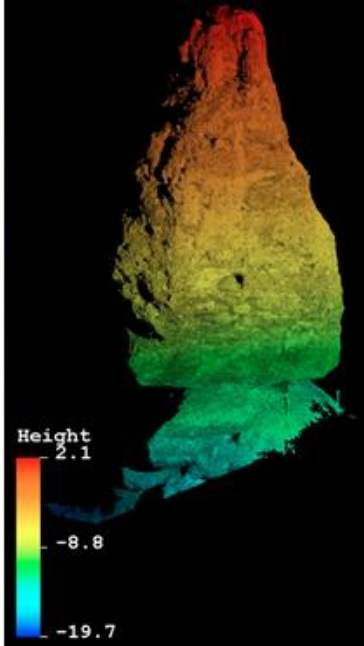
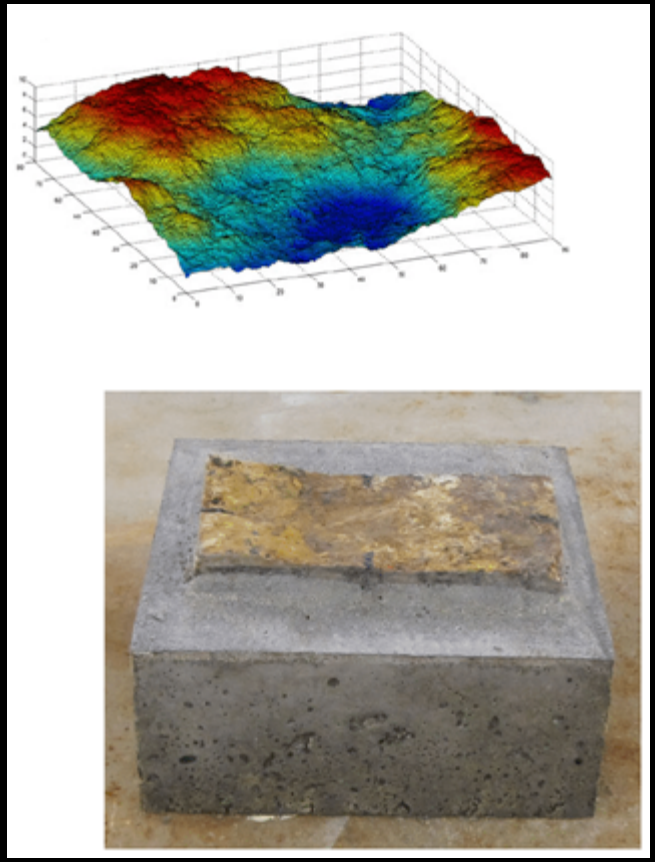
# 3D LASER PROFILOMETER

