the test person looked at the defined area of interest the lamp was turned on. The participants eyes and view were also recorded by the eye-tracker for further examination.

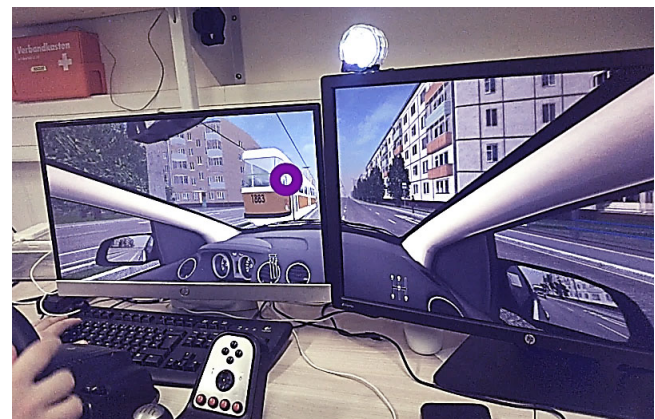


Figure 2: Screenshot from the eye tracker

4 FINDINGS

The quantitative results of the user study were collected through the CTAM, ATI and SUS questionnaires. The qualitative findings were collected through a semi-structured interview, following the experiment and the experiment recordings.

Quantitative Findings

The Affinity of Technology Interaction-Scale (ATI) questionnaire [2, 5] was used to determine the participants' affinity towards using new technology. As the ATI focuses primarily on the interaction between user and system, it is suitable for this experiment. In addition, there already exists a German

version of the ATI. Generally, the participants had an ATI score of 4.66, with a standard deviation of 0.43, which is rather high, given the fact that the ATI has a range from 1 to 6.

CTAM. The “Car Technology Acceptance Model” [9] is a questionnaire aimed to measure the acceptance of individuals towards a specific new car technology or new system integrated into a car. It ranges from 1 – disagree completely – to 5 – agree completely. The answers given by the participants are depicted in figure 3. It is evident that this result is

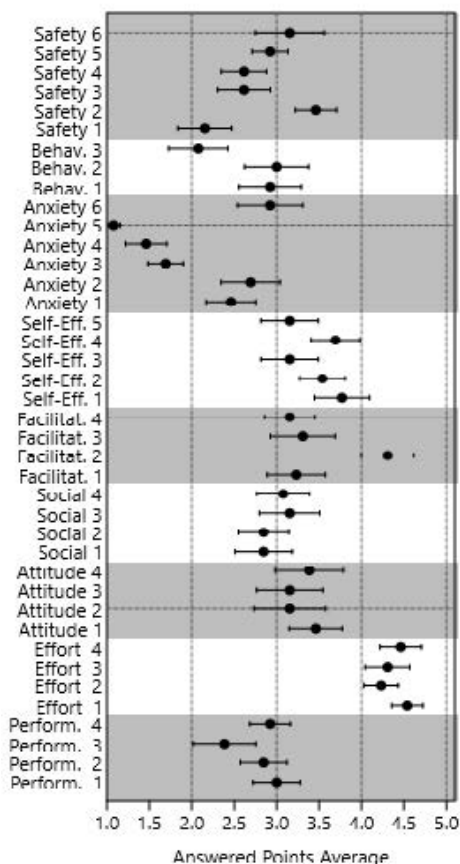


Figure 3: CTAM results

rather negative. The user’s perceived safety, his/her will to use the system again (behavior) as well as the system performance have below average results and the user’s anxiety is high. From the positively rated categories self-efficacy, facilitating conditions, attitude towards using the system and expected effort of using the system only the dimension expected effort is rated high. The social factor of using the system is nearly neutral.

SUS. The “System Usability Scale” (SUS) [4] is a questionnaire built to rapidly measure the usability of any system presented to a test person. The SUS questionnaire consists of 10 questions which the participant must answer on a Likert scale ranging from 1 – strongly disagree – to 5 – strongly agree. The overall SUS score of the tested system averages 75.19 with a standard deviation of 7.6, which means that the system was overall perceived as acceptable and good [3]. The results for each question are shown in figure 4. Nonetheless, only the system’s ease of use as well as the expectancy to learn its operation fast are rated clearly positive. The participants don’t want to use the system more frequently.

