Automated Acuity Testing
For At Home Monitoring
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Project Overview

Background:
Current visual acuity exams have been found to be only 70-90% accurate due to user error.

Problem Statement:
Visual acuity exams need to be modernized in order to reduce user errors.

Objective:
Develop a product that calculates visual acuity with minimal user input by detecting and tracking a user’s eye movement.
- Conduct test in less than 2 minutes
- Calculate and display visual acuity
- Automate device for minimal user input
- Ensure safety of user while using infrared lighting

Specifications

- Automated and easy to use
- Portable, at home testing
- Quick results
- Value driven hardware
- Reduced doctor visits
- Patient Savings
- Hassle
- Transportation

Final Design: Hardware

- Samsung Galaxy S6
- Display visual acuity exam
- 3D printed goggles
- Housing for all hardware components
- IR light circuit board (2)
  - Illumination of eye for tracking
- iDS uEye Camera (2)
  - Record eye images
- TI MSP430 Microcontroller
  - Controls IR lights and cameras
- USB Hub
  - Interface between goggles and computer
- Computer
  - Runs program and provides power to goggles

Final Design: Software

- Main Program
  - Eye tracking – records eye movement
  - Threshold/Biosignal processing – determines pass or fail for each test
  - Binary Tree Traversal – selects next test to display
  - Interface with cameras and display
- Display Program
  - Program that displays visual acuity exam images
  - Displays and randomizes optotype placement based on Tumbling E Test
  - PhoneGap converts display program to Android application
  - App communicates with main program through WebSocket

Final Design: Exam

- Tumbling E
  - Each eye is tested individually
  - ‘E’s in different quadrants with random orientation
  - Different sizes of ‘E’ correspond to logMAR acuity values
- logMAR
  - Log of the minimum angle of resolution
  - Method of detecting visual acuity at set distance

Analysis

- All hardware works as planned
- Microscopically authenticated optotype pixel count
- Eye tracking software verified to cover complete expanse of display screen
- Threshold algorithm successfully correlates camera data to optotype locations
- Binary tree traversal tested to run through all possible tests

Future Work
- IR lighting board created around display to minimize obstruction
- Improved housing design
- Reduce overheating of hardware components
- Improve algorithm accuracy
- Auto-connect phone to program
- Adjust goggles to account for wider acuity range

Conclusions

These goggles have the potential to be a more effective and convenient alternative to the current visual acuity testing methods on the market today. Utilizing today’s technology in a new and innovative way, they can reduce patient transportation and time commitments necessary to maintain health. They eliminate the need for an examiner and provide a unique test every time.

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