A
Minor Project Report on
"SIXTH SENSE ROBOT"

In partial fulfillment of requirements for the degree of

Bachelor of Technology (B. Tech.)

in

Computer Science and Engineering

Submitted by

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Under the Guidance of

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I would also like to thank my fellow mates and parents for providing me with valuable inputs.

Sukriti Shah

170349

CERTIFICATE

This is to certify that the minor project report entitled “Sixth Sense Robot” submitted by Ms. Sukriti Shah, as a partial fulfillment for the requirement of B. Tech. VII Semester examination of the School of Engineering and Technology, Mody University of Science and Technology, Lakshmangarh for the academic session 2020-2021 is an original project work carried out under the supervision and guidance of Mr. P.K. Bishnoi has undergone the requisite duration as prescribed by the institution for the project work.

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ABSTRACT

Sixth Sense is a gesture-based interface, that enhances the physical world around us with digital information and lets us use natural hand gestures to interact with it. Sixth sense technology, bridges the gap between the digital world and physical world. It connects these two worlds seamlessly. Sixth sense technology not only reduces the digital divide but also helps us stay human and intuitive. We no more have to switch between the two worlds and can stay connected to our physical world.

A typical sixth sense technology system first captures the live surroundings with the user interacting with the system either in the picture or video format. The captured images are then processed to extract features from them, and gather the required data for further operations. The user gestures are then recognized from the captured images and devices or apps in the physical world are controlled. Computer Vision is the technology used for this purpose. Humans have a very robust visual system which helps them to identify people and objects, play sports, perform operations, drive vehicles, read and so on. Although it might seem that we do not put any special effort to do most of these tasks human visual system is fairly complex to replicate and implement. Computer vision in the simplest terms is the automation of such a visual system so that computers or machines in general can obtain high-level understanding of the environment from digital images and videos. One application of Computer Vision is Object detection. It deals with detecting Instances of objects of a certain class such as humans, buildings or cars in digital images and videos. computer vision is vital in implementing object detection from digital images.

I am going to make use of Sixth Sense technology and move my robot. A coloured object held in a hand will be tracked via the camera of the laptop and OpenCV library will be extensively used for different image operations for detecting and tracking the object (as the robot will use Computer Vision to recognize hand gestures and movements). Based on the recognized gestures appropriate commands will be sent to the Arduino controlled robot. The Arduino controlled robot will be the final actuator for the Sixth Sense project. DC Motors will be used to drive the motion of the robot and a motor driver circuit will be used to power the motors.

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Chapter 1: Introduction

1. INTRODUCTION

A robot is much like a human being, that is it senses changes in the environment with the help of sensors, thinks about what processes must be performed with the help of logic circuits and electronic components, and finally performs required actions by actuating its mechanical parts.

Sixth sense is basically a gesture-based interface, that enhances the physical world that we live in with information in its digital form and so we are able to use our natural hand gestures to interact with this information, which makes the process more intuitive. Smartphones have enabled us to carry computers with enormous information in our pockets. But clearly, we know that there is no connection or bridge between our interactions with the physical world and our interactions with the digital world. Digital information is still restricted to the devices or screens. Sixth Sense technology bridges this gap by providing access to digital information in the physical world. This technology allows us to interact or access or use or manipulate digital information using simple hand gestures, that is it provides us the ability to play around digital information using simple hand gestures. A user can make use of this technology and navigate a physical map kept on a surface using natural hand gestures. These gestures can be very much like the gestures supported by our touchscreen systems. The application can be designed to zoom that is make information appear larger or smaller or closer or further with respect to the user, using intuitive hand movements. We can draw and paint on any surface virtually by tracking our fingertip movements. Sixth Sense technology can also be used to recognize a user's free hand gestures, and control a physical device based on the gesture. For example, we can control a robot switch or a fan a camera etc just by using our gestures and hand movements. Not only this, the Sixth Sense system adds value to the physical objects that the user is interacting with. For example, a piece of news on paper can show live news i.e., news in the form of a video. One can provide changing information and graphical information on a paper using this technology.

The components of a typical Sixth Sense technology-based system are –

- The system will first capture the live surroundings with the user interacting with the system either in the picture or video format.
- The images so captured are then processed to extract features or data from them, and then the required data is gathered for further operations.
- The user gestures are then recognized from the images that were captured.
- Based on the recognized gestures, devices or apps in the physical world are then controlled.
- As is evident, assessment and manipulation of live images is the most critical component of the entire Sixth Sense technology.

The tool used for this manipulation of digital information is, Computer Vision. We humans have a very powerful visual system which helps us to recognize people and objects and perform various other motor activities. So, it appears as if humans do not put in any effort to do such complex operations or activities, however it is extremely difficult to reproduce the human visual system and achieve its capabilities and mirror its abilities. To reproduce the human visual system for machines, which by the way is a marathon task in itself, we have Computer vision. This is important and crucial so that devices or in other words machines can develop a comprehensive understanding of the physical world or in other words the environment using digital information such as videos or images.

Applications of Computer Vision are –

- Object detection is done to detect occurrences or appearances of objects of a certain category such as buildings, humans or vehicles in digital images and videos. So, Computer Vision is vital in implementing object detection from digital images.
- Detection of events or activity recognition aims to recognize the actions of one or more objects based on a series of observations. For example, by automatically monitoring human activities emergency healthcare services can be provided for people suffering from traumatic health concerns.
- Not only this, we can extend its usability for safety and security purposes like surveillance against intruders and / or animals.

The interaction between people(humans) and computers or we can say the interaction between the physical world and digital world researches and explores the sketch or in other words the outline or blueprint of computer technology and its use, stressing upon the interface between computers and people. Computer vision not only

helps in creating such interfaces, it also works to make them as interactive and user-friendly as possible.

This project uses Sixth Sense technology to make a bot move based on gestures.

