CS 121

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Interactive Hangboard

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Introduction

Rock Climbers use a tool called a hangboard in order to train their forearm muscles to climb on smaller and smaller holds. Typically hangboards have multiple types of holds on them which become increasingly shallow the closer to the bottom of the board you get. Most hangboard routines consist of hanging from a specific hold for 7 seconds resting for 7 seconds and then repeating that 3 to 4 times.

Our idea is to make an interactive hangboard that will measure the exact amount of hang time from the climber and also help them optimize their hangboarding routine. Our hangboard will have LED's on each hold and a speaker to let the user know when to hang and what hold to hang on. After each workout the board will store that user's data and let them know whether they are doing a routine that is too easy, hard, or just right. The user will be able to track their hangboarding progress using our web interface.

Since building a weight bearing hangboard would require woodworking tools we don't have available to us at school, we plan on making a 3d printed to scale replica that would function the same as our final product but may not hold up to prolonged use.

Definitions

Hold - a place to temporarily cling, grip, jam, press or stand in the process of climbing.

Crimp - a hold which is just big enough to be grabbed with the tips of the fingers.

Dead-hang - to hang limp such that weight is held by ligament tension rather than by muscles.

Hangboard - training equipment used to build finger strength.

Project

Hardware

Our plan for the hardware of this project is to have an outer shell (fig 1.1) which would have a set of springs at the bottom and 4 force sensors wired in a wheatstone bridge (fig 1.4) configuration connected to a load cell combinator (NATE, n.d.). The springs at the bottom are there to add a bias to the force sensors to shift their weight range from 0-100 lbs to closer to 100-200 lbs.

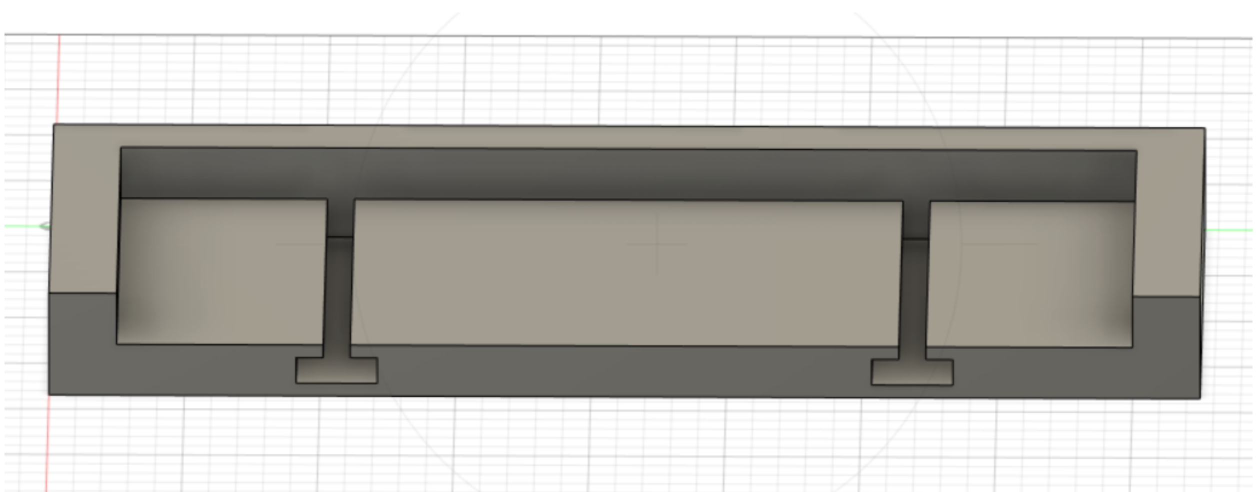


Fig 1.1

The actual hang board (fig 1.2) will slide into the outer shell (fig 1.3) with two interlocking pieces in order to prevent lateral movement of the board while still allowing for up and down movement on the springs. We will be 3d printing these parts in 2 sections since the build plate for our 3D printer is only 220x220mm and screwing the sections together. This will create a functional prototype that should be weight bearing for a short period of time.

