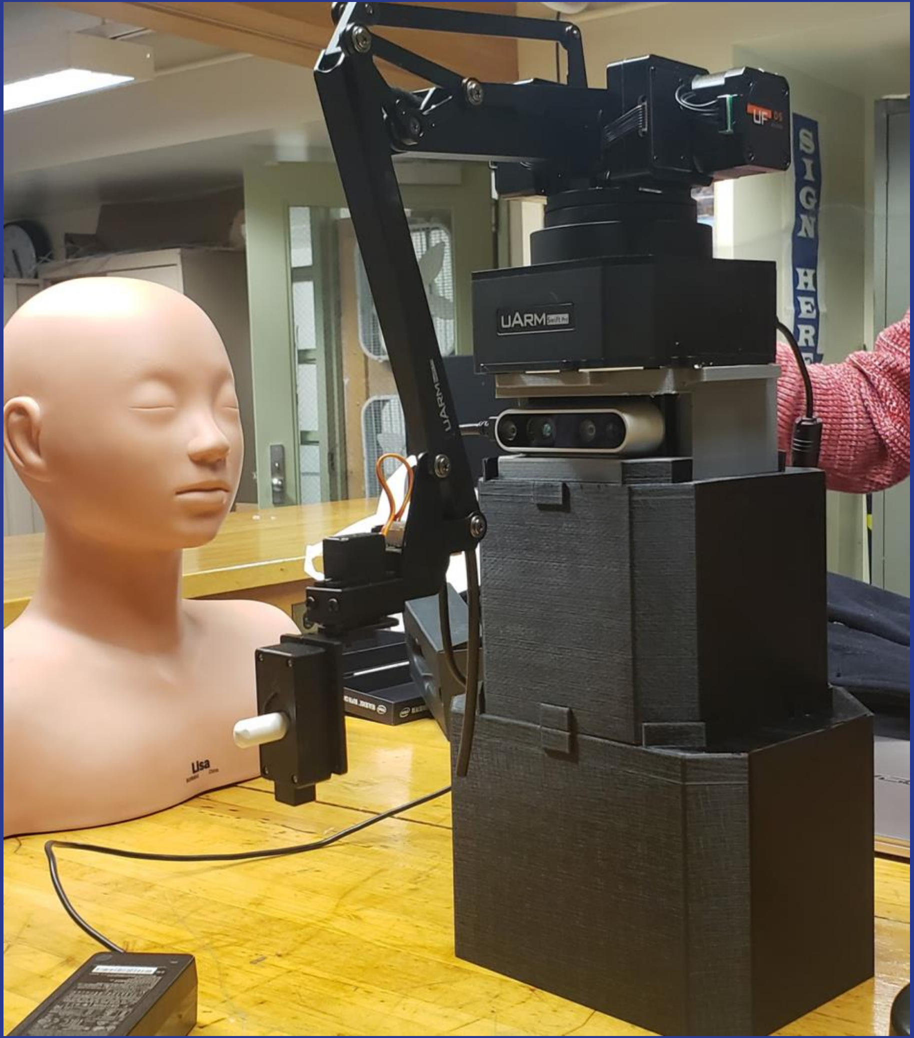


Robotic Makeup Application System

Alejandro Varela
Dillon Naidu
Jason Ramsarran
Jason Calle
Junmin Xu
Chun Kit Wong

Department of Mechanical Engineering
The City College of New York

Requirements

Met:

- Computer vision implementation ([x y z] capture)
- Responds and interacts with the user
- An adaptable base which houses the camera and allows the robotic arm to adjust itself for different heights

Not met:

- Start button and OLED display for initiation and status of lip balm command
- Ultrasonic proximity sensor to signal stop and start

Trade study: Robotic arms

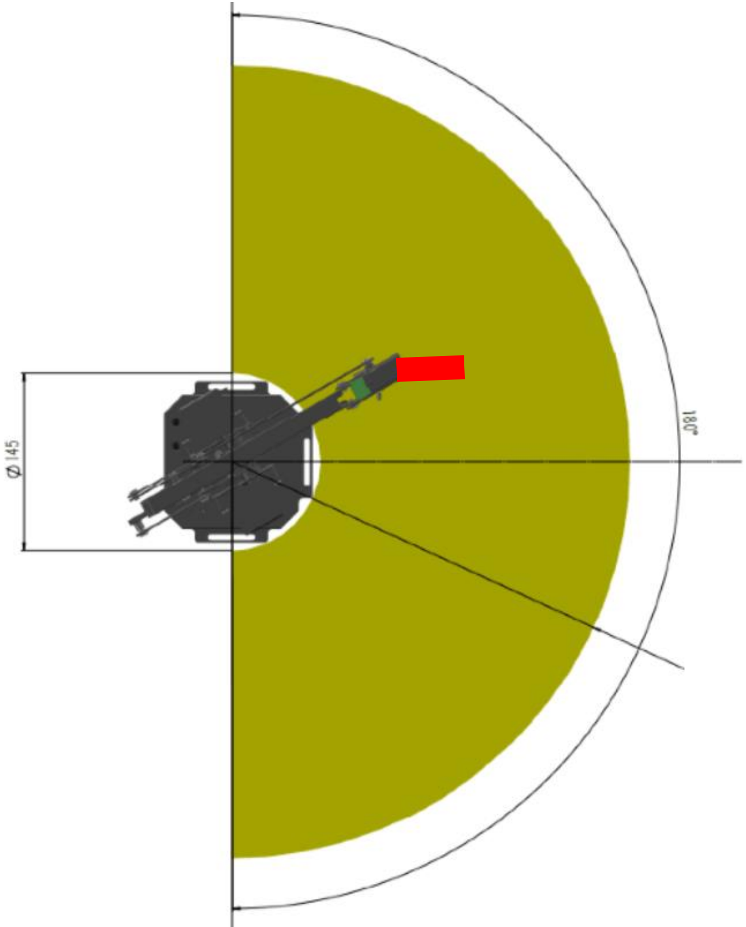
Universal Robots UR3	uArm Swift Pro	Braccio
$22,000	$749	$235

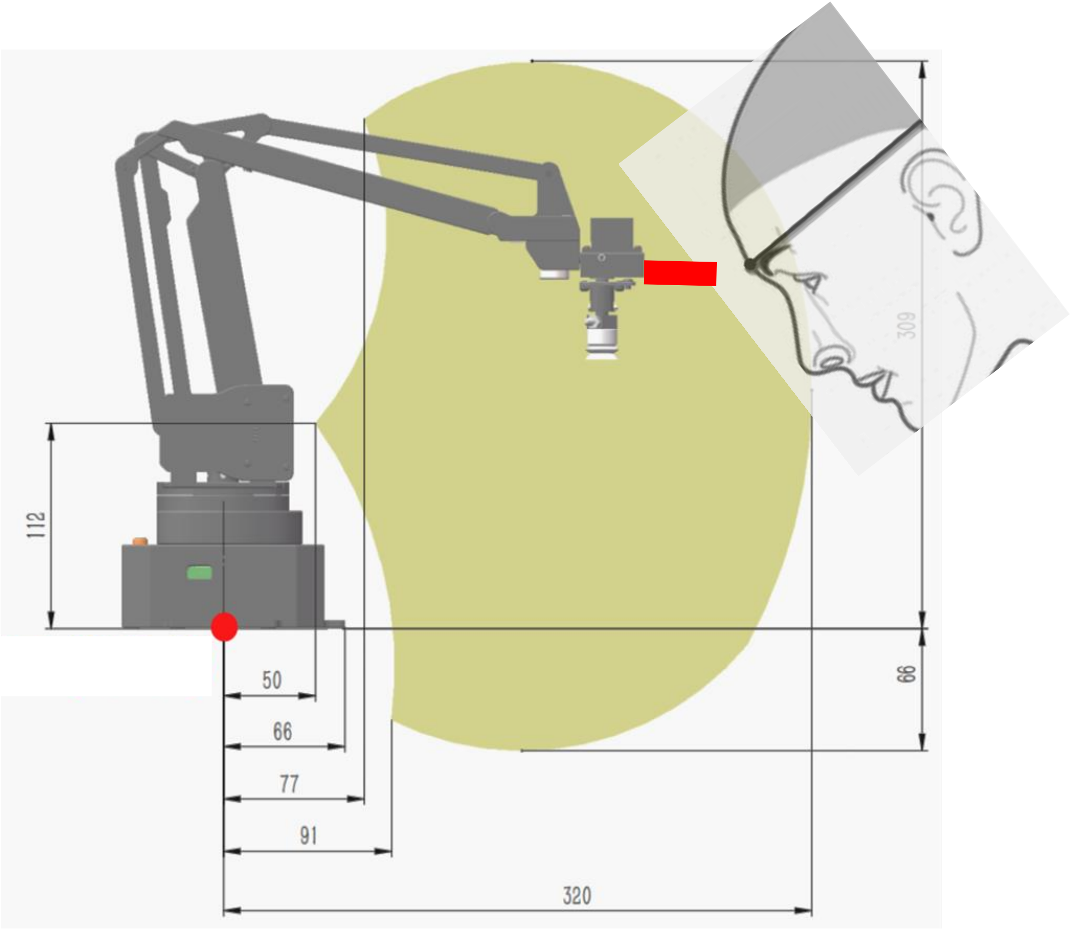
Trade study: Robotic arms

Given scores of 1-3 (higher is better)

