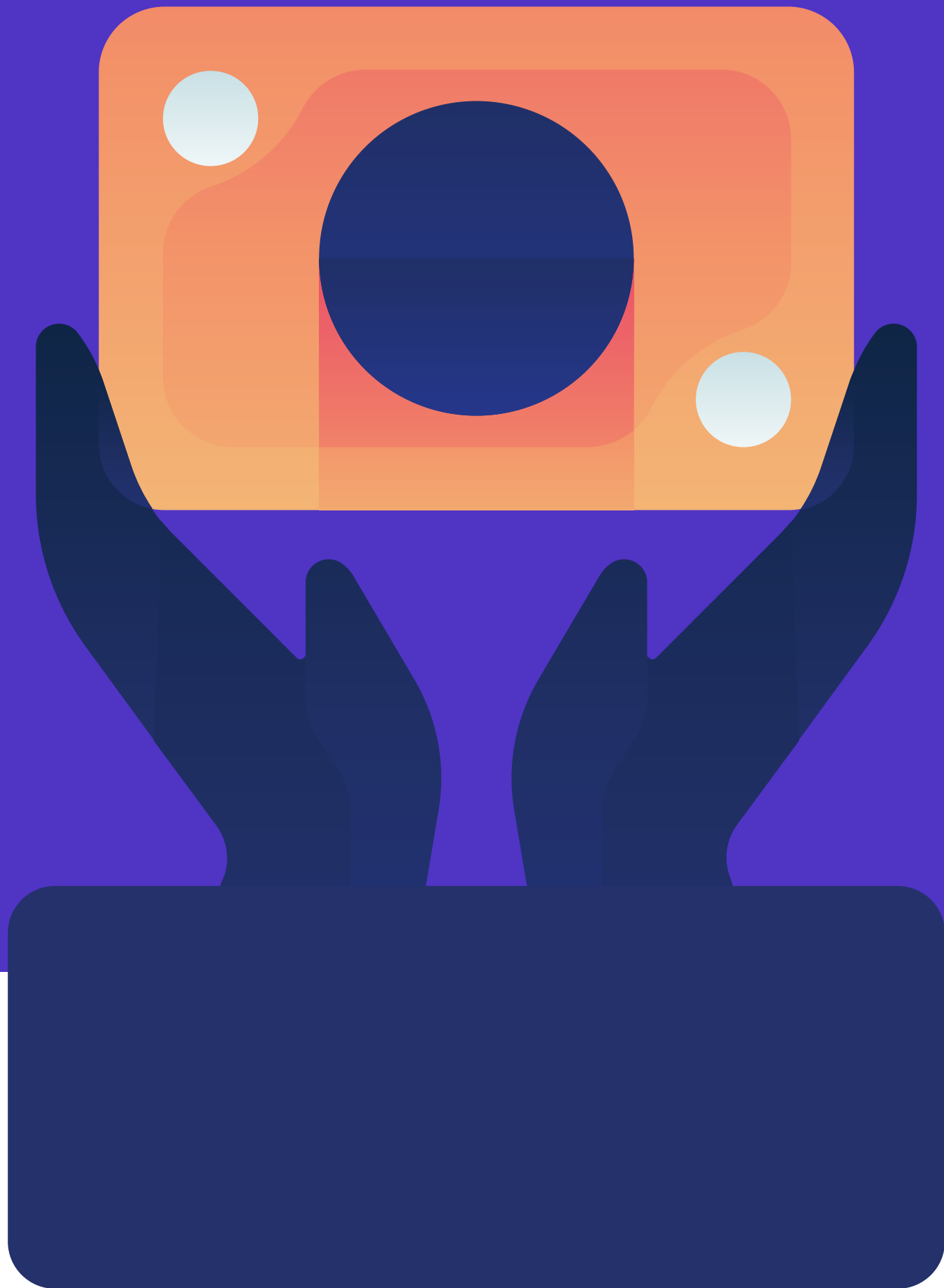ENPM 673 – PERCEPTION FOR AUTONOMOUS ROBOTS
PROJECT 4

Gesture Control for Mobile Robot

"VISION"ARIES
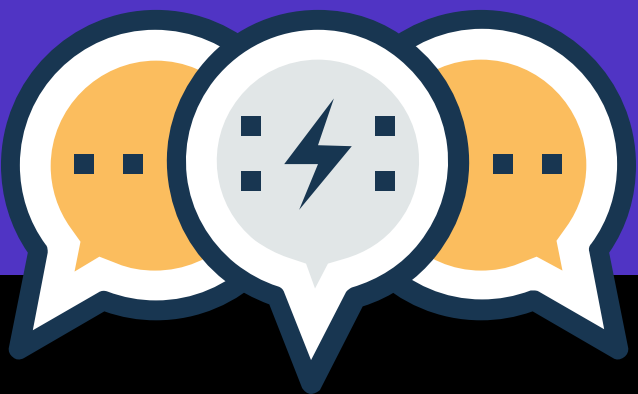
Sharmitha Ganesan
117518931

