Effects of Different Push-To-Talk Solutions On Subjective Driver Satisfaction

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ABSTRACT

In-car user interfaces are becoming more complex and pervasive. Speech interfaces are gaining more attention in automotive applications. Most of these interfaces require a push-to-talk (PTT) signal for activation. Fixed PTT buttons on the steering wheel might be hard to operate in some situations, as when taking turns or driving in curves. We explore the usage of a wireless PTT glove for activating the speech recognizer and compare its merit against a fixed solution. A 24 subject experiment was conducted for this purpose. The focus of the results is on subjective opinion of users, gathered using a Likert scale questionnaire. This shows higher user satisfaction with the 'floating' (glove) solution. We expect that researching the glove can give us valuable information on developing an even less constraining user interface that would consist of a steering wheel sensitive to taps. We also present information on a prototype interface that allows tap input.

Author Keywords

Speech user interface, glove input, driving simulator, push-to-talk.

ACM Classification Keywords

H5.2. Information interfaces and presentation: User interfaces.

INTRODUCTION

In-car user interfaces are becoming multimodal and much more varied than before. There are multiple interfacing options with devices, as keyboard, touch, speech and the combination of these. All this versatility should render a safer, more productive and enjoyable driving environment. On the other hand the multitude of interfaces can also introduce distractions. This is why special care should be taken when designing in-car user interfaces. For example, there are more push-buttons appearing on the steering wheels of today's cars. They are used to control a wide variety of devices: cruise control, entertainment system, air conditioning, horn, etc. They can also be used to activate the push-to-talk (PTT) signal when interacting with a speech recognition system. Operating these wheel-based buttons can lead to driver distraction, because any time spent not looking at the road ahead could potentially cause hazardous driving situations. Also, when driving in curves or taking turns, the buttons swerve away from the user's grip, making it even harder to locate them. When using these buttons the other option is of course to delay the operation until an easier part of the road is reached.

Subjective driver satisfaction is an important aspect of using in-car interfaces. If the drivers are not satisfied with a certain interface solution, the whole device's usage will suffer.

BACKGROUND

In a prior study, our group has found that operating PTT buttons located on the central console of a car, off the steering wheel, causes significant deterioration in driving performance [2]. This sparked further investigation of the topic. We continued to explore a more convenient solution, when the button is located on the steering wheel, much like the buttons in today's cars. In a new study we have found that operating these buttons leads to significant visual distraction compared to a less constrained, glove-based PTT solution [5]. The glove PTT was first described in [6]. This is a prototype system designed to learn more about people's preferences when interfacing with in-car devices. It could be useful for everyday use by first responders, as police officers, who frequently need to use their radio systems. Other instrumented gloves have been designed for e.g. military use [8]. They can be used both in and outside of vehicles for several applications, as radio operation, map scrolling, wearable computer control, etc. The authors have not found any research papers published using this military glove. Our glove could also serve as a possible transition to a steering wheel sensitive to tapping action, because it allows the driver to use it anywhere on the steering wheel, without constraints, much as a steering wheel sensor would. A sensored steering wheel can be implemented by using pressure sensitive strips to pick up taps on the circumference of the wheel [7]. We used these taps to trigger the PTT signal. We have found that our system allows faster reaction times while driving in complex situations, but its usability has to be tested in further studies. In a somewhat similar implementation, Cai et al. have equipped the steering wheel with multiple sensors [1]. They collected physiological measures of the drivers to assess their physical and mental state. They did not use the system to interface with in-car devices.

HARDWARE IMPLEMENTATION

The fixed PTT button was implemented using an AirClick general purpose computer remote controller, produced by Griffin Technologies. It was strapped to the crossbar of the steering wheel, as shown in Figure 1. Its position was chosen to be at 80° compared to the top of the wheel, to be at a similar location as current commericial on-wheel buttons.

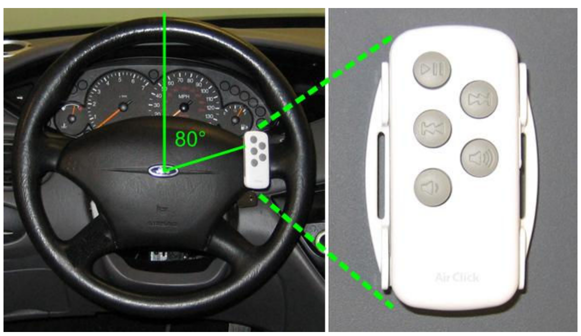

Figure 1 Fixed PTT solution

The glove implementation consists of a general use glove with momentary bush-button switches built into its fabric under the tip of the index finger and under the thumb. Their signal is transmitted to the base computer using an RF transmitter attached to the back of the glove, Figure 2.

