W.R.I.S.T.

(Wireless Reality Integrated Sensing Tool)

Design Review
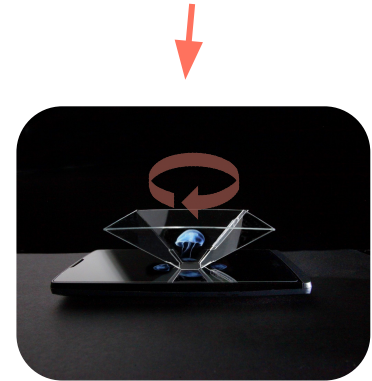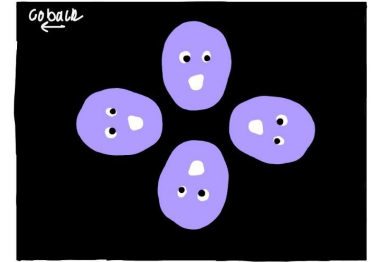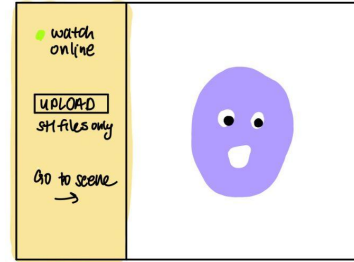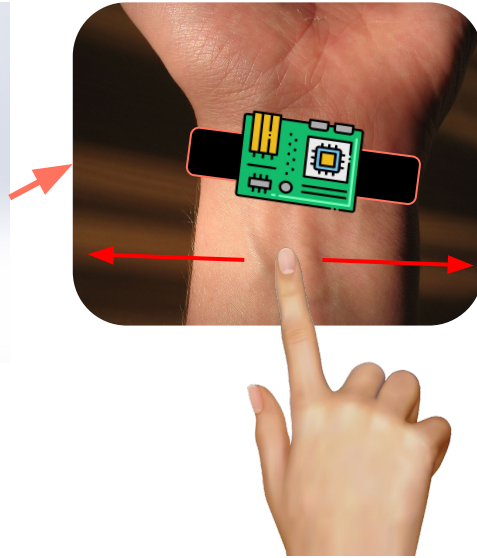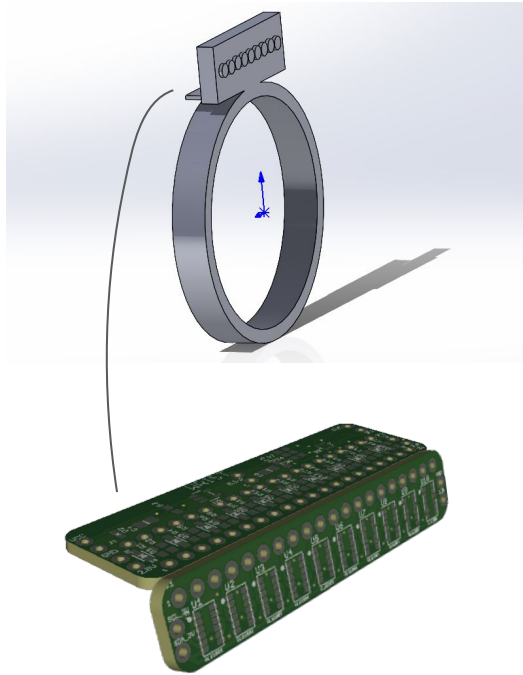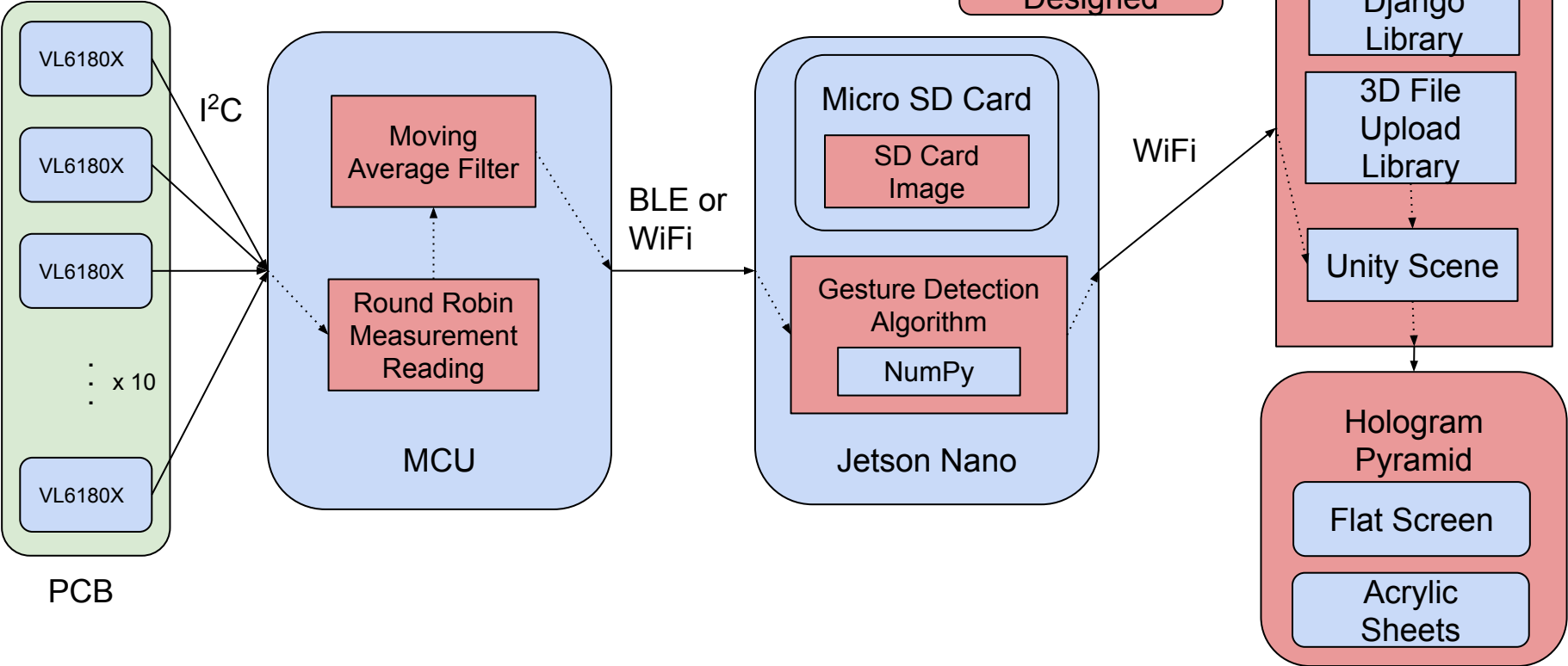
Use Case and Requirements

