CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1523

Project Title

Lumos: Automated Smartphone-based Ophthalmic Screening for Glaucoma Using Computer Vision and Deep Learning Algorithms t

Abstract

Objectives/Goals

The objective is to create 2 things: 1) a low-cost lens that attaches to the back of a smartphone and allows laypeople to take a picture of the back of the eye and 2) an algorithm that analyzes that image to automatically identify risk of glaucoma.

Methods/Materials

Used my Macbook pro laptop plus the programming languages Python and Swift to build the algorithm and app. The machine learning library used was TensorFlow and the algorithm was tested on the MESSIDOR, DRIONS, and HRF databases that all contain high quality retinal images.

The 3d printed casing for the lens was created using a 3d printer as well as OnShape to create the CAD file. The different parts of the lens included: mirrors, beam splitters, polarized filters, and paper.

I created and tested both the lens and the algorithm myself.

Results

The lens ended up being only about 30 dollars while ophthalmoscopes and slit lamps can cost from a few hundred to a few thousand. Additionally, the quality of the lens compares to more expensive lenses, despite being low-cost. Lastly, there is no need for dilation of the pupil when using the lens, because the lens can capture high quality images regardless.

The algorithm, when tested on images captured using the Lumos lens after the first clinical study, was able to identify glaucoma risk with 100% accuracy. The Lumos algorithm, when tested on the high quality image databases HRF and DRIONS, had an overall accuracy of 95.7%.

Conclusions/Discussion

Glaucoma is the leading irreversible cause of blindness worldwide. What's even more alarming is that in its early stages, it is asymptomatic. So more than half of the patients who are affected don't know that they have this illness until much irreparable damage has been done to their vision.

In order to better identify patients who would benefit from early treatment, it is necessary for patients to have early detection of this disease. But early detection is difficult. As it stands, not all patients have access to an ophthalmologist for glaucoma screening due to barriers such as finances, distance and time.

Summary Statement

I created a low-cost lens (smartphone attachment) that lets laypeople take a picture of the back of the eye (retina), and an algorithm that analyzes the retinal image to identify risk of glaucoma.

Help Received

I consulted my mentor, a clinician at UCI Medical Center specializing in glaucoma to further understand the disease. But the lens and algorithm were both created entirely by me.