Rishabh Mukund
117556124

Mukundhan Rajendiran
118154534

AGENDA

01 To project Holographic Image on detected AR Tag.

02 Establish Communications between Host Computer and Mobile Robot

03   Detect Gestures on Host Computer

04 Control the Robot using Gestures

The Impact of the Project

- This project aims at reducing the hardware required to control robot.

- Gesture control can be further implemented in the field of soft robotics.

- Gesture Control can be used to preciously control minute actuations. (Example : Manipulators & Grippers)

- Learning to control the system is comparatively easy for gestured controlled devices and is very modular. (Example : Surgical Robots)
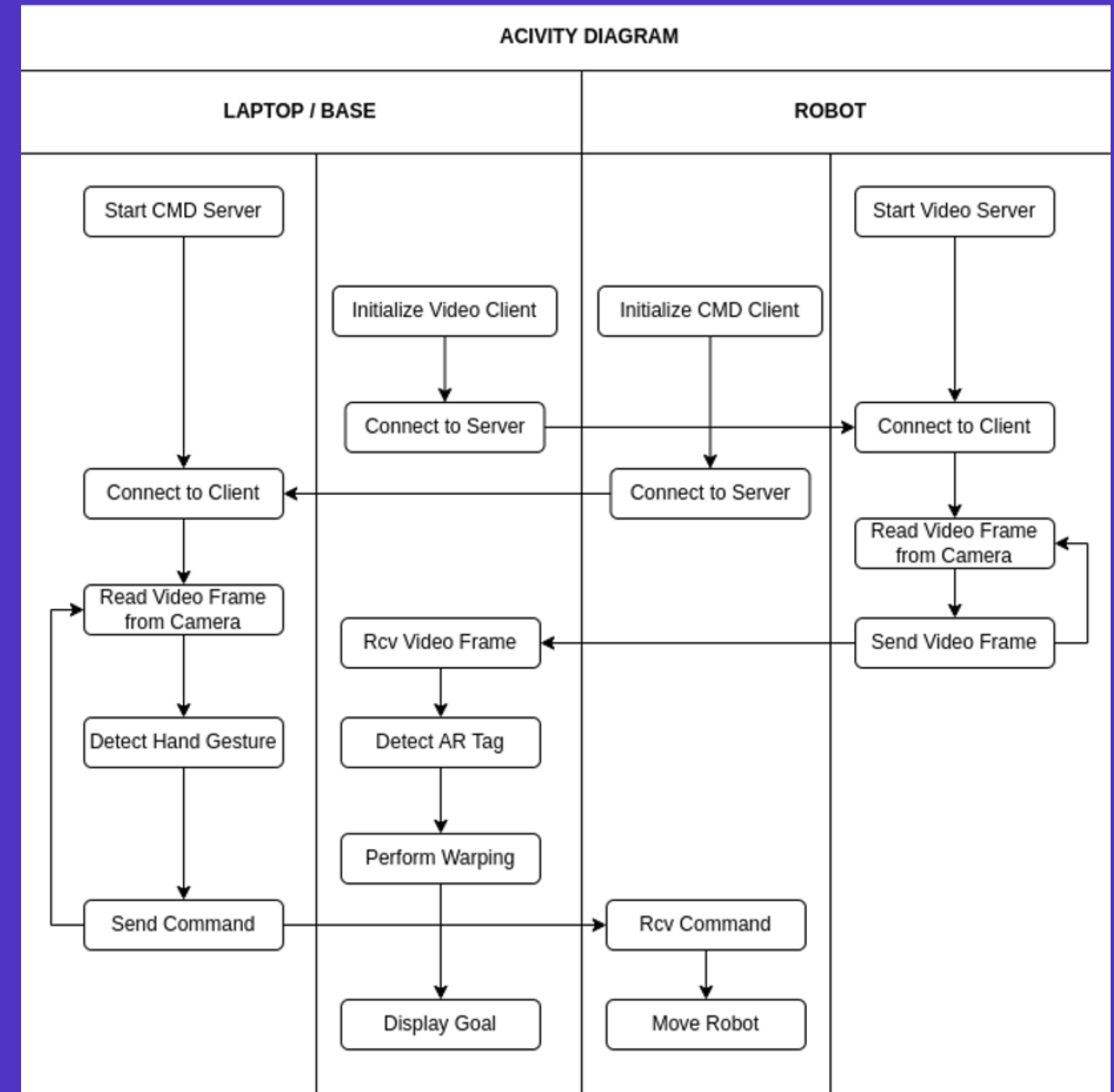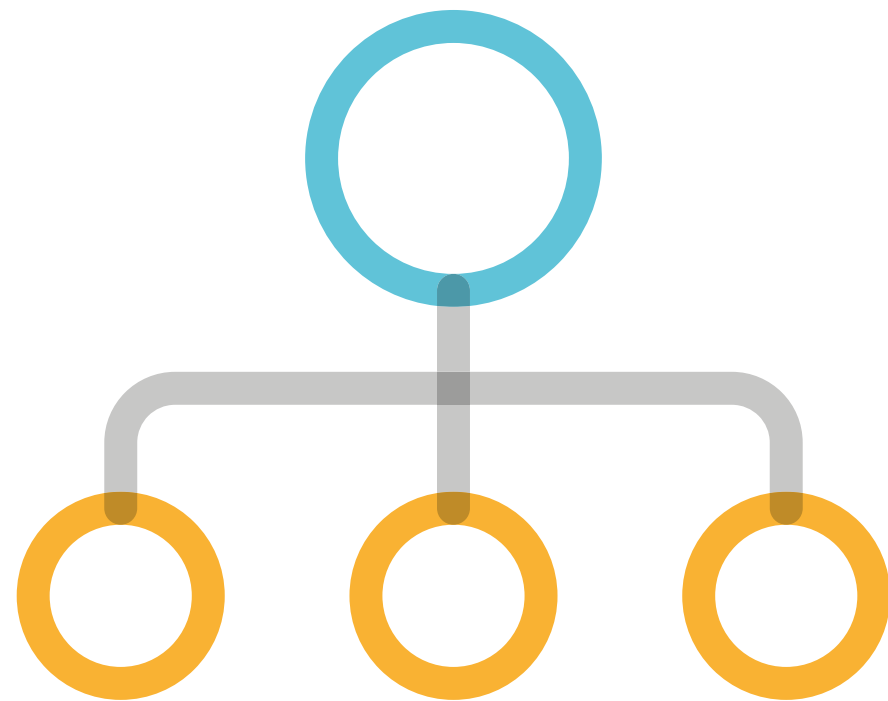
Literature Review