- Enable mobility in scenarios where a 3D visual aid is present
    - i.e. engineering, architecture, chemistry demonstrations

TEST	DESCRIPTION	TARGET METRIC
Weight, Dimension, Cost	Engineering	< 100g < 65mm x 65mm < $150
Accuracy of Gesture Detection	Intended gesture vs what our classifier identifies	Zooming/pinching: 75% Rotation/swiping: 90%
Preciseness of Gesture Detection	*True* displacement of the finger paths vs *measured* displacement of the sensors	85%
Latency	How long it takes for sensor data to be collected, processed, and sent to hologram	< 100 ms

Solution Approach

Block Diagram

Hardware

Software

Off the Shelf

Purchased

Newly Designed

PCB

VL6180X

VL6180X

VL6180X

⋮ x 10

VL6180X

I^{2}C

MCU

Moving Average Filter

Round Robin Measurement Reading

BLE or WiFi

Jetson Nano

Micro SD Card

SD Card Image

Gesture Detection Algorithm

NumPy

WiFi

Web Application

Django Library

3D File Upload Library
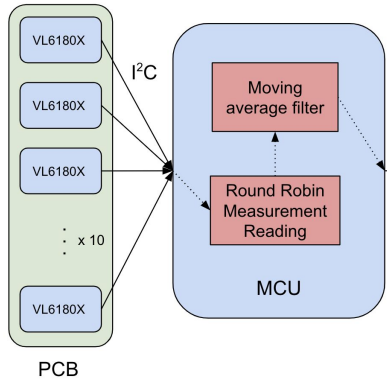
Unity Scene
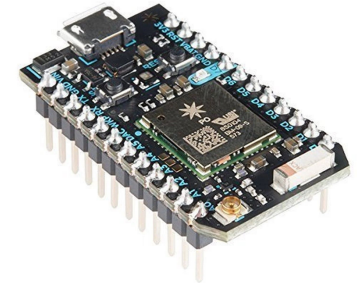
Hologram Pyramid

Flat Screen

Acrylic Sheets

Implementation Plan - Sensors & Embedded System

- VL6180X Time of Flight Sensor
  - Other possibilities: gyro, pressure, visual
- Particle Photon MCU

	VL6180X	VL6180V1	VL53L4CD	VL53L0CX	VL53L1CX	VL53L3CX	VL53L4CX	VL53L1CB	VL53L5CX
	Proximity and ambient light sensor	Proximity sensor with low power consumption	Proximity sensor with high accuracy	Ranging sensor	Ranging sensor programmable FoV	Ranging and multi-target sensor	Short to long ranging, multi-target sensor	Long Distance and multi-target sensor	8x8 multizone sensor
Part number	VL6180XV0NR/1	VL6180V1NR/1	VL53L4CDV0DH/1	VL53L0CXV0DH/1	VL53L1CXV0FY/1	VL53L3CXV0DH/1	VL53L4CXV0DH/1	VL53L1CBV0FY/1	VL53L5CXV0GC/1
Max distance	20 cm	60 cm	130 cm	200 cm	400 cm	500 cm	600 cm	800 cm	400 cm
Close distance detection	•	•	•	•		•	•		
Multi-target detection						•			•
Multi-zone								•	•
Programmable FoV					•			•	
Lower Power mode	•	•	•	•	•				•
Ambient Light Sensing	•								

https://www.st.com/en/imaging-and-photonics-solutions/time-of-flight-sensors.html

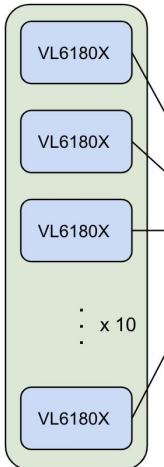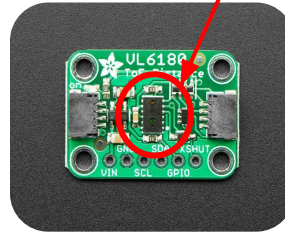# Implementation Plan - PCB

- **Build PCB off of this design**
  - It has a single VL6180X sensor; we want multiple
  - Can't fit everything into one PCB

- **Two PCB's**
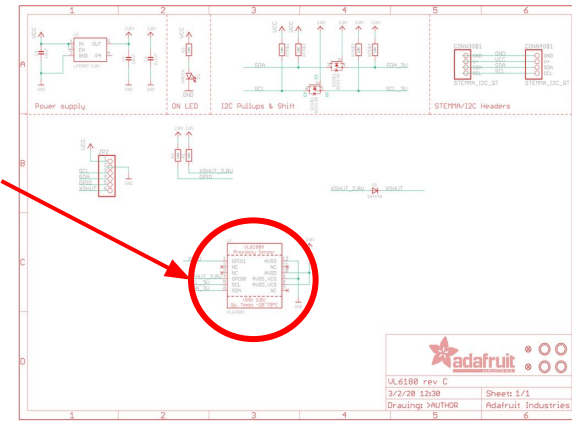 - One for sensor array
  - One for "support" components
    - Voltage regulator
    - Pull-up/down resistors
    - etc.
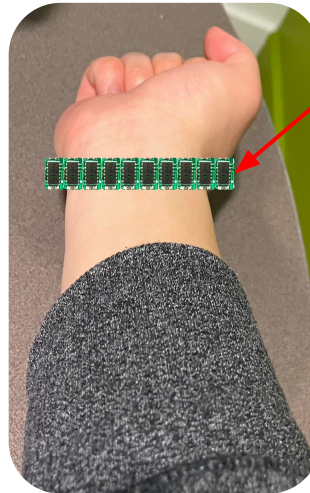
VL6180X

