CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
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Project Number
S0322

Project Title
Intraocular Camera for Retinal Prostheses: Restoring Vision to the Blind

Abstract

Objectives/Goals
To design an intraocular camera for a prosthetic device that can be surgically implanted into the human eye to give people with diseases such as Retinitis Pigmentosa and Macular Degeneration the ability to recognize common objects, navigate, and function in the home. I predict that the number of pixels necessary for recognition of common objects will be significantly smaller than that for normal human vision, and that image blurring will improve the recognition of objects.

Methods/Materials
Research the eye and its optical mechanisms, and generate a design that includes the camera's array, its position, and lens type. Experiment with various lens types and positions, with both computer-aided design techniques and with actual microlenses to determine camera capabilities. Survey people to determine the minimum human requirements for vision and recognition of common objects. Determine the optimal blur and minimum number of pixels for recognition; adjust camera design if appropriate. Create a prototype of the intraocular camera and test its image capture and video capabilities.

Model 370330 aspherical lens, Lightpath Technologies; OSLO EDU for lens design; Orange Micro iBOT Firewire Webcam; Corel Photopaint; Microsoft Office; magnifying glass; ruler; BTV Pro Carbon for video captures.

Results
We found that only 625 pixels are required for object recognition by blind people. Mature subjects (60-80 yrs) needed more pixels for recognition initially but later improved in their recognition abilities. The optimal degree of blur and number of pixels have an indirect relationship, meaning that for a picture with a larger number of pixels, less blur is needed for optimal recognition. The prototype intraocular camera yielded the surprising results that it is focused at nearly all distances, and that a blind individual could navigate and regain mobility with this device. Computer simulations showed that it is possible to replace the crystalline lens with this prosthetic device and have little aberration in the image or damage to the eye.

Conclusions/Discussion
The results indicate that this project is capable of changing blind individuals' lives. The surgical implantation of such an intraocular camera, which has the potential to help blind individuals navigate local environments, regain mobility, and recognize common objects, might be able to help blind people see within our lifetime.

Summary Statement
We used human psychophysical testing to determine design constraints, and then fabricated and tested a prototype intraocular camera for use in retinal prosthetic devices for surgical implantation in blind patients.

Help Received
Dr. Tanguay and members of the Optical Materials and Devices Laboratory at the University of Southern California helped in teaching me OSLO lens design simulations, and in assembly methods for the prototype.