[1] WIRELESS VISION MOBILE ROBOT CONTROL USING HAND GESTURE RECOGNITION

- Wireless vision based mobile robot control was implemented using gesture recognition based on perceptual color space .
- Steps Used : Image Morphology, Canny Edge Detection ,Centroidal Profile for Gesture Recognition
- Implemented on MATLAB

[2] HAND GESTURE RECOGNITION USING NEURAL NETWORKS

- Comparision of algorithms for gesture Recognition
- Wavelet Network Classifiers, Empirical Mode Decomposition, Artificial Neural Network (ANN) & Convolutional Neural Network(CNN)
- CNN is effective in extracting distinct features and classifying data accurately compartively

Process Flow

ACIVITY DIAGRAM

LAPTOP / BASE		ROBOT	
Start CMD Server			Start Video Server
	Initialize Video Client	Initialize CMD Client	
	Connect to Server		Connect to Client
Connect to Client		Connect to Server	
Read Video Frame from Camera			Read Video Frame from Camera
	Rcv Video Frame		Send Video Frame
Detect Hand Gesture	Detect AR Tag		
	Perform Warping		
Send Command		Rcv Command	
	Display Goal	Move Robot	

GESTURE RECOGNITON PIPELINE

STEP 1

Defining the Region of Interest

STEP 2

Capturing first 30 frames of background and implementing Moving Average Filter

STEP 3

Performing Background subtraction and thresholding to detect the hand layout.

