Introduction to Physical Computing

Monday 6/1/2020

Schedule

- Housekeeping
- The history of tactile and haptic machine interfaces
  - How does physical computing fit within that larger context?
- Lab
  - Processing and Arduino
- Questions!

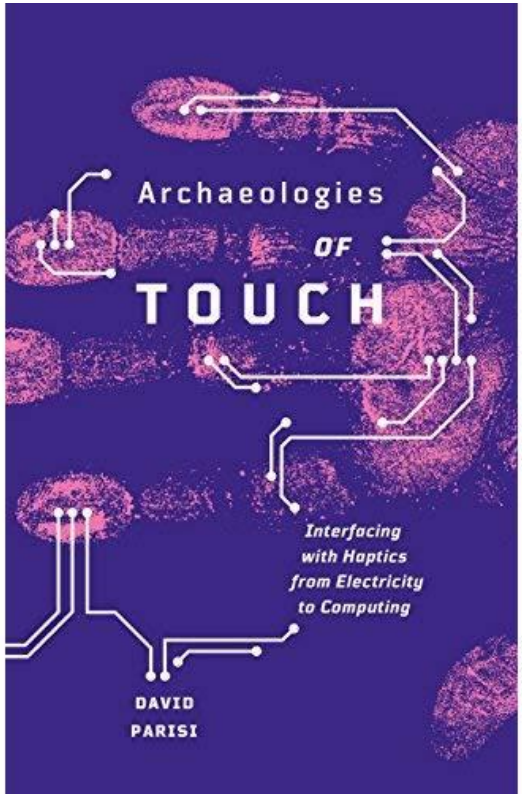
Office Hours

- Thursday 12pm -4pm
- Friday 12pm - 4pm

The History of Tactile/Haptic Interfaces

- Tactility and its relationship with machine design
- Can physical computing merge the gaps in VR/AR and mixed reality experiences?