Srisharan

# The problem - Rock surface roughness imaging



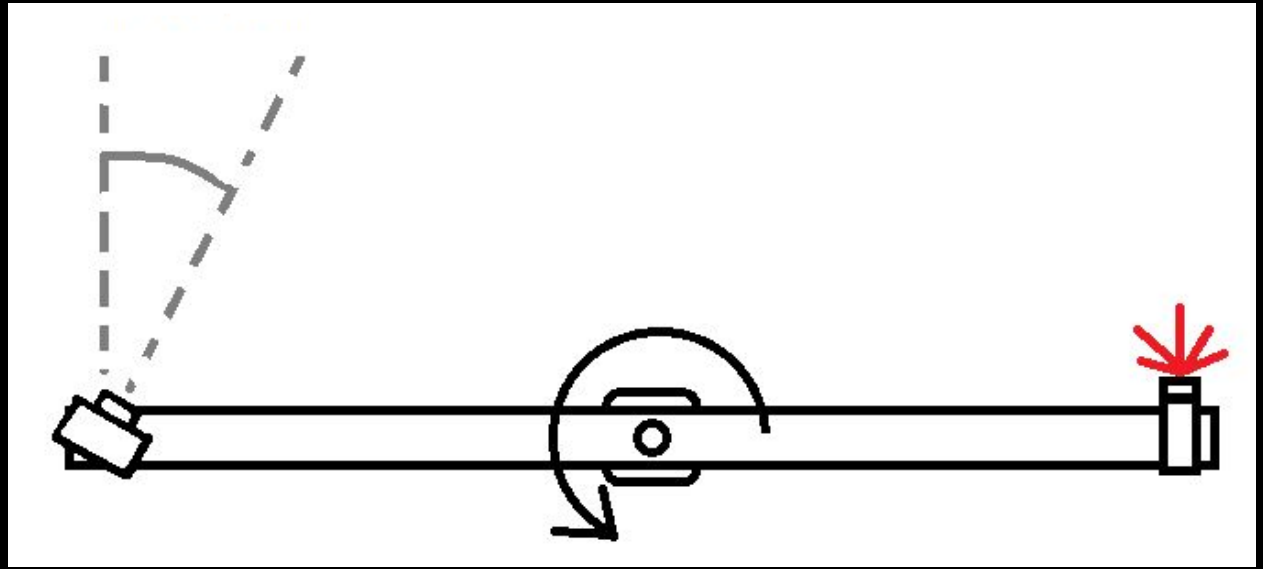



Source: UNAVCO and Muralha et al. (2014)

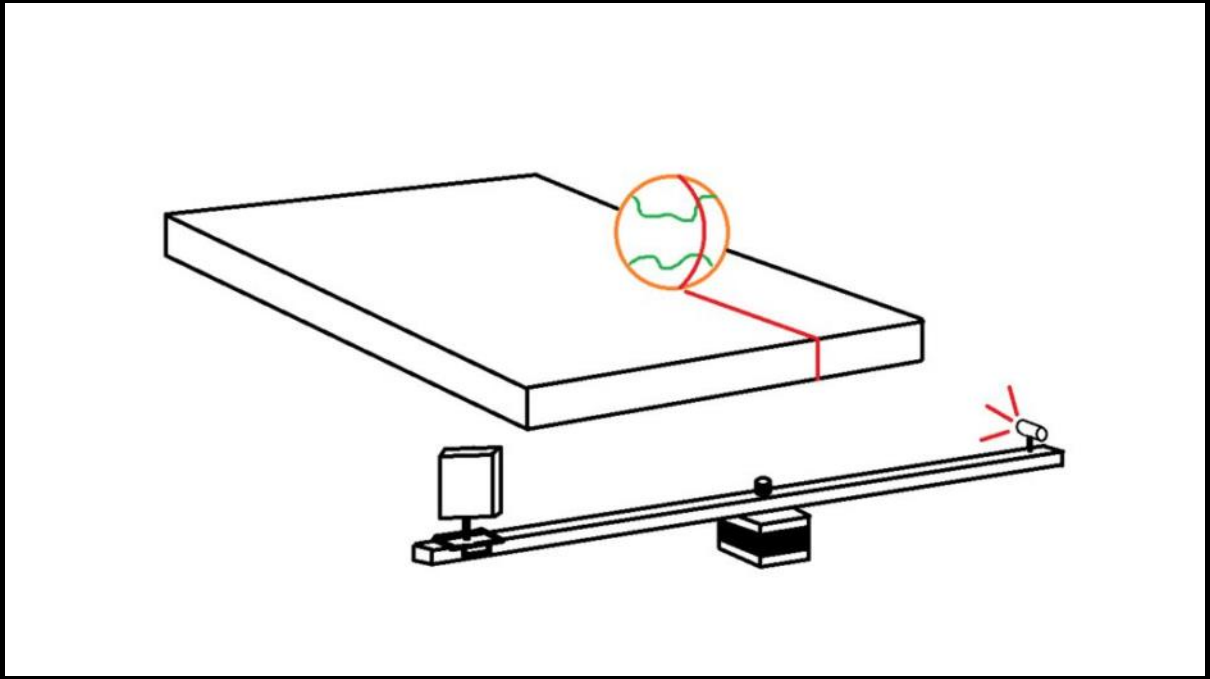
# Project objective

Create an inexpensive Arduino based laser scanner prototype for rock surface scanning in the Penn State Rock Mechanics lab

