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Is Eye-Tracking a Feasible Interaction Paradigm for Large Displays in the Sterile Field?

A technical prototype for the presentation of HIS data and for supporting surgical hand disinfection.

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Abstract: The paper describes how eye-tracking can be used to explore electronic patient records (EPR) in a sterile environment. As an information display, we used a system that we developed for the presentation of patient data and for supporting surgical hand disinfection. The eye-tracking was performed using the Tobii Eye Tracker 4C, and the connection between the eye-tracker and the HTML website was realized using the Tobii EyeX Chrome Extension. Interactions with the EPR are triggered by fixations of icons. The interaction was working as intended, but test persons reported a high mental load while using the system.

Keywords: eye tracking, sterile interaction, human maschine interaction.

1 Introduction

There are many pre- and intra-operative situations in which a sterile person (surgeon or scrub nurse) needs information from the hospital information system (HIS) or wants to interact with devices. In many cases, this person orders a different person to "scroll to an information" or "open a certain document" or else. Often, this information is displayed on larger wall-mounted screens, and the interaction needs mouse or keyboard input; sometimes touch displays are used. Those input devices can be covered with sterile foil so in theory they can be used by sterile personnel, but often they do not have free hands, or using those input devices would interrupt the intervention. Speech recognition can be a suitable interaction paradigm for sterile interaction, but since the operating room can be a noisy environment, and the presence of other people might decrease the willingness of using speech recognition systems, we were looking for other interaction methods in the sterile environment.

Eye-tracking technology is usually used for the analysis of gaze paths e.g. in usability engineering [1, 2]. Additionally, there are projects which are using eye-tracking as an input device for disabled persons [3]. This led us to the research question, of whether eye-tracking could be a feasible input device for interaction with larger displays in the sterile field.

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2 Methods

As an information display, we used a system that we developed for the presentation of HIS data and for supporting surgical hand disinfection. The functional and non-functional requirements for the system eye tracking system design are listed in table 1. Please note that table 1 only lists the requirements regarding the eye tracking and not the requirements of the underlying information system.

Table 1: Functional (FR) and non-functional (NFR) requirements for the eye tracking system.

ID	Requirement
FR01	The control with the eye-tracking camera must allow the user to select an operating room.
FR02	The control with the eye-tracking camera must allow the user to view different patient information within the patient record.
FR03	The control with the eye-tracking camera must allow the user to start the washing process.
FR04	The user must be able to see himself in the mirror.
FR05	The user must be able to calibrate the eye-tracking camera within the application.

ID	Requirement
FR06	The eye-tracking camera must detect a person within the field of view.
FR07	The eye-tracking camera must be able to tolerate variations of the human eye.
NFR01	The calibration of the camera should be easy and fast.
NFR02	The content on the user interface should be visible at the time of selection.

The display is showing relevant patient data and a timer that is guiding the user through the surgical hand disinfection process. The graphical front end is realized as a full-screen HTML page. It can be assumed that the interaction paradigms like “selection of an object”, “confirming a selection”, “scrolling information” can be transferred to other sterile intra-operative dispay solutions. Nonetheless, all systems require a reliable detection of the eye gaze of the user, which limits the distance from which such systems can be used. Therefore the study is limited to systems in which one user stands or sits in front of a display and interacts only using eye tracking.

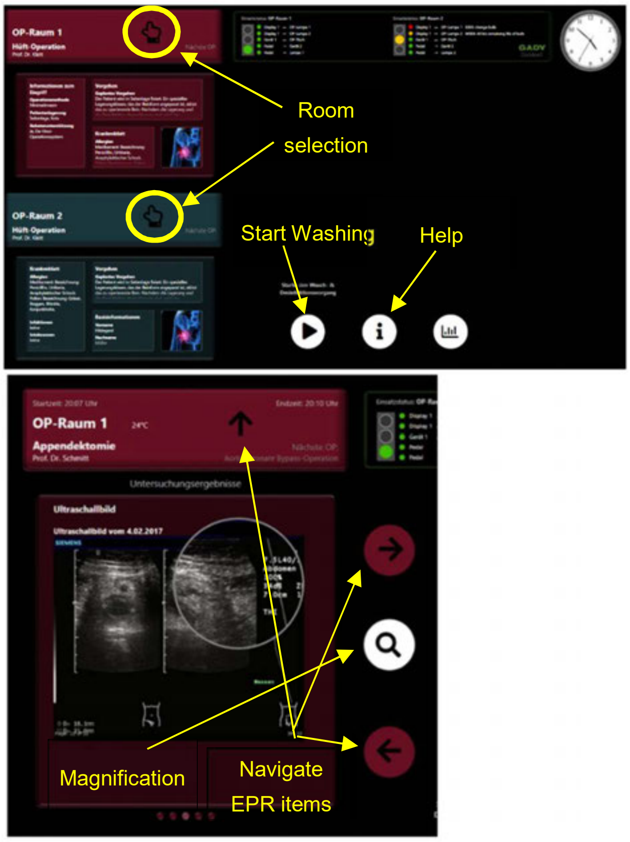

Figure 1: Main screen of the application (upper view) and part of the screen showing the magnification interaction with an ultrasound image (bottom view).

