

**EYE TRACKING USING FIBER OPTICS AND COMPUTER VISION
TECHNIQUES**

by

Noel Annette Zabaronick

Thesis submitted to the Faculty of the Virginia Polytechnic Institute and
State University in partial fulfillment of the requirements for the degree of

Master of Science in Electrical Engineering

Dr. Richard O. Claus, Chair

Dr. Lynn Abbott, Member

Dr. Marten DeVries, Member

Dr. Anbo Wang, Member

April 4, 1997

Blacksburg, VA

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Noel Annette Zabaronick
Richard O. Claus, Chair
The Bradley Department of Electrical Engineering

ABSTRACT

We describe a system for tracking the motion and determining the velocity of the human eye using a combination of fiber optics and imaging optics integrated with a CCD camera, a framegrabber, and a PC. Systems such as the one we describe are needed for monitoring location of interest for better human-computer interfaces and virtual reality simulations, for monitoring pilot cognitive skills during flight simulations, and for detecting the early warning signs of driver drowsiness. Where some eye-tracking devices are cumbersome because they require a person to limit head motion to remain in view of a camera or uncomfortable because they require the use of an elaborate headpiece, our proposed system is as simple to wear as a pair of eyeglasses, with the only added weight to the glasses being that of a fiber optic bundle.

This fiber bundle guides the image of an 880 nm LED illuminated eye as it is reflected from a hot mirror built into the eyeglass assembly. The guided image is focused onto a CCD and the camera's output is linked to a PC framegrabber card. Software written in Microsoft Visual C++ locates the user's pupil in each video image and tracks the motion and velocity of the pupil over time.

The prototype system tracks the center of the pupil to an accuracy of only 1/5 of the pupil size. This diminished accuracy results from the minimized computation scheme of pupil detection. The technique relies on edge detection and direction of image gradient over very few pixels so that the system is optimized for speed. Many other methods of pupil detection could be investigated in future research in order to optimize such a system for other parameters.

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ACKNOWLEDGEMENTS

I would like to thank Dr. Richard O. Claus, Dr. Anbo Wang, Dr. Lynn Abbott, and Dr. Marten de Vries for serving on my committee and for providing me with the particular academic guidance I had hoped to acquire during my stay at Virginia Tech. All of my committee members were excellent at teaching students—a rare talent I consider the most crucial to building a student’s confidence in academics. I would also like to thank Dr. Richard O. Claus for providing me with the opportunity to work at the Fiber and Electro-Optic Research Center; the experience gave me a practical education no classroom ever could have equaled.

This research was based on OSP project #435285 sponsored by Enlightened Technologies Associates and supported by the Virginia Center for Innovative Technology. I would like to thank Dr. Neil Goldman and Sally Goldman from ETA and the CIT for the support I received on this project. In addition, I would like to thank Vivek Arya for his help and guidance on this project. Also, I would like to thank the DARPA ASSERT program #DAAHO4-94-G-0359 for the support I received for my masters program while working at FEORC.

My thanks extend to my family and friends, those I worked with at FEORC, and the members of ACT. Without all of your gracious support, I probably would have ended up stuck singing in some rock band.

Special thanks to my best friend and tutor, David Sherrer, without whose support I would never have been a real engineer. Special thanks to my father, Robert Heiks, and my mother, Linda Heiks, for making the engineer in the first place.