# Working principle



# Working principle



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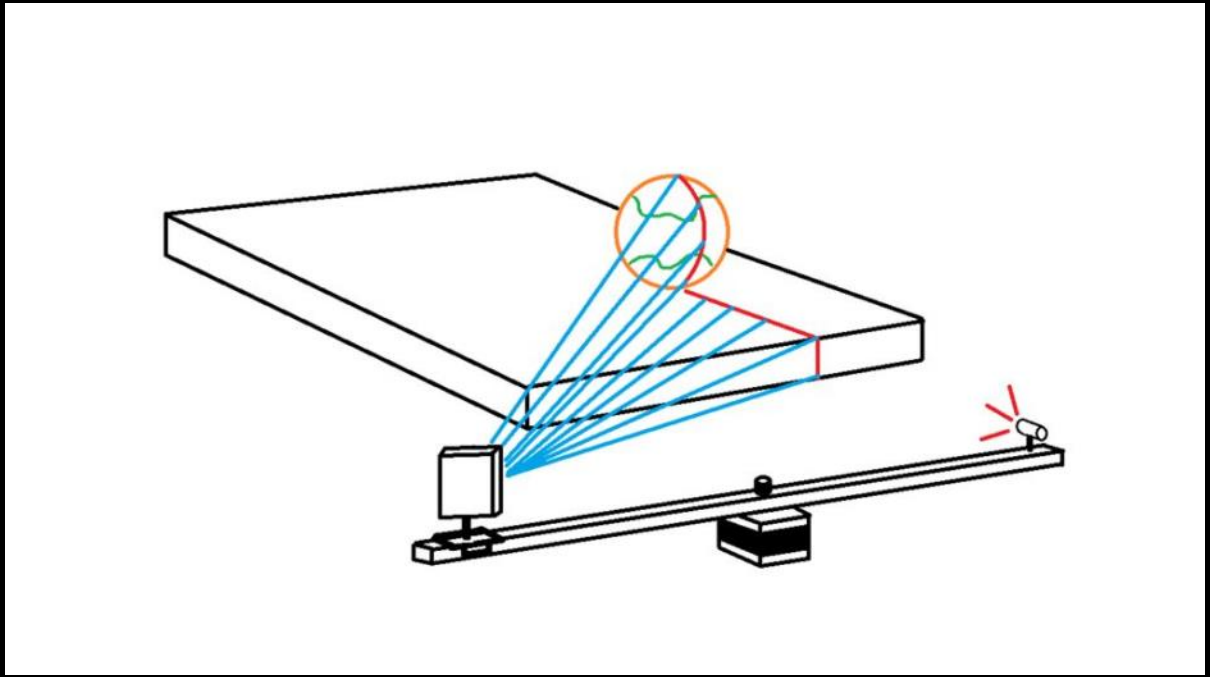

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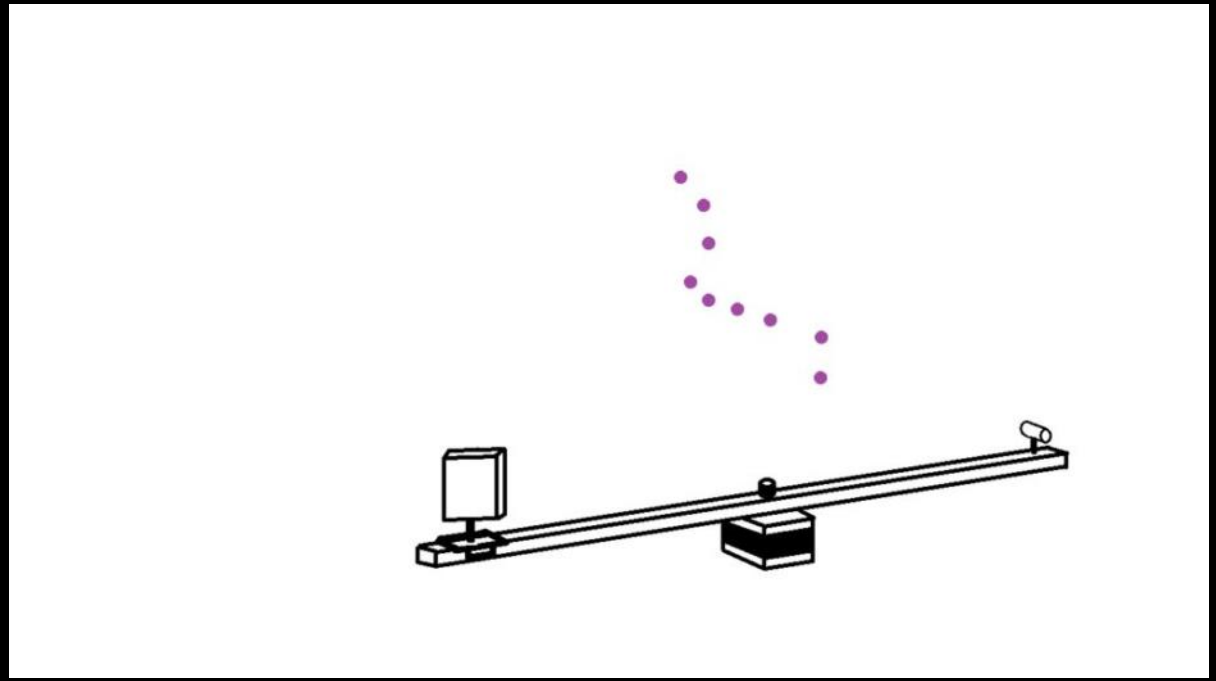