STEP 4

Finding Contours & Convex Hull of the hand

STEP 5
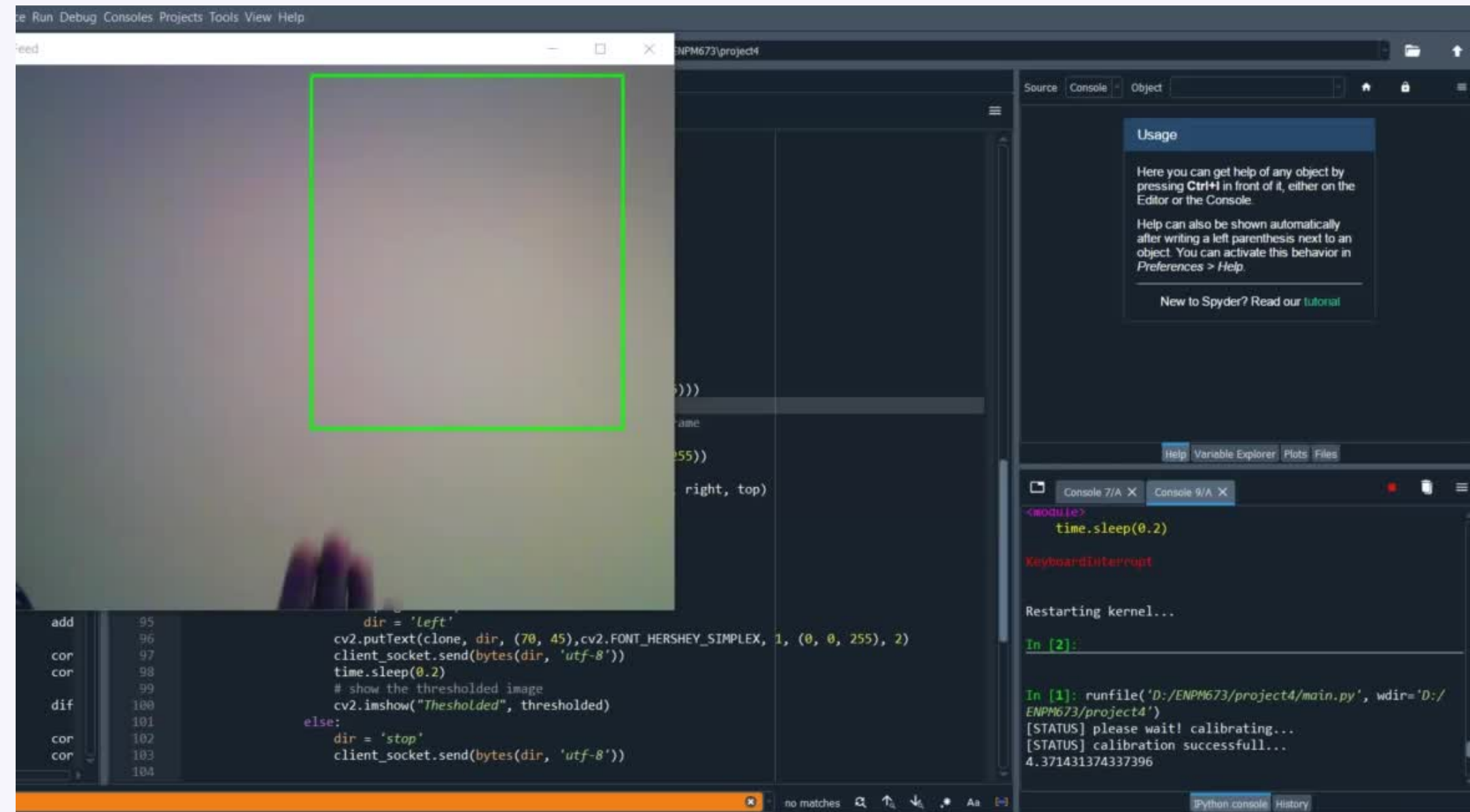
Implementing Principle Component Analysis

STEP 6

Detecting the orientation of hand and returning the angle

Implementation

Video Link:
https://youtu.be/Liex2SA1y6o

COMMUNICATION PIPELINE (LAPTOP TO RASBERRY PIE)

STEP 1
Initializing a socket server on Robot

STEP 2
Initializing socket client on laptop & establishing a connection with the server

STEP 3
Receiving commands from Hand gesture recognition algorithm

STEP 4
Sending commands over socket to the robot

STEP 5
Checking if packages are received successfully and the robot performs required actions

COMMUNICATION PIPELINE
(RASBERRY PIE TO LAPTOP)

STEP 1

Initializing a socket server on laptop

STEP 2

Initializing socket client on robot & establish connection with server

STEP 3

Reading the frames from the webcam of the robot

STEP 4

Compressing each frame into jpg format and sending it to socket

STEP 5

Receiving and decompressing images on the server.