1.1 PRESENT SYSTEM

A lot of robots are controlled using remotes that is they are moved via a remote that interacts with their setup or in other words their physical body to direct their movement and control their operation. Other robots make use of different sensors (For example, IR or Infra-red sensors, accelerometer sensors etc.) and based on the operation and working of the sensor being used, their movement is governed. For example, accelerometer sensor-controlled bots, wherein an accelerometer sensor governs the movement of the bot depending on the tilting of the sensor held by the operator. Another example, can be line follower robot. This bot is designed to follow a line of a particular color (say black or white). As long as the environment of the bot helps it detect a black or a white line, its movement is possible. This bot has a lot of useful applications, but in real life until and unless a lined environment is simulated, we can't make use of this bot, as we hardly find lined tracks or paths or environments naturally. We have more examples like, obstacle detector robots. In these robots, if an obstacle is detected by the robot, it changes its course of direction and basically prevents any accidents or collisions for the bot. These bots are extremely useful and find applications in a lot of fields. However, they are mostly integrated with some other robot and barely used directly. Then we have Bluetooth controlled bots, generally designed to have two components, of which one component is the sender part and the other is the receiver part. The Bluetooth communication takes place in between these two components and bot is moved accordingly. Also, in above mentioned kind of robots, information is in the physical world and interaction too remains in the physical world. However, such robots do not exploit computer technology to their benefit and rely partially or completely on the information they gather or process using sensors and inputs from the environment. In this project and robot, we break out of this confinement of the physical world or the confinement of the digital world and link them to make the most of the digital information in the physical world, thus making the handling or interaction more intuitive and user-friendly.

1.2 PROPOSED SYSTEM

In this project, the hand gestures are recognized using Computer Vision and based on the recognition of gestures, appropriate commands are sent to an Arduino Controlled Robot. The Arduino controlled robot is the final actuator for the Sixth Sense project. In this project, a colored object held in hand is tracked by the camera of the laptop. The entire system is programmed in Python and the OpenCV Library is used extensively for Image Processing Operations. The Arduino Uno acts as the primary embedded system for the robot. DC Motors are used to drive the motion of the robot as Arduino Uno cannot power the DC Motors directly, a DC Motor driver circuit is used to interface the Arduino Uno and the DC Motors.