Weight	3	3	3	2	2	2	2	2
Robotic Arm	**Affordability**	**On-board software**	**User-friendly**	**Degrees of Freedom**	**Repeatability**	**Expandability**	**Appearance**	**Compactness**
uArm Swift Pro	2	3	3	2	3	3	3	3
Universal Robots UR3	1	3	3	3	3	2	3	1
Braccio	3	1	2	3	1	1	2	2
Weighted score:	**uArm Swift Pro**	Universal Robots UR3	Braccio					
	52	45	36					
Cost	$749	$22,000	$235					

uArm Swift Pro

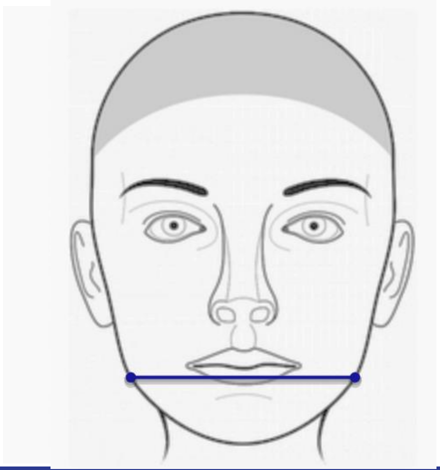


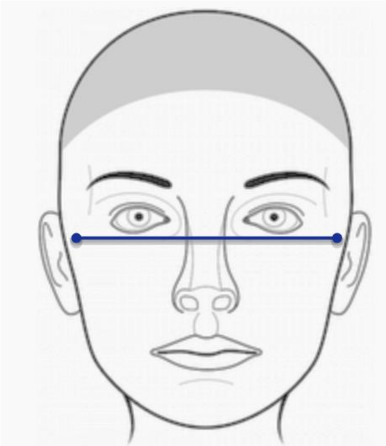


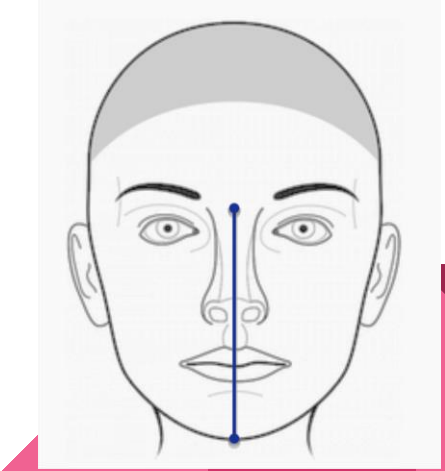
FaceBase
A Resource For Craniofacial Researchers

ace Dimensions Statistics

Mandibular Width Avg (mm)	Facial Width Avg (mm)	Facial Length Avg (mm)
Adult Male: 100 - 108	Adult Male: 133 - 141	Adult Male: 120 - 132
Adult Female: 94 - 100	Adult Female: 126 - 133	Adult Female: 116 - 123
Std: 5 - 10	Std: 4 - 7	Std: 5 - 7

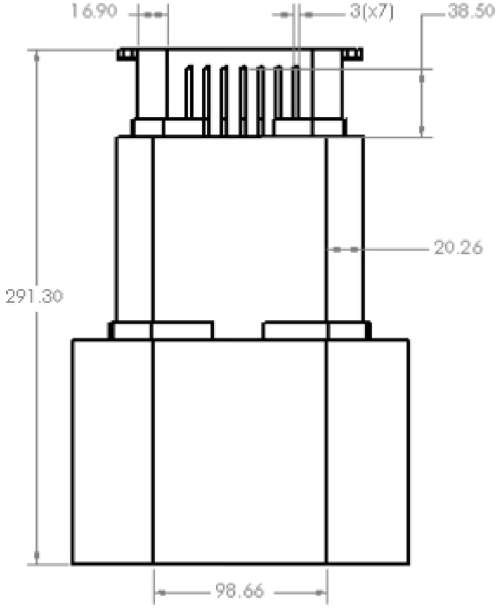


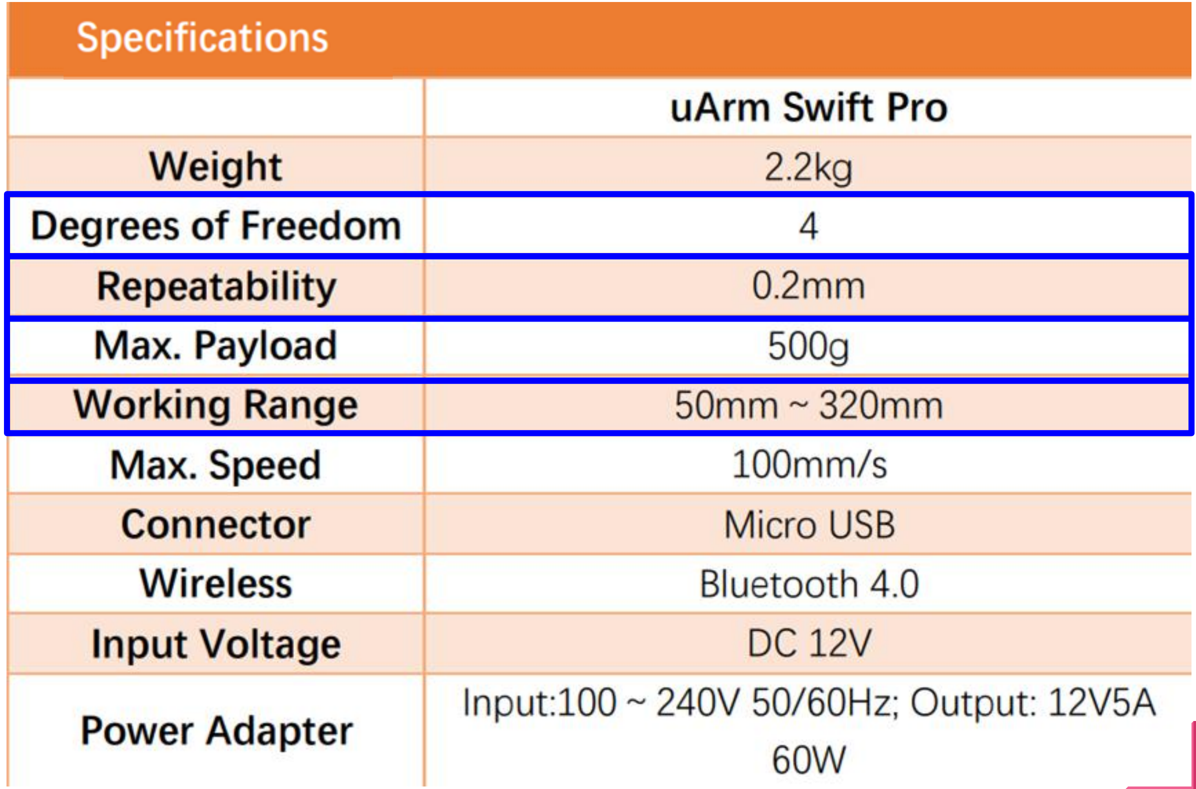




Torso length data

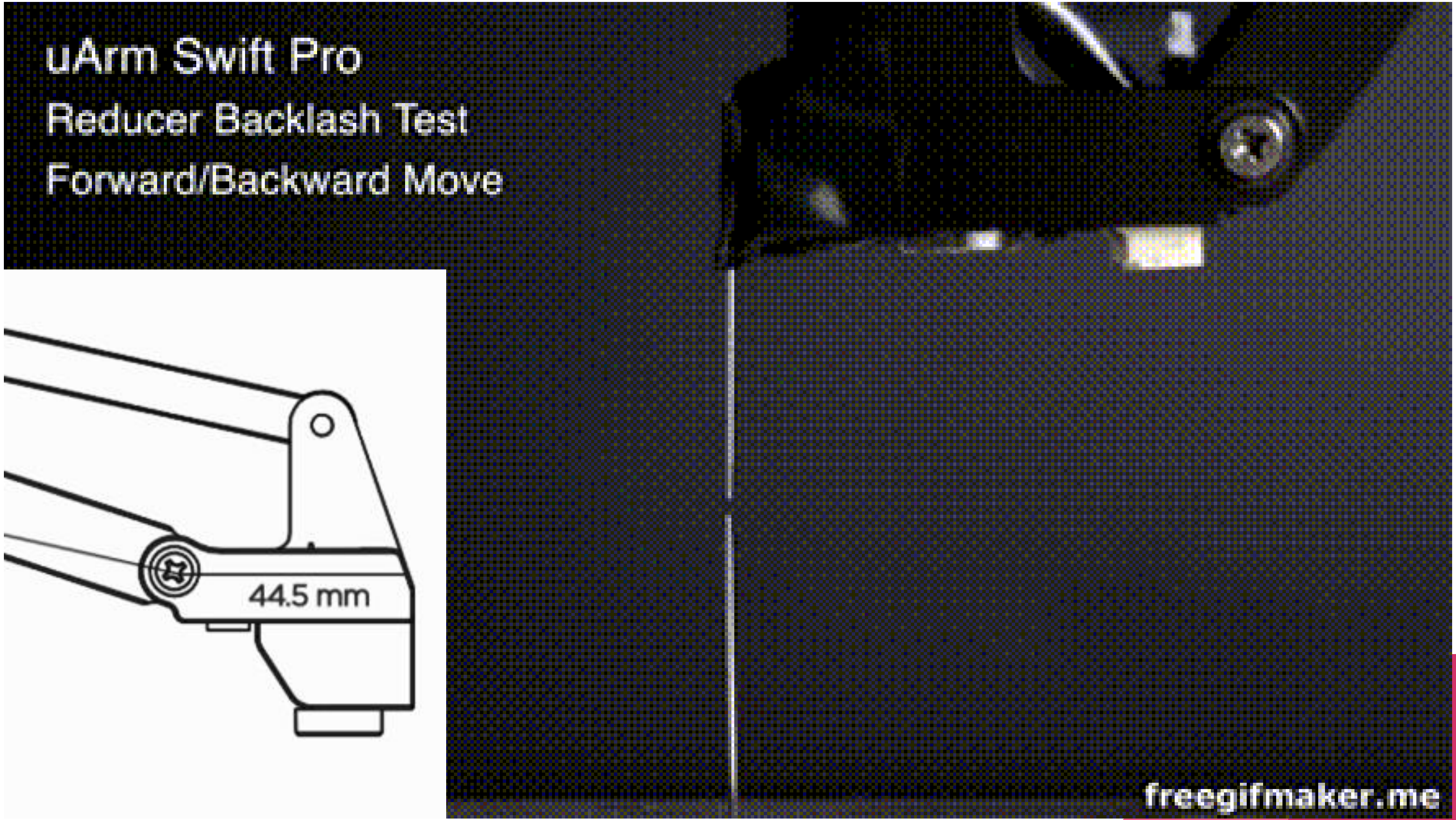
User	Height (cm)
User 1	28
User 2	25
User 3	26
User 4	28
User 5	27
User 6	26
Average User Data	**26.66**





