Pressure Sensor for Mayfield Head Clamp

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DUKE ENGINEERING PODD DESIGN

Background

- The **Mayfield Head Clamp** (MHC) (Figure 1) is a medical device that utilizes **3 pins** (Figure 2) to **hold the head rigid** during neurosurgery.
- An **inefficient 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.

Objective

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.

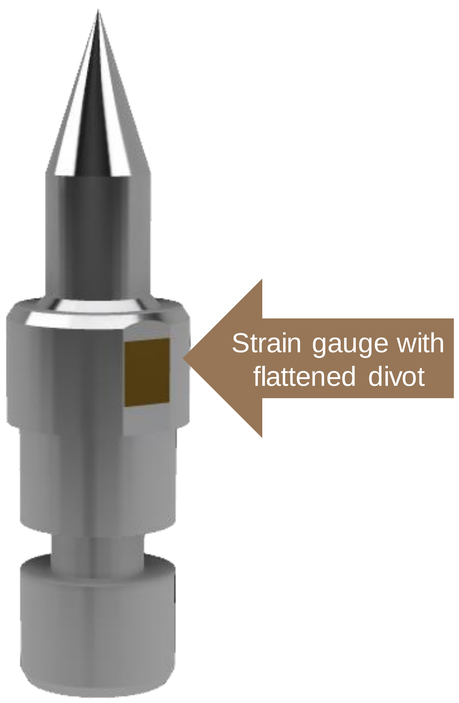
Design Criteria and Testing Plan

Design Criteria	Target Value	Test
Accuracy / Sensitivity	Pressure readings **within ±5 PSI**, **95%** of the time	Comparing reported PSI to PSI indicated by torque screw on clamp. Additional verification using material properties.
Integratable	Pins can fit into a **variety of devices**	Testing usability across multiple brands of the Mayfield Head Clamp.
Intuitive to Use	**Digital** pressure readings take **<1 minute**	User given pre-tightened clamp and asked to return PSI
Pressure Threshold	Strain gauge can **withstand up to 120 PSI**, 80 PSI minimum	Recording voltage readings at 60, 80, 100 and 120 PSI
Sterilizability	**Single use** pins	N/A

Results

Figure 3:
Modified MHC pin iteration 1

Figure 4:
Modified MHC pin iteration 2



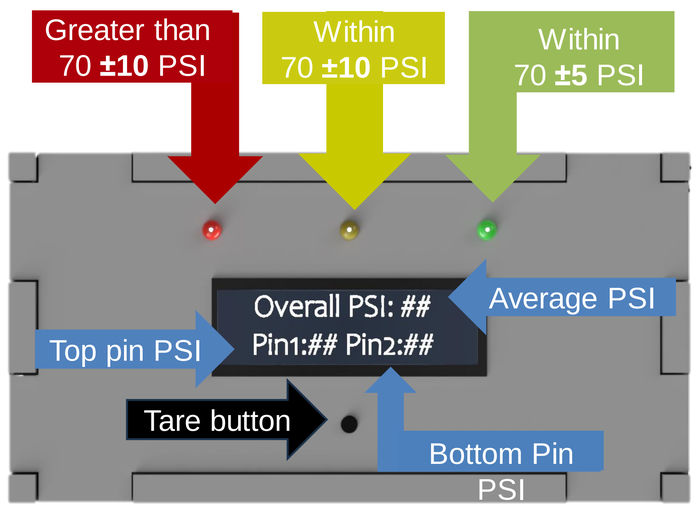


Figure 5:
Screen/LED display integration

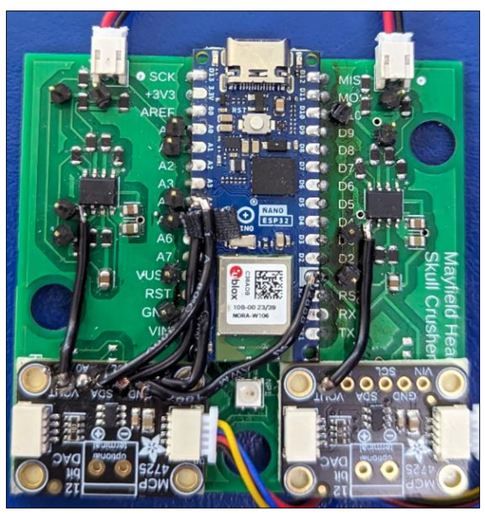


Figure 6:
60mm x 60mm PCB to digital display integration

Feature Comparison

Feature	Iteration 1	Iteration 2
Aluminum pin	✓	✓
Elongated divot	✓	✓
Flattened divot		✓
Epoxy-attached **Strain Gauge**	✓	✓
Flush fit		✓
Screen and **LED** display	✓	
60x60 mm PCB to **digital** display		✓

Pin Modification:

- **Flattened** divot **increases durability** of the pin to strain gauge connection
- **Flush** fit allows for **increased accuracy** of the strain gauge
- More precise measurements allow for a **smoother fit** into the clamp

Display Modification:

- **Personalized PCB** allows for easier modification to accommodate different strain gauges
- **PCB** can **connect** to **various devices**
- **Decreased size** reduces visual disorder and makes display **more intuitive**

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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