Chapter 2: System Design

2.1. SYSTEM COMPONENTS

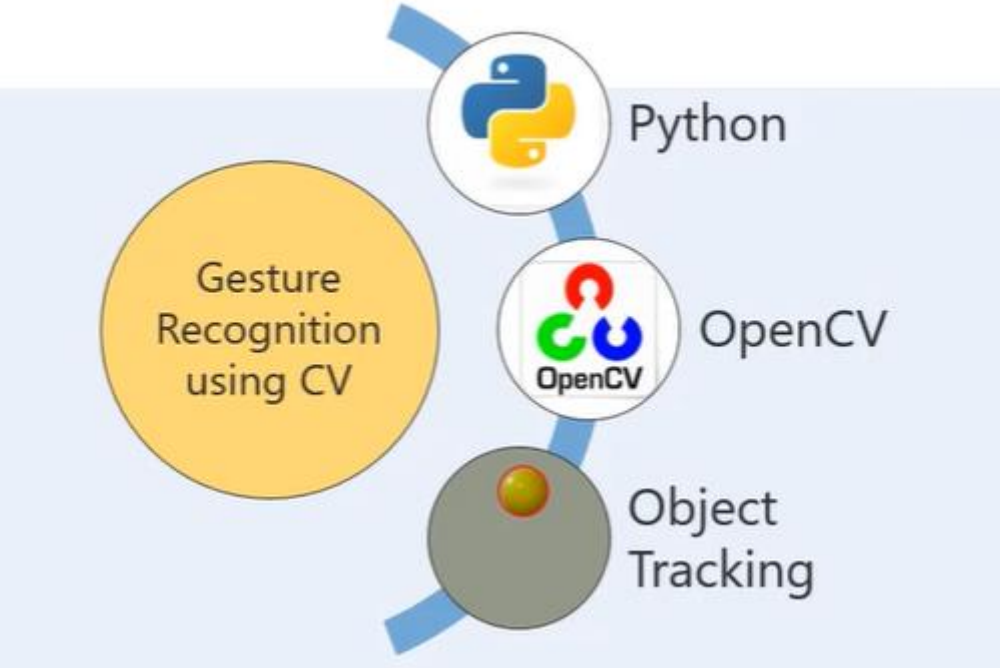


Figure 2.1 - Gesture Recognition Component

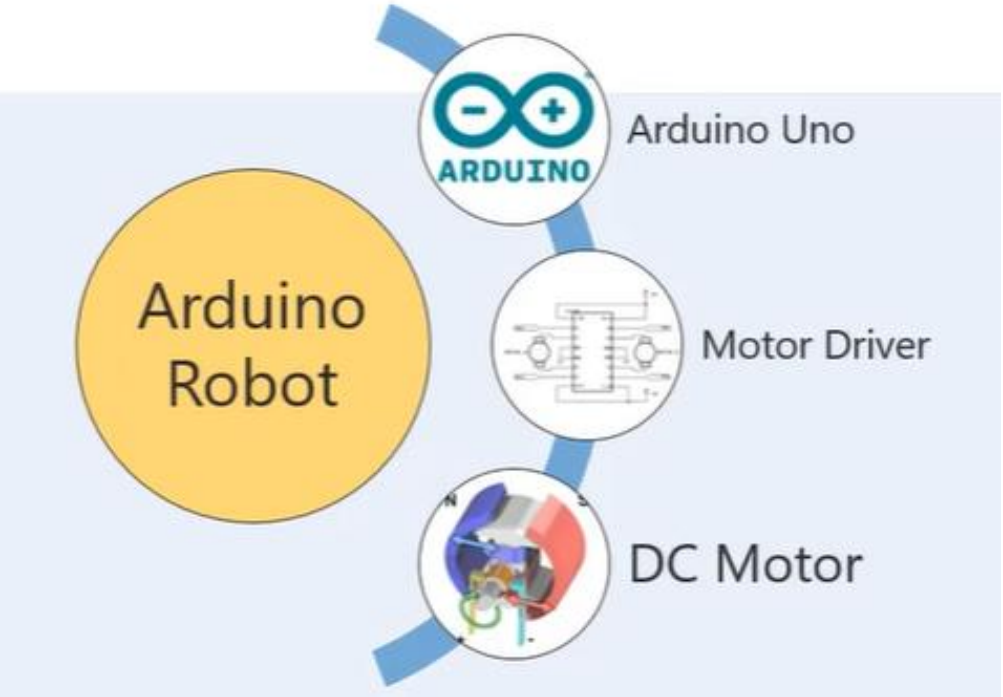


Figure 2.2 – Robot component

2.2. SYSTEM FLOWCHART

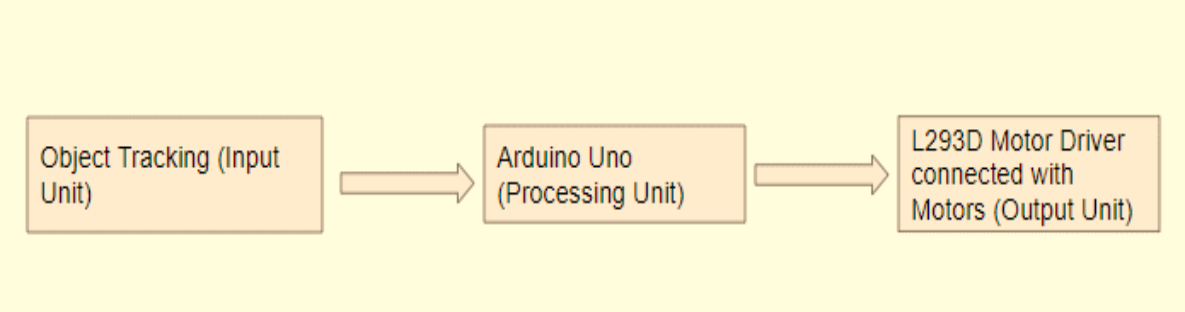


Figure 2.3 – System Flowchart

2.3. PIPELINE FOR SIXTH SENSE ROBOT

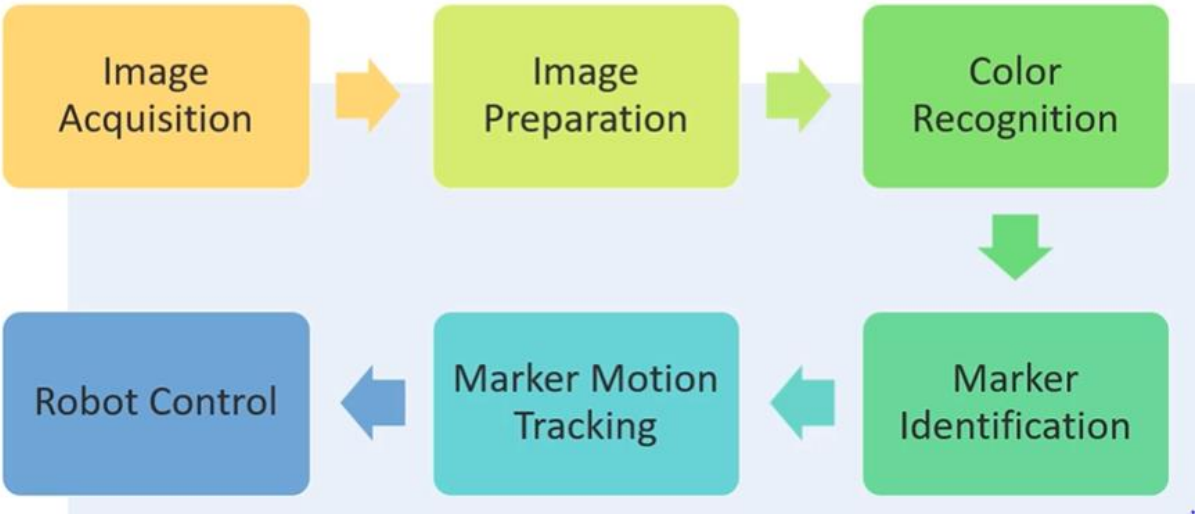


Figure 2.4 – Pipeline for Sixth Sense Robot

Chapter 3: Hardware and Software Details

3.1. HARDWARE TOOLS / COMPONENTS

- **Arduino Uno REV 3**

  Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

  "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

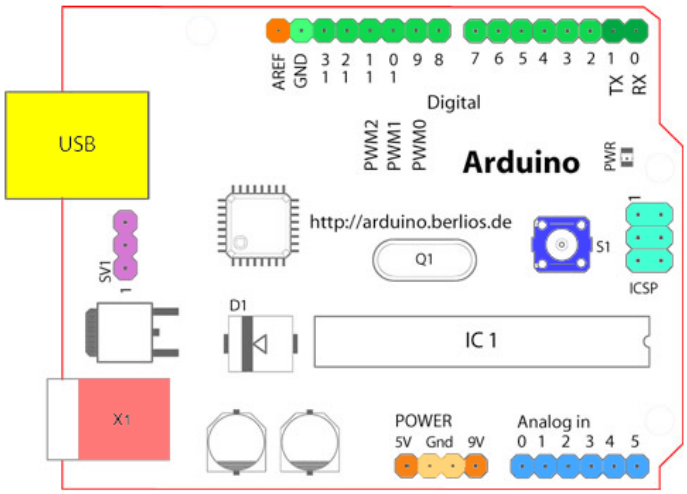


Figure 3.2 – Arduino Uno (Schematic)

Starting clockwise from the top center:

Analog Reference pin (orange)

Digital Ground (light green)

Digital Pins 2-13 (green)

Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (digitalRead and digitalWrite) if you are also using serial communication (e.g. Serial.begin).

Reset Button - S1 (dark blue)

In-circuit Serial Programmer (blue-green)

Analog In Pins 0-5 (light blue)

Power and Ground Pins (power: orange, grounds: light orange)

External Power Supply In (9-12VDC) - X1 (pink)

Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)

USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

Figure 3.2 – Pin Description (Arduino Uno)

- **L293D Motor Driver Module**

  The Motor Driver is a module for motors that allows you to control the working speed and direction of two motors simultaneously. This Motor Driver is designed and developed based on L293D IC. L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5 V to 36 V.

