A USABILITY STUDY ON HAND GESTURE CONTROLLED OPERATION OF IN-CAR DEVICES

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ABSTRACT
The aim of this study is to find out if hand gestures can reasonably be used to control in-car devices. Therefore, a set of consistent gestures which allow intuitive human machine interaction is searched. The results show a consistent gesture vocabulary for a variety of devices. Since this study is extremely dependent on its environment, in this paper mainly the methodology is described whereas about the results only a short overview is given.

1. INTRODUCTION

The integration of more and more functionality into the human machine interface (HMI) of vehicles increases the complexity of device handling. Thus optimal use of different human sensory channels is an approach to simplify the interaction with in-car devices. This way the user convenience increases as much as distraction may decrease.
This study is an isolated evaluation of gestures as input modality for in-car devices. Primarily it has to be analyzed whether the visual input channel can be reasonable be used for in-car operation. Therefore the motions of the subject's body have to be analyzed.

2. METHODOLOGY

To find a set of gesture commands several „Wizard of Oz"-studies are done. Main goal of the following analysis is the classification of the used gestures for a qualitative evaluation. The consistency of the collected gestures is of special interest. Particularly analyzing both the interindividual and the intraindividual conformity, relevant conclusions about the „quality" of the respective gesture can be taken and areas of application for gesture controlling can be extracted from the large functional range.

2.1 Experimental Setup

The study is done in a car mockup to regard the influence of seating environment and limited execution space on gesture movements. The car is located in the usability lab (see Figure 1).
Test subject and supervisor who reads out the tasks are seated in the car (see Figure 2). The wizard who interprets the gesture commands and controls the MMI is located in the control room that is connected via audio and video to the car. The function of supervisor and wizard is dissociated because of the mental strain of the wizard while doing gesture interpretation. Additionally the supervisor's attendance in the car comforts the subject. Since this study is carried out for communication, comfort and information devices, an integrated concept for operation was developed which can be controlled with a conventional haptical input device (see Figure 3) and the wizard. The MMI is shown on the standard display of the car mockup.
The whole experiment is recorded on videotape (camera picture and MMI display, picture-in-picture) and later analyzed using the scheme described in 2.4.

2.2 Test sequence

After a short briefing the subject has to process tasks given by the supervisor. These are device specific control flows (e.g. selection of radio stations) on the one hand and controls of general vehicle functions (e.g. windshield wipers) on the other hand. The subject is told to comment the performed gestures in case of malfunction of the system. The wizard reacts very cooperative to avoid discouragement of the subject while trying to operate with gestures. The test is divided into four parts.

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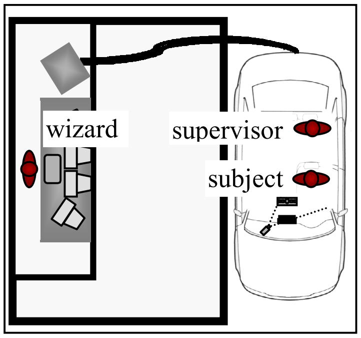

Figure 1: Experimental set up

Figure 2: Subject seated in the left front doing gestural user input, with arrow indicating hand movement.

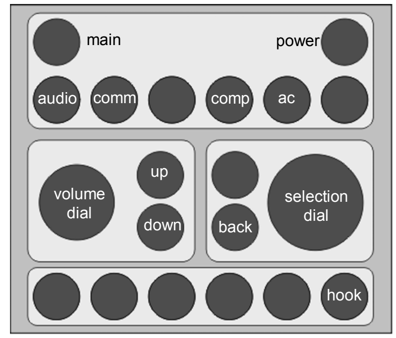

Figure 3: Drawing of the haptical input device

2.2.1 Exploration

Before the subject is confronted with the implemented HMI, she/he is asked to control a given device with gestures. (e.g. which gesture would you use to answer a call?). This way spontaneous gestures are found which are not influenced by any visual or structural design of the MMI.

2.2.2 Training

During the training the subject is lead through the full functional range and the menu structure of the MMI by using a haptic input device. The training that the following gesture controlling isn't influenced by any comprehension errors. At the end of the training the subject is asked to try out the MMI for a few minutes and afterwards is tested with specific tasks.

2.2.3 Scenario

In the first part of the scenario the supervisor reads out device typical tasks, which must be solved by the subject (seated on the left side) using only the right hand. The subject's gestures are watched, interpreted and executed by the wizard. In the second part the subject has to process given tasks with optional – either gestural or haptical - input modality.