Archaeologies of Touch by David Parisi

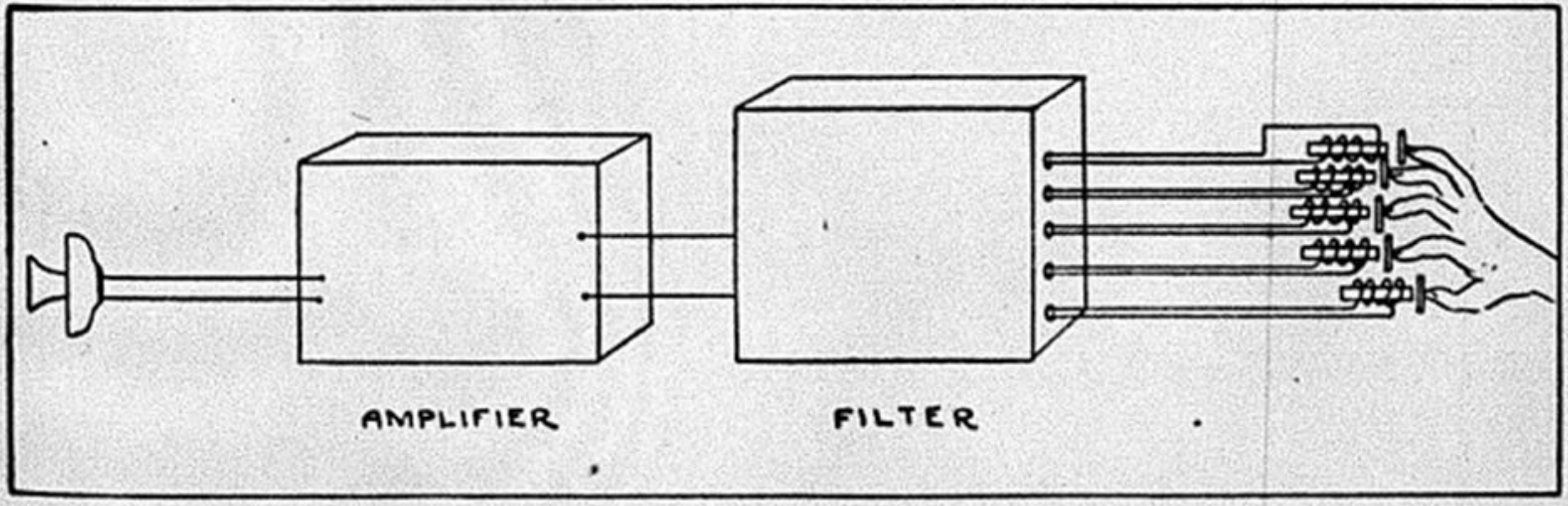


The Electrotactile Machine

- In the eighteenth century, exposing the body to electricity was integral part of researching and understanding it.
- Scientists would touch, lick and apply electrical shocks to various body parts including inside of the mouth and their eyeballs
- Tried to see which parts of their body were more adept at differentiating between shocks
- Activities at parties and fairs centered on electricity

The Tongue of the Skin

- The Teletactor
  - Intended to convey audio-visual data to the skin
- Believed that the ears and eyes had become overburdened with sensory information
  - The skin posed a means of lessening the burden on these senses
- A particular tactile language independent of the other senses
- Similar to morse code - series of electrical pricks or vibration that encode data



SCHEMATIC DIAGRAM OF THE TELETACTOR SYSTEM

At left is the transmitter. Wires connect it with the receiving unit whose filter sends to each finger its assigned frequency range. The finger impressions are combined in the brain


DIRECTIONS FOR VOLTAMP BATTERY No12 "CHAMPION"
SERIAL No. 1563
MONTGOMERY WARD & CO.
VOLTAMP
VOLTAMP
FIELD CURRENT REGULATOR
1
2
4
N
P

Human-Machine Tactile Communication

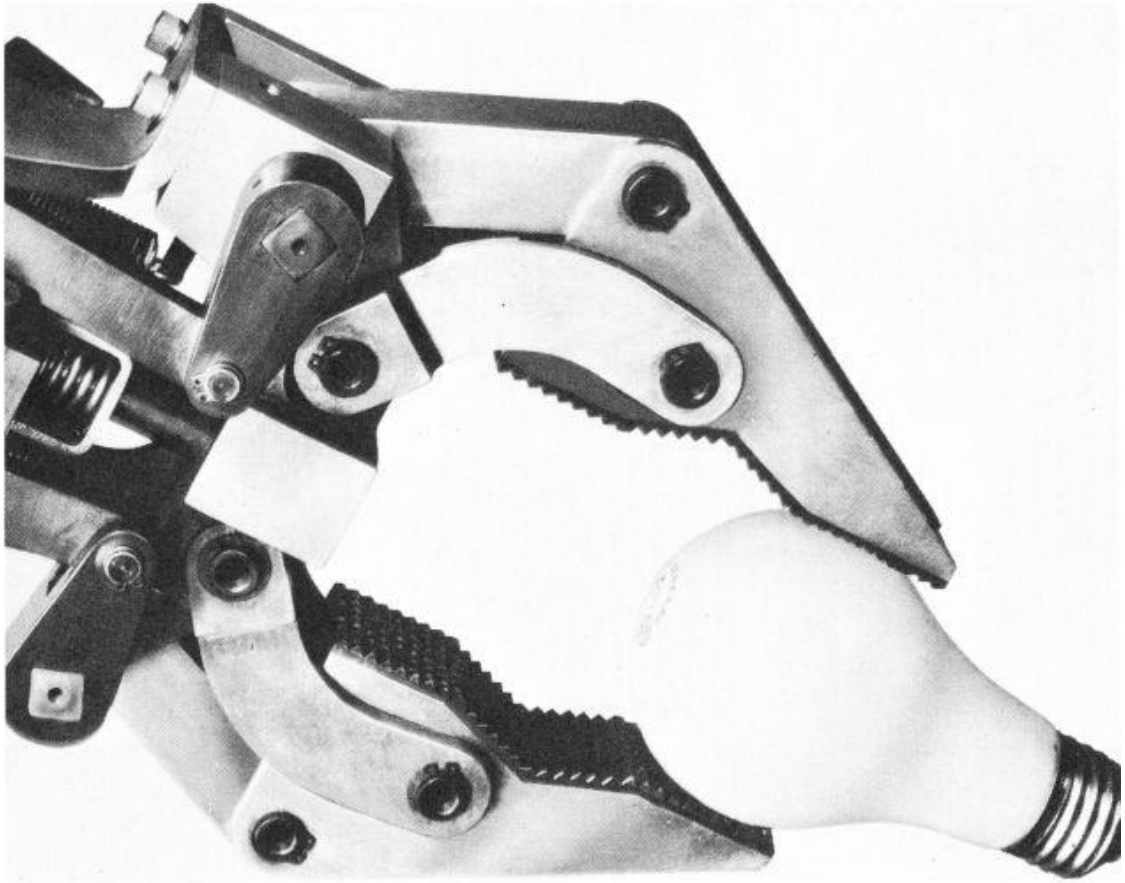
- The Ultimate Display (1965), Ivan Sutherland
  - Sutherland known as the grandfather of computer graphics
- “ . . . the ultimate display would, of course, be a room within which the computer can control the existence of matter.”
- Perfect fidelity: “a bullet displayed in such a room would be fatal”