Figure 2 The PTT Glove

METHOD

In this study we used the experimental method to research the subjective opinion of users concerning using fixed and 'floating' PTT buttons. We have employed Likert scaled questionnaires to find out about users' preferences. Beside the subjective opinion measure we also looked at driving performance, visual attention and location of PTT operation. These results are reported in other publications [4,5].

We have performed our experiments in our DriveSafety (DS600c) high-fidelity driving simulator. Its main features include: 180° field of view, side and rear view mirrors, real car cab, realistic sound and vibrations. It was also equipped with an eye tracking system mounted on the dashboard in front of the driver (SeeingMachines, FaceLAB 4).

Figure 3 The driving simulator

There were 24 subjects participating. They were recruited at the university campus using mailing list notifications and posters. Most of them were either students or university staff. Their mean age was 26 years. There were 16 male and 8 female subjects. They had on average 8 years of driving experience.

The primary task of the participants was driving. Their route consisted of a curvy rural two-lane highway with one lane in each direction. The curves were both left and right ones with the radius of 230 meters. The subjects had to follow a leading vehicle driving at 60MPH, at a distance convenient for them, without losing sight of the leading vehicle.

The secondary task was related to the in-car radio device. In the role of a police officer the subjects received and retransmitted messages from one to another radio channel. Participants did not have to memorize the speech task grammar. Instead, the system prompts informed them of the appropriate utterances to use. The secondary task was performed in a Wizard-of-Oz manner, where the subjects thought that they were interacting with the in-car computer system, while the answers were being provided by the experimenter.

Upon arrival to our lab, the subjects filled out a personal information questionnaire. After that they trained for the primary and secondary tasks for 25 minutes, followed by another 25 minutes of recorded driving. A video was shot of this part of the experiment. During this period all the subjects were using both the glove and the fixed PTT button sequentially. As a conclusion, the subjects filled out the experiment questionnaire on which we report here.

RESULTS

The questionnaire contained statements about the simulator, experiment, the speech recognizing system, the complexity of the primary and secondary tasks and about the different PTT methods used. The subjects had to express the level of their agreement with each of the statements. The levels for all the statements were: yes, somewhat, neutral, not quite and not at all. It can be noticed that these levels adhere to the definition of a Likert scale: they cover the full range from strong agreement to strong disagreement with the rest of the levels falling between these two extremes. Even though, these described levels could be considered equally apart from each other, the results of Likert scaled questionnaires cannot be analyzed using quantitative statistical measures [3] which include the mean, standard deviation, variance, etc. Even if the answer levels would be coded from 1 to 5, there would be no sense in calculating for example the mean over all the subjects. A mean of 3.46 cannot be coded back into one of the worded levels. Rather, definitions of descriptive qualitative statistics should be used: the median, mode and inter quartile range [3].

In this paper we are going to concentrate only on the four questionnaire statements that describe the two types of PTT solutions used: fixed and glove. In the following, the proposed statements, their bar graphs, statistical analysis and discussion are presented.

Statement (S): Using the fixed PTT button while driving interfered with driving.
Response (R): Mode – Somewhat
Median – Neutral
Inter quartile range – 2 units

Discussion: Most of the drivers found that the fixed PTT somewhat interfered with driving. This is shown in Figure 4 below. It can be noticed that the Mode and Median give different results. This is due to the asymmetric nature of the distribution. The Inter quartile range (IQR) is relatively high, spanning 2 answer levels. Ten of the 24 subjects thought that the fixed PTT button interfered with driving, which is a relatively high number.

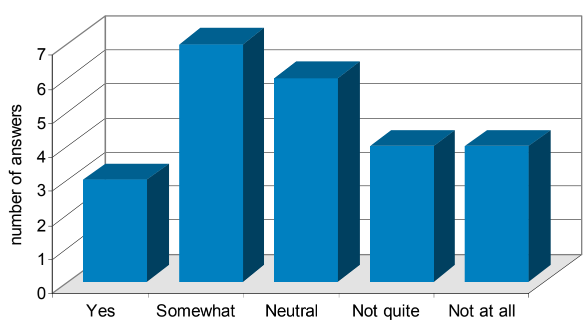

Figure 4 Using the fixed PTT button interfered with driving

S: Using the glove while driving interfered with driving.
R: Mode – Not quite
Median – Not quite
Inter quartile range – 1.5 units

Discussion: The subjects found that using the glove 'did not quite' interfere with driving, Figure 5. In this case, the Mode and Median are at the same level, while the Inter quartile range shows less variance. More than half of the participants (15/24) thought the glove did not interfere with driving.

