Improving Non-Contact Tonometry through Advanced Applanation Techniques and Measurement of Corneal Deformation

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Introduction

- Glaucoma, the leading cause of preventable blindness worldwide, is a disease characterized by increased pressure within the eye
- Leading diagnostic method: Corvis® Non-Contact Tonometer
  - Function: applies a force to the eye (applanation) using an air puff and calculates intraocular pressure (IOP) by imaging corneal displacement
  - Drawbacks: system is expensive and inaccessible for many worldwide, particularly in developing countries
- Glaucoma remains a serious health problem worldwide

Project Goals

- **Main Goal:** Develop a less expensive IOP measurement system utilizing neural networks and microcontroller technology
- Specific Aims:
  - Determine lowest possible puff pressure that yields accurate IOP measurements
  - Train neural network to derive corneal displacement from deformation of patterns projected onto it (monocular depth estimation)
  - Integrate new idealized puff and imaging process into one system
  - Assess performance of new system by comparison to Corvis®

Data

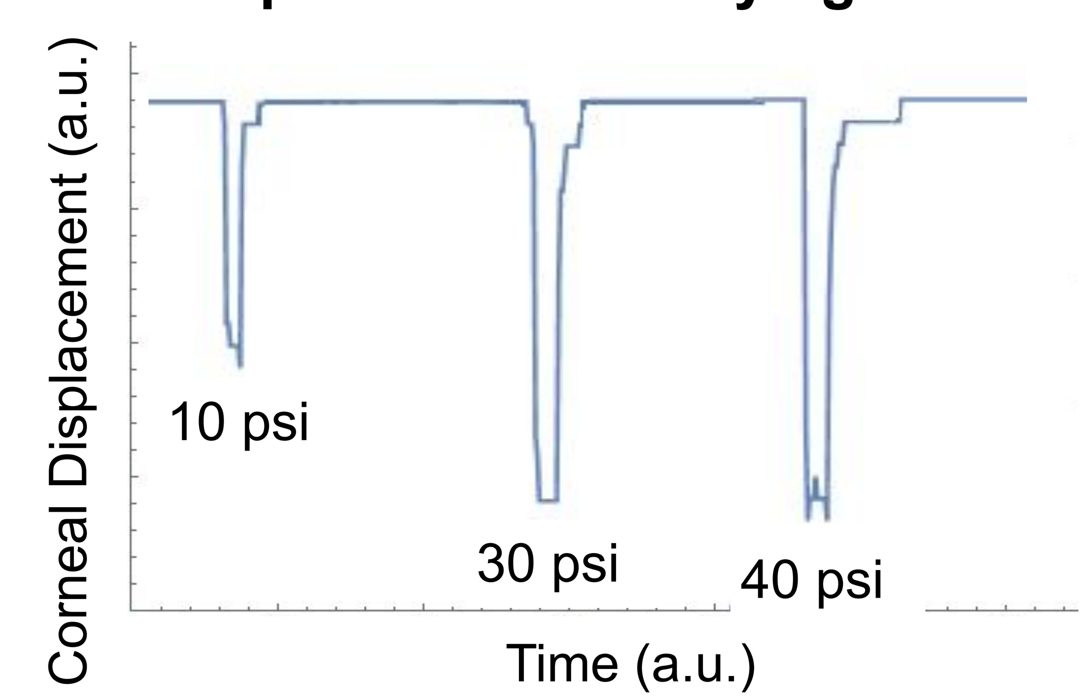

Figure 3: Relationship between puff pressure and relative corneal displacement. The graph tracks the apex of a cornea during video capture