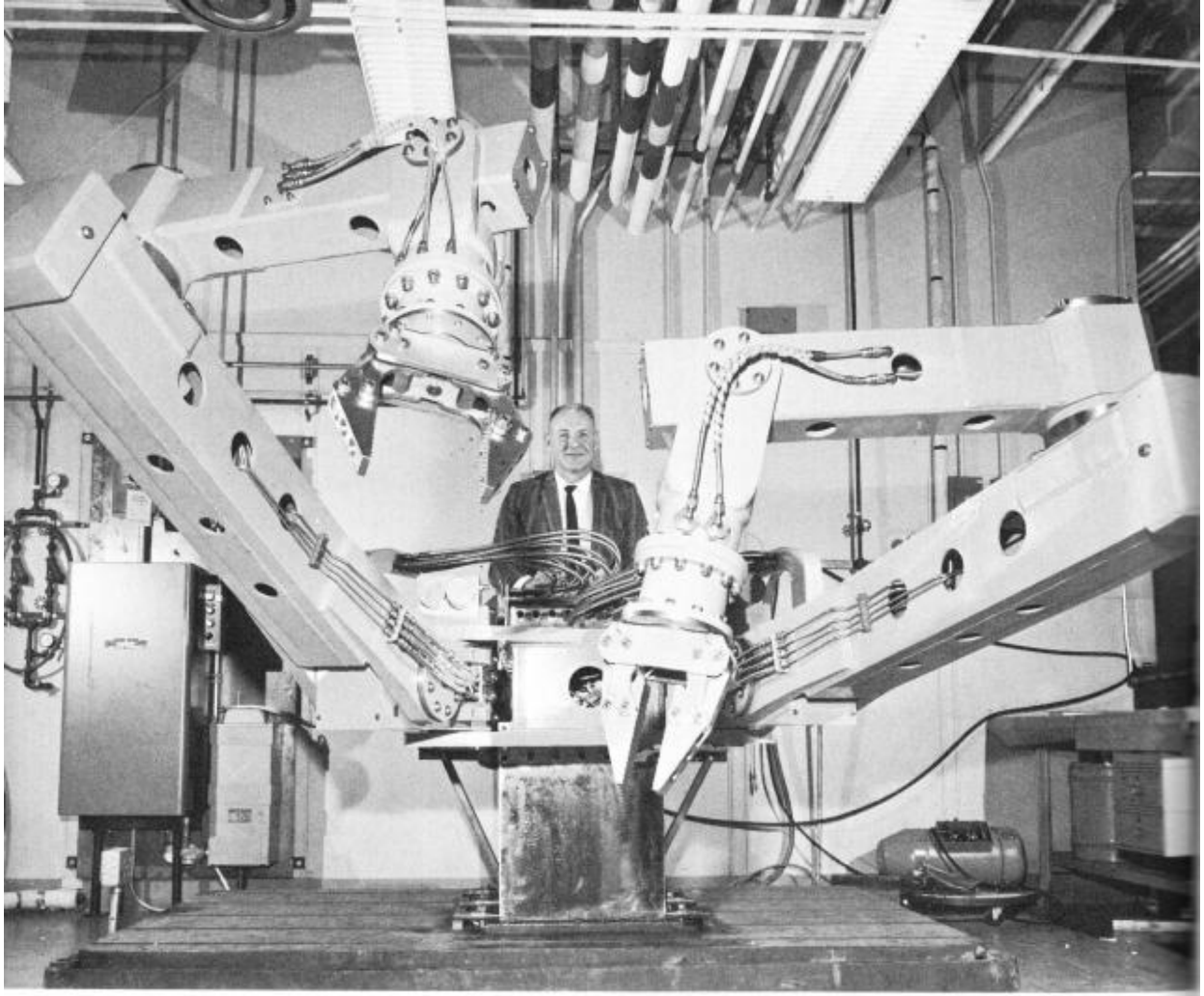
- Advances in force-reflection during the 1950’s and 1960’s
- Allowed for interaction with remote objects
  - Dangerous and radioactive substances
  - Created the notion that computers would be able to influence the control of objects through space and time