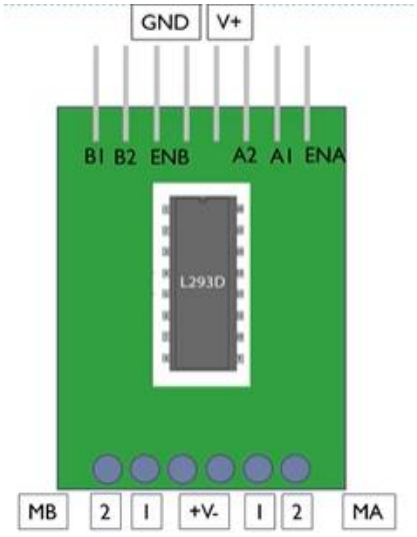


Figure 3.3 – L293D Motor Driver Module (Schematic)

- **Wooden Chassis**

  It is that part of the robot, onto which we place other components of the robot. It is basically responsible for providing structure to the robot.

Figure 3.4 – Wooden Chassis

- **BO1 wheels and BO1 motors**

  Wheels are used for the locomotion of the robot and motors are used to rotate the wheels.

Figure 3.5 – BO1 Wheel

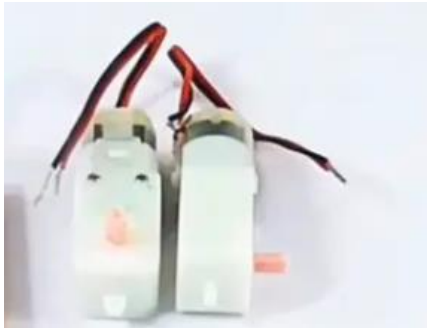


Figure 3.6 – BO1 Motors

- **Metal Clamps (Z Clamps)**

  Metal Clamps are used to hold the motors in place and attached to the chassis i.e., in a way with the body of the robot.

Figure 3.7 – Z Clamps

- **Castor Wheel**

  This is also known as the free wheel, as it can provide movement in any direction and does not need power to do so. It is used to support the front part of the robot, as the back of the robot is supported by 2 BO1 wheels. We cannot use 4 BO1 wheels as the L293D Motor driver Module can provide power and operation for only 2 wheels.

Figure 3.8 – Castor Wheel

- **9V battery connectors and 9V batteries**

  Since we require external power supply, we use 9V batteries and the required 9V battery connectors.

Figure 3.9 – 9V Battery and Connector

- **Male to male Single Pin Connectors**

  These are used for connection purposes.

- **Male to female Single Pin Connectors**

  These are also used for connection purposes.

- **USB to UART cable**

  This is used when Arduino Board, placed on the robot is connected with laptop.

3.2. SOFTWARE TOOLS / PROGRAMMING LANGUAGES

- **Arduino IDE 1.8.13**

  Needed for Arduino Programming which is done on the laptop. The code written here, is sent to the Arduino Board.

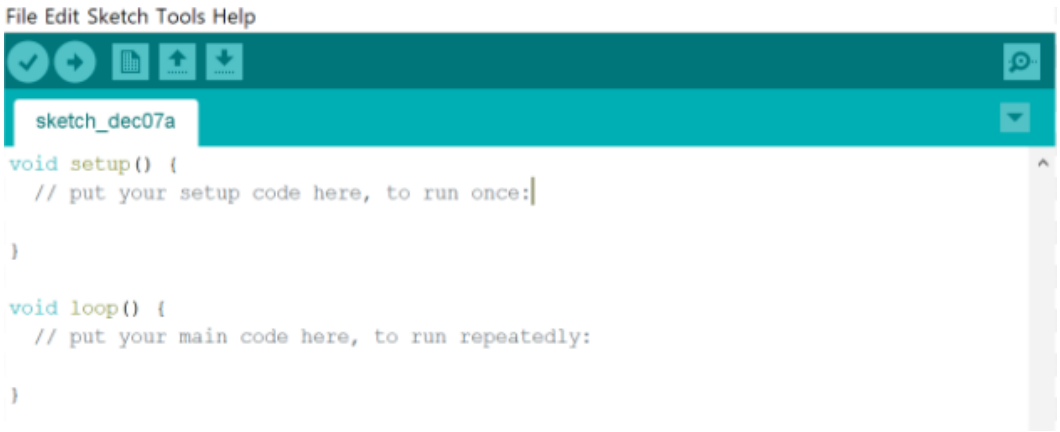


Figure 3.10 – Arduino IDE

- **Python 3.7.1**

  It is a programming language. This is used for coding the object detection part.

- **NumPy 1.15.4**

  Package for Scientific Computing with Python

- **matplotlib 3.0.1**

  2 D Plotting Library available in Python

- **OpenCV-python 3.14.3**

  Library available in Python for Image Processing Operations

Chapter 4: Implementation Work Details

4.1. CONNECTION SCHEMATIC

Component 1	Terminals/Pins		Terminals/Pins	Component 2
Left Motor	Positive Terminal (+)	→	MB2	Motor Driver
	Negative Terminal (-)		MB1	
Right Motor	Positive Terminal (+)		MA2	
	Negative Terminal (-)		MA1	

Figure 4.1 – Connections between Motors and Motor Driver Module

Component 1	Terminals/Pins		Terminals/Pins	Component 2
Motor Driver	EN A	→	5V	Arduino Uno
	INP A1		Digital Pin 10	
	INP A2		Digital Pin 11	
	EN B		5V	
	INP B1		Digital Pin 12	
	INP B2		Digital Pin 13	

Figure 4.2 – Connections between Motor Driver Module and Arduino Uno

4.2. PROGRAMMING LOGIC - MOVEMENT OF THE ROBOT

- **Forward Movement of the Robot**

  In order to move the robot forward, both the wheels should rotate in clockwise direction. For that we need (High, Low) on both the wheels.