STEP 6

Detecting and tracking AR Tag

HOLOGRAPHIC PROJECTION PIPELINE

STEP 1

Performing Fourier transform on the detected frame

STEP 2

Implementing High pass filter to detect edges of the frame

STEP 3

Performing Morphology, Thresholding and Corner Detection

STEP 4
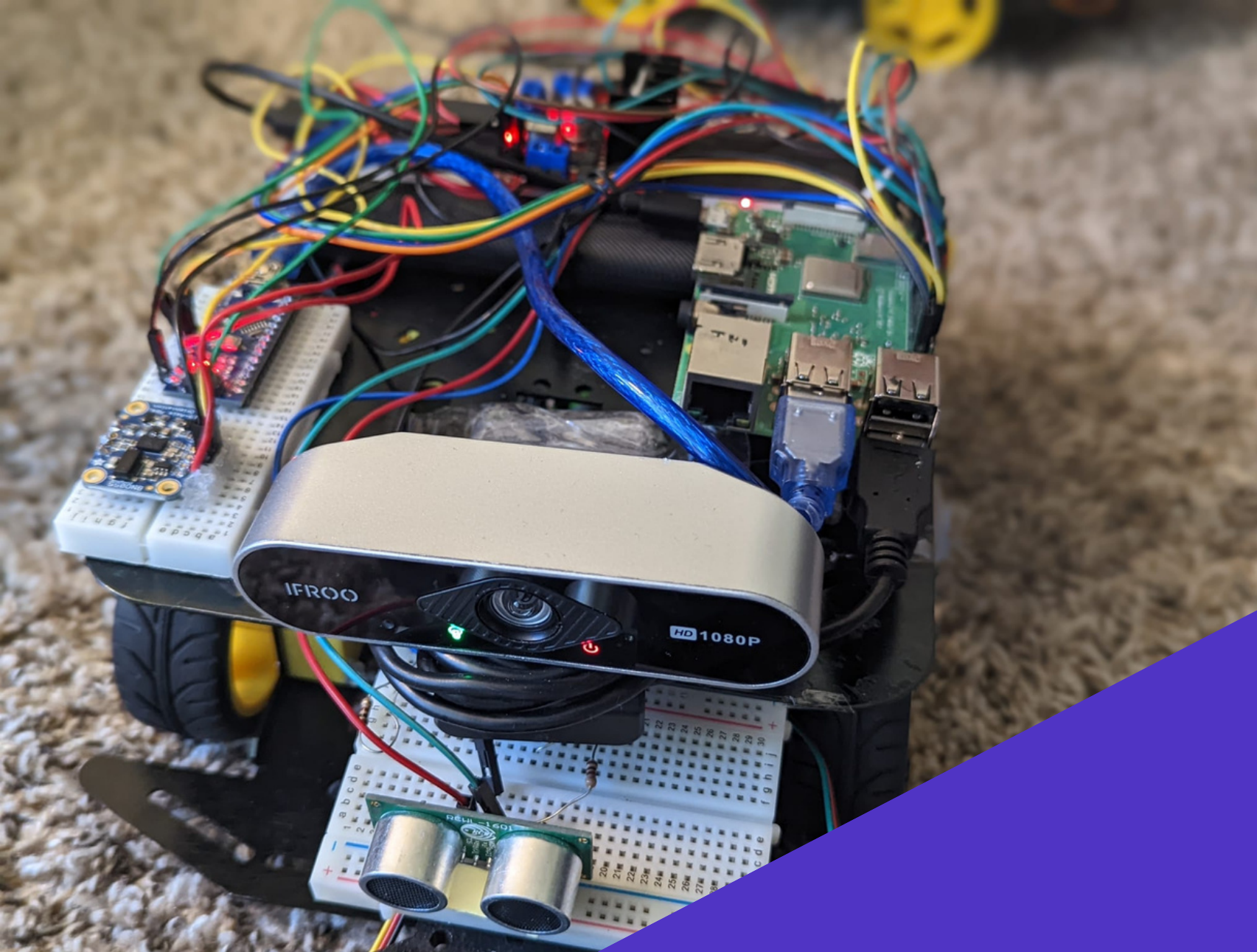
Acquiring AR Tag points and calculating homography matrix