2.2.4 Interview

The interview is to collect subjective impressions of the test person. The subject has to give a ranking for each of the different areas of application for gestures. These statements are used as a measure for user acceptance and for the comparison with the objective data like intra- and interindividual conformity.

2.4 Classification Scheme

The videotaped data are analyzed using a specific gesture taxonomy that enables us to describe all gestures qualitatively. Each gesture is defined by a set of properties:

- Kind of gesture
- Direction of fingertips
- Execution space (see Figure 5)
- Velocity
- Occurrence of motion
- Main link of motion (see Figure 6)
- Spontaneity
- Number of repetitions
- Number of gestures per command
- Interference with left hand
- Look at the display
- Influenced by graphical display
- Menu controlling
- Comment of subject

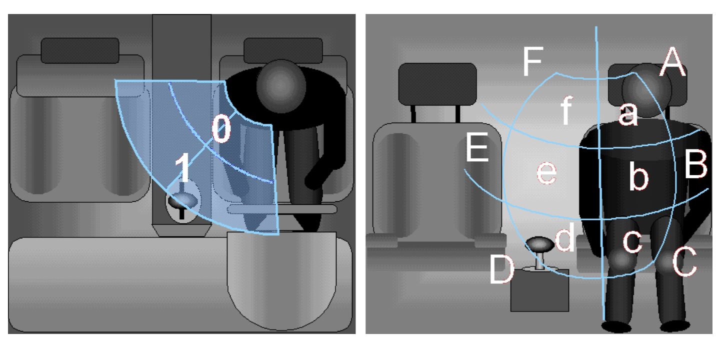

Figure 5: Partitioned and numbered execution space

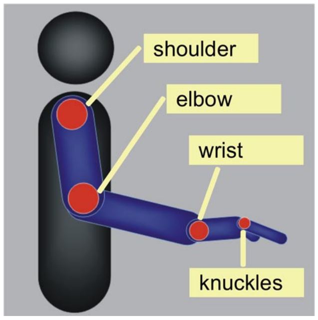

Figure 6: Main links of motion for right-hand-gestures

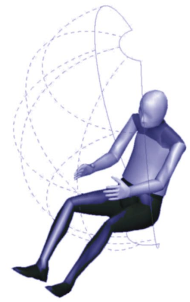

Figure 7: CAD man model RAMSIS [LfE] in a car seat with normal execution space for right hand operation

The execution space for right-hand-gestures is determined by the CAD man model RAMSIS (see Figure 7) and is segmented into 24 sectors. This information can later be used for the implementation of an automatic gesture recognition system and for interior design aspects with regard to optimization for gestural user input.

3. RESULTS

The set of gestures can be divided into referencing (e.g. pointing) and kinemimic gestures (e.g. beckon) which don't have to be learned and symbolic (e.g. pointing for "go") and mimic (e.g. virtual phone) gestures that have been learned and seem to be culture-dependent. Subjects use gestures mainly based on dynamic movements except for most referencing gestures.

The results show a limited gesture vocabulary with a high inter- and intraindividual conformity for a variety of applications. These are consistent to the findings of the interview. Grouping of goal equivalent gesture commands leads to even higher conformity. Such a gesture vocabulary ideally allows intuitive controlling. Initial problems with gestural controlling can be reduced by adaptive help systems [Nie01]. Without further optimization gesture controlling leads to visual distraction. Granted, statements about the distraction effects cannot be given by this study, because a standing car was used and the subject only had to process user input, but a recent study [Gei01] shows significant reduced distraction effects when using gestural in comparison to haptical user input.

With regard to multimodal in-car communication gestural user input proves to be a promising approach to an optimized human-machine-interface, provided suitable measures in GUI and interior are taken.

REFERENCES

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[LfE] CAD Man Modell RAMSIS. Illustration provided by Lehrstuhl für Ergonomie (http://www.lfe.mw.tum.de/), Technische Universität München, Boltzmannstraße 15, D-85748 Garching.

[Nie01] Nieschulz, R., Geiger, M., Bengler, K., Lang, M. (2001). An Automatic, adaptive Help System to Support Gestural Operation of an Automotive MMI. *Poster Proceedings HCII 2001 (New Orleans, Louisiana, USA), (this conference*).