A Project

on

Mouse Cursor Control Using Hand Gestures based on Detection and Tracking Confidence

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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2021-22

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CERTIFICATE

This is to certify that the project report entitled

"Mouse Cursor Control Using Hand Gestures based on Detection and Tracking Confidence"

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is a bonafide student of this institute and the work has been carried out by him/her under the supervision of **Dr. Sandeep Kadam** and it is approved for the partial fulfillment of the requirement of Savitribai Phule Pune University, for the award of the degree of **Bachelor of Engineering** (Computer Engineering).

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Principal

Name and Signature of External Examiner

Place: Pune
Date: / /

ACKNOWLEDGEMENT

*It gives us great pleasure in presenting the project report on **'Mouse Cursor Control Using Hand Gestures based on Detection and Tracking Confidence'**. We take this opportunity to thank all those magnanimous persons who rendered their valuable services to our work.*

*It's with a lot of happiness that we are expressing gratitude to our guide **Dr. Sandeep Kadam** in the Computer Engineering Department, for timely and kind help, guidance and providing us with most essential materials required for completion of the project. We are thankful to our guide for his indomitable guidance. His inspiration up to the last moment had made things possible in a planned manner.*

*We would like to express our deepest appreciation toward principal **Dr. Sunil Thakare** in ABMSP's Anantrao Pawar College of Engineering Research, and we are grateful to **Dr. Sandeep Kadam**, Head of Computer Engineering Department, ABMSP's Anantrao Pawar College of Engineering & Research, for his indispensable support, suggestions and for providing us the infrastructure for our project.*

Finally, we would like to thank each and every one who helped to complete our project work with their cordial support.

Kedar Mane
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ABSTRACT

Using hand gestures is a natural method of interaction between humans and computers. We use gestures to express meaning and thoughts in our everyday conversations. Gesture-based interfaces are used in many applications in a variety of fields, such as smartphones, televisions (TVs), video gaming, and so on. With advancements in technology, hand gesture recognition is becoming an increasingly promising and attractive technique in human-computer interaction.

Gesture recognition allows humans to communicate with the machine directly without any external devices. Our system will allow the user to navigate the computer cursor using their bare hands. The proposed system will only require a webcam as an input device. The result of the camera will be displayed on the system's screen so that it can be future calibrated by the user. This system could be a very comfortable method to control the mouse. It also has the potential of being a viable replacement for the computer mouse.

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LIST OF ABBREVIATIONS

ABBREVIATION	ILLUSTRATION
HCI	Human Computer Interaction
SVM	Support Vector Machine
RGB	Red Green Blue
BGR	Blue Green Red
UDP	User Datagram Protocol

CHAPTER 1

SYNOPSIS

1.1. PROJECT TITLE

Mouse Cursor Control Using Hand Gestures on Detection and Tracking Confidence.

1.1.1. PROJECT OPTION

Internal Project.

1.2. INTERNAL GUIDE

Dr. Sandeep Kadam

1.3. SPONSORSHIP AND EXTERNAL GUIDE

Entrepreneurship

1.4. TECHNICAL KEYWORDS

A. Human-Computer Interaction.

B. Pattern Recognition.

C. Virtual Mouse.

D. Hand gestures.

1.5. PROBLEM STATEMENT

To develop a virtual mouse that detects hand gesture patterns without using any external hardware.

1.6. ABSTRACT

Gesture recognition allows humans to communicate with the machine directly without any external devices. Our system will allow the user to navigate the computer cursor using their bare hands. The proposed system will only require a webcam as an input device. The result of the camera will be displayed on the system screen so that it can be future calibrated by the user. This system could be a very comfortable method to control the mouse. It also has the potential of being a viable replacement for the computer mouse.

1.7. GOALS AND OBJECTIVES

- The purpose of our project is to create a system that will comprehend hand gestures and control the computer/laptop using a webcam.
- For most laptops, the touchpad is not the most comfortable and convenient so our system has the potential of being a viable replacement for the computer mouse.
- Reduce the cost of hardware.
- Our project is user-friendly. Since it mainly focuses on handling simple operations like left-clicking, right-clicking, scrolling, dragging, etc.