STEP 5

Projecting blimp using inverse warping and interpolation

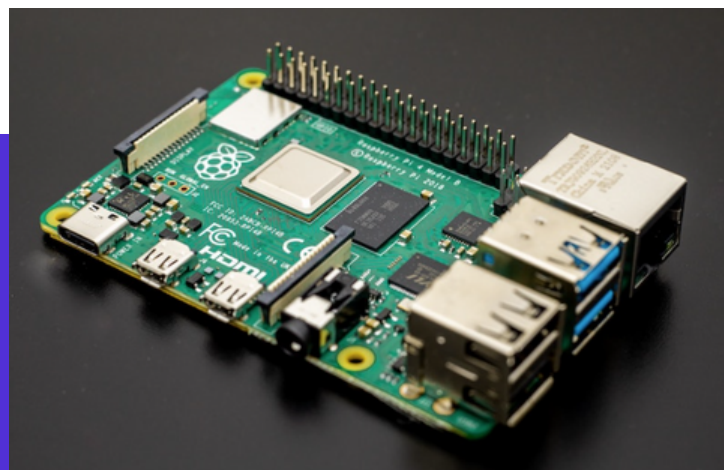# Implementation

Video Link :
https://youtu.be/Q_RIAZu5FfI

Mobile Robot

Hardware Specifications

Rasberry Pie 4 Model B

- Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
- 8GB LPDDR4-3200 SDRAM
- 5.0 GHz IEEE 802.11ac wireless
- H.265 (4kp60 decode), H264 (1080p60 decode, 1080p30 encode)OpenGL ES 3.1, Vulkan 1.0
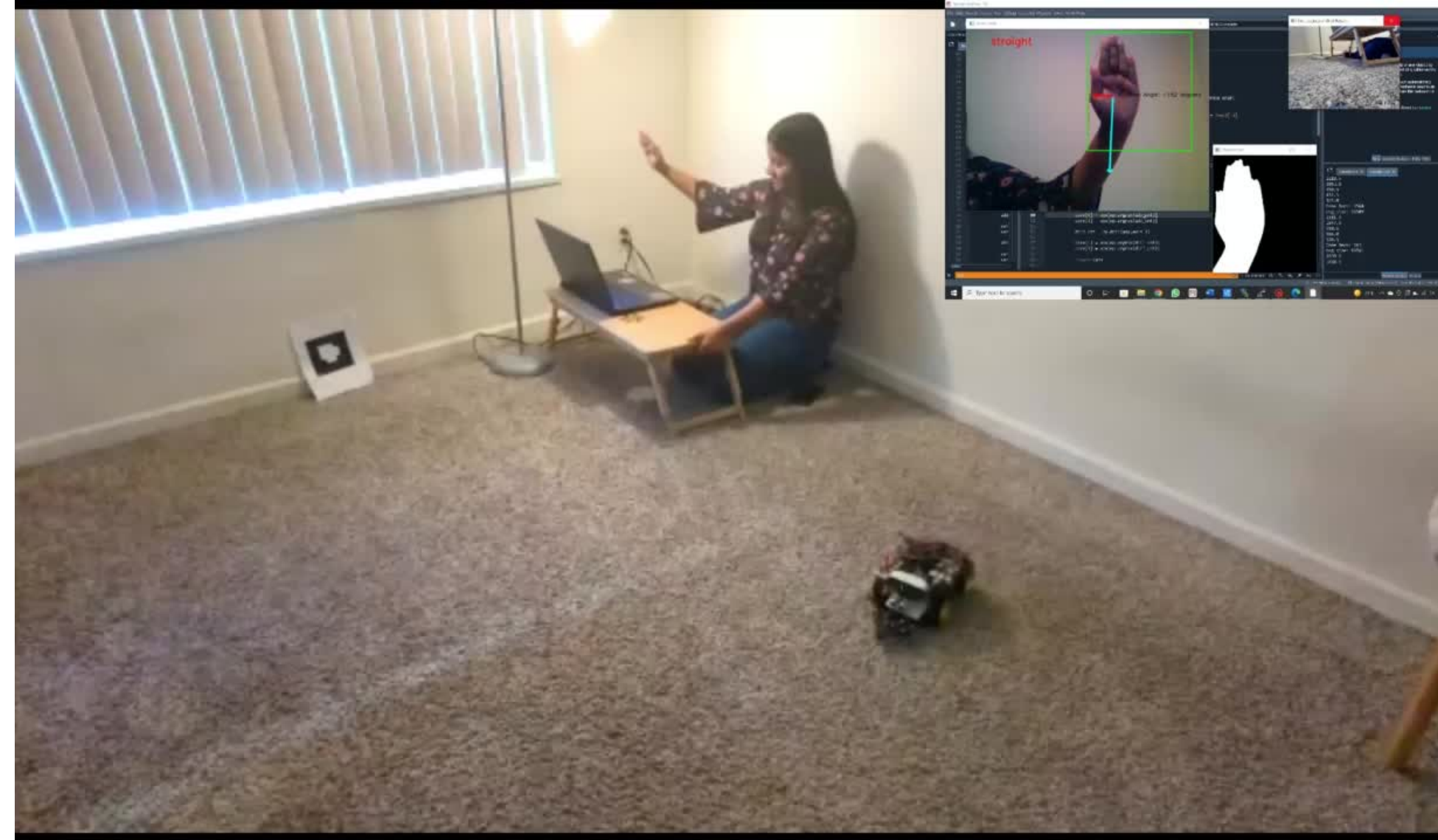

