CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

38177

Project Title

Smartphone Controlled Portable Phoropter Powered by Variable Focal Length Liquid Lens

Abstract

Objectives/Goals

A phoropter is a large, expensive device that has sets of precisely machined lenses that are used to subjectively determine which eyeglass prescription provides the clearest vision. The goal of this project was to develop a cheaper, portable device to accurately determine the degree of spherical correction for eyeglass prescriptions.

Methods/Materials

Liquid Lens and Driver IC, Arduino, Smartphone, Static Lenses, 3D Printer, Laptop with Xcode, Solidworks, and Arduino Create. A liquid lens, which changes focal length in response to an applied voltage, was used. The Arduino board was wired to the Liquid Lens Driver IC, and I programmed a C++ script that provides I2C commands to direct the applied voltage in response to wireless calls to a custom-implemented REST API. I programmed an app for the smartphone that runs the algorithm to zero in on the prescription by displaying pairs of lens powers and allowing the user to select which of the two is clearer with push-button input. The smartphone also displays a LogMAR visual acuity chart to give a point of reference for subjective clarity. An array of lenses was designed in order to project the test chart to a virtual image at optical infinity.

Results

The sample data provided the following linear regression:
(Official Prescription Power in Diopters) = 0.3235 * (Final Lens Voltage) - 17.8150
with R^2 = 0.8350 for the 26 eyes tested and compared against a refraction officially done by a phoropter.

Conclusions/Discussion

The test results yielded a relatively large R^2 value of 83.50%, meaning over 80% of the relationship between final lens voltage and the actual spherical equivalent was accounted for by the regression line. This strongly supports the hypothesis that the final lens voltage can be used to determine the spherical eyeglass prescription.

Summary Statement

I incorporated a voltage-controlled liquid lens, an Arduino, and a smartphone to create a portable, inexpensive device to effectively replace a phoropter and provide eyeglass prescriptions.

Help Received

I designed, programmed, and built the prototype myself, at home. Dr. Shira Robbins of the UCSD Shiley Eye Center helped me understand the human eye.

Preliminary