An AR Workbench for Experimenting with Attentive User Interfaces

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Abstract

We present a workbench to build, evaluate and iteratively develop user interfaces using augmented reality, eye tracking, and visual programming. To test our system, we have developed an Attentive User Interface (AUI) for automotive environments, which coordinates its activities based on the context and visual attention of the user. Development of AUI requires interdisciplinary teams like psychologists, human-factor engineers, designers and computer scientists to work together. The main problem of interdisciplinary communication is a lack of common language and different notion of the system. We have developed a workbench, which facilitates the communication between the team members and enhances the comprehension of the system by visualizing users' attention and system reactions.

Figure 1. Virtual cones show the user's attention. This application is used to monitor the deployment of visual attention.

1. Introduction

User interfaces for cars are different from user interfaces for desktop environments because the main amount of visual attention must be spent on driving the car. Only bursts of attention can be directed toward attending to the computer interface. Moreover, input devices like mice and keyboards are not available. It is desirable that the system should take the user's focus of attention into account in order to achieve a more intuitive communication. For example, an attentive user interface (AUI) should try to gain the user's attention and wait until she focuses on it, e.g. by turning her head towards an interactive icon like a blinking telephone icon that shows an incoming phone call.

Zhai and Jacob have shown that the eye is, in principle, not very suitable to control user interfaces [5, 3]. Instead of controlling, we use the eye direction to notify the system about the user's current focus of attention. By looking at a device, a user conveys her attention for that device and the AUI can adapt its behavior accordingly.

2. AR Workbench

When developing these and other highly interactive user interfaces for cars, knowledge from many different research areas such as human factors, human-machine communication and computer science is required. Based on their experience, the development team members need to discuss, simulate and evaluate different strategies for attracting the user's attention in the least disruptive and most consistant way. To this end, a rapid prototyping environment is needed which allows domain experts to easily configure and modify different attentive user interaction schemes without requiring major changes to the underlying computer system.

In this poster, we present an AR workbench which allows teams of domain experts to jointly develop and exchange interaction strategies at runtime, thereby saving a lot of time between design iterations. Using a visualization that augments a user's current view with a viewing cone, the design team can evaluate the efficiency and effectiveness of various attentive strategies and design elements (e.g. level of details, forms, colors, brightness, size, etc).

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Systems that use attention as a input have been already presented [2], but with our workbench one could visualize why certain behavior of the system occurs. The main contribution to current eye tracking methods [3] is that our visualization method with superimposed cones shows the eye direction within the scope of the application instead of snippets of the environment viewed by the eye camera. Moreover, it can be used for monitoring multi-user applications by augmenting all tracked users. The focus of this project is set on exploring interruptive qualities (not disruptive vs. effective attention requests) and maximizing usability while a driver's attention is divided between several tasks (e.g. by showing the optimal amount of information without decreasing the driver's safety).

3. Implementation

Our application is built on DWARF [1], a highly flexible AR framework for testing and rapid evaluation of new technologies. We use Petri Nets to model and visualize interactions [4]. The rapid prototyping workbench for attentive user interfaces receives input from a commercial tracking system [1] and a custom built eye tracking device [2] to obtain the user's head position and eye direction. The eye direction is visualized as a virtual cone and superimposed on the video of the user (Fig. 2). The virtual cones represent foveal and parafoveal areas, and the outer boundaries of these areas are generally set at $\pm 1°$ and $\pm 6°$ degrees of visual angle, respectively.

After receiving an event (e.g. phone call, event reminder, or information) the system presents initial information on a peripheral display, trying to attract the user's attention. The application remains idle, until the user looks at the peripheral display. To determine whether the user focuses on the attentive icon, the position of the display is also registered in the laboratory setup. When the user moves her head, the intersection of her viewing cone with the plane representing the display is computed. As soon as the cone intersects with the display area showing the attentive icon, an event is generated upon its behalf. As a reaction to the eye contact, further action to respond to the inital event (phone call etc) is taken.

4. Conclusions

In this poster we have presented our AR workbench. It has been used in our laboratory to build, evaluate and improve an AUI for cars. Our visualization methods facilitated the comprehension of the AUI concept and thus motivated the communication between team members. This approach can be applied in all physical environments with 3D tracking, and can be therefore used for evaluation of all kinds of user interfaces and devices by observing users eye direction in the given context. In future work, we want to implement further strategies to attract the user's attention and conduct user studies.

[1] http://www.ar-tracking.de/viewtopic.php?t=7

[2] http://www.lfe.mw.tum.de/forschung/versuchseinrichtungen/sonstiges.htm

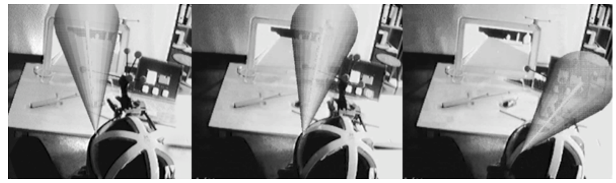

Figure 2. Visualization of the user's attention with virtual cones. First, the user's attention is set on the driving task. Eventually, a moving icon in the AUI causes the user to look to it and provides her with additional information.

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