Specifications

	uArm Swift Pro
Weight	2.2kg
Degrees of Freedom	4
Repeatability	0.2mm
Max. Payload	500g
Working Range	50mm ~ 320mm
Max. Speed	100mm/s
Connector	Micro USB
Wireless	Bluetooth 4.0
Input Voltage	DC 12V
Power Adapter	Input:100 ~ 240V 50/60Hz; Output: 12V5A 60W


uArm Swift Pro
Reducer Backlash Test
Forward/Backward Move
44.5 mm
freegifmaker.me

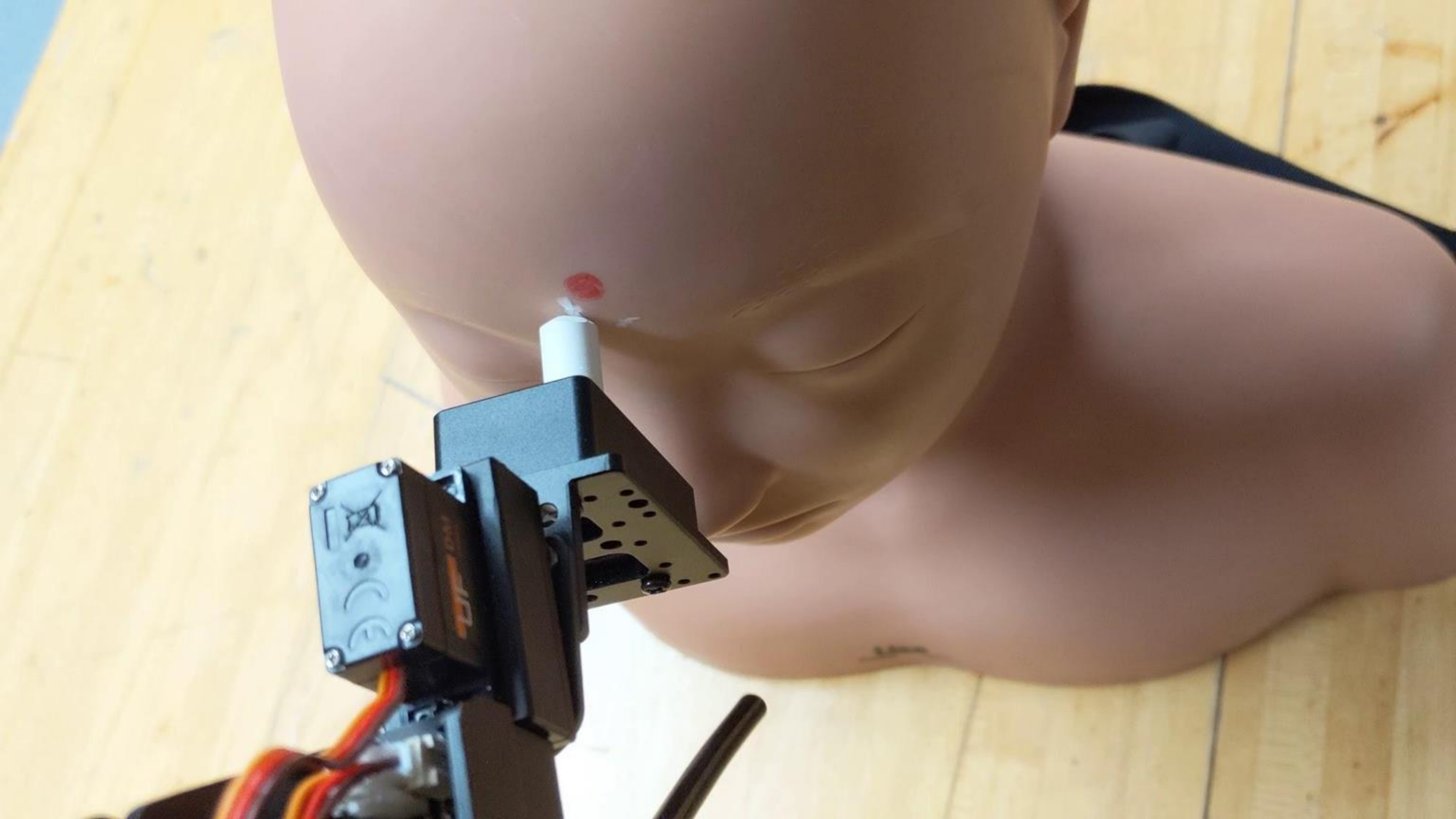
Testing

A. Accuracy testing: we are trying to see how much the robotic arm is in synch with the Intel's Depth camera by testing out our equation for data manipulation

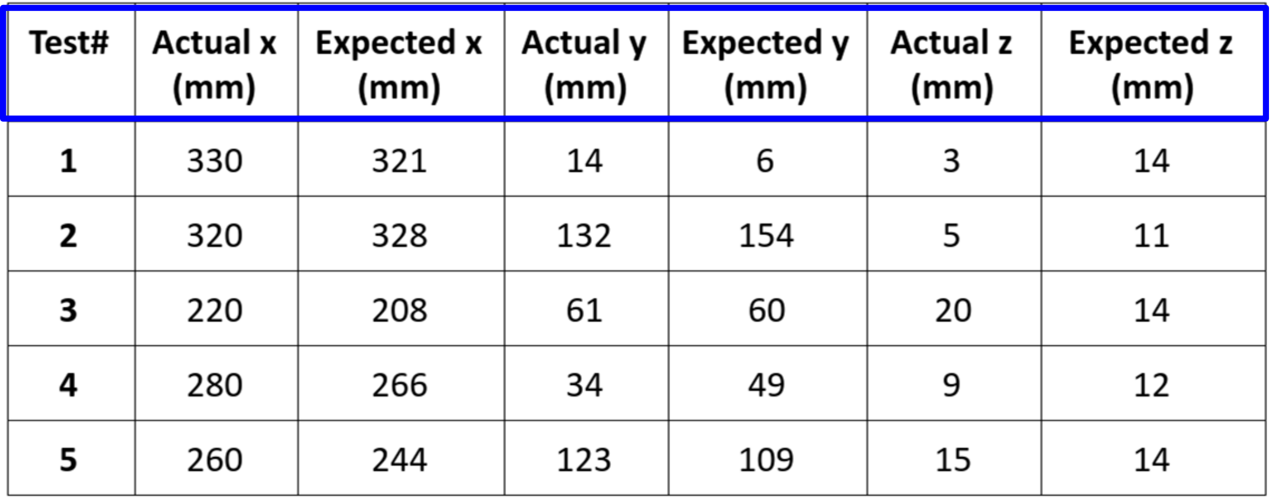
1. A red dot is drawn on the mannequin
2. The camera is used to extract the red dot's location data
3. The data points is manipulated through the code
4. Then the robotic arm attempts to move to that location

A. How was this accomplished?

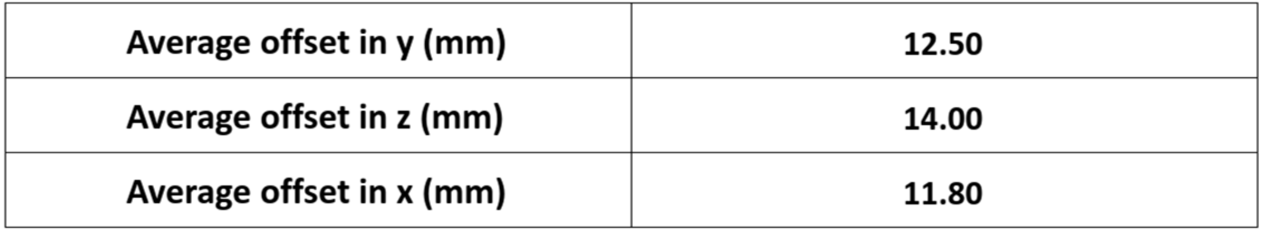
1. Uarm's applications can tell us the exact location of the robotic arm
2. And we then compared these values to our data points after it was manipulated



Accuracy Test



Test#	Actual x (mm)	Expected x (mm)	Actual y (mm)	Expected y (mm)	Actual z (mm)	Expected z (mm)
1	330	321	14	6	3	14
2	320	328	132	154	5	11
3	220	208	61	60	20	14
4	280	266	34	49	9	12
5	260	244	123	109	15	14



Average offset in y (mm)	**12.50**
Average offset in z (mm)	**14.00**
Average offset in x (mm)	**11.80**

