Artificial Cornea Modeling for Validation of a Novel Handheld Ophthalmic Device

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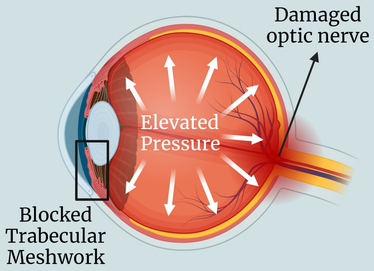
Background

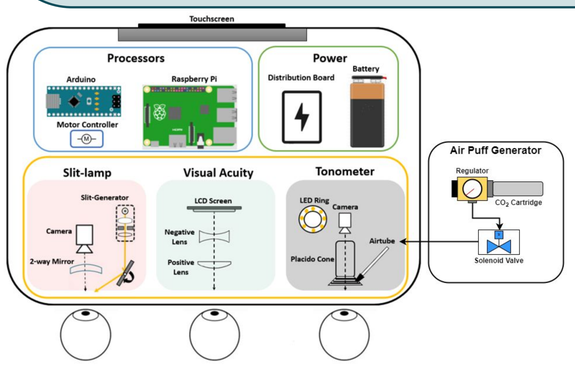
Glaucoma is a set of eye diseases that is induced by elevated intraocular pressure (IOP) and increased stress on the optic nerve. It is the leading cause of irreversible blindness today, with more than 75 million people worldwide. The progression of glaucoma can be so gradual that it commonly goes undetected by at-risk patients. Thus, IOP monitoring is imperative in glaucoma detection and early treatment before extreme vision field loss occurs.

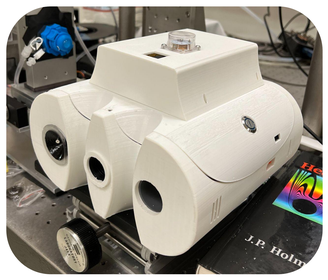


Novel Handheld Ophthalmic Device

To screen for glaucoma, several comprehensive eye exams have been developed including slit lamp microscopy, visual acuity screening, and IOP measurement using tonometry. We have developed a novel device that combines these 3 instruments in a single self-examining device. It features:

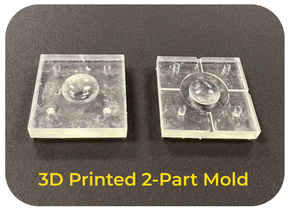
- Portable device with multiple eye examinations
- Internet capabilities to allow remote result evaluation
- Self-monitoring of the eye for at-home patients

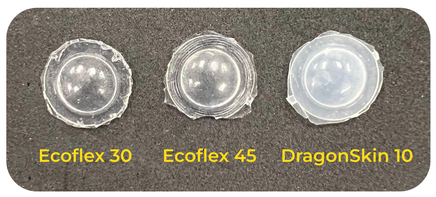


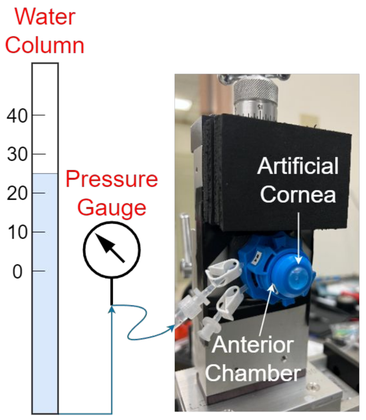


Artificial Cornea Model

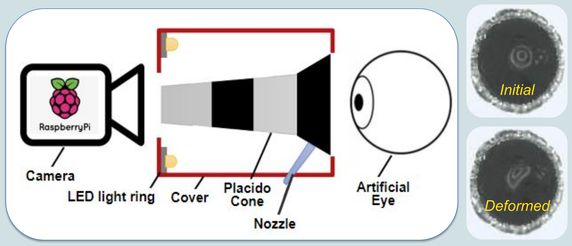
To test and validate the tonometer inside the handheld device, a phantom cornea was developed to allow for standardized testing and comparison to other tonometers. This model was designed by taking into consideration the dimensions and the Young's modulus of a human cornea. The cornea was molded using commercially available silicone materials and a 2-part, 3D printed mold. Coupon tensile testing confirmed their Young's modulus values were within the human corneal range. These samples are then clamped inside an anterior chamber connected to a manometric water column to simulate a range of eye pressures between 0 and 40 mmHg.







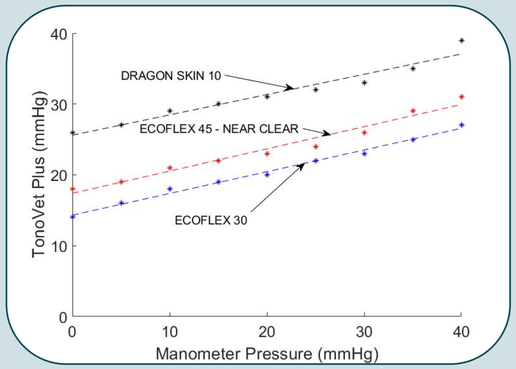
Performance Testing



Commercial Tonometer	*3-in-1 Device Tonometer*
• Mini probe measures rebound speed off corneal surface to calculate IOP • Increasing IOP should increase tonometer readings	• Air pulse gives deformation in Placido Ring projection for IOP measurement • Increasing IOP should decrease observed corneal deformation

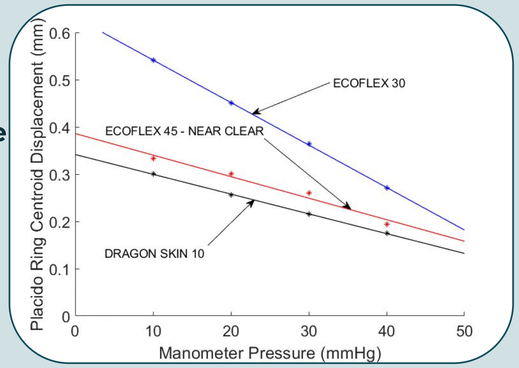
Results

Commercial Tonometer



- Linearly increasing readings with increasing IOP
- The stiffest material (DragonSkin 10) showed the highest range of values

3-in-1 Device Tonometer



- Linearly decreasing Placido Ring deformation with increasing IOP
- The softest material (Ecoflex 30) showed the highest corneal deformation

These results suggest that the cornea models can be used to test and validate similar handheld tonometers in the future. The 3-in-1 device can also effectively be used to test for high IOP levels.

Acknowledgements

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