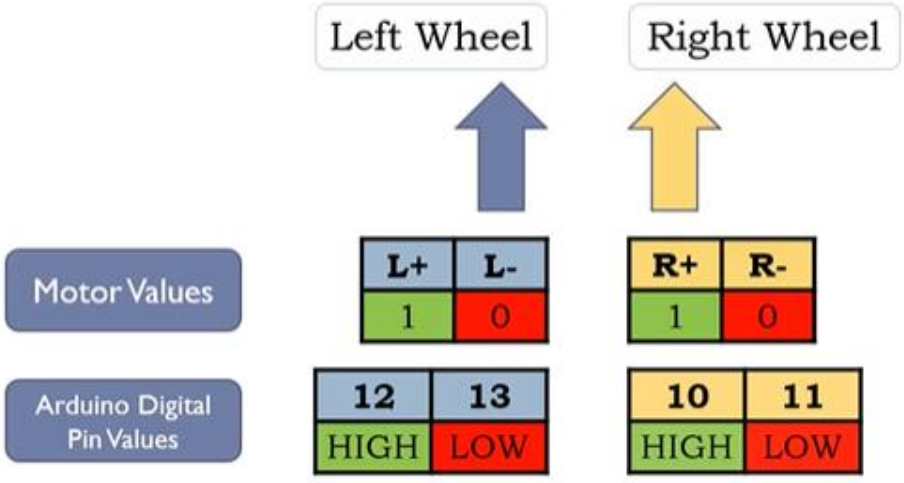


Figure 4.3 – Forward Movement of the Robot

- **Backward Movement of the Robot**

  In order to move the robot backward, both the wheels should rotate in anti-clockwise direction. For that we need (Low, High) on both the wheels.

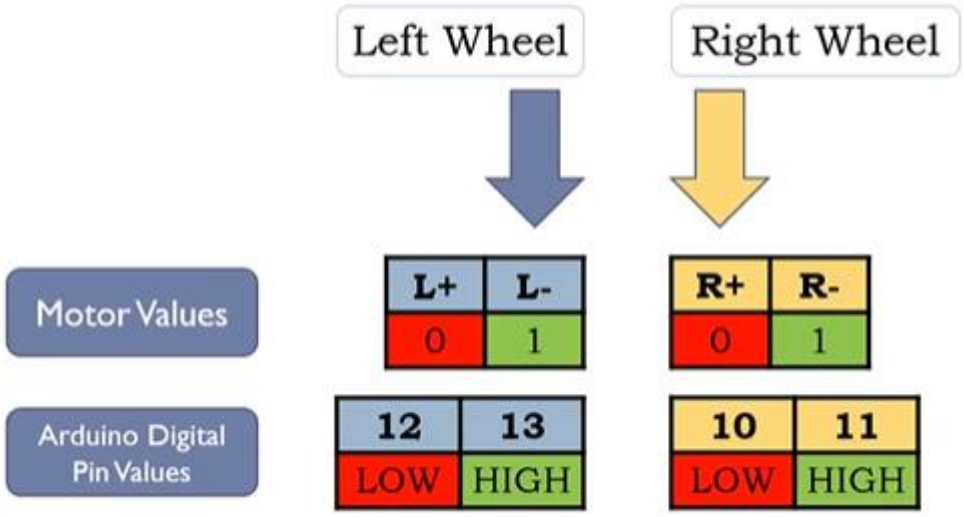


Figure 4.4 – Backward Movement of the Robot

- **Left Movement of the Robot**

  In order to move the robot to the left, left wheels should rotate in anti-clockwise direction and right wheel should rotate in clockwise direction. For that we need (Low, High) on left wheel and (High, Low) on the right wheel.

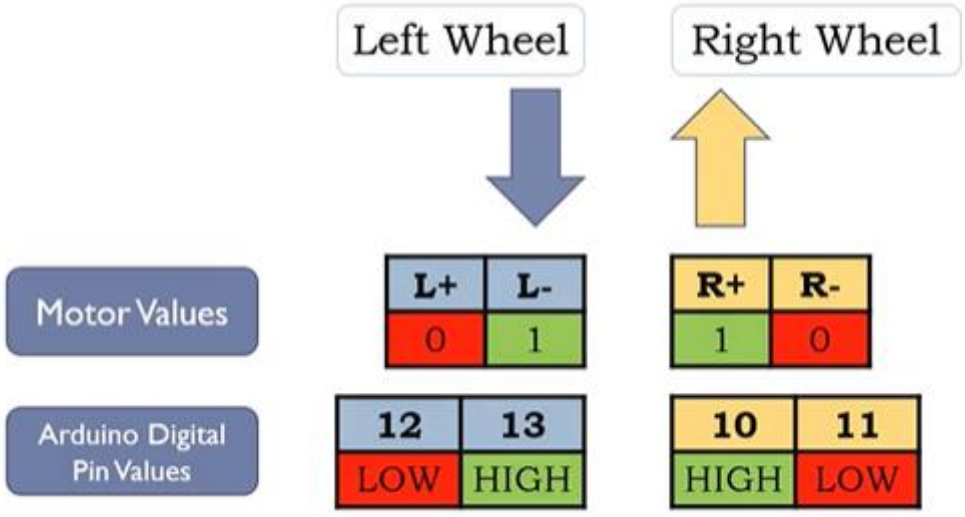


Figure 4.5 – Left Movement of the Robot

- **Right Movement of the Robot**

  In order to move the robot to the right, left wheel should rotate in clockwise direction and right wheel should rotate in anti-clockwise direction. For that we need (High, Low) on left wheel and (Low, High) on the right wheel.

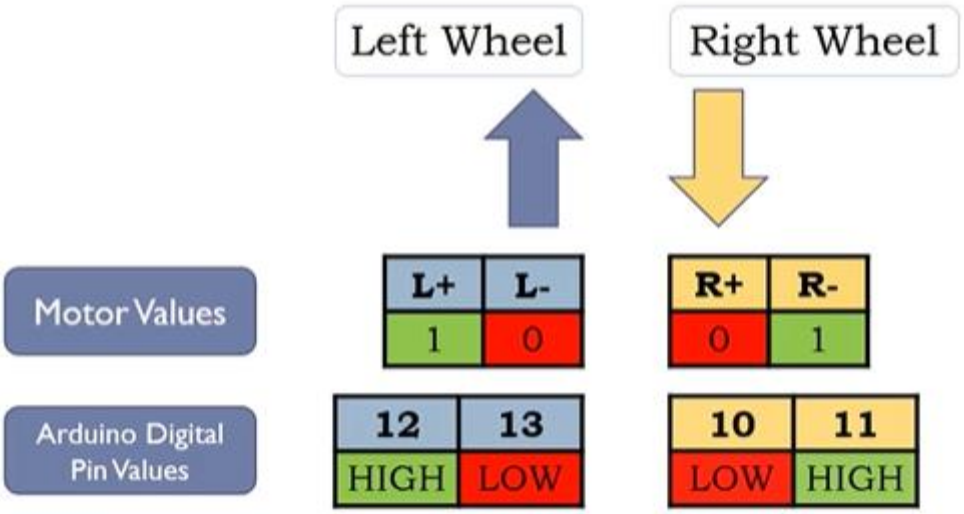


Figure 4.6 – Right Movement of the Robot

- **Stop the Movement of the Robot**

  In order to stop the movement of the robot both the wheels should rotate in anti-clockwise direction. For that we need (Low, Low) on both wheels.

