Interactive Interior Spaces in Cars using e-textiles

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ABSTRACT

Future vehicles are envisioned to enable much more functions than mere transportation and -with the rise of automated vehicles- cars will be living spaces that support an array of activities beyond driving. While current research mostly focuses on user interaction with in-car systems to enhance usability, performance and functionality, we focus on enhancing experience of users and the aspects of enjoying non-driving activities by using e-textiles. This paper introduces e-textiles (i.e. fabric-based sensors, circuits and actuators) to the design space of human-vehicle interaction (HVI) to enrich user experience within car interiors. Through this research, we aim to introduce a new modality to in-car interactions through e-textiles and design user interfaces for drivers and passengers according to user experience goals.

KEYWORDS

user experience, in-car interactions, e-textiles, e-textile user interfaces

1 INTRODUCTION

In the past, in-car interaction modalities have been restricted to traditional mechanical gear, knobs, buttons and handles. Lately, graphical UIs were introduced in commercial cars including dialogue-box representations and speech-based input. Today, novel interaction technologies create many opportunities for designing valuable and attractive in-car user interfaces. For instance, in technologies that assist the user in driving, such as navigation systems or voice assistant systems, the user interface is essential to the way people perceive the driving experience. New means for user interface development and interaction design are required as the number of factors influencing the design space for automotive user interfaces increases [3].

In this paper, we will discuss novel interactions through parts of the car consisting of fabric. As vehicle interiors are primarily made out of fabric, this is be an excellent opportunity to utilize these parts of the car and embed seamless, less focus-demanding interactions by employing e-textiles techniques. In the rest of the paper, we will first discuss some of the existing tactile user interfaces for in-car systems in the literature review section. Second, we discuss how e-textiles could improve user experience and overcome issues related to other user interfaces. Finally, the methods and processes that will be used to evaluate this study will be elaborated.

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2 LITERATURE REVIEW

For enhancing user experience inside the vehicle, various in-car systems have been designed and developed to fulfill the requirements of passengers during the journey, for example, a navigation system, music player, multi-functional display. As we know, all of these in-car systems in a manually-driven context are distracting and focus-demanding; thus, it is in opposition to the primary task of driving, which requires great visual and cognitive attention. As a result, engaging a driver with various auditory and visual demanding systems could cause devastating crashes[2].

To redeem this issue of distracting systems, many researchers have proposed to increase the modality of input and output channels so that the driver does not have to divide their visual attention between the primary task and in-vehicle systems. One of the less employed interaction methods in vehicles is a tactile sensory modality that does not interfere with the driving [7].

Many papers have discussed the effects of adding tactile feedback to the steering wheel on driving performance and user experience[1; 2; 7]. The results illustrate there is no significant difference between the tactile display and conventional navigation system in terms of performance, but the user experience has improved. They felt comfortable with getting feedback from tactile display[1]. Minor improved performance could be one of the signs that indicates this system is not calm technology, since the driver's attention is mostly dedicated to the UI, which is in opposition to calm technology definition that will be defined in section 4. Besides, the enhanced interaction is mostly for the purpose of improving the usability and ease of use goals, while the experiential values such as the playful, engaging, aesthetic and pleasant aspects of UX are less regarded in the design and user evaluation.

Derived from the literature, most of these tactile-based interfaces are utilized for assisting driving-related tasks such as for getting navigational information, and while only a few of them were about non-driving-related activities (NDRA). All The vast majority of these user interfaces are designed for 'drivers' users, and while only a few considered tactile UIs for 'passengers' users. E-textile UIs could be designed for drivers and passengers for secondary and tertiary tasks to enhance user experience and offer seamless and less-focus demanding interactions based on the calm technology definition.

3 METHODOLOGY

Our hypothesis for this research is that when passengers or drivers interact with in-car systems through e-textile interfaces, their in-car experience will be enhanced. These user interfaces help them to interact seamlessly with in-car systems or other users without being

overloaded with so much information. For analyzing and testing our hypothesis, we have to fulfil a set of steps that are concisely mentioned down below.