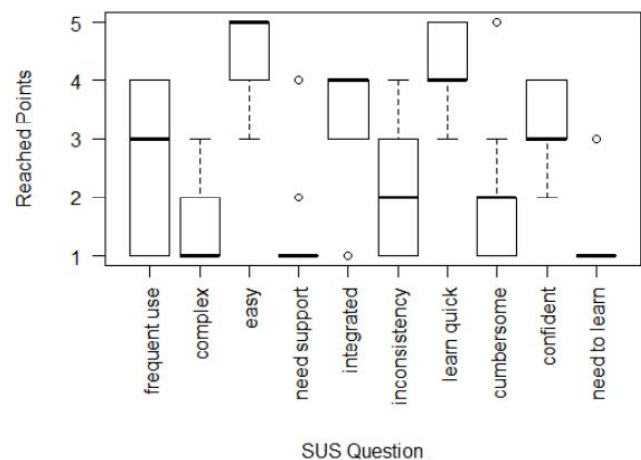


Figure 4: Box plot of SUS item answers

Qualitative Findings

In order to collect the required qualitative data, two questions were asked: whether the participants liked or disliked using the system and which parts of the system they liked or disliked. The results are as follows with the sum of participants having this opinion in parentheses: Some participants liked the idea of being able to show the driver non-verbally (3) that they disagree with his driving style and that they can trigger a light by just looking at a fixed point (6). Three of them appreciated the system’s ease of use. One participant thinks that the nonverbal kind of feedback is less likely to annoy the driver. Another participant figures that the system might be of potential use when sitting in a car with an unknown driver because the communication through the light is less personal as verbal communication (P2). Another participant said that she had the impression to not only increase the driver’s safety, but also her own (P8). One participant liked that the brightness of the indicator light wasn’t too high (P4). The fact that the front seat passenger has to look at the speed indicator in case of a risky situation is negatively perceived because it is hard and counter-intuitive to look at a fixed

point in the car, and not towards the approaching danger (4). One participant (P4) even expressed concerns that the system could annoy the driver, especially when sitting next to an overly nervous front seat passenger. Some participants didn't like the idea behind the system itself because the front seat passenger should trust the driver (1) and shouldn't distract (3) or unsettle (1) him by using the light. It was also stated that it is possible to want to look at the speed indicator – out of boredom or not judgemental interest – without wanting the driver to be noticed about this action (2). The evaluation of the eye-tracker data also shows that front seat passengers gazed at objects the car was approaching fast. Sometimes the participants looked at the speed indicator in order to light the lamp, but only looked for a very short amount of time, before they again focused on the approaching obstacles.

5 DISCUSSION

This conclusion is, among other things, supported by the measured SUS scores. The data collected through the SUS questionnaire suggest that the system is easy to learn and easy to use. The category with the best score was “I needed to learn a lot of things before I could get going with this system” with 1.15 points on average. This item also had the lowest standard deviation (0.55), which indicates that the gaze input technique was intuitive to use and to learn for the probands. However, the questionnaire also shows that the probands don't want to use the system frequently and that they don't feel confident using the system. The collected data do not indicate why the participants, on the one hand, felt that the system was easy to learn and to use, but on the other hand were not confident using it. It should be kept in mind that the participants all had a high acceptance towards technical interaction (high ATI results), with an average ATI score of 4.66 and thus, a high technology affinity. In order to examine if the system is usable by everyone and not only by technology affine persons, it should also be tested with people less affine to technology. The results of the CTAM were rather various. The following aspects should be improved: addressing existing anxieties towards the system as well as the system's performance. One possible reason for the system's low rating regarding its performance could be that it was just a mocked-up system and the person turning the lamp on and off acted delayed, because of human reaction times. The users' anxiety must be researched further in order to find out what exactly was feared by the probands and why. Since the results of the dimension gained safety is slightly positive is not clear whether the system makes the user feel unsafe. The qualitative findings reveal further existing anxieties on the user's side; e.g. the fear of irritating the driver or even infuriating him. However, the participants also stated that they perceived the system as pleasant regarding the input technique and the idea and implementation of

the lamp. Also, the recordings of the observation camera suggest that the users had fun using the input technique of lighting a lamp by looking at a dedicated area. The CTAM-dimension “attitude towards using the system” was rated slightly positive, which indicates that the test persons want to use the system even if there were issues with the system's functionality. The reasons for the discrepancy between the CTAM results and the SUS results suggesting that the test persons don't want to frequently use the system could be further researched.

This study is subject to some limitations: Not only is the sample of test participants not heterogeneous enough, but also is the number of 13 participants insufficient for making general statements. Also, the study was not conducted in a real car but in a laboratory situation. Furthermore, the system was not implemented but simulated which led to non-avoidable human errors. The light source should be chosen carefully and further researched.

6 CONCLUSION

This paper evaluates a system which reacts to the gaze input of front seat passengers by lighting a lamp. The conducted experiment leads to the conclusion that the system is usable. However, potential users do not want to use it. While there is data that supports the thesis that a gaze interaction system for front seat passengers is usable (SUS), there is also data that indicates that the participants did not feel well using the system (CTAM). Further research should examine if the uneasy or uncomfortable feeling towards this kind of systems originates from the type of interaction, the used function or the use case. This should also be tested with a more heterogeneous and thus more representative sample. Moreover, the question arises, if the examined type of interaction increases the security perception of front seat passengers and/or drivers. Also, it could be researched if the driver feels more distracted, better, worse or even more annoyed by the visual feedback triggered by his front seat passenger compared to verbal feedback. It might also be worth considering using a participant as a driver.

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