IFROO Webcam

- CMOS Image Sensor
- Refresh Rate :1080P@30fps
- Resolution :1920x1080

Implementation

Video Link :
https://youtu.be/jSl22JyqCok

Further Enhancements

- DETECT AND RECOGNISE MORE GESTURES, TO INCREASE THE ACTION SPACE FOR THE ROBOT

- IMPLEMENT ERROR HANDLING IN COMMUNICATIONS

- MAKING THE ALGORITHM ADAPTIVE FOR DIFFERENT LIGHTING CONDITONS
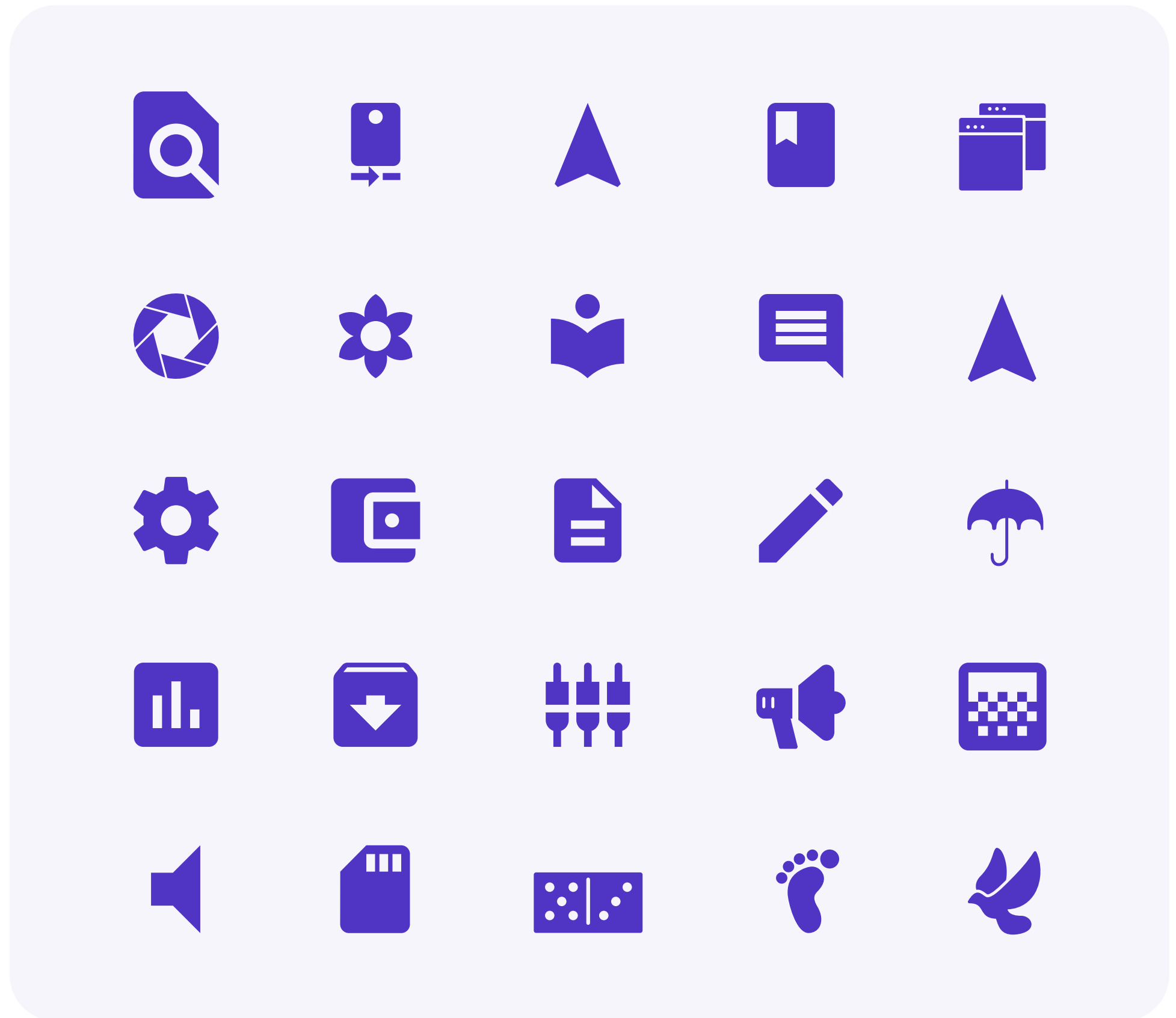
- REDUCTION OF NOISE IN LIVE FEED

Resources Used

Software Used :
- Python :
  - OpenCV
  - Numpy
  - socket
  - scipy
  - MatplotLib

