Eye-R, a Glasses-Mounted Eye Motion Detection Interface

Ted Selker, Andrea Lockerd, Jorge Martinez

MIT Media Lab
20 Ames St.
Cambridge, MA 02139
(617) 253-0219
selker@media.mit.edu, alockerd@media.mit.edu, martinez@media.mit.edu,

ABSTRACT

Eye-R is a system designed to detect and communicates the intentional information conveyed in eye movement. This glasses-mounted, wireless device stores and transfers information based on user eye motion and external IR devices thus promoting an enriched experience with their environment. This paper describes how the system measures eye motion and utilizes this as an implicit input channel to a sensor system and computer. In the primary scenario, eye motion detection is used to recognize a users gaze. When the person's eyes are fixated the system infers that they are paying attention to something in their environment and then tries to facilitate an exchange of information in either direction on the user's behalf.

Keywords

Eye motion detector, implicit input, interface.

INTRODUCTION

Eye position detection has long heralded many possible uses and values. By watching a person's pattern of eye fixation, people have proposed that one could interpret where they are looking to control cursors [1]. In general, people's eyes are constantly attending to many things at once; requiring a user to exercise highly controlled eye movement can be stressful. Successful scenarios require the benefit of the interaction to outweigh the difficult requirements on the eyes (paraplegics that don't have other meanings of control, for example, can have great benefits from using this kind of control). However, outside of extreme cases, we do not want to require specific eye behavior from the user. Jacob describes this interface technique as coupling natural eye movements with an unnatural response [2].

Typical computer interface devices (keyboards, mice) can be described as explicit input channels because they require a direct manipulation of the user. Alternatively, implicit input channels gather information without user interaction [4]. Eye-R is designed to look at eye motion and imply intention from ambient activity. Since it is observing the user's natural eye movement it does not require any specific action from the user and is therefore is an imp licit channel.

The infrared (IR) technology is used to detect eye gaze and transfer information about a user to the environment. Eye-R is a reference to the IR technology as well as a reference to the very personal detection of the state of the eye. The personal reference is continued in the "R" which reflects the individuality of who the users "are".

ARCHITECTURE

The system was designed to be battery operated and able to mount on any common pair of glasses. The infrared emitter-detector pair is positioned between the lens and the eye (figure 1). The Eye-R sensor system detects pupil motion by monitoring light fluctuations from infrared light. An infrared LED (the emitter) illuminates the eye and a phototransistor (the detector) senses the reflected light coming from the eye.

The analysis of the signal coming from the eye's detector is achieved with a sample-and-hold circuit at a 60Hz rate and a PIC micro controller, which searches for patterns of fixation. During fixation, the PIC uses an Infrared transmitting LED mounted on the edge of the board to send a personal ID number to the user's environment and the visible indicating LED presents user feedback.

The infrared transmitting LED was selected with a narrow angle of transmission (between 17 and 20 degrees) in order to facilitate directional intent of the user during transmission. The circuit also contains an infrared receiver module, which allows the system the possibilities of bi-directional communications.

There are also base station circuits, which are modified IRX boards [5] (figure 2). These devices gather the information stored in the Eye-R circuit as well as interchange information with it. The base station also allows communication to a PC thru a serial port.

Figure 1. *Eye-R system worn on a pair of glasses*

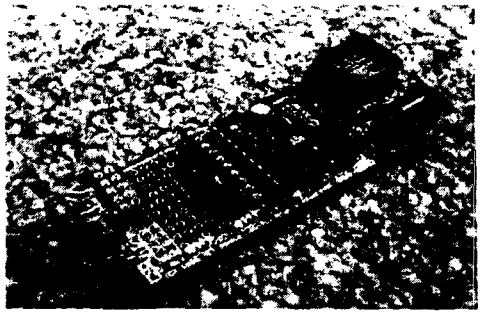

Figure 2. *Modified IRX board*

SCENARIO

In general, Eye-R glasses worn by a user detect eye fixations and interpret this as the user paying attention to something in the immediate environment. The glasses then try to establish communication with a target in the environment to alert the target of the user's attention. The target responds to the user and records this interaction.

Having demonstrated this interaction the following is one application. In this scenario, multiple users have Eye-R modules in a party environment in which the can interact with other users or base station targets. When a user's eyes are fixated the Eye-R module sends a one-byte ID and tries to receive an ID from the person or object on whom the user has focused their attention. Hence, the system is set up to transfer so-called business cards between two people looking at each other, or record base stations in the environment that caught the user's attention. The storage memory can hold 30 IDs.

As a person walks around the party, each time they are looking at an exhibit that has a base station receiver, information about the user is transferred between the Eye-R module and the exhibit. Then this information is transferred to a server. The server, using a database with a Java interface, records that the user has seen this exhibit. Alternatively the stations need not be networked, a wireless base station senses that it is the focus of attention and transfers data about itself to the user's glasses.

One important networked base station is the kiosk station. When a user focuses on the kiosk base station it will show names of every demo and person that the user has seen in front of them. It then allows the user to select further information about any of the subjects. In this way, a kiosk can allow a user to view and utilize the information they have gathered while they are at the party (i.e. sending an e-mail).

EXPERIENCE

People have been able to use the glasses to communicate with the base station connected to a PC, similar to one of the scenarios described earlier. Currently, we are making several Eye-R module systems to fulfill the numerous requests we have received from people interested in using this as a platform in their research.

FUTURE WORK

The Eye-R system will serve as a base infrastructure in various future applications. The pattern recognition will be expanded to include blink and wink detection. The ability to detect blink rate can then be a useful tool in gathering information about changes in the user's state such as stress and fatigue [3]. Detecting intentional blinks (winks) will expand this interface to include an explicit input from the user. We also plan to use the Eye-R system in a video selection situation. The user will be situated in front of a display of multiple video clips. The Eye-R glasses worn by the user will communicate with the display conveying relative interest in the clips.

CONCLUSION

The Eye-R System allows researchers to experiment with eye motion, and demonstrates that an inexpensive wireless eye motion detection system can be made. It shows that eye motion can be robustly detected, even in the unstable format of being mounted on a pair of glasses. We have generated a platform for demonstrating and testing eye based interfaces at a low cost in both individual and collaborative situations.

ACKNOWLEDGEMENTS

Thanks to Winslow Burleson for his invaluable help.

REFERENCES

1. R.A. Bolt, Eyes at the Interface. *Proc. ACM Human Factors in Computer Systems Conference*, pp. 360-362, 1982.

2. R. Jacob, Eye Tracking in Advanced Interface Design. in *Virtual Environments and Advanced Interface Design*. Oxford University Press, 258-288, 1995.

3. F. Kanfer, Verbal Rate, Eyeblink, and Content in Structured Psychiatric Interviews. in *Journal of Abnormal and Social Psychology* (Vol. 61, No. 3), pp. 341-47, 1960.

4. H. Lieberman and T. Selker, Out Of Context: Computer Systems That Adapt To, and Learn From, Context, in *IBM Systems Journal* 39, Nos. 3&4, 617-632, 2000.

5. R. Poor, iRX 2.1 PIC Development Board Available at http://www.media.mit.edu/~r/projects/picsem/irx2