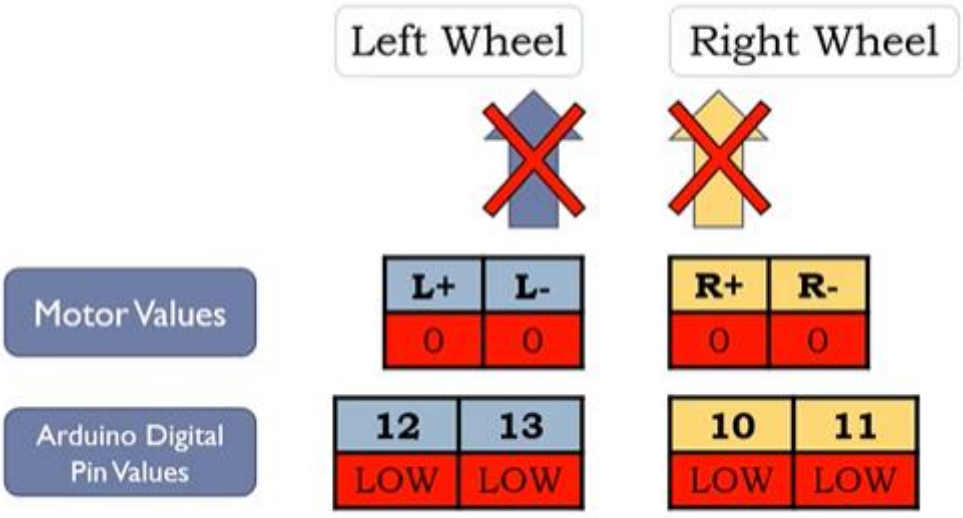


Figure 4.7 – Stop the Movement of the Robot

- **Overall Programming Logic**

  Based on the above analysis, the final programming logic looks like this -

Robot Movement	Right Wheel	RM (+) Pin 10	RM (-) Pin 11	Left Wheel	LM (+) Pin 12	LM (-) Pin 13
Forward	Forward	HIGH	LOW	Forward	HIGH	LOW
Backward	Backward	LOW	HIGH	Backward	LOW	HIGH
Right	Backward	LOW	HIGH	Forward	HIGH	LOW
Left	Forward	HIGH	LOW	Backward	LOW	HIGH
Stop	Stop	LOW	LOW	Stop	LOW	LOW

Figure 4.8 – Overall Programming Logic of the Robot

4.3. PROGRAMMING LOGIC – TRACKING COLOURED OBJECT

- **Image Acquisition**

Figure 4.9 – Image Acquisition

To capture the video, we need to create a video capture object.

Then we need to read the image from the video being captured.

- **Image Preparation**

Figure 4.10 – Image Preparation

Image Smoothing is used to remove noise from the image. It removes high frequency content like noise and edges from the image.

- **Colour Recognition**

Figure 4.11 – Colour Recognition

We will now convert the image into a different colour space.

- **Object Identification**

Figure 4.12 – Object Identification

We will now find the contours of the coloured objects, from the binary image. We will find the contour with maximum area and identify it as the object.

4.4. SERIAL COMMUNICATION (PYTHON → ARDUINO)

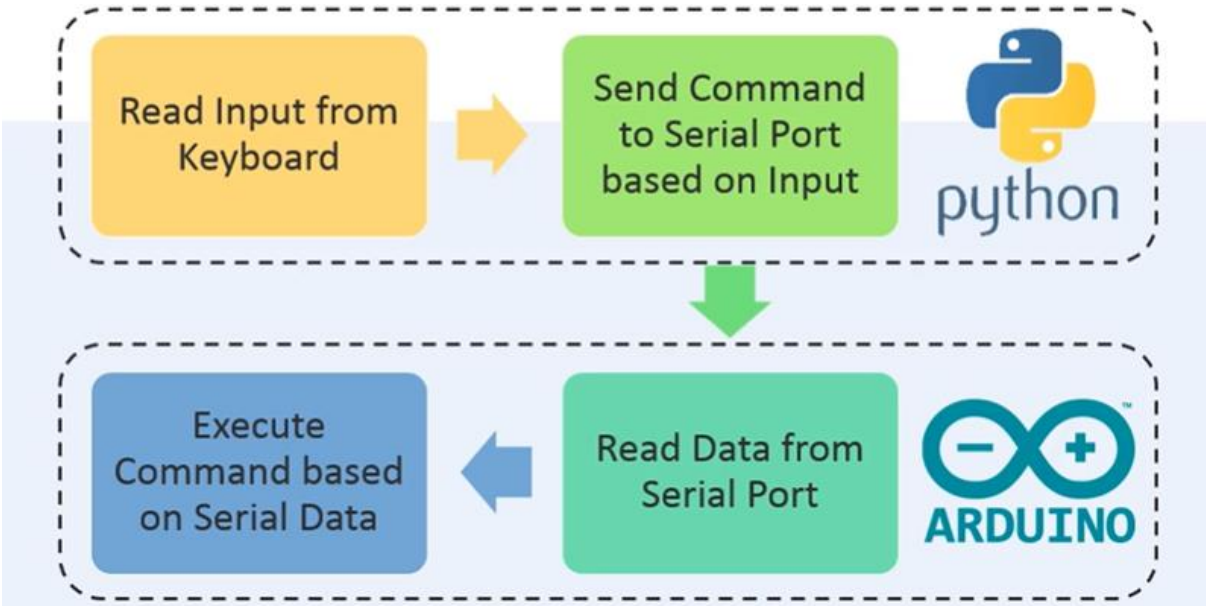


Figure 4.13 – Serial Communication (PYTHON → ARDUINO)