1.8. RELEVANT MATHEMATICS ASSOCIATED WITH THE PROJECT

System Description:

- **System**: -

  Input, Output, Function, Success, Failure.

- **Input**: -

  Capturing the real-time video from the webcam.

- **Output**: -

  Operations of the mouse will be performed by hand gestures.

- **Functions**: -

  - Gesture recognition (): -

    In this module, we are going to recognize hand gestures from the acquired frame.

  - Correction check (): -

    In this module, we are going to check for any noise in the environment.

  - Gesture execution ():-

    In this module, we are going to convert a recognized pattern into a meaningful command.

- **Success Conditions: -**

  On successful pattern recognition, the respective mouse operation will be performed.

- **Failure Conditions: -**

  Desired output is not generated due to the following failures:

  - Software failure.
  - Hardware failure**.**

1.9. NAMES OF CONFERENCES / JOURNALS WHERE PAPERS CAN BE PUBLISHED

International Journal of Scientific Research in Engineering and Management (IJSREM)

1.10. REVIEW OF CONFERENCE/JOURNAL PAPERS SUPPORTING PROJECT IDEA

Sr. No.	Authors	Description
1.	Abhishek B, Kanya Krishi, Meghana M, Mohammad Daaniyaal, Anupama H S	This system uses OpenCV and TensorFlow Object Detector for capturing and processing hand gestures. It describes how hand images can be interpreted as gestures to perform operations like switching pages and scrolling up and down the page.
2	Yewen Ding, Feihong Zhang and Jack Sheng, Wei Fang	Deep CNN algorithms used to implement gesture recognition.
3	Vijay Kumar Sharma.	In this system, it detects the hand gestures in which if the angle between any two fingers is less than 15 degrees then left click is performed.
4	Dipankar Gupta, Emam Hossain, Mohammad Sazzad Hossain	This system helps paralyzed people by providing a virtual mouse and a keyboard to ease their work instead of a physical mouse and keyboard. This system uses OpenCV for Object detection and image processing.

5	Zhou Ren, Jingjing Meng, Junsong Yuan	To demonstrate the accuracy, efficiency, and effectiveness of the FEMD based hand gesture recognition system [16] by comparing its performance on a 10-gesture dataset with Shape Context, as well as a real-life HCI application built on top of it.
6	Hong-Xiang DUAN Qiu-yu ZHANG2 Wei MA3	Detecting hand gesture's changes in movement rate the start and end of hand gesture can be determined. It gain starting hand and ending hand shape based on motion and color information and real-timely track the trajectory of hand
7	Yanmei Chen1;2, Bing Luo, Yen-Lun Chen, Guoyuan Liang, Xinyu Wu	The system will allow the user to operate their computer’s keyboard and mouse using only their hand bearing a yellow color cap on their fingertip. The main objective of this research is to build an interactive keyboard and mouse system so that motion impaired people can communicate with the computer through its webcam using their one hand only.

8	Kabid Hassan Shibly, Md. Aminul Islam	The cursor control using a hand gesture system can be implemented in MATLAB. The system was able to control the movement of a cursor by tracking the user's hand-bearing color caps. Cursor functions were performed by using different hand gestures
9	Danling Lu, Yuanlong Yu, and Huaping Liu	The whole system consists of three components: hand detection, gesture recognition, and human-computer interaction (HCI) based on recognition; and realizes the robust control of mouse and keyboard events with higher accuracy of gesture recognition.
10	Pooja Kumari, Saurabh Singh, Vinay Kr. Pasi.	The cursor control using the hand gesture system can be implemented in MATLAB. The system was able to control the movement of a cursor by tracking the user's hand-bearing color caps. Cursor functions were performed by using different hand gestures.

1.11. PLAN OF PROJECT EXECUTION

1. Information Gathering and Literature Survey:

   This phase comprises research work. We first researched the existing needs of the market, available products, needs of the customer and so on. Based on this we gathered the information and came to this conclusion.

