

# Climb-Sense-Hold



April 24<sup>th</sup>, 2022  
CS 365I

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## Introduction

The goal of this project is to develop a climbing hold that can sense when a person has grabbed it with their hand. Climbing gyms often have moon boards, or large 8'x8' boards that are used to train climbing athletes by forcing them to follow predefined paths across the board. These boards have an array of hundreds of climbing holds throughout and LEDs to light the desired holds. I believe that climbing holds with sensing will be the next step in this evolution. This proposed system will assign next holds to climbers as it detects the current holds have been grabbed.

This system has many business applications and could be the next step for climbing gyms that are looking to differentiate from the competition for athletes that are dedicated to the sport. In addition to implementing on moon boards, this system could be used with actual top-rope routes as well as to create more specific training regiments for individual climbers. This technology could be licensed to companies that make climbing holds or individual gyms that would like to implement the wider system with their gym.

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## Technical Summary

The sensing technology relies on capacitive touch sensing in conjunction with a nickel-based conductive paint that lines the hold. When a person grabs the hold, their skin comes into contact with the conductive paint and consequently the bolt. This bolt is wired to a breakout board and acts as a capacitive touch sensor that is measured by the Arduino Mega 2560.

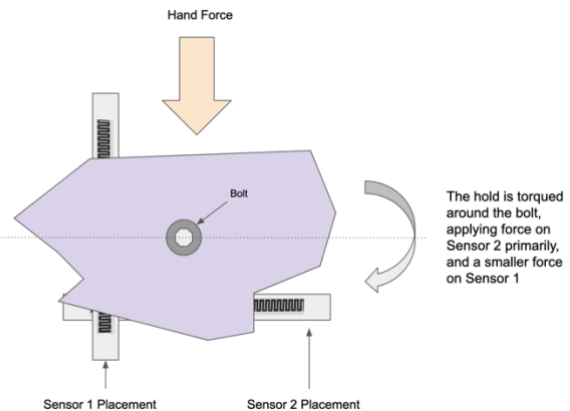
### Parts List:

- Arduino Mega 2560
- Adafruit 12-Key Capacitive Touch Sensor Breakout - MPR121
- Modern Elevate Resin Rock Climbing Holds
- Conductive Paint (MG Chemicals Nickel Print)
- 24-gauge Wire
- 2x4s
- MDF Board – ½ inch thick

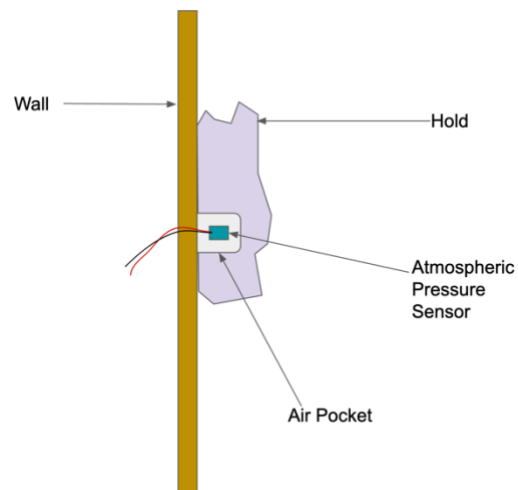
## Prototyping

Over the course of this project, I tried three various methods for sensing the grip of people.

First, I tried the flexible pressure sensor, which I laid underneath the hold with the goal of detecting extra force from someone hanging on the hold. This method didn't end up working because it was very dependent on how hard the hold was tightened onto the wall as well as the direction the film was laid. If the direction of the film was not directly underneath the direction of the force, then the sensor would not detect a climber.



Second, I tried an atmospheric pressure sensor inlaid into the hold. The idea was to create a pocket of air within the hold that would be slightly compressed as a climber applied force and caused the hold to compress. This was by far the coolest method, but unfortunately it was very difficult to create a seal between the hold and the wall. Additionally, this method varies between holds due to sizing differences and was difficult to mount and set up – not very viable in a business context.



The last one, capacitive touch via the bolt was the clear winner. Not only does it minimize the amount of extra hardware on the wall itself (there is none), but it also requires the simplest setup. The main problem I needed to debug with regards to the capacitive touch method was figuring out a way to make the entire hold conductive. Running a wire along the hold ruined the grippiness of the material and making the holds out of a different material wasn't really an option due to constraints on time. Fortunately, conductive paint allowed me to make the hold conductive while maintaining the integrity of the grip.