4.5. SIXTH SENSE ROBOT – DETAILED PIPELINE

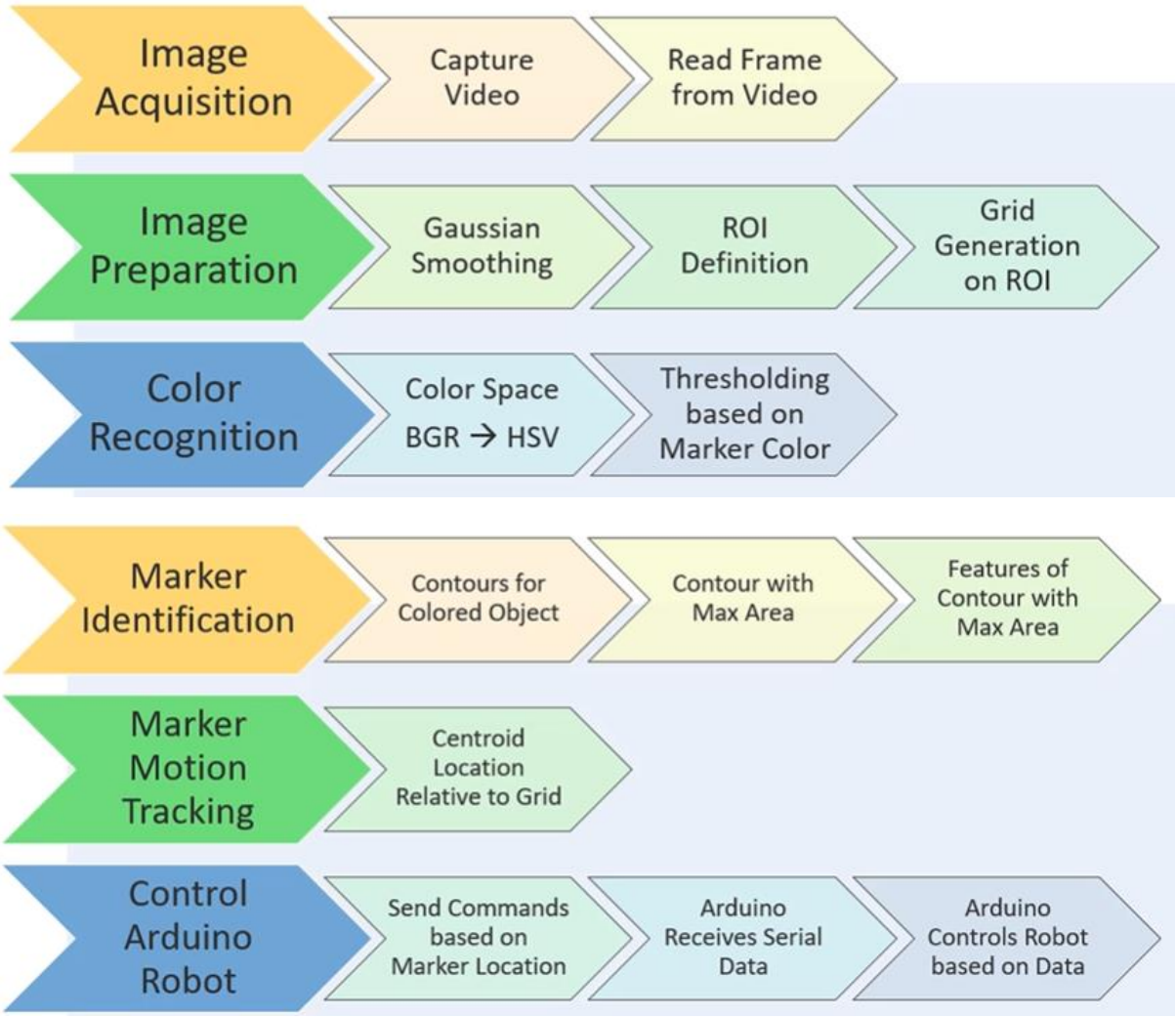


Figure 4.14 – Pipeline of Sixth Sense Robot

4.6. REAL-LIFE APPLICATIONS

- This robot can help specially abled people to move their wheelchairs.
- This robot can be used for surveillance or spying purposes i.e., remote surveillance by adding a camera.
- This robot can also be used for identifying/finding people in rescue operations by adding a camera.
- This idea can be extended to robotic arms.
- This robot can be used to carry/deliver stuff within a premise by adding a camera.