- Raymond Goertz’s early mechanical manipulator
  - The robot arm communicates information about the physical state of the manipulated object back to the operator
  - Uses voltage of the remote arm as an indicator of the force it needed to move objects
  - Operator “feels” these objects from a distance
  - Extends the human nervo-motor system beyond the limits of the human body

- General Electric’s Research and Development
  - (1960’s) Series of exoskeletal interfaces that served as “man-amplifiers”
  - CAMs (Cybernetic Anthropomorphous Machine)
  - Goal was to offload perceptual and cognitive labor onto humans, place physical tasks on machine
  - GE obscured amount of cognitive load placed on operator
    - CAMs were large and cumbersome
    - Difficult for operators to determine the difference and significance of the force-feedback and pushback sent from the machine

Man-Mate can pick up a light bulb without cracking the glass.





This man amplifier was developed for the research submarine, *Aluminaut*.

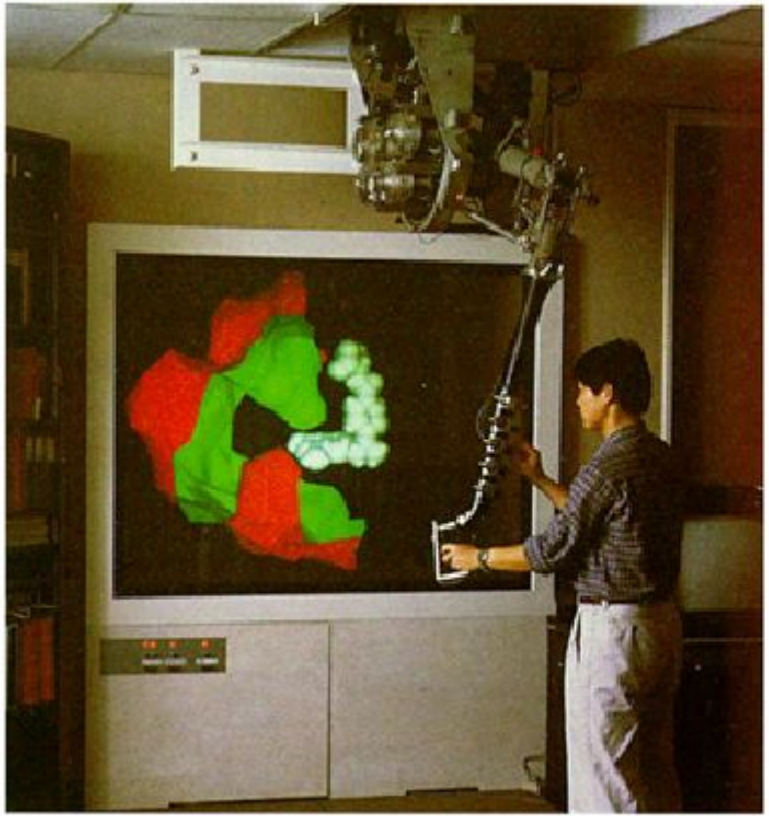
GE Walking Truck (1969)