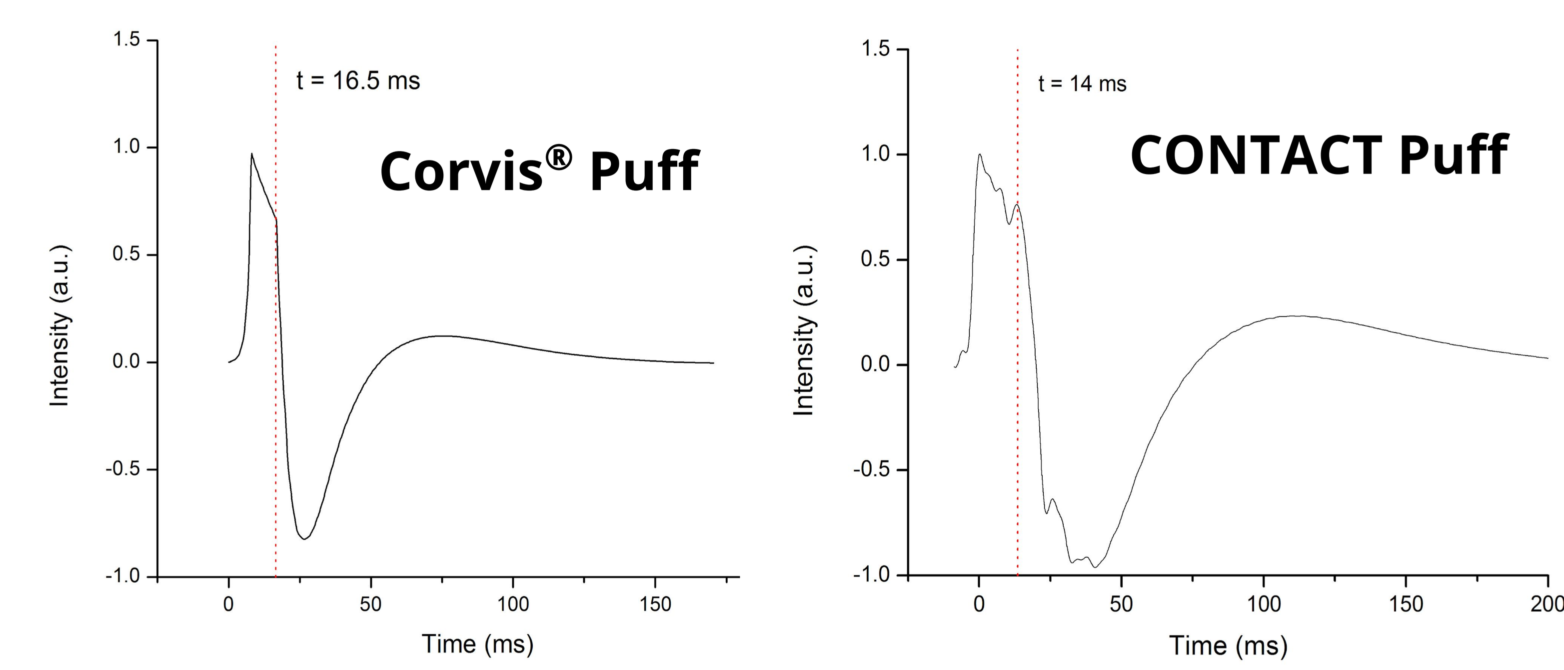

Figure 5: Corvis® and CONTACT puff measured with a microphone, where the y-axis represents displacement of the microphone diaphragm. Similar timing and intensity are observed, with the CONTACT puff experiencing slightly more noise

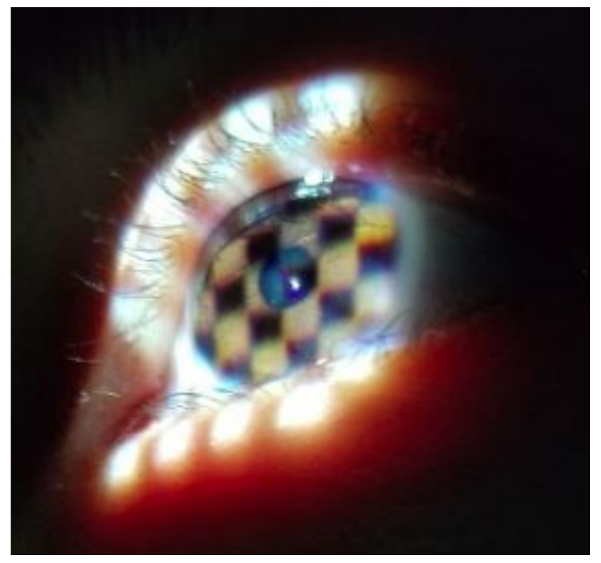

Figure 4: Square grid pattern projected onto eye, used for testing our neural network

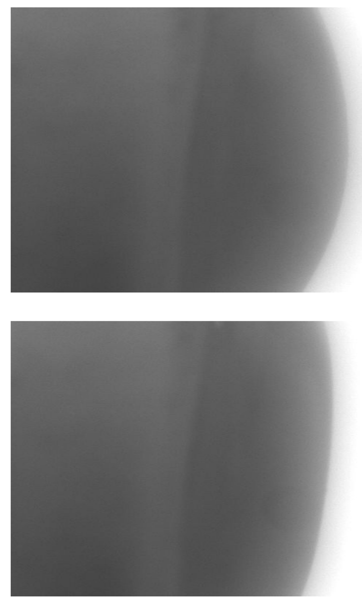

Figure 6: Pictures of porcine cornea during testing of CONTACT system

Top: Normal, unforced cornea

Bottom: Same cornea deformed by CONTACT puff

Methodology & Setup

1. Build a novel variable puff generation system using an Arduino-controlled valve
2. Test variable puff generation system on porcine eyes, in order to determine relationship between puff pressure and corneal displacement
3. Train a neural network to ascertain corneal displacement from deformation of square grid pattern projected onto eye
4. Develop a method to mathematically resolve IOP from neural network output (corneal displacement) and puff pressure
5. Compare the CONTACT system's measurement of IOP with true, known values
6. Determine price of the CONTACT system and compare to Corvis®