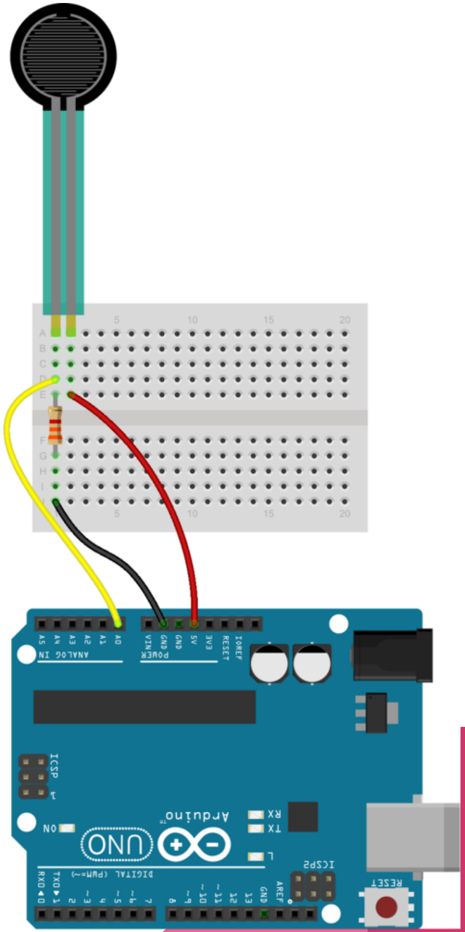
Results

1. Our data manipulation equation was found to have different offset values at different depths
   a. The reason for this will be explained by Dillon
2. Through the tests we found to have better accuracy for the Z and Y coordinates at a smaller X, while at higher X

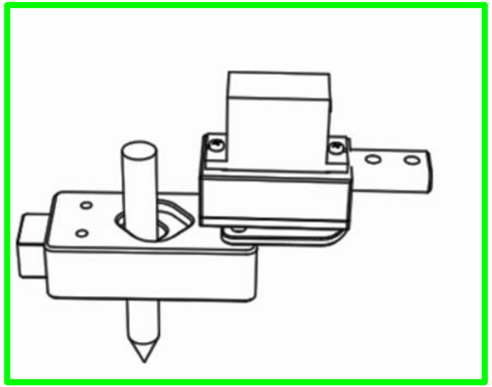
1. We expected to have almost identical (X) depth values but that seem to vary as well

Force Sensor

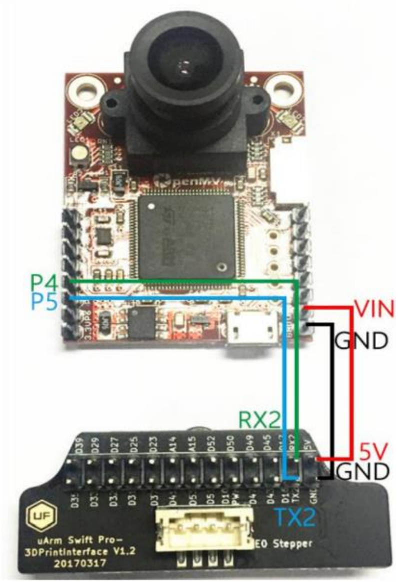
Trial - 1 **Force (N)**	**Trial - 2** **Force (N)**	**Trial - 3** **Force (N)**
0.66	0.77	1.2
0.47	1.29	0.77
1.66	1.57	0.81
1.77	0.67	0.62
1.19	0.78	1.3
0.16	1.05	0.62
Average: 0.99 (N)	**Average: 1.02 (N)**	**Average: 0.88 (N)**



FRIXION BALL
UARM



Trade study: Sensors

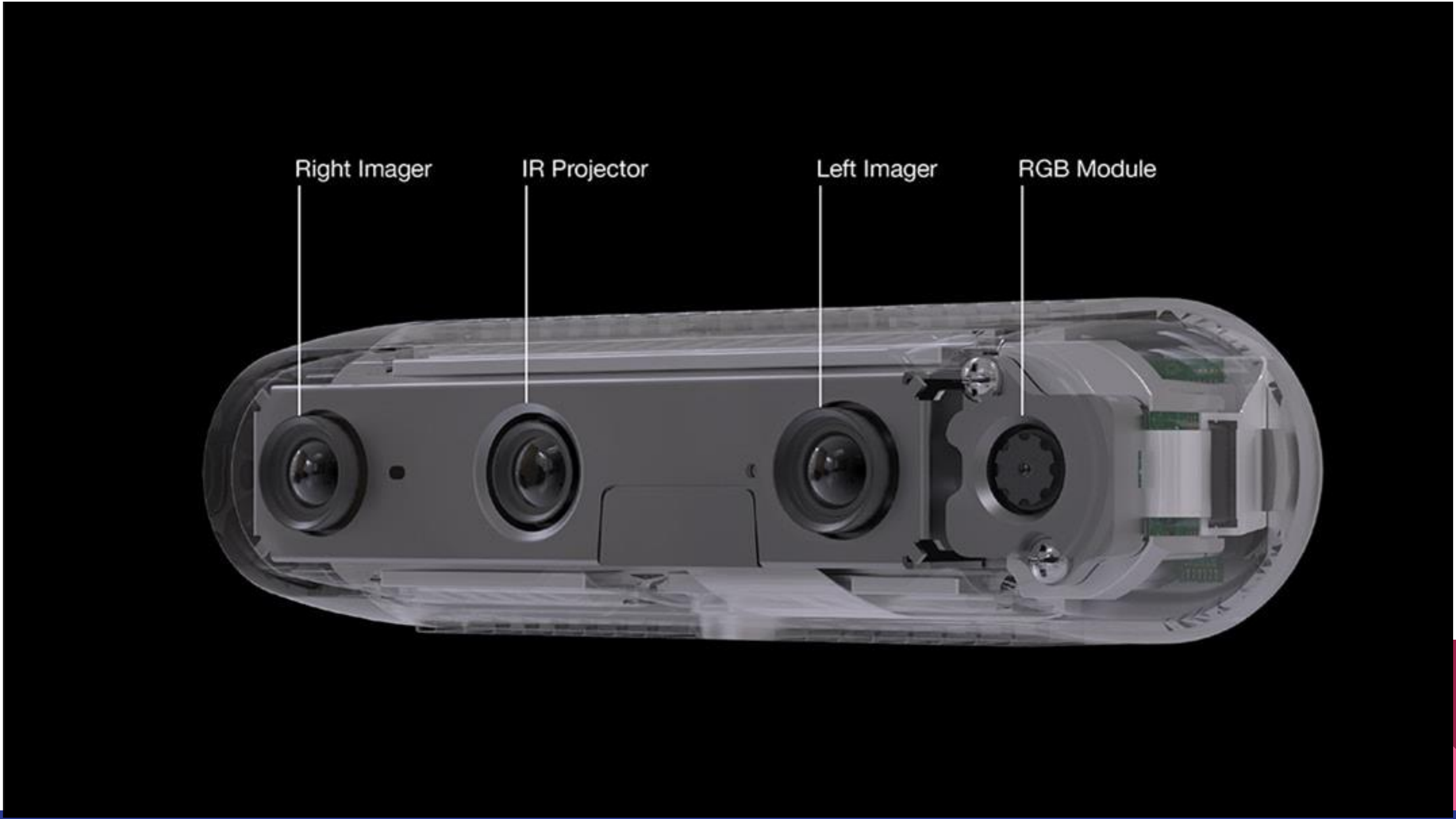


OpenMV Cam H7	Pixy 2	Intel RealSense
$60	$59	$199

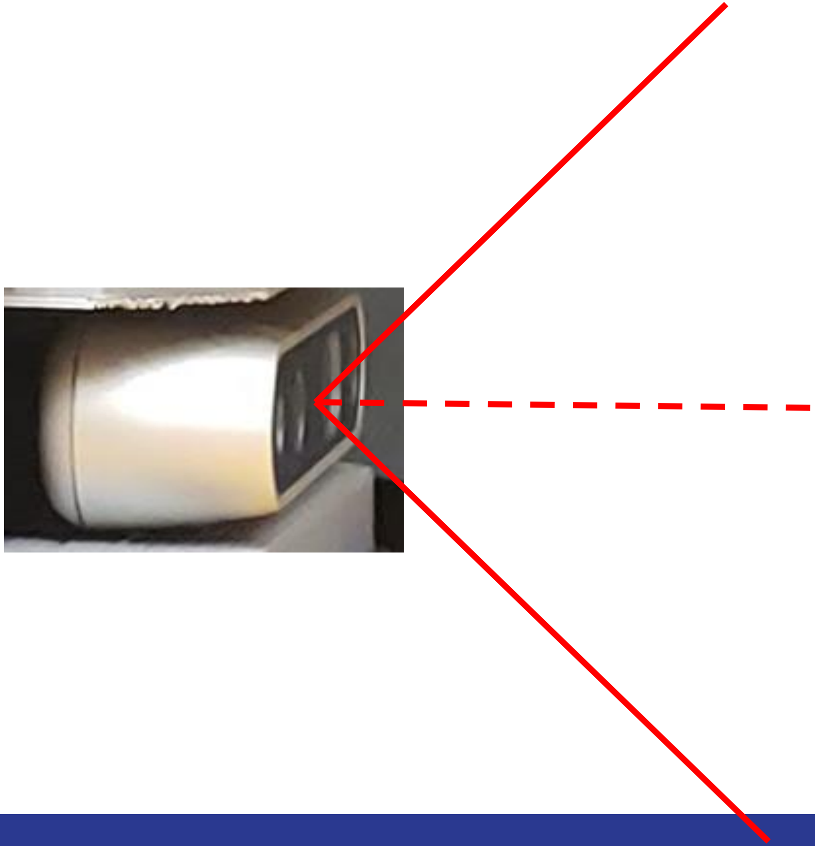
Trade study: Sensors

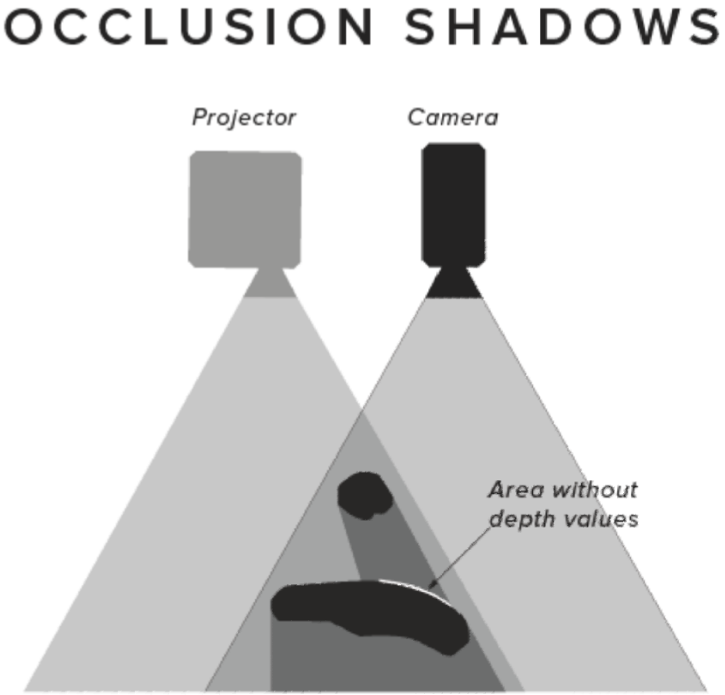
Given scores of 1-3 (higher is better)