https://www.youtube.com/watch?v=ZMGCFLEYakM

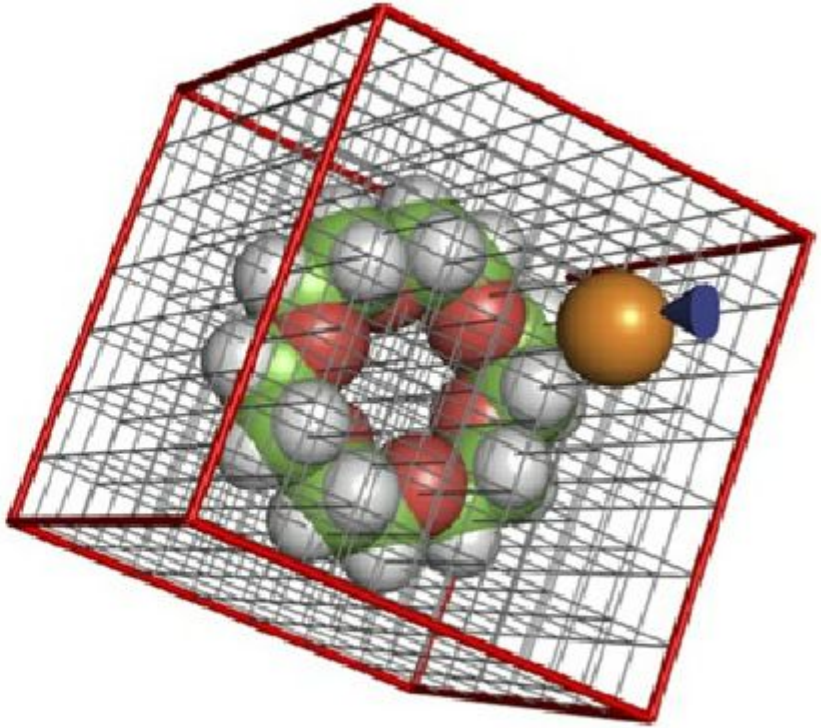
- Sutherland's speech inspired engineers to focus on tactile channel as a source of input
  - However, the necessary technology was not available
  - Means of implementation not clear
  - Viewed as a future goal for computer interfaces
- Michael A. Noll
  - Engineer working at the nexus of the visual, audio and tactile modalities of human-computer interaction
  - Believed computer graphics were being given too much emphasis as form of man-machine communication
  - Force cues could aid users in interactions with stereoscopic images
  - Created a force-feedback joystick which experienced force feedback from three dimensions
  - Used to identify contours of objects on stereoscopic displays
  - Users focused on force feedback more than objects on screen

Project Grope

- Used force-feedback to simulate sensations that are impossible to touch
- Interactions between molecules
  - Complemented and challenged visual impressions displayed on the screen



(a)



(b)

PHANToM (1994)

- Provided a single point of contact between the user and the virtual environment to render sensations of force and contact
- Insert index finger in “thimble-gimble”
- “Thimble-gimble” connected to robot arm
  - 3 motors to track movement and apply force
- Simulate the weight, texture and stiffness of objects in 3D space
- Force and motion are the most important haptic cues

PHANToM

https://www.youtube.com/watch?v=REA97hRX0WQ

CyberGrasp

- Glove-like exoskeleton
- Force sensations rendered to individual digits
- Squeezing a ball in virtual space, the user would feel pressure applied to each finger
- Consists of 22 sensors, multiple contact points, cannot render weight

CyberGrasp

https://www.youtube.com/watch?v=4aMCJDOEi0k

Challenges, Then and Now

- Difficult to capture haptic sensations
  - There is no single, specialized organ for processing haptic inputs
- With limited time and resources, how do you choose which haptic experiences to focus on?