Chapter 5: Screenshots of the Project

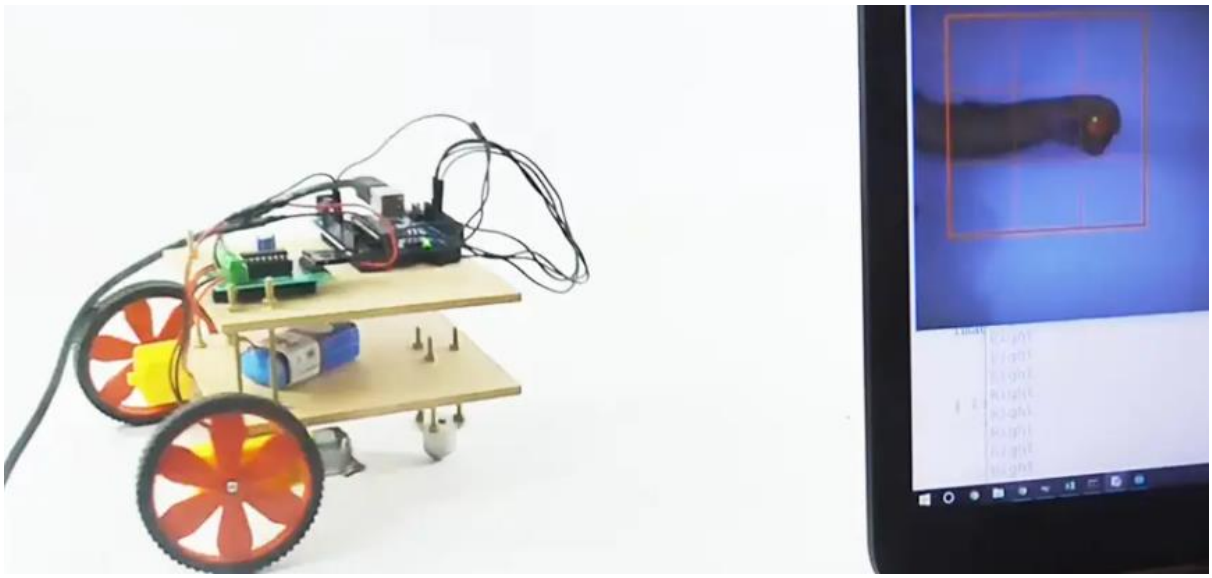


Figure 5.1 – Picture of the project

```
import cv2 as cv
import numpy as np
import serial
import time

Arduino = serial.Serial('com8',9600) #Create Serial Port object called arduino Serial Data
time.sleep(2) #wait for 2 seconds for the communication to get established

cam = cv.VideoCapture(0)

lower_red = np.array([0,125,125])
upper_red = np.array([10,255,255])

while(1):
    ret, frame = cam.read()
    frame = cv.flip(frame,1)

    w = frame.shape[1]
    h = frame.shape[0]

    # Smoothen the Image
    image_smooth = cv.GaussianBlur(frame,(7,7),0)
```

Figure 5.2 – Screenshot of a portion of Source Code

Chapter 6: Conclusion

6.1. LIMITATION

- It is a small-scale implementation as of now.
- The external supply to Arduino Board is being provided by laptop as of now, so a cable is connected with the laptop which limits the movement of the robot. The range of movement is limited.

6.2. FUTURE SCOPE

- The range of operation of the robot can be increased.
- Other kinds of cameras (wearable) can be used to capture the images.
- It can be extended to robotic arms.

BIBLIOGRAPHY

[1] Rao, S. Sadhana. "Sixth sense technology." *2010 International Conference on Communication and Computational Intelligence (INCOCCI)*. IEEE, 2010.

[2] Kumar, S. Pradeep, and O. Pandithurai. "Sixth sense technology." *2013 international conference on information communication and embedded systems (ICICES)*. IEEE, 2013.

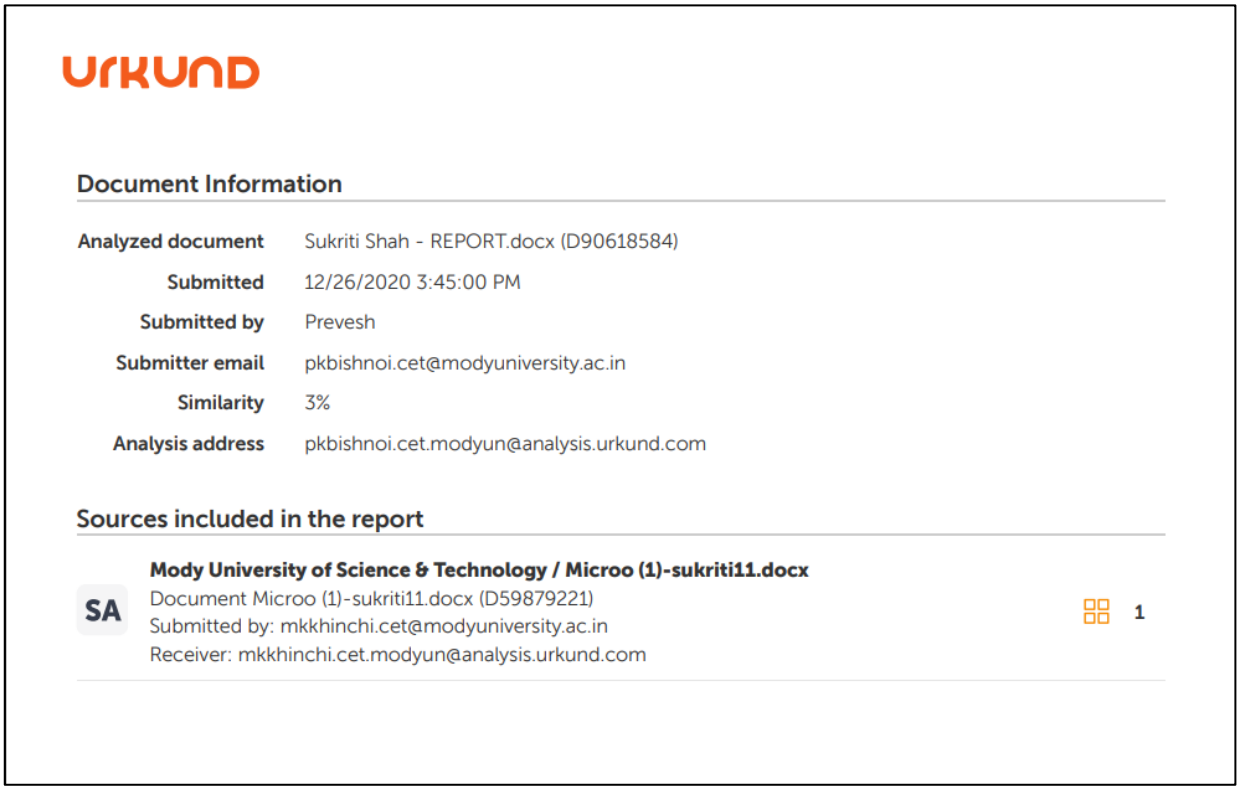
[3] AlKassim, Zeenat, and Nader Mohamed. "Sixth sense technology: Comparisons and future predictions." *2014 10th International Conference on Innovations in Information Technology (IIT)*. IEEE, 2014.

[4] Mistry, Pranav, and Pattie Maes. "SixthSense: a wearable gestural interface." *ACM SIGGRAPH ASIA 2009 Art Gallery & Emerging Technologies: Adaptation*. 2009. 85-85.

[5] Desale, Rakesh D., and Vandana S. Ahire. "A study on wearable gestural interface–a sixthsense technology." *IOSR Journal of Computer Engineering (IOSR-JCE)* 10.5 (2013): 10-16.

ANNEXURE

PLAGIARISM REPORT (SCREENSHOT)



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