Weight	3	1	2	3
Type of Sensor	**Programming ease**	**Depth sensing**	**Image tracking**	**Affordability**
OpenMV Cam H7	3	1	3	2
Intel RealSense	**3**	**3**	**3**	**2**
Pixy 2	2	1	2	2
Weighted score	OpenMV Cam H7	Pixy camera	**Intel RealSense**	
	22	17	**24**	

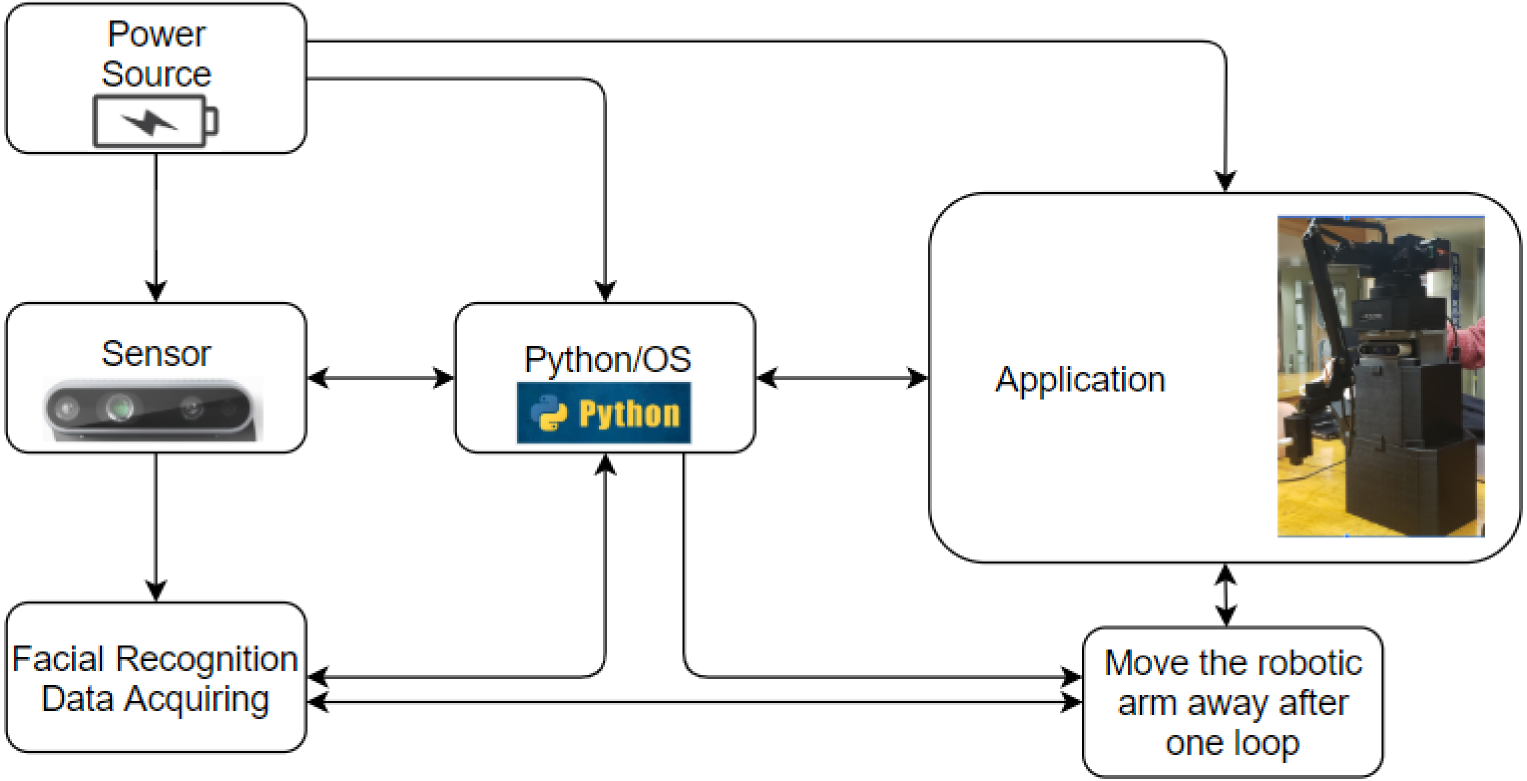

Right Imager
IR Projector
Left Imager
RGB Module

Infrared Projector and Camera

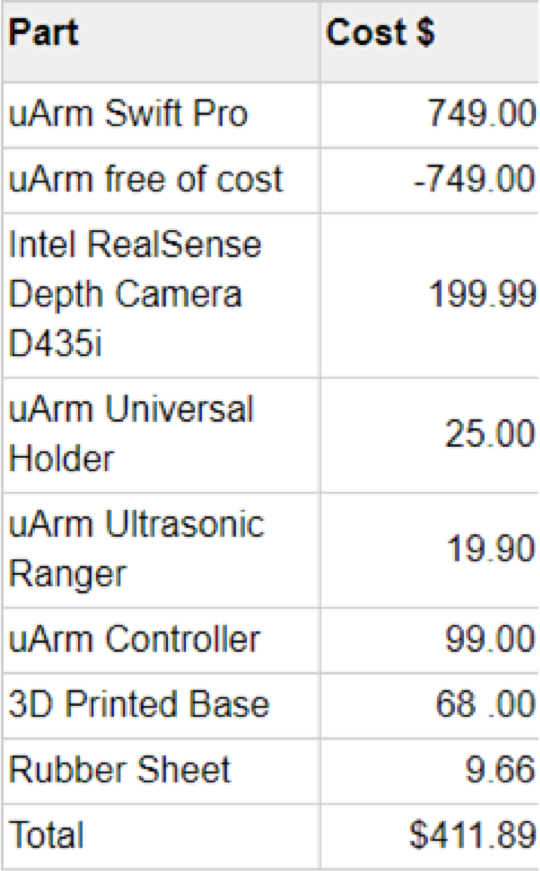




System Schematic


Power Source
Sensor
Python/OS
Python
Application
Facial Recognition Data Acquiring
Move the robotic arm away after one loop

Budget



Part	Cost $
uArm Swift Pro	749.00
uArm free of cost	-749.00
Intel RealSense Depth Camera D435i	199.99
uArm Universal Holder	25.00
uArm Ultrasonic Ranger	19.90
uArm Controller	99.00
3D Printed Base	68 .00
Rubber Sheet	9.66
Total	$411.89

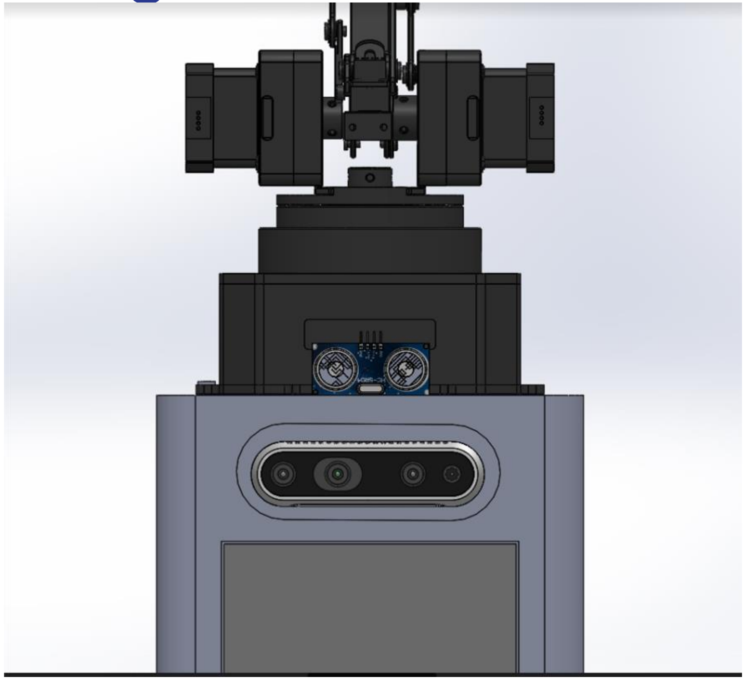
Modeling of the Base Platform

The CAD file for the uArm Swift Pro was obtained from the manufacturer.