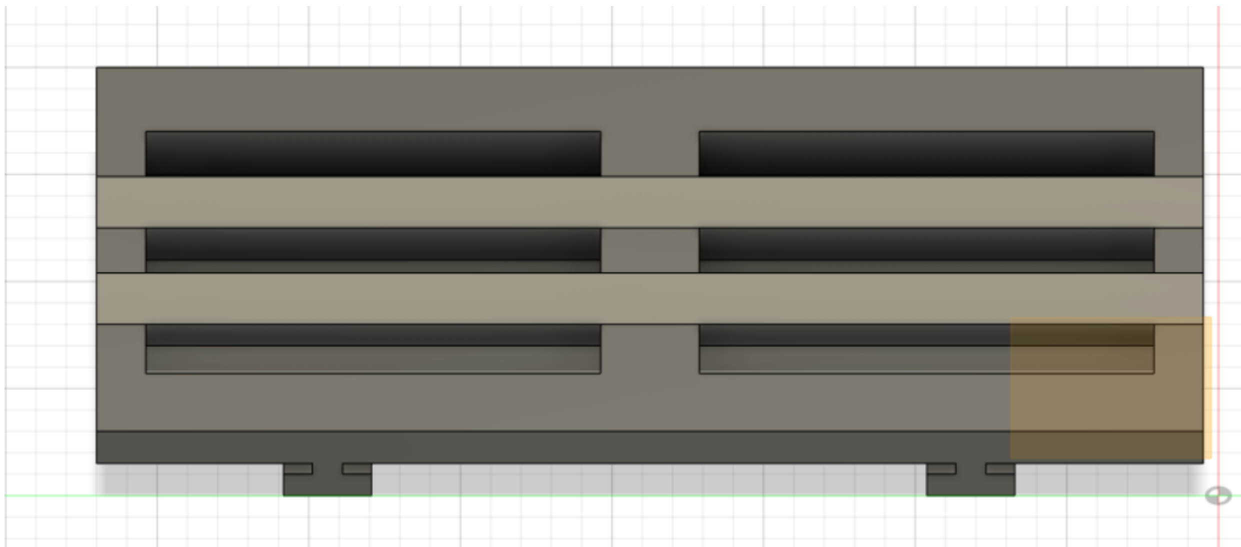


Fig 1.2

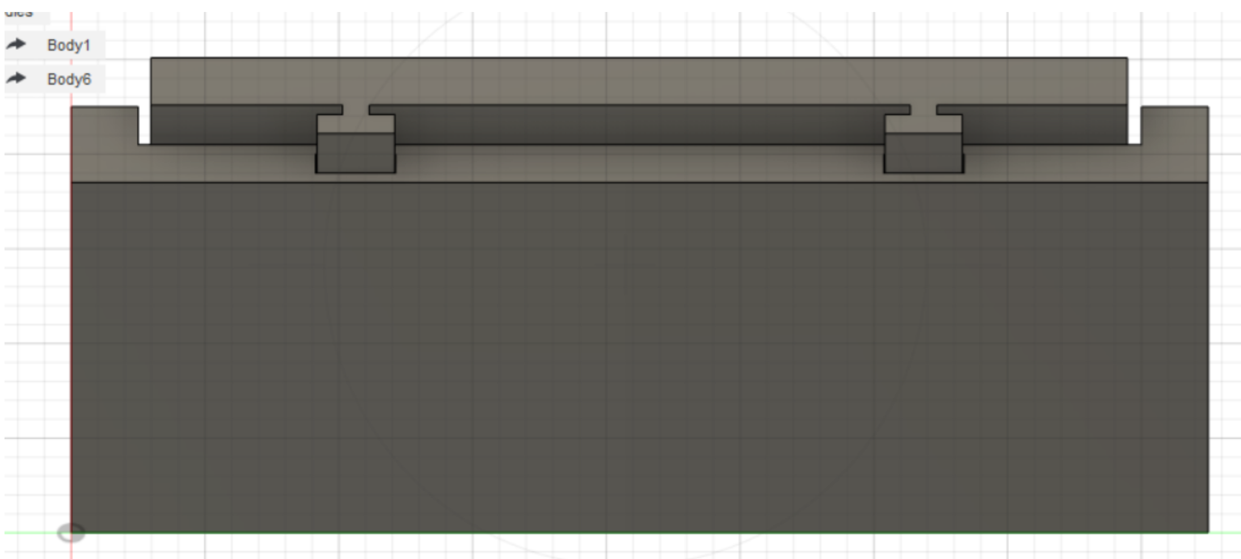


Fig 1.3

The amount of time hanging will be calculated using the load cells mounted at the bottom of our outer shell (fig 1.1). By using a load cell combiner and 4 50kg load cells we should reasonably be able to detect when someone is hanging. Since the Raspberry Pi cannot read the analog output from the load cell combiner we have to use an additional component to amplify the signal and convert it to digital output. Finally we can connect the output of the load cell amplifier to a GPIO pin on the Raspberry Pi and configure the load cells using known weights (fig 1.4).

