TonoSense: A Novel IOP Monitoring Device for At-Home Glaucoma Screening

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Glaucoma, the second leading cause of blindness, affects more than 80 million people worldwide. This disease is asymptomatic, so the patient is unaware until vision impact has started. A significant risk factor of glaucoma is high intraocular pressure (IOP). An affordable, easy-to-use, at-home IOP-measuring device could help save millions of people from vision loss. My research goal was to build such a device, TonoSense, based on the novel pressure sensing method I developed last year. TonoSense, will enable (1) Home monitoring of IOP to detect any substantial changes to provide early detection, (2) Self-measurement with eyelids closed (no anesthesia required) and (3) Low-cost system. The IOP measurement principle is derived from Imbert Fick's law, which assumes that the cornea is infinitely thin, perfectly elastic, and perfectly flexible. These assumptions are only partially true for the eye. Using a finite element model the corneal strain distribution was simulated. The material for the eye model was selected based on stress-strain measurements. Several eye models were built and tested and the hybrid silicone model was found to be the best. The validity of the pressure measurement method was demonstrated through measurement. Multiple finger-tip sensors were built and evaluated for building TonoSense. The device showed a good linear proportional relationship between measured and actual pressure. Further steps include improvement of measurement algorithm, custom design of pressure sensor, packaging and integration of microcontroller, wireless communication module and battery, and the development of a mobile app. Successful clinical testing would enable TonoSense, a game-changing tonometer in the fight against glaucoma.

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