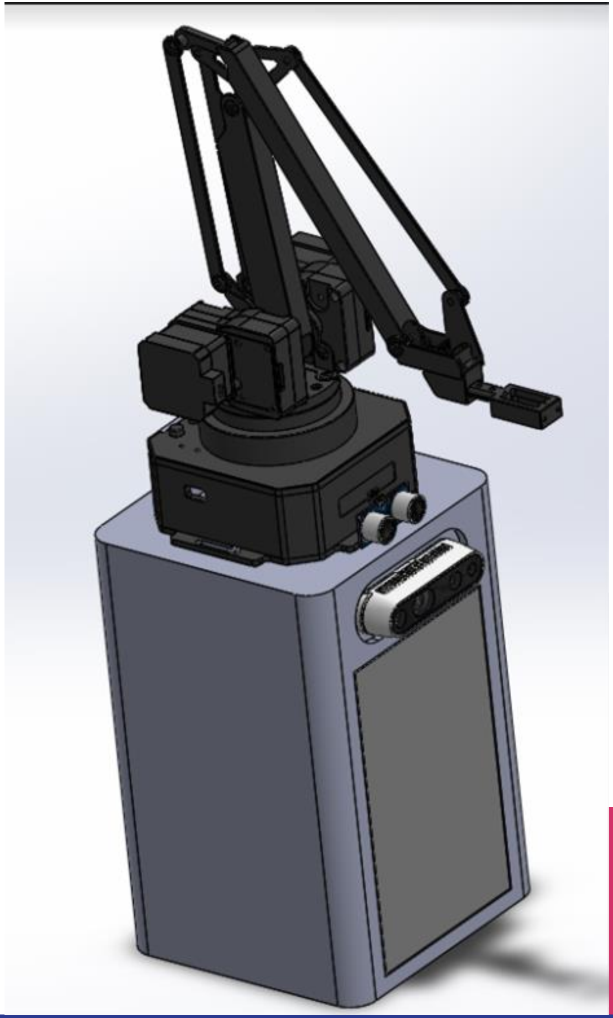
We plan to mount the robotic arm on a platform to raise its height, then secure sensors on openings in the platform.

The camera and sensor will be mounted at eye-level with the user sitting upright at ~10 cm away.