Hardware Used :
- Laptop's Camera
- Rasberry Pie
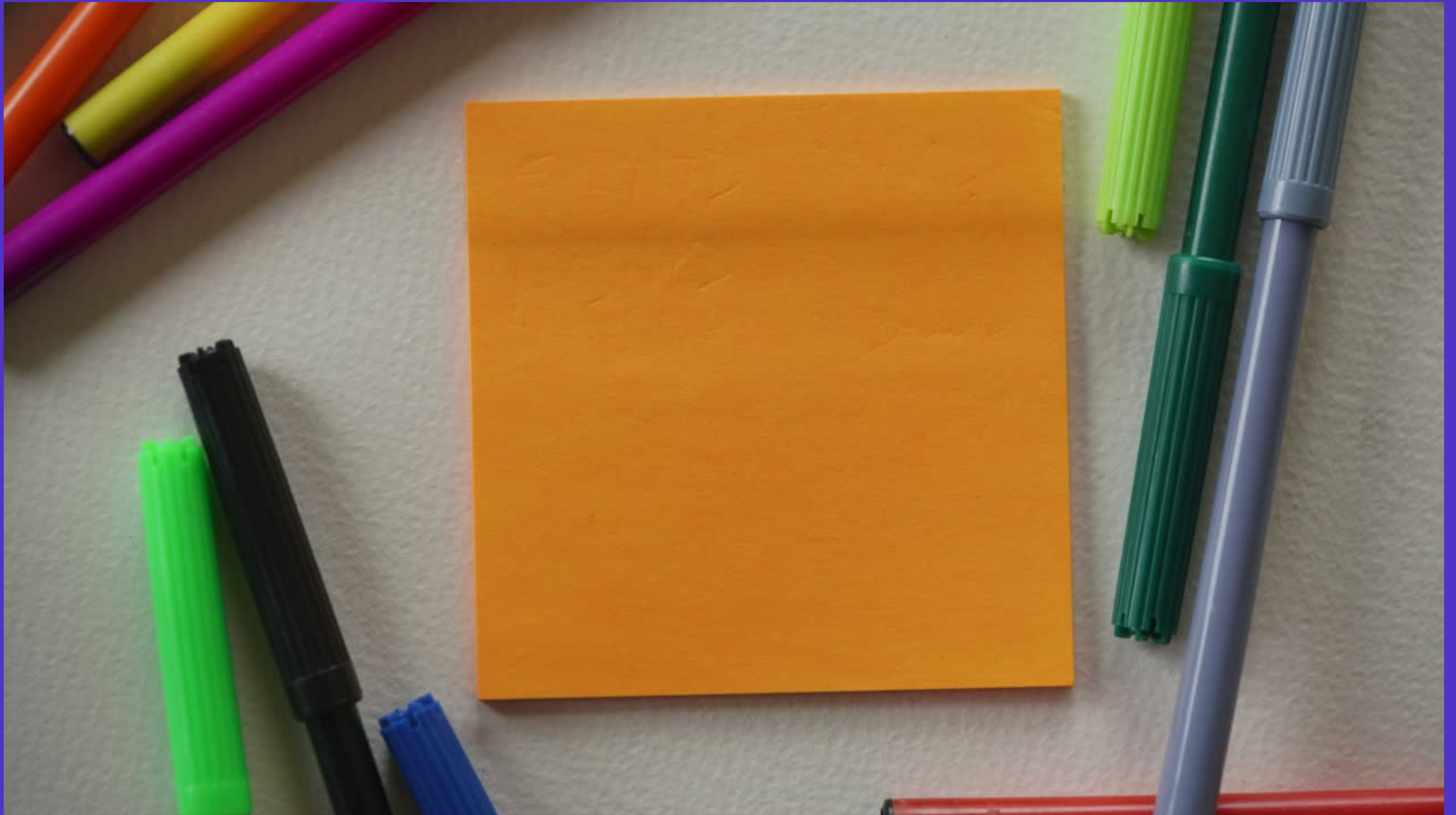- External Web camera
- Motors

Learning Curve

- **Implementation of Convex Hull**

- **Principle Component Analysis was more applicable for the use case comparative to other methods**

- **JPEG Compression**

- **Socket Communication**

CONCLUSION

- Gesture Recognition was implemented
- Serial Communication was established
- Holographic Projection was implemented

References

- Mrs.I Manju Jackin, Mr Manigandan – "Wireless Vision based Mobile Robot control using Hand Gesture Recognition through Perceptual Color Space" –2010 International Conference on Advances in Computer Engineering

- N. Alnaim and M. Abbod – "Hand Gesture Detection Using Neural Networks Algorithms" , International Journal of Machine Learning and Computing, Vol. 9, No. 6, December 2019

- Zhang Ruoyu, Research and Implementation of Key Algorithms of Gesture Recognition in Human – Computer Interaction.[D]. Guangdong University of Technology, 2014.

Do you have
any questions?