For this system, we analyzed the interaction needs. For each identified interaction, we designed icons that can be used to trigger the interaction via eye-tracking. We used the eye gaze position to position the cursor on an object, and a longer fixation on the object triggers the corresponding action.

The eye-tracking was performed using the Tobii Eye Tracker 4C. The connection between the eye-tracker and the HTML website was realized using the Tobii EyeX Chrome Extension. We tested the system on a small 13” notebook display and a large 55” wall-mounted display in a defined test environment which were determined by a successful calibration. The dimensions are the screen angle, which was 20mm for the 13" and 60mm for the 55" display, and the distance to the eye-tracker, which was 470mm for the 13" and 700mm for the 55" display. For each test run, the system was calibrated to match the individual anatomy (especially eye distance) of the respective person and the screen size. In order to take into account the variations in height, the test was performed on three people with body heights of 1.57 m, 1.70 m and 1.80 m. Since the eye tracker is designed for smaller screens, we placed all interaction items on the left side of the screen. Therefore, we were able to use the system within its specification even with the large screen.

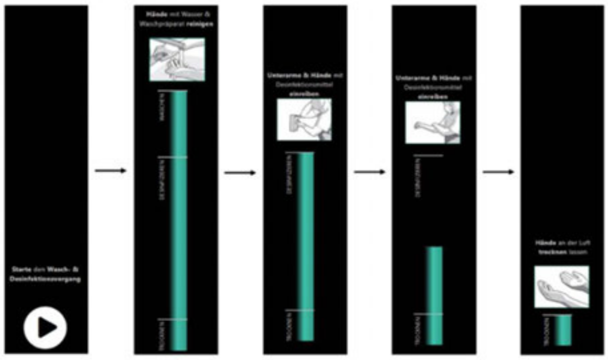

Figure 2: Sequential visualization of the guiding for the surgical desinfection process after interaction with the icon.

3 Results

The main screen layout including icons for interaction is shown in Figure 1 (upper view). The main interaction paradigm is: The users can freely explore the whole screen area, e.g. to read text or to orient themselves. Icons that can be used for an interaction are visually highlighted when the gaze-guide mouse movement touches them. To trigger an interaction, the users have to fixate the respective interaction icon for one second. To visualize this, a round progress bar is circling around the icon. We implemented interactions for selection of the operating room (finger-icon), selection of different documents of the electronic patient record (EPR) (horizontal arrows), digging deeper in the EPR structure (buttons up and down), magnification (loupe) (see Figure 1 (bottom view), starting the handwashing sequence (play-button), and a help- as well as an exit button. The “statistics” symbol is only used for displaying statistical information regarding the performed interactions. This symbol is not used during the study.

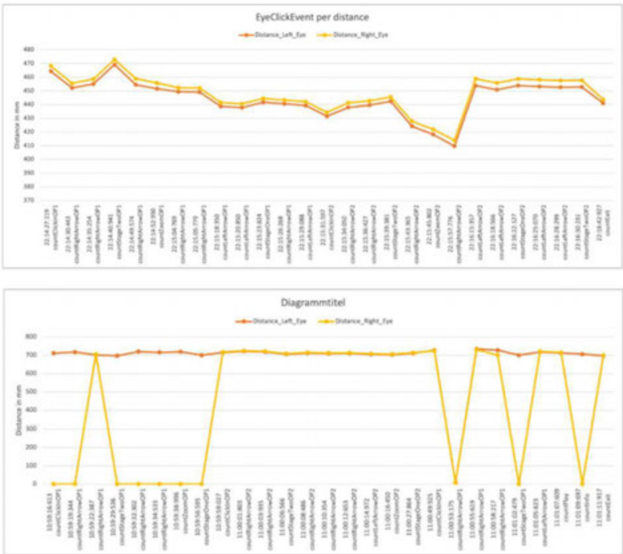

Figure 3: Distance of left (orange) and right (yellow) eye to an icon at subsequent click events during an interaction sequence. The upper view shows the results for the 13” display, the lower for the 55” display.

The calibration and interaction were performed without technical problems on the 13” laptop display (see Figure 2). On the larger display, the eye-tracker had significant problems in determining the eye position since it was operated on a larger display and with more distance between the human and the eye tracker than specified. Fortunately, we found configurations of eye-tracker, distance-to-display, and environment brightness which allowed us to perform tests on the large display with our existing hardware.

4 Discussion

From a technical standpoint, we demonstrated that interaction with an EPR via eye tracking in a sterile environment is feasible. The technical limitations for large screens could be resolved by using a different tracking device. Such devices are more expensive than the consumer device we used for testing, but for intra-operative solutions we would assume that the eye tracking system will be integrated in the display solution to facilitate easy cleaning and relyable system behaviour.

Unfortunately, the test users reported that using the system – even though the interaction is rated as intuitive – is very tiring and it takes a long time to fixate an element correctly with the gazepoint.. The need for re-calibration for each user hinders the fast interaction with the system.

5 Conclusion

Eye-tracking can be used for interaction with EPR data in the sterile field, but it introduces additional cognitive load. We assume, that in most interaction scenarios there are more appropriate interaction methods available, but for specific tasks eye-tracking might be helpful.

Author Statement

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