Towards Work in Automated Vehicles

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ABSTRACT

In this position paper we describe our work investigating an important promise of automated vehicles: that they can help drivers reclaim the time they spend traveling, and allow them to spend some of this time engaged in work or wellbeing-related tasks. Our goal is to create systems that will allow drivers to safely engage in work, or wellbeing-related activities, in automated vehicles. These systems will serve as embodied intelligent cognitive assistants and will combine tangible and voice interaction with augmented reality interfaces. Here we describe some designs considerations and early prototypes.

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KEYWORDS

Automated vehicles; autonomous vehicles; in-car activities; mobile office; secondary task; future workplace.

INTRODUCTION

Data from the US Census Bureau indicates that US workers spend an average of about 50 minutes a day commuting to and from work [8]. Approximately 25 million workers spend more than 90 minutes commuting each day and about 600,000 workers travel at least 90 minutes each way. In most of the world's major cities, commute time is over an hour. The impact on individuals, organizations, and society at large is enormous: millions of workers waste about 4 hours per week in vehicles with an economic cost in the US of $90 billion per year [10]. Research also indicates that people with long commutes are more exhausted, less productive at work, and have lower job satisfaction [1].

However, with automated vehicles, commuters could spend some of this time engaged in productive work-tasks [6] or wellbeing activities. Our goal is to create systems that allow workers to engage in work-related and wellbeing activities in automated vehicles. However, for an automated vehicle to become a place of productivity, we need to understand how technology can allow to safely combine activities related to work and wellbeing with those related to driving.

Current trends in the automobile industry make it likely that in the near future, cars will be increasingly automated [7]. Drivers will be able to engage in non-driving tasks in automated vehicles that are classified as SAE level-3 (or higher) automated vehicles by the J3016 standard of the Association of Automotive Engineers (SAE) [5]. With level-3 automation, the vehicle can travel without human intervention for extended periods of time, and the driver is not expected to monitor the automation. However, there are situations where the human has to take over driving. This does not have to happen immediately when the system requests help, but within some reasonable amount of time, which might be on the order of seconds to minutes. Vehicles with level-3 automation are becoming available [9], and are expected to be more common in the next 2-5 years [3].

We hypothesize that the integration of three types of user interfaces (voice interfaces, augmented reality (AR) interfaces, and tangible interfaces) will support both engagement in non-driving tasks and safely returning to the driving task when needed. We are currently designing and developing prototypes that integrate the three in-vehicle user interfaces in order to assess their effectiveness in supporting work and wellbeing-related activities within automated vehicles, while also allowing for safe driving when necessary. Similar ideas were also explored in an AutomotiveUI '18 [4].

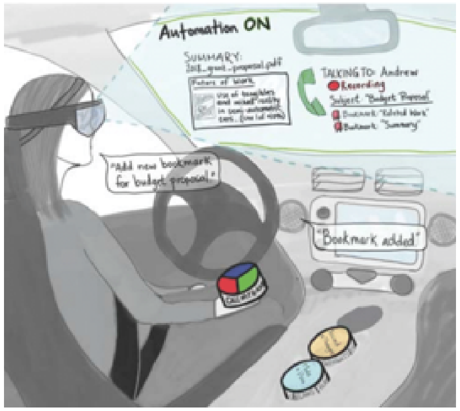

Figure 1: Our vision for the in-vehicle environment to support work and driving. The interface combines AR, voice, and tangible interaction to support work-related calls. It will allow the operator to take actions within a call (e.g., record, annotate, end call).

IN-CAR MOBILE OFFICE

We expect that the human operator in the car does not need to attend to the driving activity while under the control of automation. She can focus on participating in a meeting using a see-through augmented reality glasses (see also Figure1), which display a summary of a document and information about an ongoing audio call. The driver’s hands are free to manipulate the tangible interface. There will also be a speech-based interface. The interface should allow the driver to maintain her gaze toward the outside world. We expect that this will help minimize motion sickness as well as retain awareness of her surroundings. The latter will help make it safe for her to take back control of driving, when needed.

When the vehicle requests that she takes back control, the interfaces will support her. First, the interfaces will help her in wrapping up the work-related tasks, such that she knows that she can resume later. And, once she is driving, the interfaces will provide support for the driving task, or simply stay out of the way. For example, the augmented reality glasses can provide navigation instructions.

We are currently creating prototypes to explore our envisioned environment. We implement augmented reality using the Magic Leap device, which projects visual information, such as simulated 3D objects or application windows, within a field of view that is about 40°wide by 30°high. Additionally, the device supports speech input, and directional sound output. We implement speech interaction using developer tools from Microsoft. We design and implement the tangibles from off-the-shelf parts, such as embedded processors and LCDs. As a starting point, the tangibles operate through a consistent token and constraint [11] interaction syntax. We expect some overlap between the voice and tangible interactions and will study when drivers prefer each interaction style.

SUPPORTING TRANSITION BETWEEN WORK TO DRIVING

As drivers engage in work-related tasks they will use multiple perceptual, cognitive and response resources [12]. Thus, they might use their focal visual perception to view the outline of a document, their auditory perception to listen to a remote conversant, and their verbal cognitive resources to reason about a work-task. They might also manually manipulate a tangible interface. To safely transition to the driving task, they will have to reorient the majority of their resources. Thus, their focal visual perception will have to be mostly dedicated to observing the road, some of their auditory perception will be needed to listen to ambient noises and navigation instructions, and their resources for manual manipulation will have to be mostly used for steering.

An important aspect of our design is facilitating the transition back to driving. Removing the work-related functionality too quickly might leave the user confused, and resentful when work is lost. It might also change how they behave when the functionality is available (c.f. [2]). This could ultimately lead to unsafe driving, as well as to users rejecting the system.

It is also important to design the interfaces to support drivers when they transition back to the work task from driving. We expect that, if drivers know that this support will be available, they will transition from the work-task to the driving task more readily.

We will conduct experiments to assess the appropriate amount of time that users need to complete work-tasks and transition to driving. We will also experiment with different ways to support resumptions, using speech, AR, and tangible interfaces.

SUMMARY

Automated vehicles hold out the exciting promise of reclaiming commute time, by allowing drivers to use some of that time for work and wellbeing activities. To take advantage of this promise we need to better understand how to design in-vehicle interfaces that support safe engagement and transitions between driving and work activities.

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