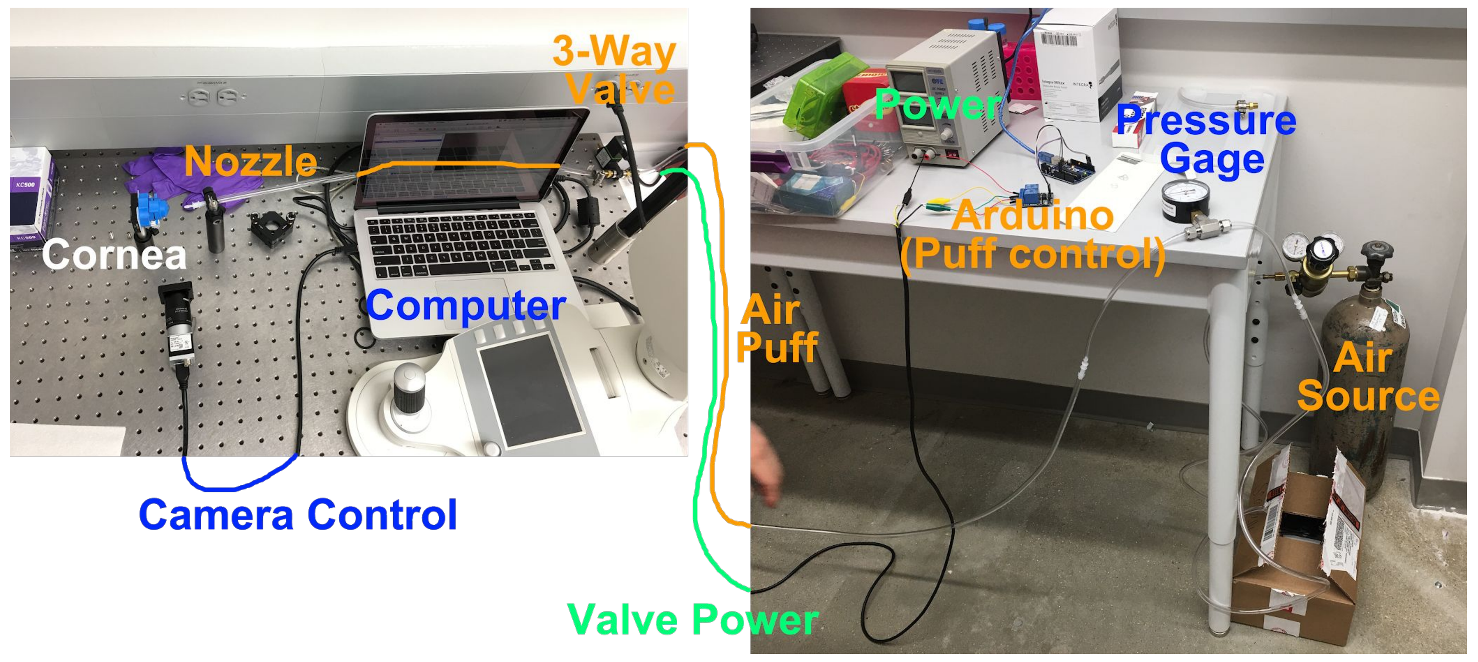

Figure 1: Variable puff generation system

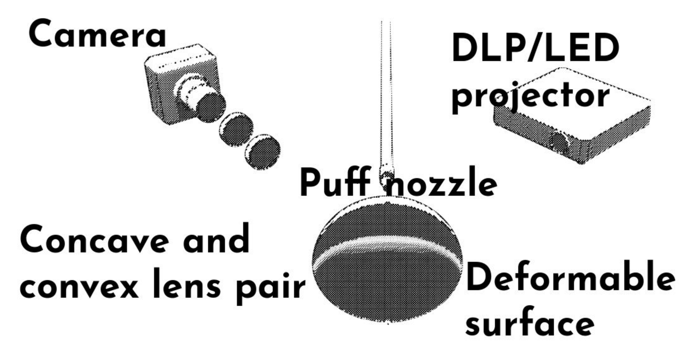

Figure 2: Setup of new imaging system

Future Directions

- Perform exact cost-benefit analysis against Corvis® and other standard tonometers
- Determine viability of using the CONTACT system in walk-in clinics
- Investigate outcomes of combining neural networks with traditional methods of tonometry

References & Acknowledgements

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