Small Animal Cyclic Loading Device (SACLD)

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Problem Statement

Professor Lidan You and the Cellular & Biomechanics Laboratory has requested a modification to their current model of cyclic bone loading device in order to investigate effect of mechanical loading on the **formation of bone structures.**

The current model in *Figure 1* shows the existing model of the loading device which only:

- operates with a loading force of 3N
- Produce a loading frequency of up to 1Hz

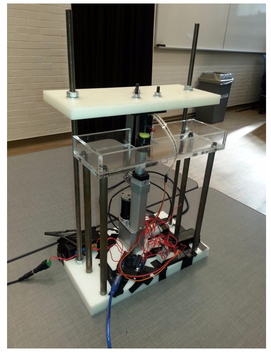


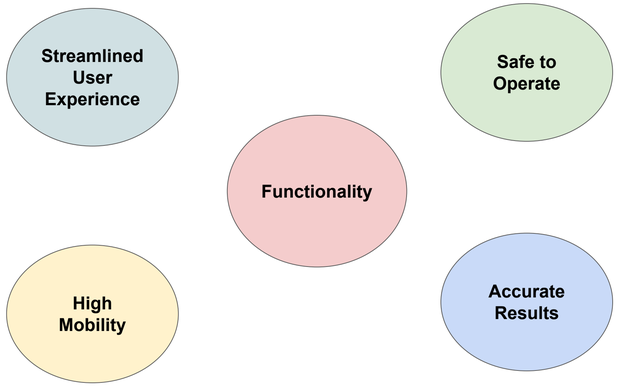
Figure 1: Existing model of the bone loading device

Design Requirements

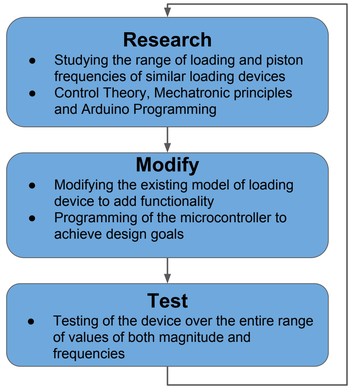
➢ **Magnitude of the loading** :
Increase to a range of **1N** to **10N**

➢ **Frequency** : Increase to **0.5Hz** to **5Hz**

Design Goals



Development Process



Iterate
Testing and iteration will be regularly carried out to slowly improve functionality and move towards design goal

Figure 2: Flowchart of the Methodologies

Design Overview

Mechanical Modification

- Using Aluminum for improved stability of support structures
- Re-orienting the loading actuator to apply a downward force
- Adding fixtures for Electronics
- Adding 3D printed caps to the base to secure the bone sample in the desired orientation
- The linear actuator will be surrounded by a custom housing to prevent exposure