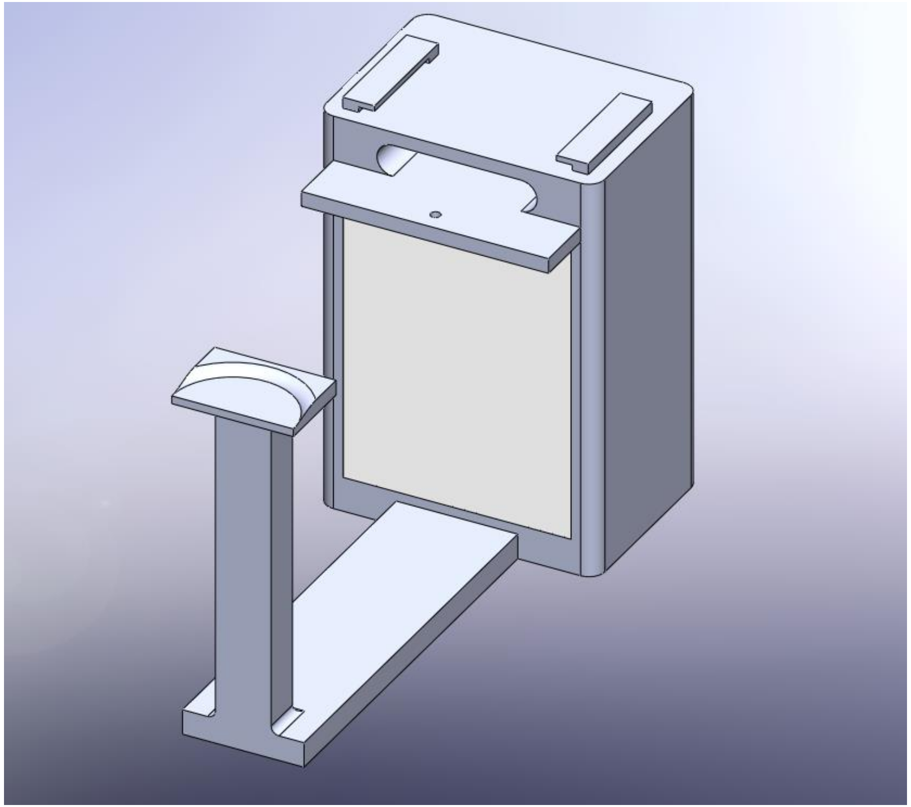
Original Model

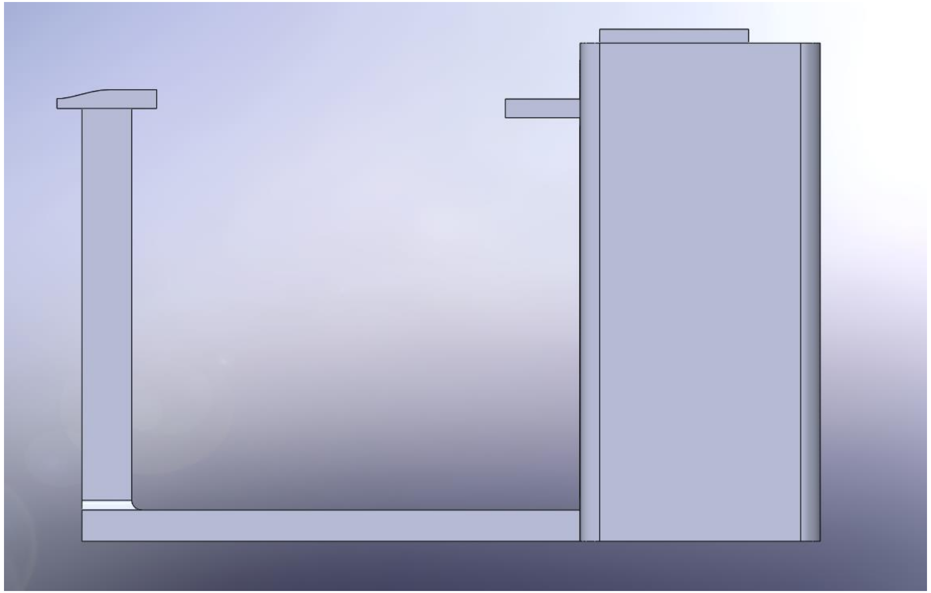


FRONT VIEW



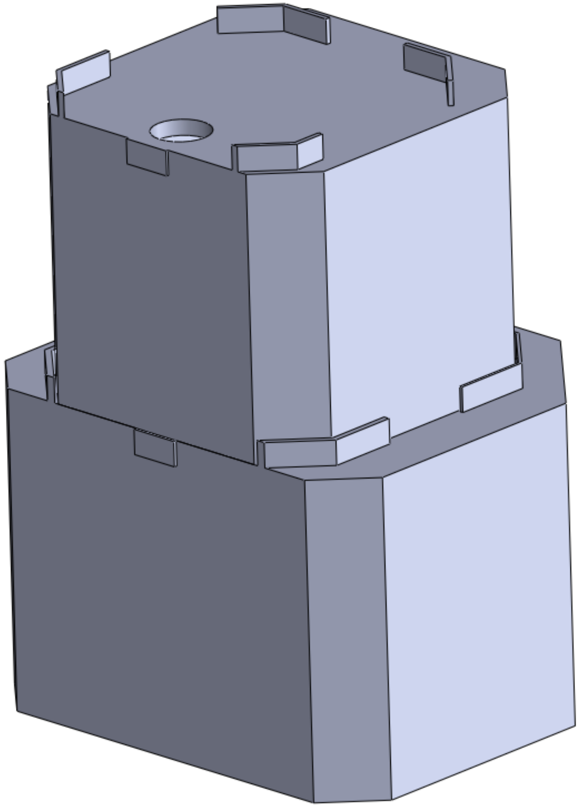
Platform Model Mk2

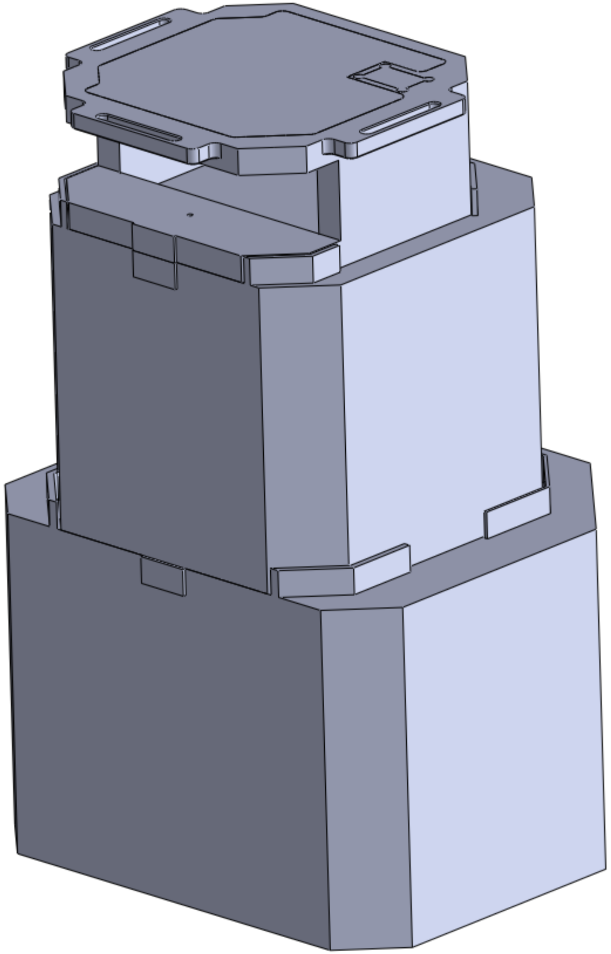


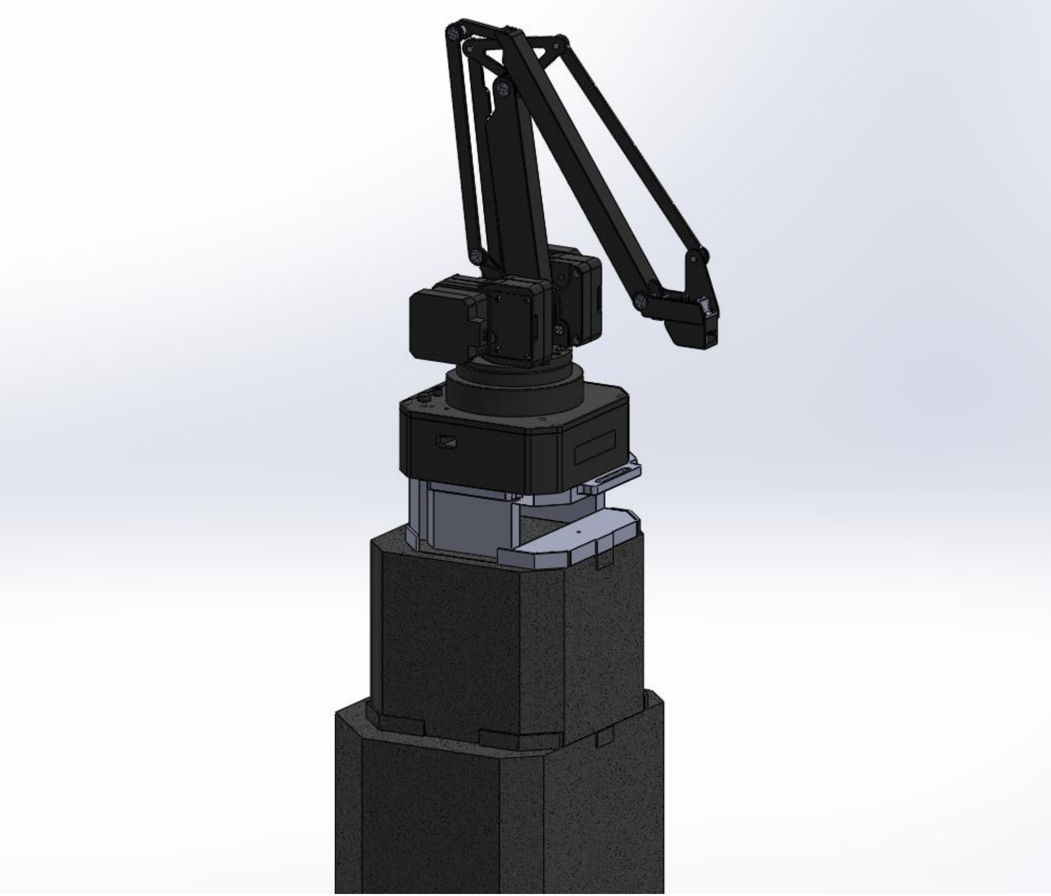


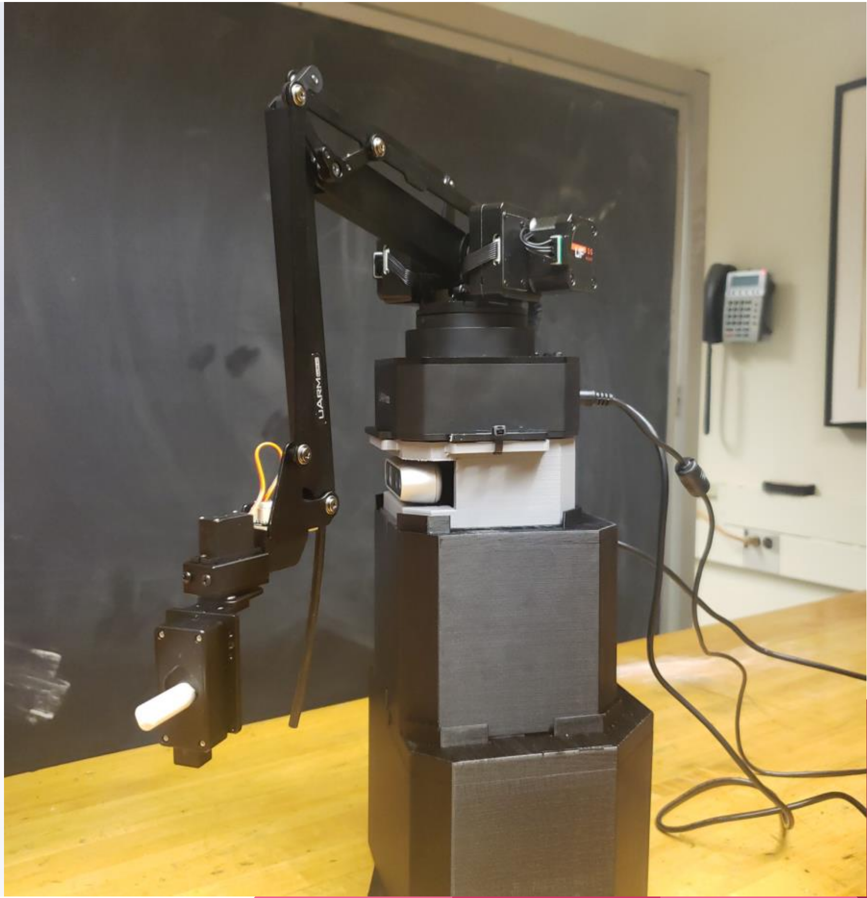
RIGHT VIEW

Final Platform Model

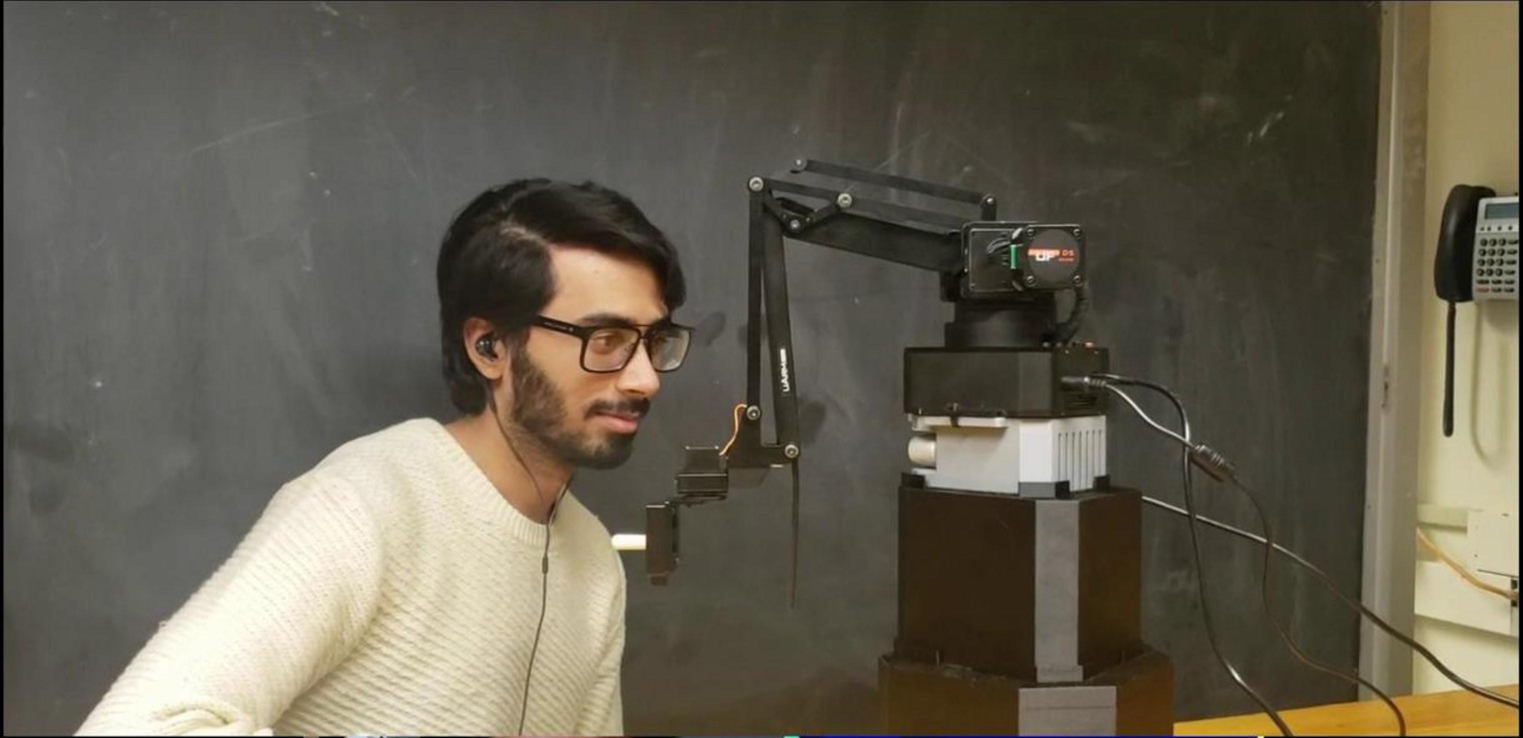


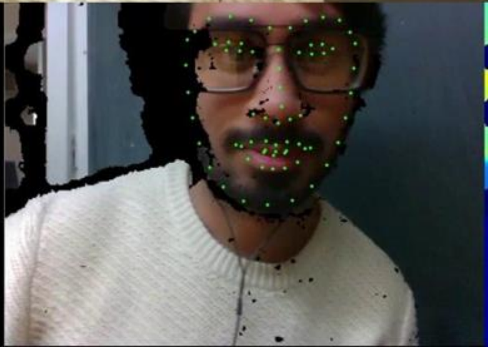






UARM



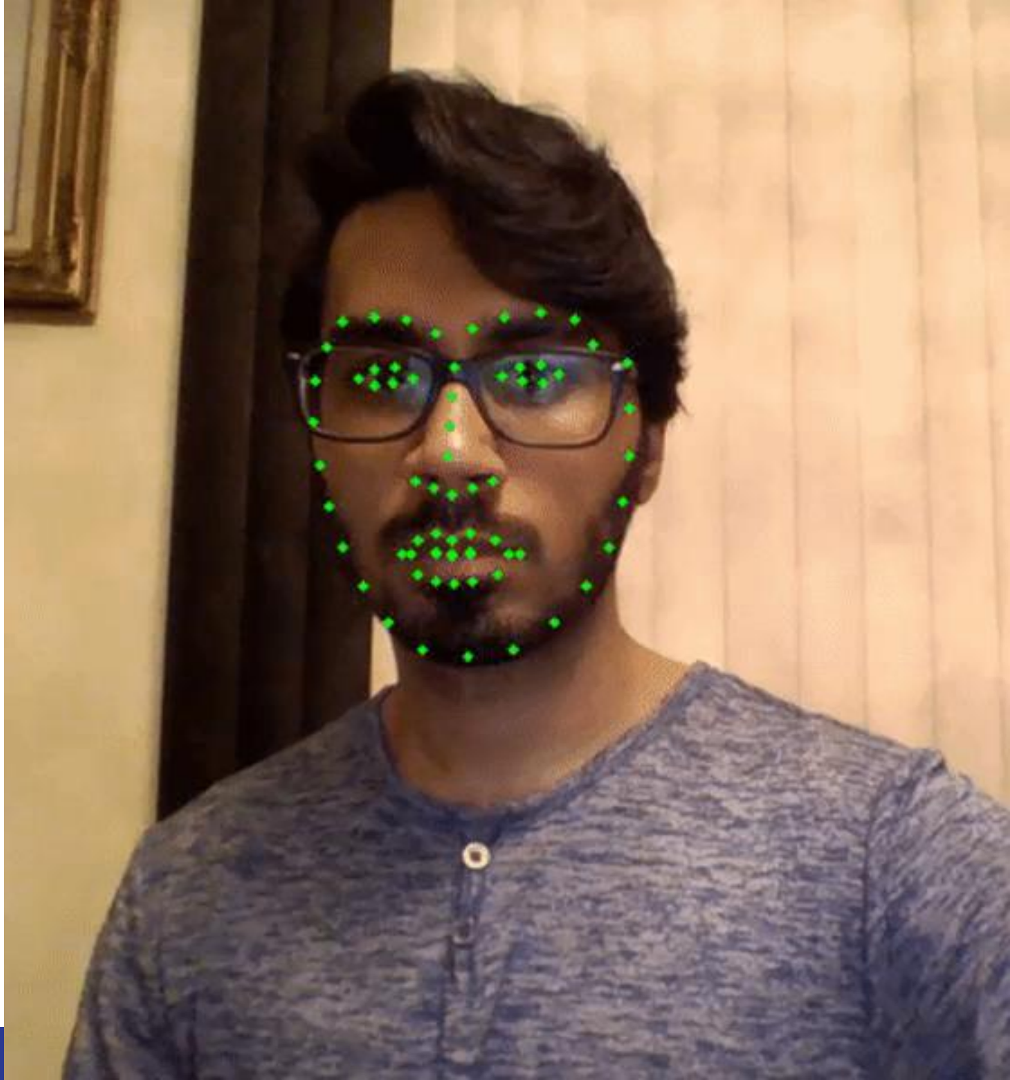


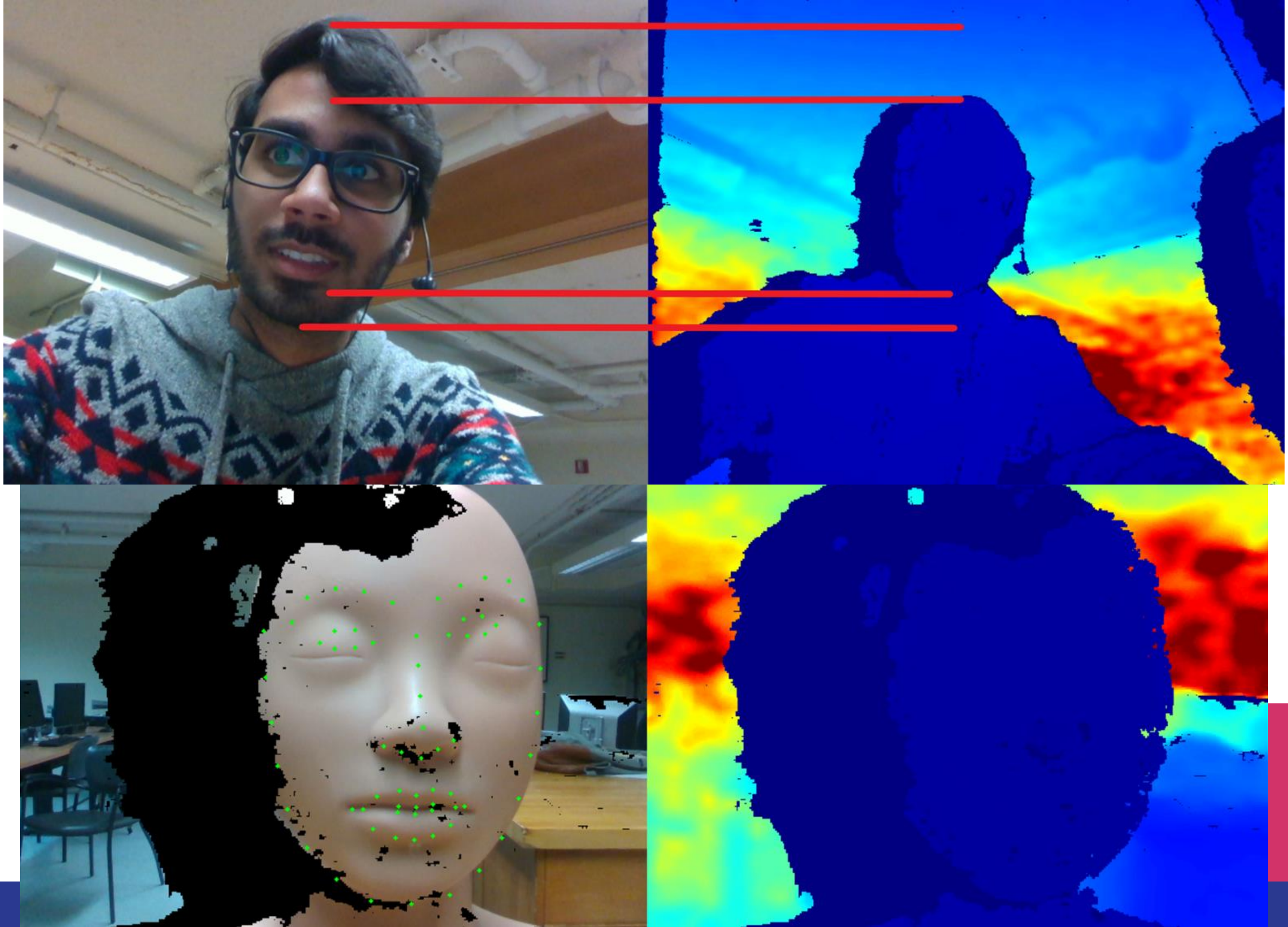
Landmark Tracking

Facial tracking was used by using a machine learning library called dlib.

68 facial landmarks were placed on the face and were tracked in real-time.

This was used on the output of the Intel RealSense D435i to track both the face along with the depth.





Coordinate System Conversion

The camera coordinates are obtained from a 640x480 grid of pixels of an image

The range of the robotic arm was observed inside the range of the camera.