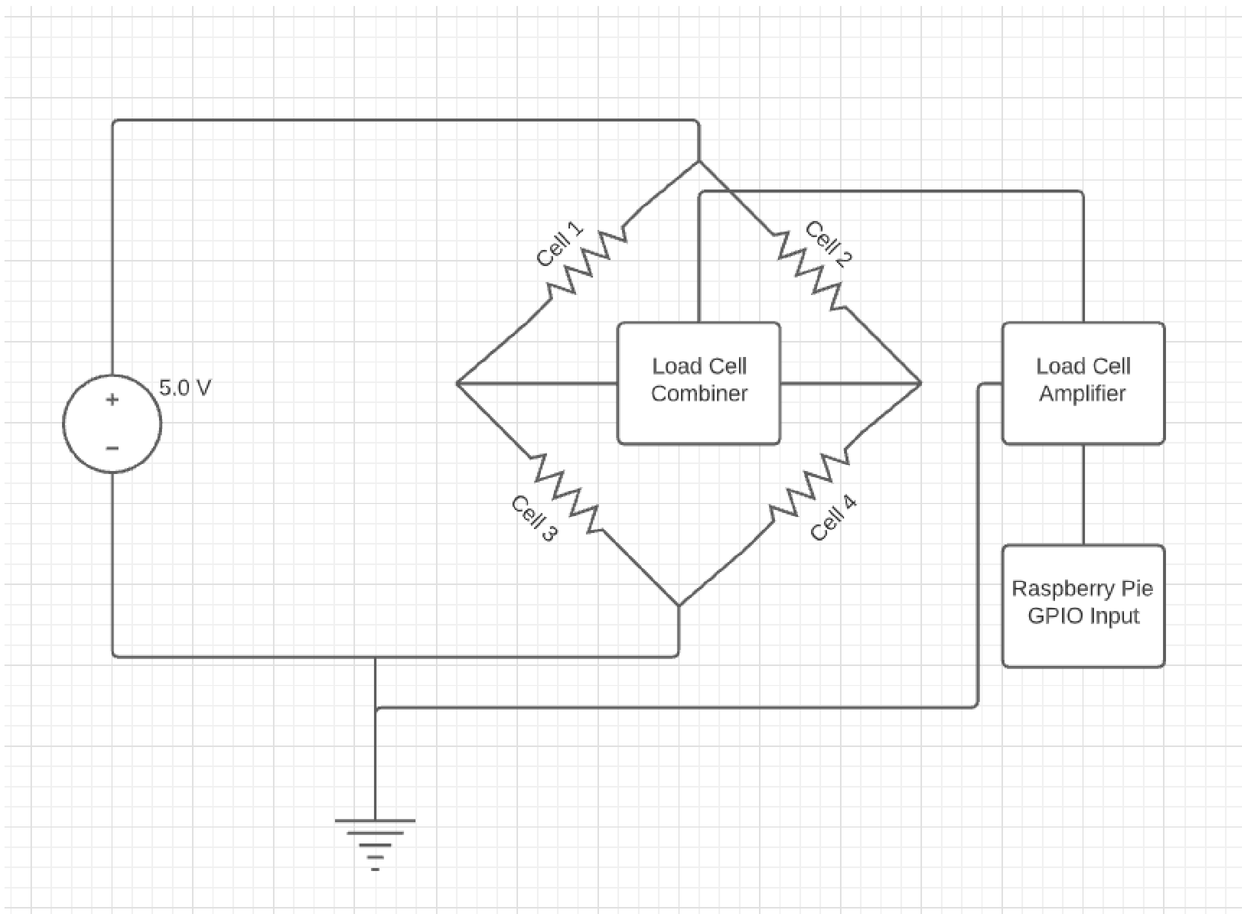


Fig 1.4

Software

Pi Software

All of the force sensor data will be handled using a python library called hx711py that can read data from the load cell amplifier (Barilatti, 2016). This data raw will be converted into an integer representing the time hanging, and that integer will be associated with what holds the user was hanging off of and if the sensor picked up any extra weight. When the user completes their workout all of this data will be packaged and sent to a database hosted by the UVM silk server where it can be retrieved later using our web interface. The packaging process will essentially put the data into an associative array where each hold references the time that it was held.

Web Interface

The web interface will be a database driven website where each user can view the data from the individual workouts and see how their workouts are progressing over time. This system will have profiles, where a user can log in with their information and create an account. The account will have a survey to assess how long the user has been climbing, what their climbing ability is, etc. to personalize the training plan. Their account will be the medium in which data is stored, received, and displayed. This will include customizable graphs, one for time and another for added weight, where the user can change timeframe, etc. There will also be a personal training plan on the account, that will tell you if you're overtraining, undertraining, etc, and how much weight/time to add or subtract from the plan, and which holds to use. If you cannot complete your workout, i.e. the computer reads that you are not hanging for the allotted amount of time, it will adjust your training plan accordingly.

Budget

- Materials
  - 3D printer filament: $25
  - 4 load cells: $8
  - Load cell Combiner: $10
  - Load cell Amplifier: $10
- Labor 18$/hr
  - Web Interface - 30hrs: $540

