Problem Statement

Problem Statement Title	Development of portable device (non-contact device) for measurement of eye pressure in glaucoma patients for usage at home.
Description	Background: Glaucoma is a leading cause of blindness worldwide, and managing intraocular pressure (IOP) is crucial for preventing disease progression. Description: Traditional methods of measuring IOP, such as Goldmann applanation tonometry, require direct contact with the eye, topical anaesthesia, and skilled personnel, making them less accessible for regular monitoring. Non-contact methods, such as air-puff tonometry, offer a more convenient alternative but are often limited to clinical settings due to their size and cost. Expected Solution: Problem statement is to develop a cost-effective, portable, and non-contact device that can measure IOP accurately and reliably with safety. This device should be easy to use, and allowing patients to use at home.

Existing soln:

Possible solutions that are non contact:

Ultrasound can be used to measure pressure in several ways, including blood pressure, liquid pressure, and central venous pressure

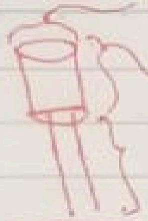
Doppler measurement
Yes, Doppler ultrasound can be used to measure intraocular pressure (IOP).
Doppler ultrasound can detect the shift in frequency of ultrasound pulses that scatter off red blood cells in the ophthalmic artery. This shift can be used to measure the velocity of blood flow in the artery, which is responsive to changes in IOP

Purpose: To compare the diameter of Schlemm's canal in children with and without congenital glaucoma as measured in vivo by means of ultrasound biomicroscopy.

Methods: In this prospective single-center study of pediatric subjects (<18 years of age) the diameter of Schlemm's canal in nonglaucomatous and glaucomatous eyes was compared. An 80 MHz iUltrasound probe (iScience Interventional Inc, Menlo Park, CA) placed near the limbus was used to identify and measure the canal's diameter with special attention to the anterior segment anatomy (especially in subjects with congenital glaucoma).

–Ultrasound 80MHz probe

MA40S4S / MA40S4R
[Emitter]
Speaker



10.2 mm
7.1 mm
~~[illegible]~~ 11.1 mm

LM358 (TI)
~~5.2 X 5.32mm~~
~~[illegible]~~ 4.9mm X 3.9mm
~~9.81mm X 6.35mm~~

~~AD7745 (TI)~~
~~6.4 X 5.1 X 1.2~~
~~(mm) including pins~~
~~4.5 X 5.1 X 1.2~~

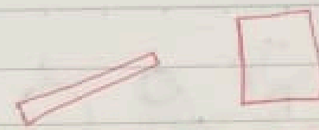
AD7745 (l X L X b) =
6.4 X 5.1 X 1.2 (mm)
including pins
4.5 X 5.1 X 1.2 (mm)
excluding pins

LM 385
9.81 mm X 6.35mm

Bourns (3296W-1-103RLF)
9.53 X 4.83 X 11.55mm

Battery = 34mm X 62mm X 5mm

VM 1000
MEMS Microphone

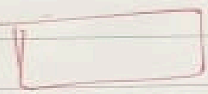


3.76mm X 2.95mm X 1.1mm

Knowles Microphone

3.76mm X 3mm X 1.1mm

Arduino 68.6mm X 53.4mm



~~0.8 mm X 4 mm X~~
~~thickness~~

AD 8232
4.10 X 4.10 (mm) & 0.8 - 0.75mm
Package height

(Emitter) ~~[illegible]~~.
Murata - MA58MF14-7N

14.1 9.1mm 45mm

FORMULA:

Reference Doc: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5494779/#EEq1

09/09/23 6:21

10 - 50mmHg — - 1.5393 to 1.5698 M rayl. → Mean ~~acoustic impe~~ Posterior cornea

- 1.5399 - 1.5519 M Rayl → Mean val & anterior corn

Cornea Impedance - Z_1

Impedance of Saline - Z_0

Max amplitude of reflected signal - A_1

Amplitude of incident signal - A_0

Posterior reflection. - Y (Young's modulus) - interior & posterior op.

A_r - reflected signal

3 layer medium.

Saline, cornea, anterior

$$\frac{A_r}{A_0} = T_{01}\, R_{23}\, T_{10}$$

$$T_{01} = \frac{2Z_1}{Z_1 + Z_0} \qquad R_{23} = \frac{Z_3 - Z_2}{Z_3 + Z_2} \qquad T_{10} = \frac{2Z_0}{Z_1 + Z_0}$$

Z_0 - Air ~~saline~~ (Surrounding).

Z_1 - Anterior Cornea

Z_2 - Posterior cornea

Z_3 - Aqueous Humour

$$R = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$$

Aqueous humour, Z & Comp.

$$Z = \frac{P}{U}$$

P → eff sound pressure

U → volume velocity

$U = V \cdot A$

$$= \left(\frac{Z_1 - Z_0}{Z_1 + Z_0}\right)^2$$

$10 - 50$ mmHg. $\rightarrow$ IOP

$1.5393 - 1.5698$ Mrayl. $\rightarrow Z$

$\cancel{y = mx + c.}$

$$IOP = mZ + c.$$

$$\frac{40}{0.0305} = m = 1311.4754 \ \frac{mmHg}{Mrayl.}$$

$$1.5393 = 13114.7540 + c.$$

$$C = -13113.2147.$$

$$\boxed{IOP = 1311.47540 \times \underline{Z_2} - 13113.2147.}$$

$$\frac{A_r}{A_i} = \frac{2Z_1}{Z_1 + Z_0} \times \frac{2Z_0}{Z_1 + Z_0} \times \frac{Z_3 - Z_2}{Z_3 + Z_2}.$$

$$= \frac{4 \times Z_1 \times Z_0 \times (Z_3 - Z_2)}{(Z_1 + Z_0)^2 \times (Z_3 + Z_2)}$$