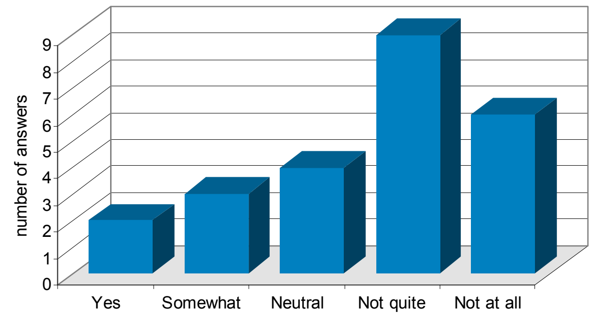

Figure 5 Using the glove interfered with driving

S: It was easier to use the glove compared to the PTT button.
R: Mode – Yes
Median – Yes
Inter quartile range – 2.5 units

Discussion: Here, users found the PTT glove to be easier to use compared to the fixed PTT solution, Figure 6. The Mode and Median agree in this case, while the IQR is high. Clearly, most subjects preferred the glove over the fixed PTT button.

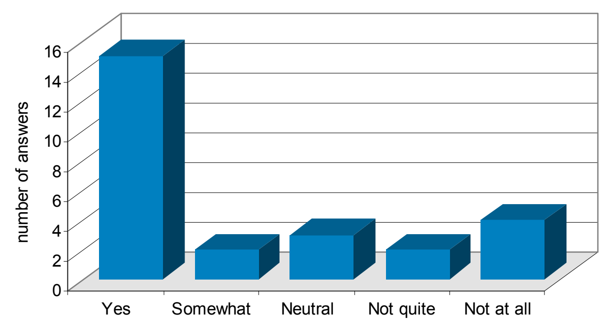

Figure 6 Glove easier compared to the PTT button

S: It was more frustrating to use the glove compared to the PTT button.
R: Mode – Not at all
Median – Not at all
Inter quartile range – 2 units

Discussion: To counter-balance the previous question, it was asked if the glove frustrated the subjects compared to the fixed PTT button. They rejected this with high Mode and Median values, Figure 7.

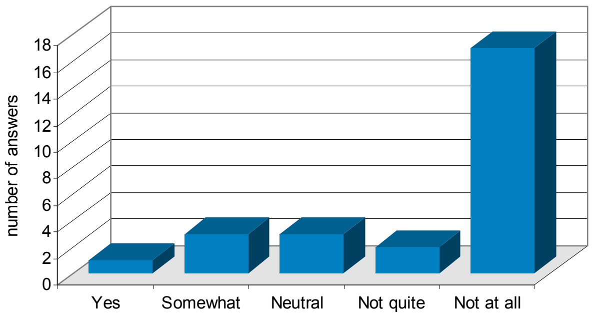

Figure 7 Glove more frustrating compared to the PTT button

In the first two bar graphs of the Results section (Figure 4 and Figure 5), the answers are spread out, but still the Medians show a clear preference of the glove. The third and fourth graphs in Figure 6 and Figure 7, show a much clearer distinction, when the subjects were asked to directly compare the two solutions to each other. Again, the glove solution is more favorable to most of the users compared to the fixed PTT.

A few subjects (3) have expressed their opinion that the glove might not be the most convenient solution to be used during the summer months, as drivers might feel uncomfortable wearing them in warm weather.

It is not clear if the participants were biased in any way towards one or the other solution. The experimenter did ask them to provide unbiased opinion on all aspects of the study.

These encouraging questionnaire results motivate us to continue researching a solution that would allow freedom of operation anywhere on the steering wheel just as the glove but would remove the need for wearing the button as in the case of the glove. We have already implemented a prototype solution, in which we use pressure sensitive strips attached to the perimeter of the steering wheel [7]. We have programmed the accompanying electronics in the way that it activates the PTT signal when a double tap is detected (much like a double click on the computer mouse). As the referenced paper describes, we ran a pilot study using this prototype on four subjects. The subjective opinion of these users was split in half. Two of them liked the solution, while two of them were not too comfortable with it. They needed training to get a hold of tapping, and it still misfired is some situations. Overall these results also encourage us to further develop the system to be more reliable which could increase user satisfaction.

CONCLUSION

In this paper we have reported on subjective user satisfaction while using different in-car push-to-talk solutions. It is very important how users feel about different in-car technologies, because if they are not satisfied, they might choose not to use them. We have seen that the users were much more satisfied with the benefits of the glove solution compared to the fixed PTT. Here we explored only the case, when such buttons have to be used frequently. Infrequent usage might decrease dissatisfaction with a more standard (fixed) solution. Also, with subjective opinion, it is hard to be sure, that the questionnaire data is unbiased. Overall, the results encourage us to continue with more studies and develop new interface solutions which might lead to safer and more enjoyable in-car environments.

ACKNOWLEDGMENTS

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