# Working principle

Line Equation Components:

$$x = A[0] + AB[0]t$$
$$y = A[1] + AB[1]t$$
$$z = A[2] + AB[2]t$$

Plane Equation:

$$CD[0]x + CD[1]y + CD[2]z = n$$

Intersection of Line and Plane:

$$CD[0](A[0] + AB[0]t) + CD[1](A[1] + AB[1]t) + CD[2](A[2] + AB[2]t) = n$$

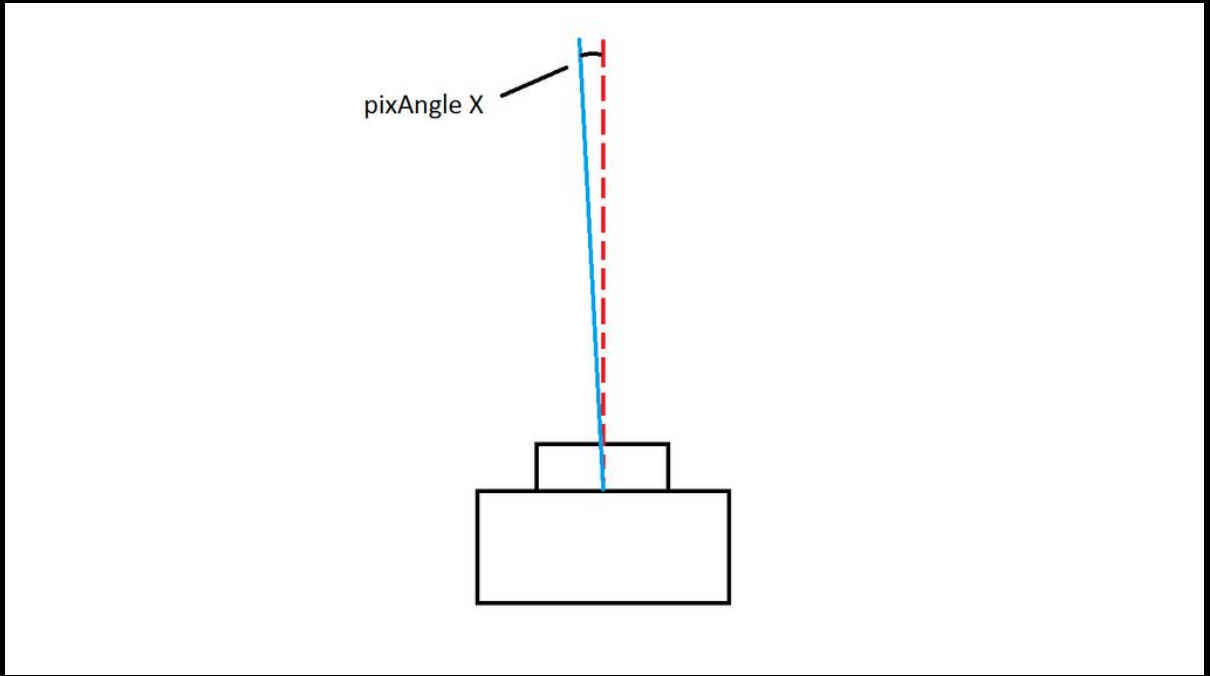
$$CD[0]A[0] + CD[0]AB[0]t + CD[1]A[1] + CD[1]AB[1]t + CD[2]A[2] + CD[2]AB[2]t = n$$