VL6180X
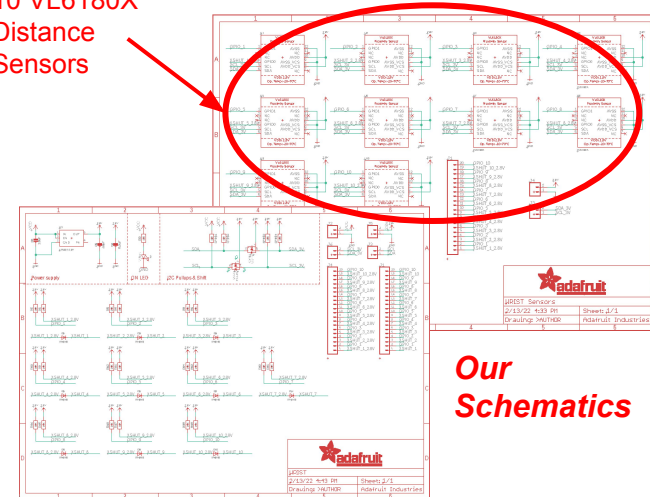
VL6180X

⋮ x 10

VL6180X

PCB
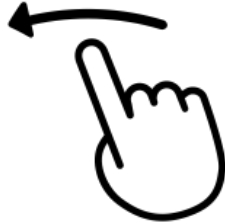
VL6180X Distance Sensor

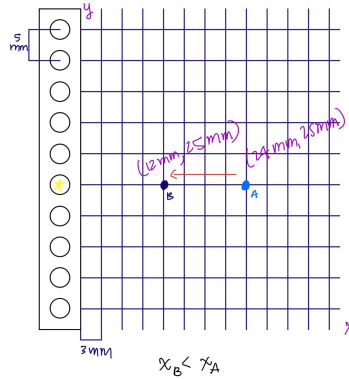*Adafruit's Schematic*

10 VL6180X Distance Sensors

Our Schematics

Implementation Plan - Gestures

Rotate left

$x_B < x_A$

Rotate right

$x_B > x_A$

Zoom in

$x_{Bindex} > x_{Aindex}$ & &
$y_{Bindex} > y_{Aindex}$ & &
$x_{Bthumb} < x_{Athumb}$ & &
$y_{Bthumb} < y_{Athumb}$

Zoom out

$x_{Bindex} < x_{Aindex}$ & &
$y_{Bindex} < y_{Aindex}$ & &
$x_{Bthumb} > x_{Athumb}$ & &
$y_{Bthumb} > y_{Athumb}$
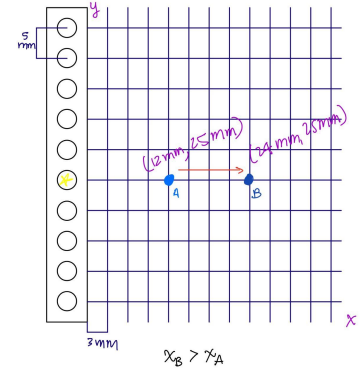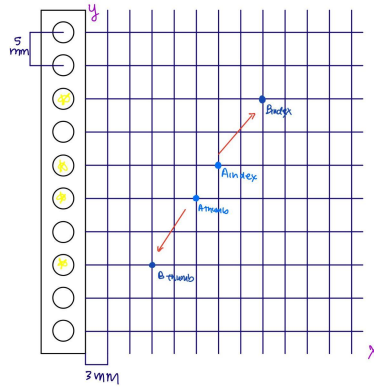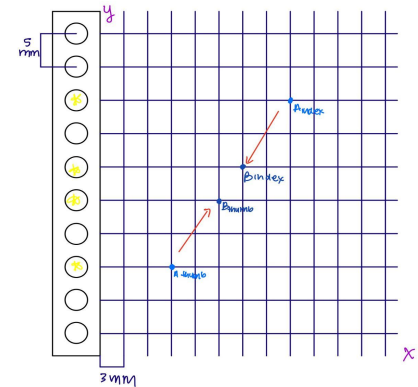
Python gesture
detection algo