(1) Eliciting user requirements and expectations by conducting a small workshop
(2) Designing interactions and create a prototype for evaluating and testing our hypothesis by bridging textiles with electronics
(3) Conducting a user study to measure user experience in a simulated environment
(4) Analyzing our data qualitatively and quantitatively, and elicit useful information out of it by statistical or mathematical methods to evaluate whether UX is improved by having e-textiles UI or not

4 DESIGN CONCEPT

As we transition towards automated cars and they are becoming a space for many entertainment and non-driving activities , more user interfaces are being added to the vehicle interior. As a result, this number of interfaces may be disruptive and sometimes annoying, which contradicts the definition of calm technology that requires the smallest amount of attention and should quickly move from the periphery of our attention to the center of our attention, and vice versa[8].

Textile components(e.g. fibers, yarns, leathers) could be integrated by with electronic components(Lilypad micro-controllers, input/output sensors) by using fabrication techniques such as embroidery, weaving or coating etc. to make e-textile user interfaces. Furthermore, for capturing inputs from a driver or passenger through textile components, conductive threads or fabrics could be interwoven with textile components for making the e-textile user interface for input modality.

By using e-textile user interfaces, the drivers or passengers would be able to conduct secondary and tertiary tasks (assisted driving-related activities for secondary tasks and non-driving-related infotainment activities for tertiary tasks) without being requiring as much cognitive and visual attention(e.g. Controlling media player through fabrics of interior car). Apart from this feature of e-textiles that could be less focus demanding and distracting, the fabrics inside the car are within the range of passengers' hands, and could be a new modality for in-car interactions. For example, the car interior fabrics could be used for e-textile sensors or soft actuators [5] for in-car interactions. These applications could be of particular value and interest to passengers with some physical disabilities such as vision impairment, people who are hard-of-hearing or people who have a speech-impairment. To the best of our knowledge of the literature, there are no interfaces designed for these types of people to help them have a great experience inside a car. So, in this research, we address this gap in order to determine how to design practical and useful interfaces by using e-textiles to enhance the user experience of these types of people as passengers.

After designing interactions and creating a prototype for car users to have a UI with enhanced user experience, we need to employ an iterative design process to continuously test and update our prototype according to the feedbacks of users[6].

5 USER EVALUATION

For the last part of this research, which the most important section, we aim to understand how people interact with the e-textiles user interfaces designed for in-vehicle interactions, which is called research through design. Accordingly, We will design and conduct a user study in a simulated environment in the laboratory.

The goal of the user study is to measure user experience. We have to be more specific and detailed as to what aspects of user experience have to be considered and what methods exist for measuring UX. One of the methods for measuring UX is CTAM (Car Technology Acceptance Model)[4], which is a questionnaire. This model considers usefulness, ease-of-use, intention to use, and subjective workload UX factors. So, according to this model, we will conduct a questionnaire and analyze these UX factors. In addition to these UX factors, we must need to consider other UX factors such as fun and pleasantness to see how enjoyable the e-textiles UIs are inside a vehicle. Participants will score for each of the UX factors mentioned above, and evaluate whether e-textiles UIs have increased the UX or not. We will need to compare it to the baseline UI that existed before and measure the difference.

In addition, we will have a qualitative analysis where short interviews will be conducted to ask the participants about their experience interacting with e-textiles UIs. For this part, a set of compelling questions needs to be designed, and the interview should be directed in a way to obtain meaningful results.

6 CONCLUSION

In this extended abstract, we proposed our new modality for in-car interactions, the e-textile user interface, and explained how it can be helpful and why it is essential to consider it a new modality. We hypothesized that this user interface could enrich the user experience of drivers and passengers for in-car interactions. The steps of conducting this research were mentioned in section 3, and the design concept was explained in section 4. Lastly, how user study will be conducted and how UX is measured were explained in the last section.

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