

Towards a Multimodal Interface for In-Car Communication Systems

Work-in-Progress Paper

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Abstract— The number of cars provided with an in-car communication system has considerably increased during the past few years. Using a mobile phone whilst driving is a safety-critical task and can cause usability issues. Speech modality has been incorporated in order to allocate hands and eyes solely to the driving task speech. This paper discusses an investigation into in-car communication systems and multimodal interfaces in order to design an in-car communication system which improves the driving experience and meets usability goals. This multimodal interface will make use of speech and manual control as input and output modalities.

Index Terms — In-Car Communication Systems, Interaction Design, Multimodal Interfaces, Usability Study.

I. INTRODUCTION

An increasing number of new in-car communication systems that enhance comfort, safety and driving performance are included in modern cars. On the other hand, the computerisation of the car can cause driver distraction. Several studies [1, 2] show that almost half of car crashes are caused by driver distraction. The driver is either distracted by a lack of concentration, an outside event or the use of in-car applications. In many countries, including South Africa [3], it is illegal to use a mobile phone whilst driving unless the car is provided with a hands-free system through which the driver may interact with the mobile phone.

Several studies [1, 2] have shown that speech modality can help to increase the attention of the driver on the road whilst using an in-car communication system. Interfaces that take into account eyes-free and hands-free modality (e.g. gesture, eye-gaze and speech) can help to improve driver safety.

The use of a mobile phone in the car should also allow a driver to use the basic features of that phone (e.g. making or receiving calls, contact management and sending text messages) using any of the modalities available (speech, manual).

Section II of this paper discusses problems faced by driver when using in-car communication systems as well as

usability principles, Section III gives an overview of multimodal interfaces which could help to reduce distraction and improve the drivers' experience and Section IV presents some conclusions and ideas for future research.

II. IN-CAR COMMUNICATION SYSTEMS

Driving, which is the primary task of the driver, is not easy. According to well established models [4], driving involves three levels of hierarchical activities, namely strategic, tactical and operational. Any secondary task added to the primary task can affect driver's attention.

In-car communication systems were introduced in order to address visual and biomechanical distraction. Cars are now becoming ad-hoc networks which connect Bluetooth-enabled phones with in-car communication systems. The system is controlled through either manual input from the steering wheel or voice input from an array of microphones installed in the car. The main features of in-car communication systems are voice-activated, hands-free calling, conference calling, audible text messages, and phonebook management.

Usability principles used to design such systems are concerned with information presentation, dialling rules, context sensitive feedback and voice input. Integrated models [5] (phone model, driving model) can be used to predict distraction during the design phase. The 15-second rule [2] is also used for this purpose; any task that takes longer than 15 seconds in a static car should not be allowed in a moving car.

Although these usability principles are applied by some designers, in-car communication systems still have several usability issues. It is difficult to design interfaces for a wide range of users (16-90 years old) [2] and dealing with context-awareness and driver adaptation are difficult because it depends on workload management which is still not very accurate. Speech recognition is still not 100% accurate, especially in a noisy environment.

This research will investigate existing techniques which can be used to manage driver's workload and multimodal input integration.

III. MULTIMODAL INTERFACES FOR IN-CAR COMMUNICATION SYSTEMS

A multimodal interface is a user interface in which either more than one sense is available for the channel of communication (e.g. output that can be auditory or visual) or for the same channel a particular piece of information is represented in more than one sensory modality (e.g. the command to dial the phone can be spoken or typed). Multimodal interfaces are more important in embedded scenarios because the standard ways of input (keyboard, mouse, stylus) as well as output (display) are constrained and less comfortable [6]. Moreover, it is easier to manage recognition errors from speech recognisers. Cooperation between input and output is very important when designing multimodal interfaces.

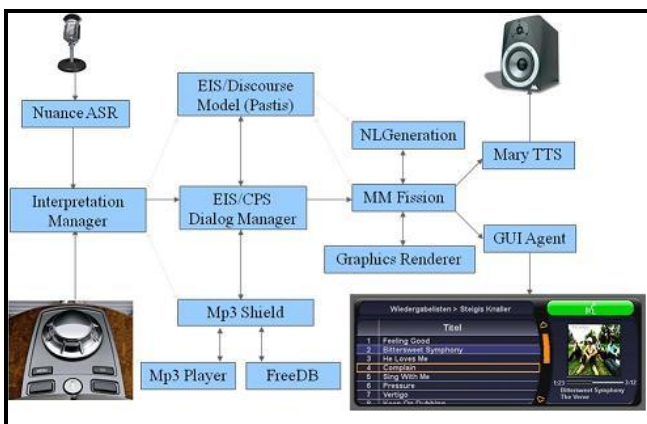


Figure 1. SAMMIE¹ Multimodal System Architecture [7]

Figure 1 shows the architecture of an in-car multimodal MP3 system. This system architecture follows the classical approach [7] of a pipelined architecture with multimodal fusion and fission modules being a part of the dialogue manager. The dialogue manager decides on the next system move, based on its model of the tasks, the current context and the result of the phonebook database. The dialogue manager then generates an appropriate message to the driver.

According to Vilimek [6], learnability is likely to be met when modality fusion is designed in parallel and the “say what you see” strategy is used to enter commands. This strategy helps to increase the recognition rate, because the vocabulary becomes less weighty.

IV. CONCLUSION AND FUTURE WORK

This paper has discussed some usability principles used to design in-car communication systems and some usability issues which are still present in existing applications. These problems include a lack of feedback, poor context-awareness and driver adaptation. Multimodal interfaces which are more suitable to deal with input errors are

¹ Saarbrücken Multimodal MP3 Player Interaction Experiment.

presented as a possible solution towards more usable in-car communication systems.

The next steps of this research are design, implementation and evaluation of a multimodal interface for an in-car communication system. In order to meet usability goals, drivers will be taken into account from the design phase to the evaluation phase. User experience could be enhanced with the availability of hands-free text messaging. The proposed prototype could be tested with a PC-based driving simulator (e.g. TORCS [8]) and a Bluetooth-enabled mobile phone. The participants will be asked to use the in-car communication system while virtually driving a car.

V. ACKNOWLEDGEMENT

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