NumPy

Implementation Plans - Middleware

- NVIDIA Jetson Nano
  - Faster computational power than other computers
- Wifi vs. Bluetooth
  - Distance, energy consumption, etc.
- Communication protocols
  - Considering MQTT, CoAP, and AMQP

Micro SD Card

SD Card Image

Python gesture detection algo

NumPy
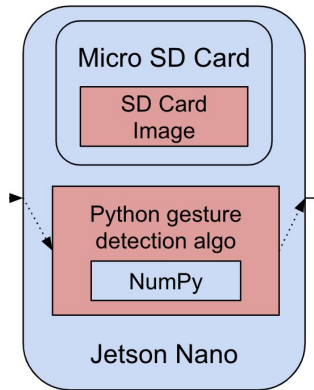
Jetson Nano

Implementation Plan - Unity
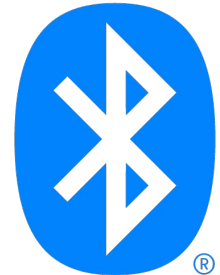
- Get data from Jetson Nano via Bluetooth/WiFi to web application.
- Web application will have Unity embedded onto its page
- Using the web application, we will communicate the data from the Jetson to the 3D model (via Unity)
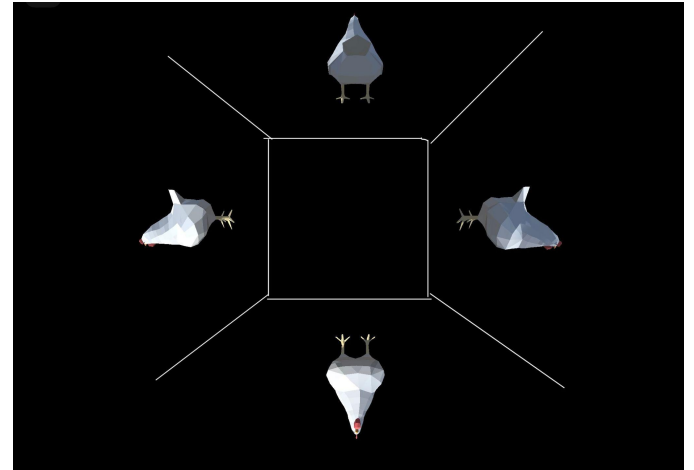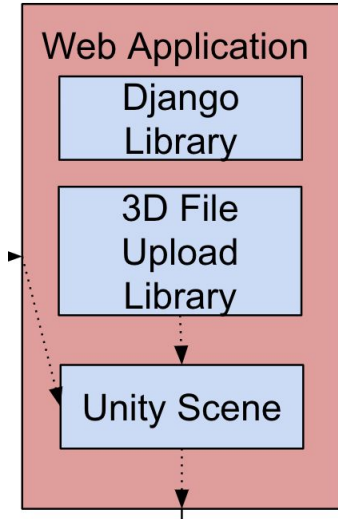
Implementation Plan - Hologram

- Project four views of a 3D object onto 4 sides of the Pyramid.
- Will give an effect like the person is viewing the image in 3D

