Pressure Sensor for Mayfield Head Clamp

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DUKE ENGINEERING PODD DESIGN

Background

- The **Mayfield Head Clamp** (Figure 1) is a medical device that utilizes **3 pins** (Figure 2) to **hold the head rigid** during neurosurgery.
- A **pressure pin** is currently used to **communicate the pressure** exerted on the skull by the prongs.

Figure 1: Mayfield Head Clamp

Figure 2: Mayfield Head Clamp pin

Problem

The **current method** of communicating pressure is **inaccurate, inefficient, and difficult to read.** This can lead to **complications** during surgery, including skull fractures, impaling of the brain, lacerations from the head slipping and superficial abrasions.

Objectives

To **increase patient safety** during neurosurgery, the device should be designed to quickly **report the PSI exerted on the skull by the Mayfield Head Clamp** to neurosurgeons.

The device must be:

- **Sterilizable** and compatible with hospital cleaning standards to protect patient safety
- **Integrable** with the current clamp and not obstruct standard practices
- Capable of **withstanding** the safe **pressure threshold** applied during neurosurgery

Results

Figure 3: Final prototype

Final Prototype
(Figure 3) **Includes:**

- **Aluminum** pins with **elongated divot** to accommodate a strain gauge (Figure 4)
- Epoxy-attached **strain gauge** to measure deformation
- **Calibration curve** to convert from deformation to PSI readings (Figure 5)
- **Screen & LED** to display pressure (in PSI) (Figure 6)

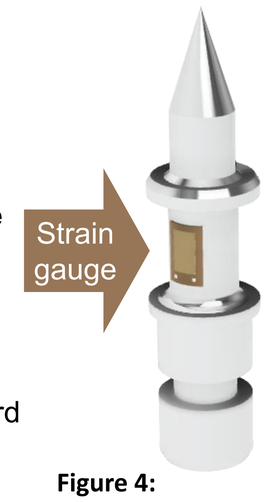

Figure 4: Aluminum pins with elongated divot

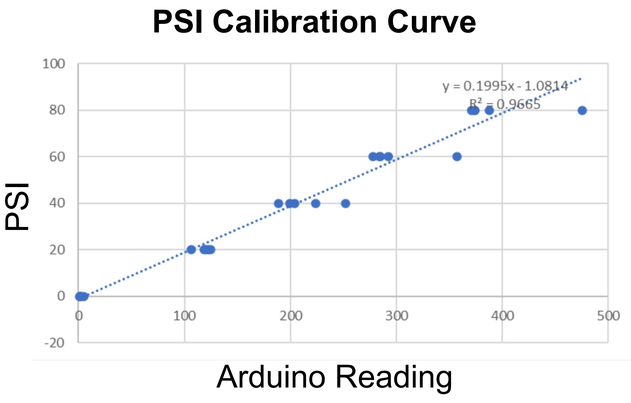

Figure 5: Calibration Curve

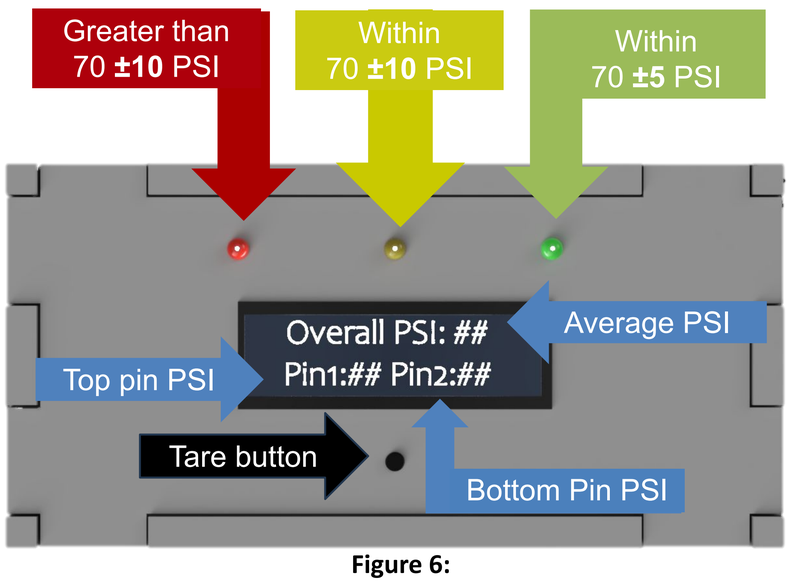

Figure 6: Screen/LED integration

Design Criteria and Testing

Design Criteria	Target Value	Test	Results	
Accuracy	Pressure readings **within ±5 PSI**, **95%** of the time	Comparing reported PSI to PSI indicated by torque screw on clamp	Passed **5/5** calibration curve tests	✓
Intuitive to Use	Pressure readings take **<1 minute**	User given pre-tightened clamp and asked to return PSI	Readings took **~10 seconds**	✓
Pressure Threshold	Strain gauge can **withstand up to 120 PSI**, 80 PSI minimum	Recording voltage readings at 60, 80, 100 and 120 PSI	Dynamic range of strain gauge is **150 PSI**	✓
Durability	**5 year** lifespan	Research and lifespan calculation	Pins are **replaceable** and electronics last **10+ years**	✓
Sterilizability	**Withstand 15 sterilization cycles** at 134°C	N/A due to available resources	TBD	

Conclusion

Our team modified the Mayfield Head Clamp pins to allow for the ability to **efficiently** and **accurately inform** neurosurgeons of the **pressure** exerted **on the skull** by the clamp during surgery.

Future enhancements/plans may include:

- Increasing prototype fidelity by moving from aluminum to stainless steel
- Further calibration and accuracy testing
- Sterilizability testing

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