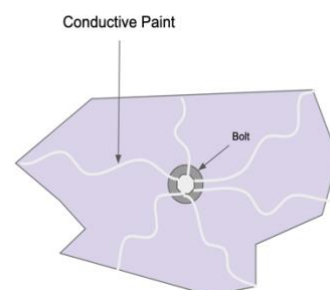
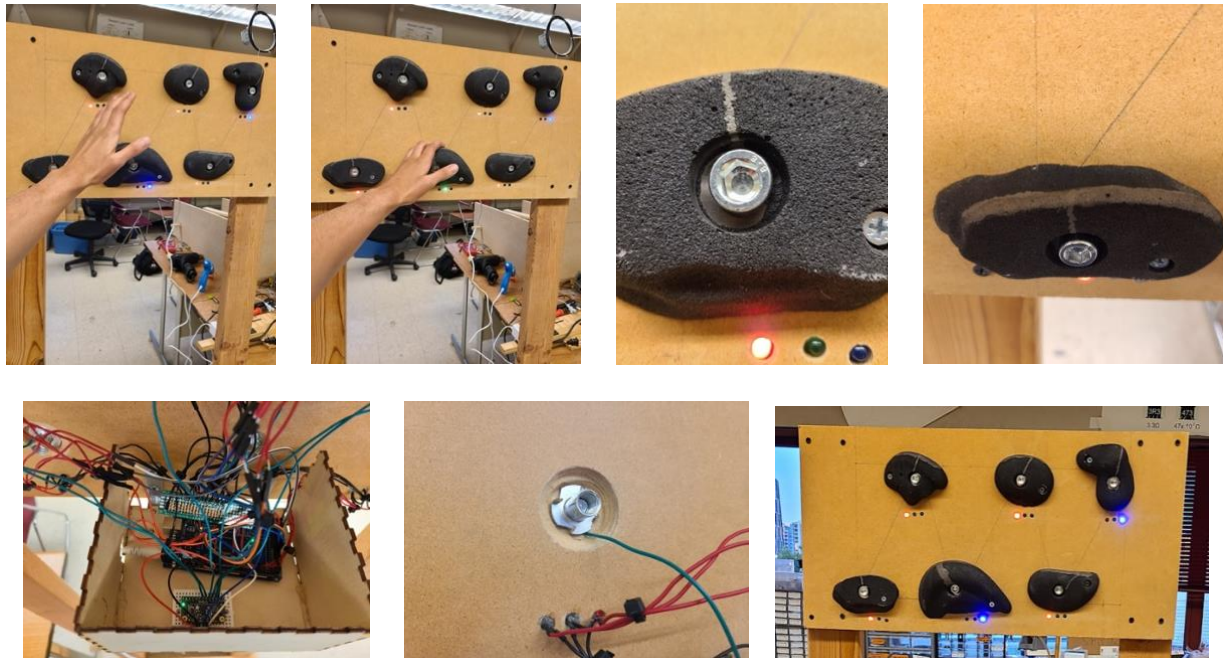






Figure 1: Prototyping Board. Left to Right as follows 1) Capacitive Touch 2) Flexible Pressure Sensor 3) Atmospheric Pressure Sensor

## Final Design



The final design for my project utilizes capacitive touch sensing via the bolt and conductive paint that lines the hold to sense a climber's hand. Using this system I built a hang board with six climbing holds that implements a simple strength training game. When the LED underneath a hold is blue – grab it, when it's red – don't grab it, and when it's green – the system has detected that the hold has been grabbed. I implemented some simple C++ logic that takes inputs from the MPRI21 capacitive touch breakout board and assigns the next hold to grab using the LEDs.

## Lessons Learned and Future Work

- Lesson - Measure wires! I had to cut and resolder so many wires that were too short.
- Lesson - Prototyping takes a lot of time. The bulk of my entire project work was trying to make failed prototypes work
- Future – potentially patent this idea and try to license to a climbing hold producer
- Future – try to make the entire hold conductive instead of paint which is toxic