The range (in mm) was divided by the total number of pixels, to get a ratio of mm per pixel.

The camera coordinates were multiplied by this ratio to obtain the mm value to be used by the arm.

Improvements

1. Improve accuracy by either keeping the face at a fixed distance or having different equations depending on distance (machine learning)
2. User Interface with different options for makeup applications such as (eyebrows, foundation)
3. Incorporate Display
4. Force Feedback
5. Proximity sensors around the arm
6. Incorporate voice activated shutdown/pause feature

Our website

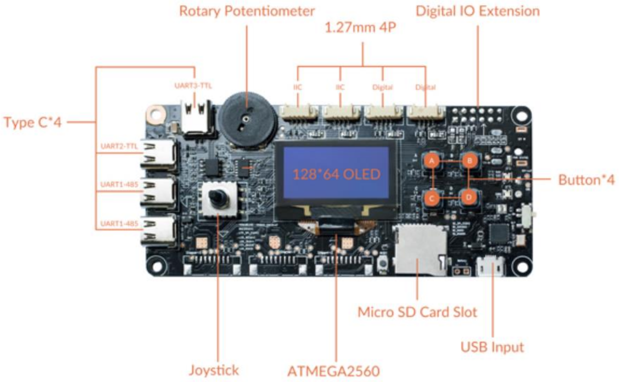
https://vinlarzaby.github.io/Automaticmakeup/

Q&A

References

Face statistics: https://www.facebase.org/facial_norms/summary/#palpfislength_r

Hardware Pictures for website


Rotary Potentiometer
Digital IO Extension
1.27mm 4P
UART3-TTL
IIC
IIC
Digital
Digital
Type C*4
UART2-TTL
UART1-485
UART1-485
128*64 OLED
Button*4
Micro SD Card Slot
USB Input
Joystick
ATMEGA2560