- Pi Software - 15hrs: $270
- Board Design/Fabrication - 20hrs: $360

- Estimated Gross Cost: $1223

Plan

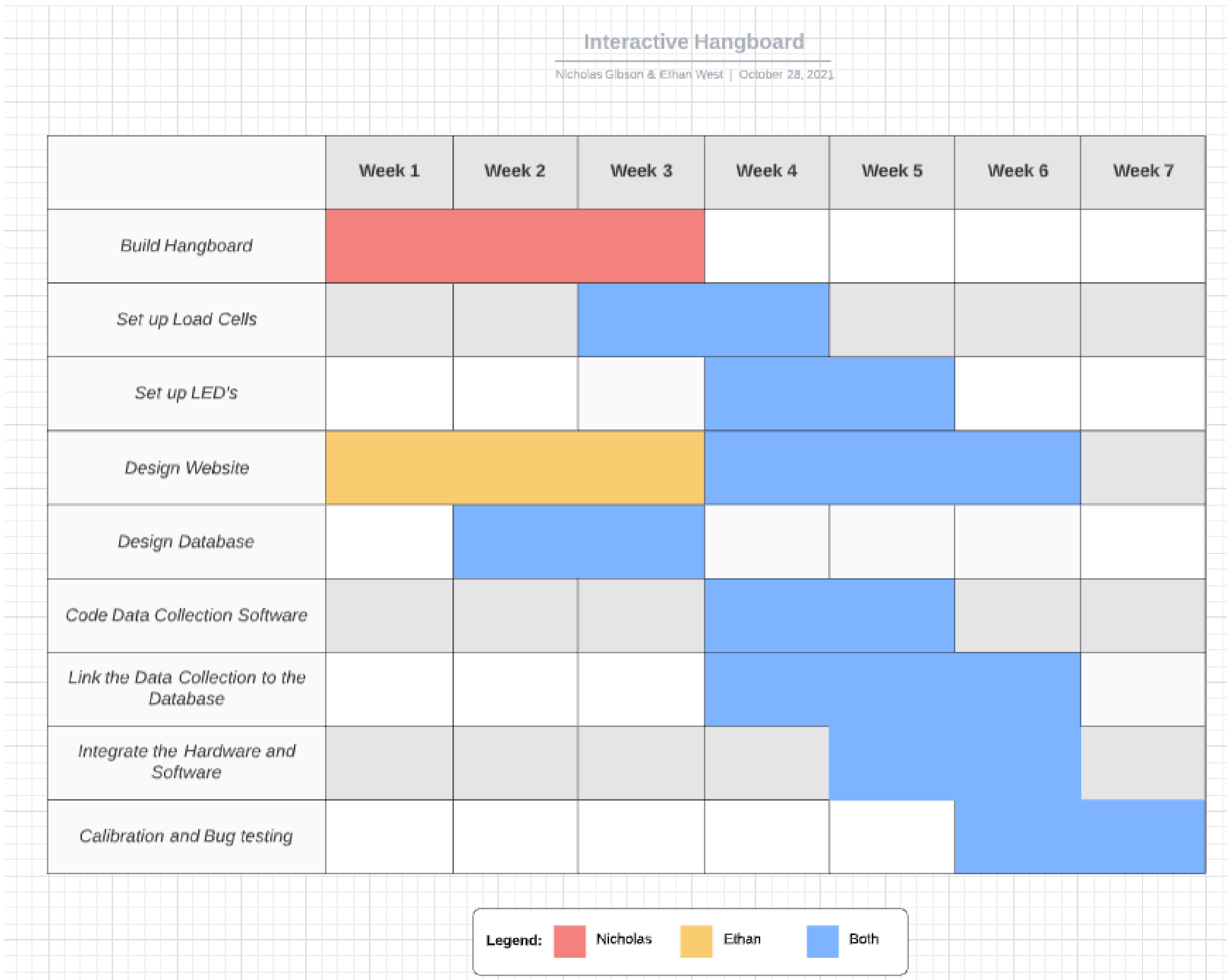
I

To start, a rudimentary prototype of the hangboard will need to be created as soon as possible. This is the backbone of the project, and there is not much that we will be able to do without it. This prototype may be as simple as being able to read data from the sensors and store that data into the databases. What we will be able to do, however, is create an outline of the website. The profile system, survey, and anything unrelated to the display of data will be built.

II

Once the first prototype for the hangboard is built, we will be able to continue the construction of the website, and start displaying personal data on the user's account. We will also be able to continue the construction of the hangboard, and build a more complete and final prototype.

Gantt Chart



Target Market

Almost every climber, from someone who climbs once a week all the way to a professional boulderer, will use a hangboard at some time in their lives. For beginners this hangboard can be used as an introduction to hangboarding. Hangboarding is inherently dangerous and it's hard to know whether you're getting a good workout or hurting yourself when you first start. The board will let them know when they are overtraining and putting their tendons at risk of injury and vice versa. For advanced climbers this hangboard offers a very convenient way to track and maximise the efficiency of their hangboard routine while also providing an engaging interface for a somewhat mundane activity.

References

Barilatti, T. (2016, June 6). *hx711py* [A python library for the hx711 amplifier]. GitHub. https://github.com/tatobari/hx711py

NATE, N. (n.d.). *Qwicc Scale Hookup Guide*. Sparkfun. https://learn.sparkfun.com/tutorials/qwiic-scale-hookup-guide