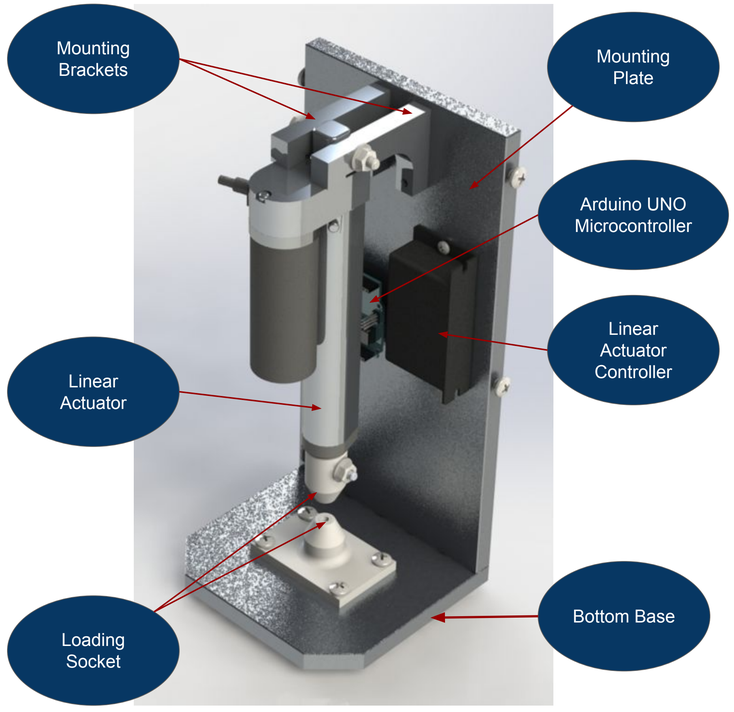


Figure 3: 3D CAD drawing of proposed design

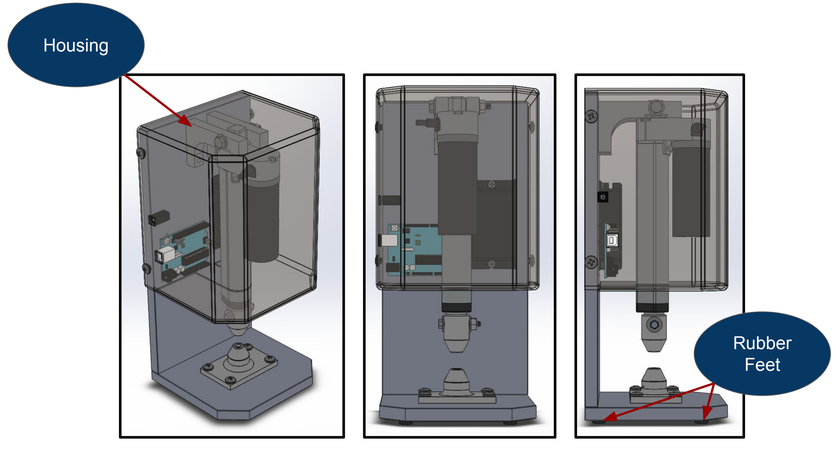


Figure 4: Alternate views of SACLD

Design Overview

Electrical Design Overview

The electrical system of the SCALD Device consists of **4** main components :

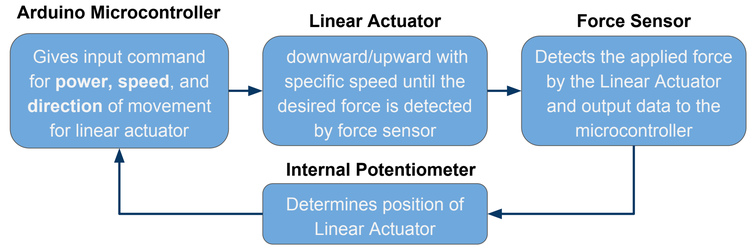


Figure 5: Operation Flow diagram of the SCALD

The electrical system of the SCALD Device consists of **4** main components which

1)**Arduino UNO R3 Microcontroller:** controls the entire system
2)**BX-1 Brushless DC Motor Controller:** Linear actuator controller
3)**PA-14 Linear Actuator:** Custom built specifications
4)**Force Sensor System:** Load detection and feedback control

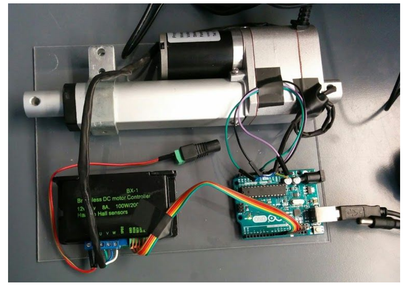
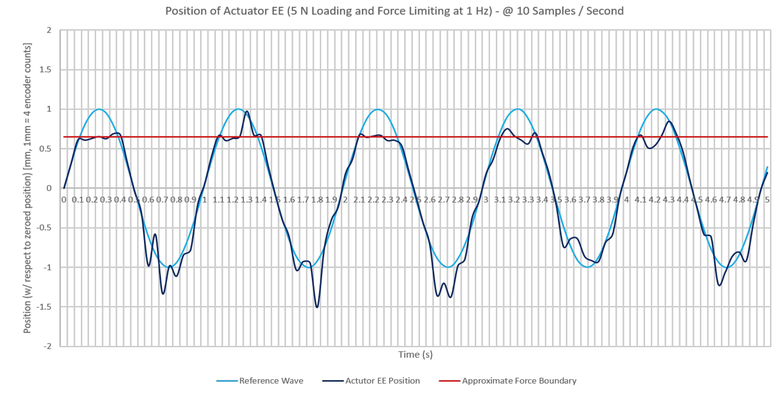


Figure 6: Linear Actuator Testing Rig

Testing and Results



Conclusions and Future Work

The SCALD device is proved to be capable of precisely loading designated force into a small animal bone. A comprehensive PID control loop integrated with the device shows its potential to limit the error of force input within 0.1N and the frequency tolerance of 0.1Hz. The portable size makes it suitable for use in a small lab. By further standardizing the dimension of each components, this device is ready for commercialization and bulk fabrication.