$$CD[0]AB[0]t + CD[1]AB[1]t + CD[2]AB[2]t = n - CD[0]A[0] - CD[1]A[1] - CD[2]A[2]$$

$$t(CD[0]AB[0] + CD[1]AB[1] + CD[2]AB[2]) = n - CD[0]A[0] - CD[1]A[1] - CD[2]A[2]$$

$$t = (n - CD[0]*A[0] - CD[1]*A[1] - CD[2]*A[2]) / (CD[0]*AB[0] + CD[1]*AB[1] + CD[2]*AB[2])$$

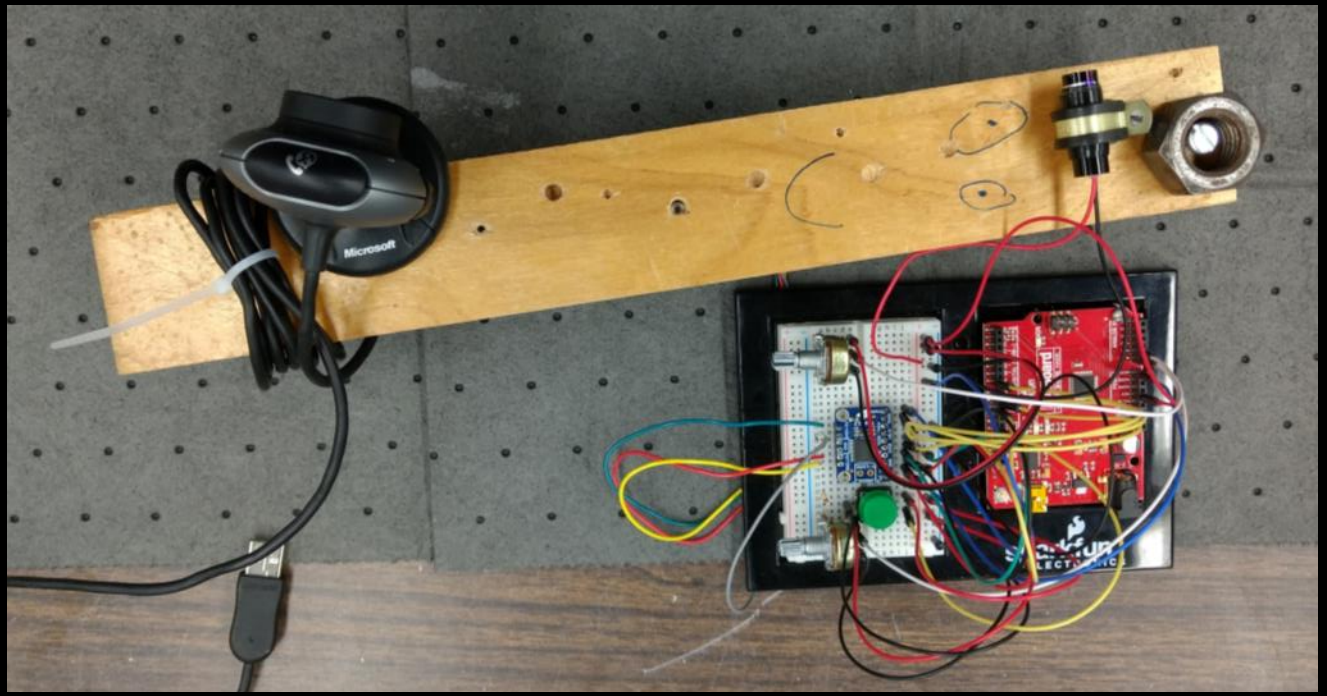
# Working principle



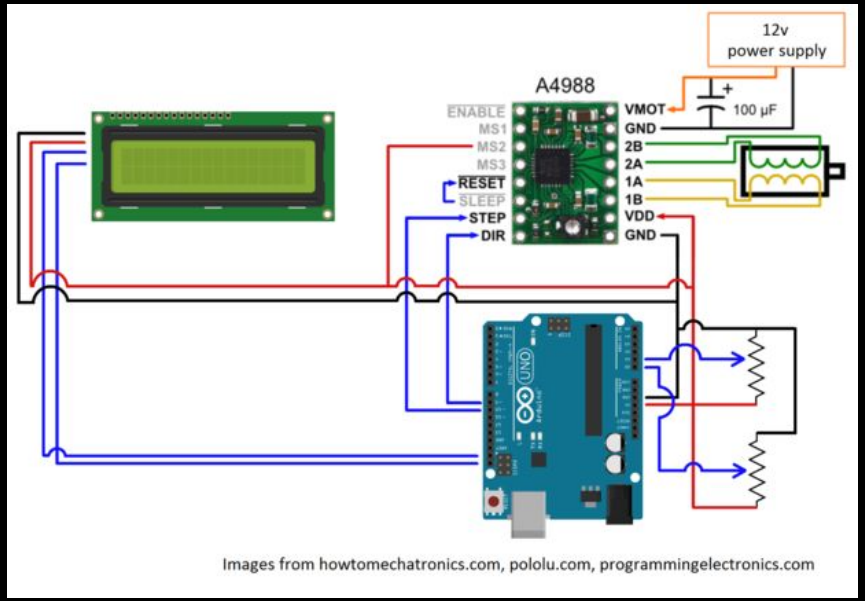
# List of parts

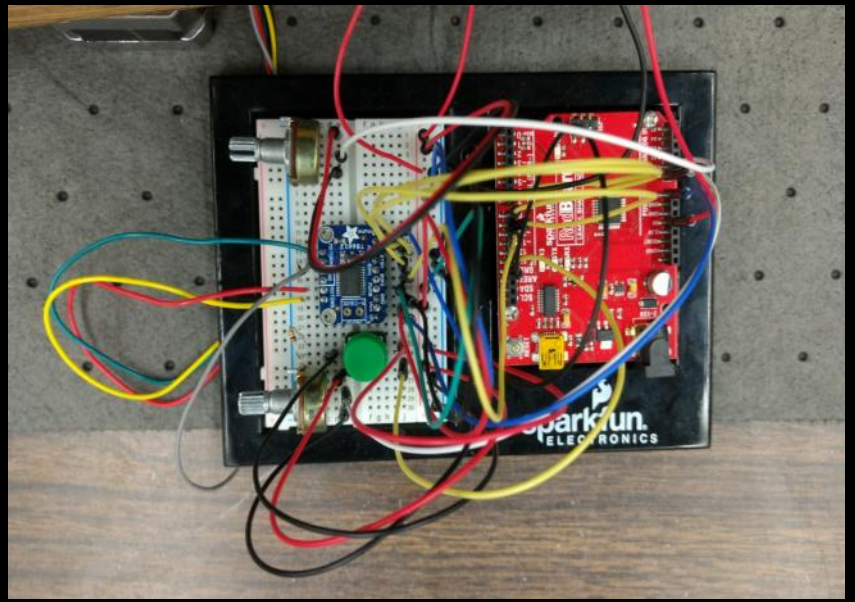
- Sparkfun RedBoard and associated parts (eg. jumper cables, breadboard etc.)
- 10k potentiometers x 2
- Line laser module
- Logitech webcam
- NEMA 17 stepper motor (200 steps/revolution or $1.8^{o}$ resolution)
- TB6612 Stepper driver
- 100 uF capacitor
- Open source codes – Arduino 1.6.11 and Processing 3.2.1