Things to ponder

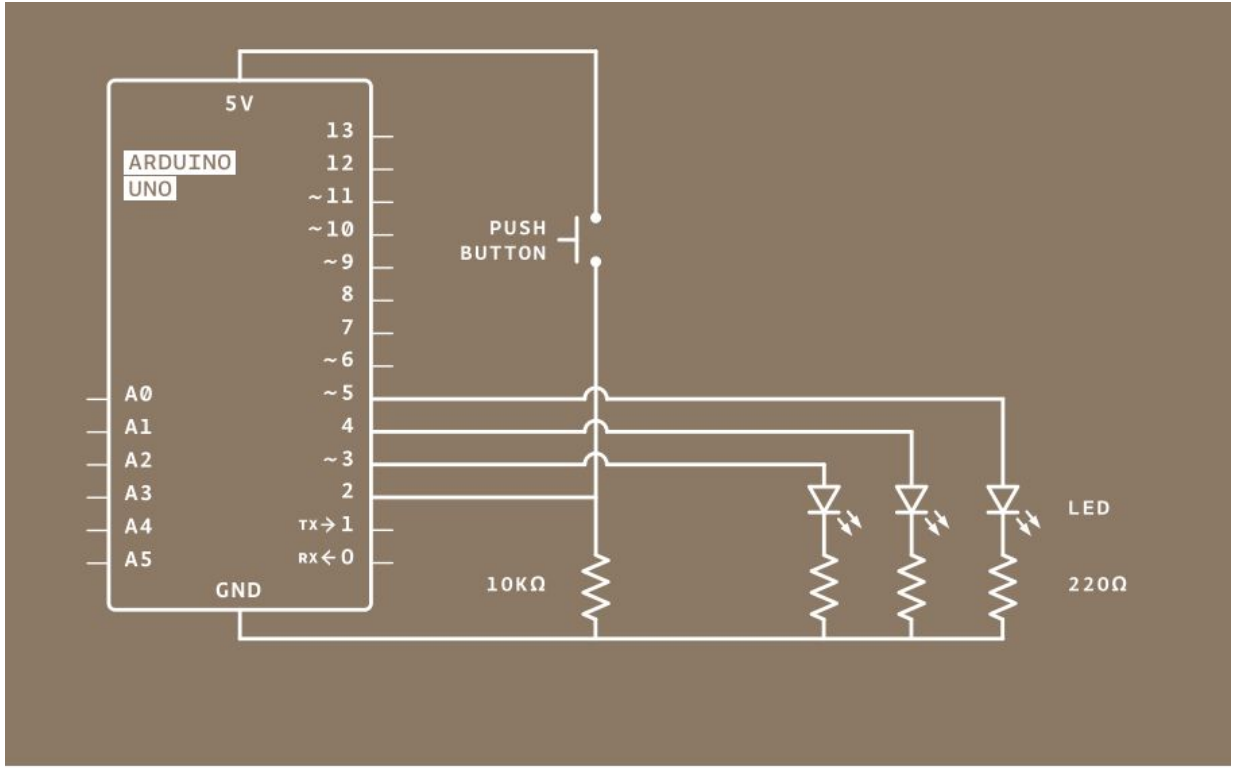
- Why did the focus shift towards visual displays?
- Are we missing out by not having haptic feedback in our interactions with virtual systems?
- Has the skin been misused as a channel of interaction?
- How can the skin be optimally used as a channel of interaction?

==LAB==

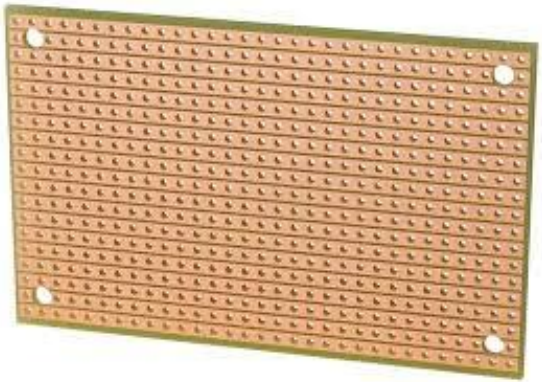
- A quick review!
- We will be using Processing to generate visualizations based off of Arduino data and to send data back to Arduino based off of user inputs

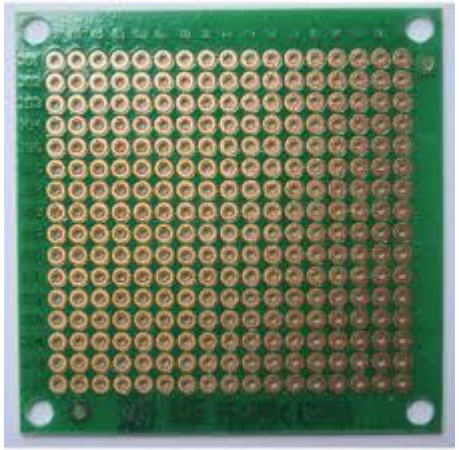
Review

- What is this schematic?



