Smart Handle - 2nd Generation

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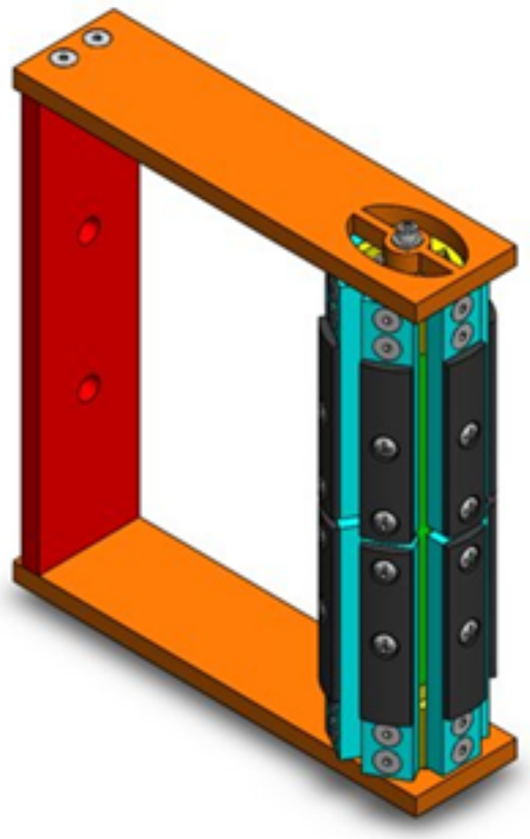
Abstract

The smart handle is designed as a **human-machine interface** to be used to provide an intuitive way to control actuators of **robotic exoskeleton devices**. By collecting data from key sensor locations, each motion applied to the handle produces a **unique data pattern**. Using these patterns, a **neural network** can be trained to correctly **predict the indented motion** of the user which can be then used to **drive the actuators** of the exoskeleton.
The second-generation smart handle aims to achieve the same success of the first-generation while removing the limitations in its design. These designs use load cells to detect forces applied to the stationary handle and then send the force data to the neural network.

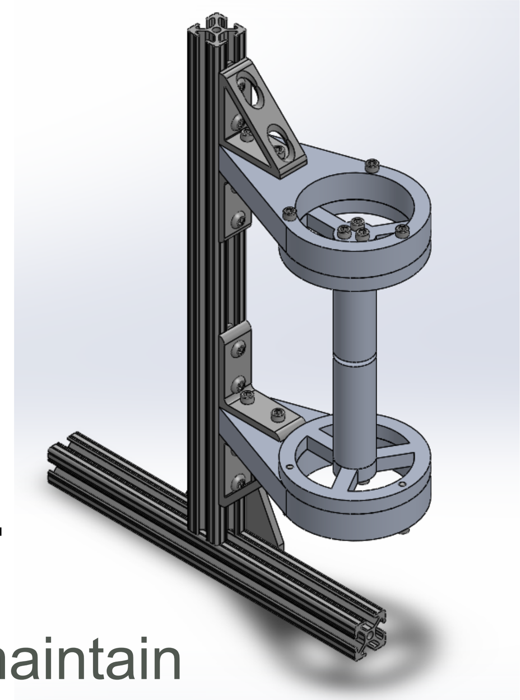
Introduction



The first-generation smart handle used linear strain gauges to determine the forces along and the torque around the handle. Twisting forces caused parts of the original design to start to fail, the handle diameter was too large, and could only detect upwards and downwards forces by use of the orange plates. The second-generation's goal was to fix these issues.

Methods and Materials

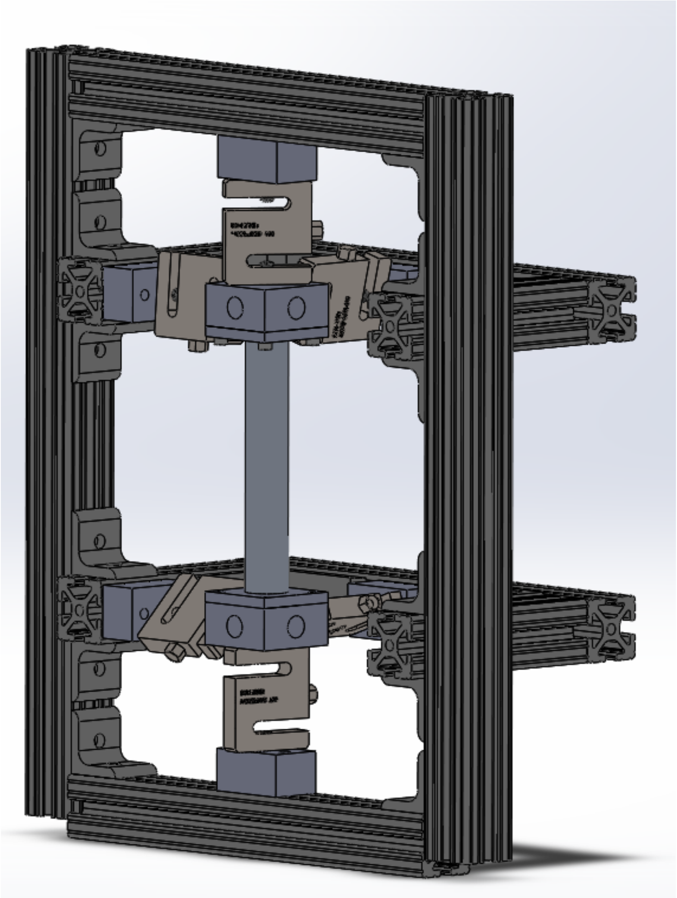
Strain Gauge Design:



This design utilizes **strain gauges positioned at key points** on the branching parts of the top and bottom base pieces. These strain gauges detect how the material in those areas **deforms under stress.**

The purpose of this design was to maintain the functionality of the first generation while **simplifying the design and manufacturing process.**

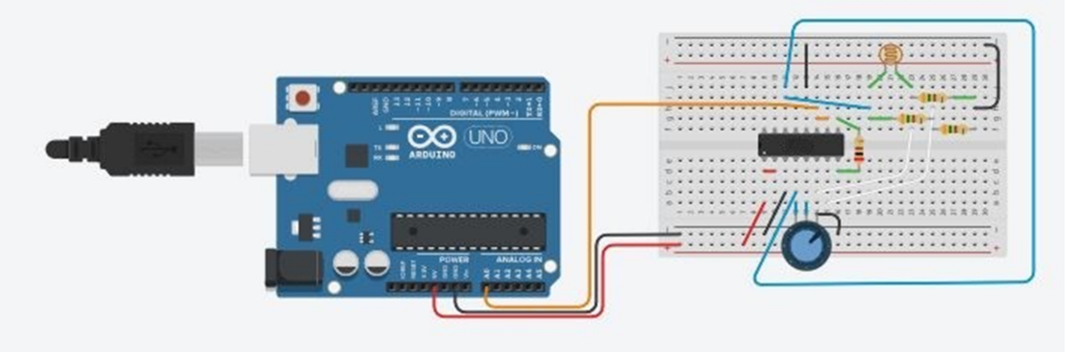
Pre-made Load Cell Design:



This design utilizes **three single -axis load cells** on either end of the handle arranged in a triaxial alignment to **simulate a single tri-axial load cell**.

The goal with this design is to determine just how much data is necessary to allow the neural network to deduce intended motion--**reducing the number of data channels** from 12 to 6 compared to the alternative design.

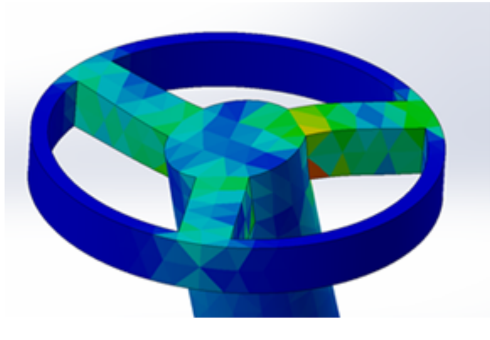
Electrical Design:



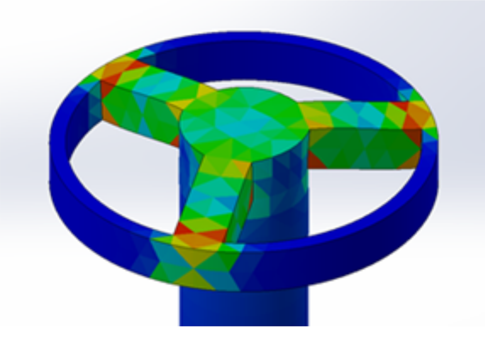
The circuits for each of these designs are quite **similar**, both make use of **Wheatstone bridges**, to analyze force changes, **amplifiers and Arduinos**

Discussion

By using data gathered from strain gauges and **comparing them to each other**, the motion enacted on the handle can be found. In the case of a pushing force, the connector along the push would give a positive strain value while the other two are negative. A lifting force would give positive strain readings for all gauges.



Pushing Force



Lifting Force

This is the principle behind how both designs achieve the same functionality as the first-generation in unique ways.

Conclusions

These two designs explore different ways to expand the concept behind the first-generation smart handle. The load cell design shows promise in its simplicity and lower amount of data while the strain gauge design offers greater functionality at a greater cost to construct and an excessive amount of data.

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