# Mechanical build

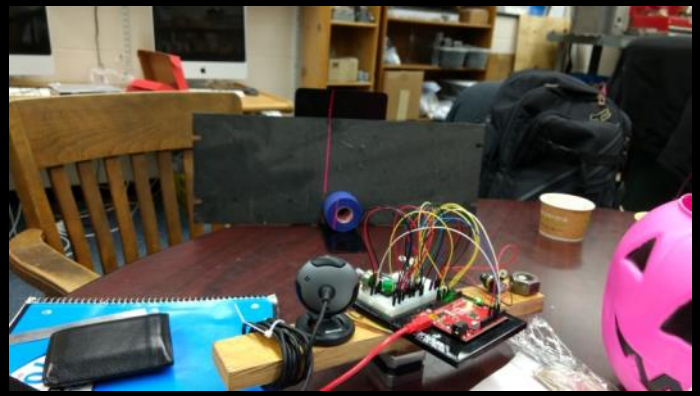


# Circuitry


12v
power supply
A4988
ENABLE
MS1
MS2
MS3
RESET
SLEEP
STEP
DIR
VMOT
GND
2B
2A
1A
1B
VDD
GND
100 µF
Images from howtomechatronics.com, pololu.com, programmingelectronics.com


SparkFun
ELECTRONICS

# Proof of concept results



# Challenges

- Environmental reds interacting with poor webcam contrasts
- Microstepping and pulse width modulation
- Lens curvature distortion

# Future work

- Better resolution
- Mirostepping or using geared DC motor for non-jerky movements
- ‘Blackbox’ for the setup
- Using Python/Matlab for pointcloud instead of Processing

# Takeaways

- Learnt some fundamentals of electrical circuitry and profilometry
- Learnt all about stepper motor drivers
- Preemptive vs reactive design considerations