- How do you make connections on these perfboards?





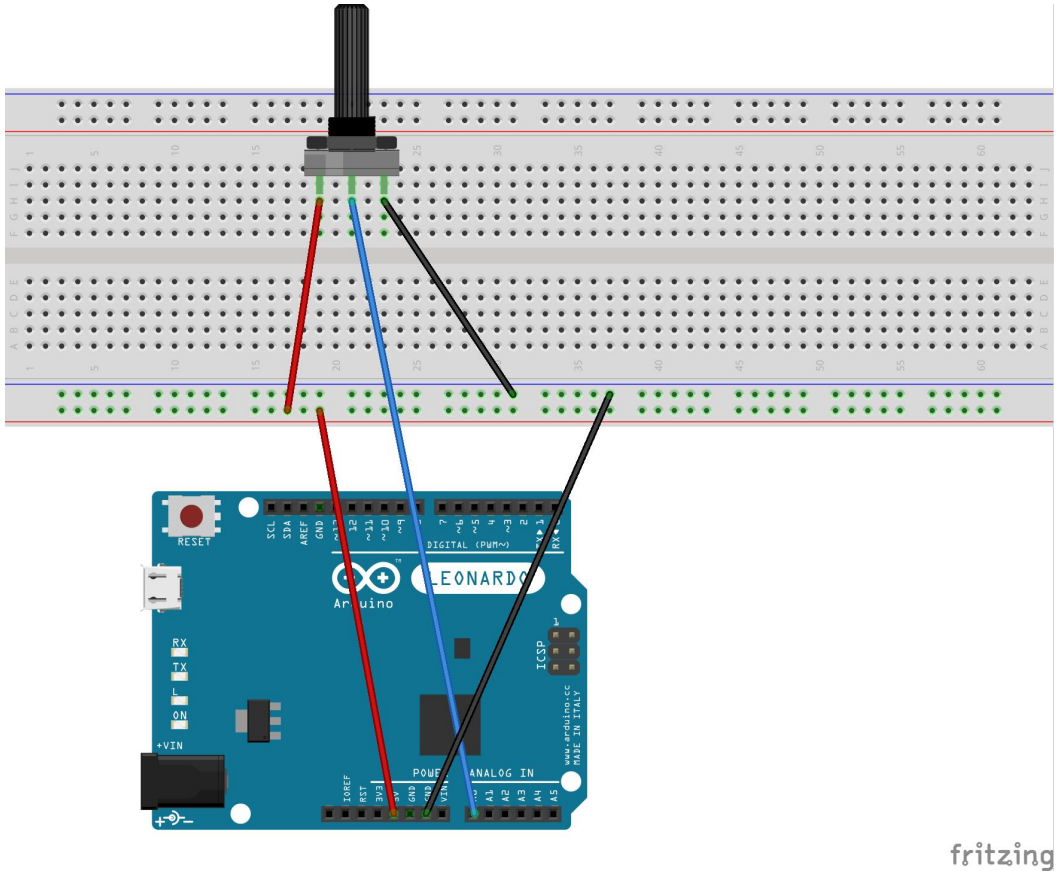
Processing

- Download Processing from here: https://processing.org/
- Mostly used for generating visuals and sound using code
- Java based programming language
- P5.js is the JavaScript version of Processing

Key differences between p5 and Processing

- Processing uses its own IDE just like Arduino
- Processing does not run in the browser like p5 but runs locally on your machine
- Processing is quite heavy and difficult to display on the web
    - Therefore, if your project requires a connection to the web, it is better to use p5 instead of Processing

Sending Arduino Data to Processing



Questions?

Ask me any questions you have about your projects