Reflected light rays

Virtual image

Projection pyramid

45°

Image on screen

Smartphone

Hologram Pyramid

Flat Screen

Acrylic Sheets
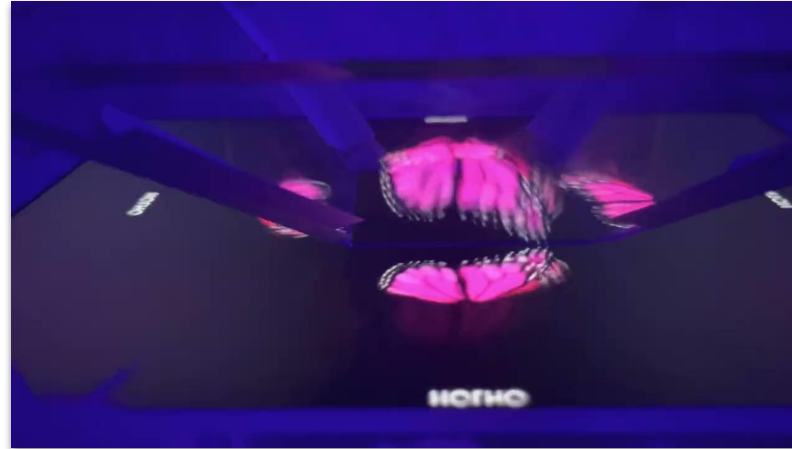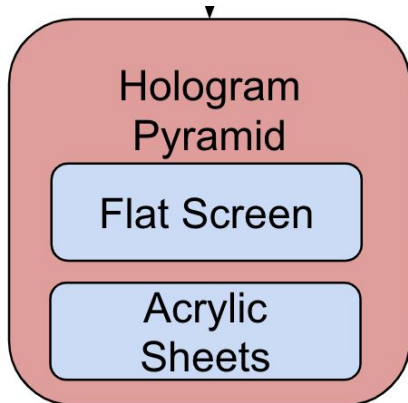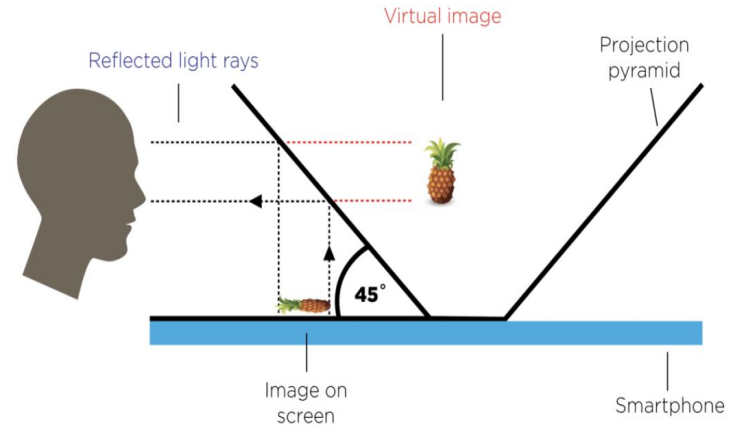
Testing, Verification, and Validation

- 1 test per sensor x 10 sensors x 4 cardinal gestures = 40 tests per gesture

REQUIREMENT	TEST
Accuracy of Gesture Detection	Have user tap/swipe/pinch and see if the proper gesture was detected
Correctness of Gesture Detection	Measure actual displacement of swipes and pinches and see if measured displacement matches actual displacement (actual / measured)
Latency	Timestamp all incoming and outgoing data and compare elapsed time in software
Weight/Dimensions/ Cost	Measure and keep track of weight, dimensions, and cost of our wearable device

Project Management

- 6 main tasks
  - Edward: Board Creation & Communication
  - Joanne: Unity & Hologram
  - Anushka: Gesture Recognition & Weable Prototyping
  - LOTS of overlap
- Currently ahead of schedule

Task Name	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Phase 1a: PCB Design	Edward	Edward										
Phase 1b: Unity Design	Joanne	Joanne										
Phase 1c: Hologram Design	Anushka	Anushka										
Phase 1d: Band Design			Anushka	Anushka								
Phase 2a: Jetson Communication with Intern			Anushka & Edward	Anushka & Edward								
Phase 2b: Web Application Development					Edward & Joanne	Edward & Joanne						
Phase 2c: Sensors Communication with Jetson					Edward	Edward						
Midpoint Check: Testing and Improvement					All	All						
Phase 3a: Band Fabrication							Anushka & Joanne	Anushka & Joanne				
Phase 3b: Unity and Web Application Connection							Joanne	Joanne				
Phase 4: Integration									All	All		
Final Tests										All	All	All