2. Problem Definition and Finalization:

   After finalizing our topic, we went ahead as to how to implement it, using what tools and technologies, etc. Based on our topic various papers were searched and also the efficiency of the language which we are using was checked.

3. Modeling and organizing tools/techniques:

   Once our topic was selected, we finalized in which area we needed to work and using which technology. The problem statement was thus defined. The problem was divided into various modules.

4. Implementation:

   The implementation of various modules started in this phase. The various features were implemented as per the implementation phases.

5. Testing:

Testing of the various modules of the system is done in this phase and also testing of the system as a whole was done.

6. Report submission:

A final report was prepared.

CHAPTER 2

TECHNICAL KEYWORDS

2.1 AREA OF PROJECT

Artificial Intelligence

2.2 TECHNICAL KEYWORDS

A. Gesture recognition
B. Human-Computer Interface
C. Image Processing
D. Pattern Recognition
E. Virtual Mouse

CHAPTER 3

INTRODUCTION

3.1 PROJECT IDEA

We are increasingly seeing the importance of human-computer interaction (HCI) and in particular the concept-based touch and object recognition. In our project, we propose a new method that uses a video device to control the mouse system (Mouse functions). We use a few image processing algorithms to do this. For maximum laptops, the touchpad isn't the maximum snug and convenient, so our project has the ability to be a possible alternative for the laptop mouse it additionally reduces the fee of hardware. Our challenge is user-friendly. Since it especially focuses on dealing with easy operations like left-clicking, right-clicking, scrolling, dragging, etc.

3.2 MOTIVATION OF THE PROJECT

We all are living in a digital world in which we are dealing with different technologies. The most important inventions are computers, laptops, mobiles, etc. which have become part and parcel of our life. We complete all our tasks with the help of these technologies. Because of this, our life becomes faster, easy, and more relaxed. In the present-day scenario, most mobile phones use touch screen technology to interact with the user. Also, we are using different devices like mouse, and joysticks in order to handle laptops and computers. But these are all hardware devices, and these may get damaged over a period of time. We need to handle such devices very carefully in order to overcome such hardware problems.

As computer technology continues to develop, people have smaller and smaller electronic devices. Increasingly we are recognizing the importance of human computing interaction (HCI) and in particular vision-based gesture and object recognition. In our project, we propose a novel approach that uses a video device to control the mouse system (Mouse tasks). We employ several image processing algorithms to implement this.

For most laptops, the touchpad is not the most comfortable and convenient, so our system has the potential of being a viable replacement for the

computer mouse. It also reduces the cost of hardware. Our project is user-friendly. Since it mainly focuses on handling simple operations like left-clicking, right-clicking, scrolling, dragging, etc.

3.3 LITERATURE SURVEY:

[1] Dipankar Gupta has published An Interactive computer system with gesture-based mouse and keyboard paper in which they have proposed a system that helps paralyzed people by providing a virtual mouse and a keyboard to ease their work instead of a physical mouse and keyboard. They used color tapes to recognize the user's fingers and this system achieved 78% - 90% accuracy but it did not work efficiently in a rough and complex background.

[2] Kanya Krishi published a Hand gesture recognition using Machine Learning Algorithms paper in which the proposed system uses OpenCV and TensorFlow object detector for capturing and processing hand gestures. It describes how hand images can be interpreted as gestures to perform operations like switching pages and scrolling up and down the page.

[3] Vijay Kumar proposed a system in their virtual mouse control using hand class gestures that detect the hand gestures in which if the angle between any two fingers is less than 15 degrees then left click is performed. They have used python dependencies such as NumPy, math, wx to develop the system along with the kernel function which identifies the skin color using RGB parameters.

[4] Kamlesh Patil and Atharv Kasodekar published a Virtual mouse application paper that proposed an executable application for a virtual mouse which was developed with the help of OpenCV and Tkinter package.

[5] Vinay Kr. Pasi, Saurabh Singh, and Pooja Kumari in 2016 proposed “Cursor Control using Hand Gestures” in the IJCA Journal. The system proposes the different bands to perform different functions of the mouse. The limitation is it depends on various colors to perform mouse functions.

[6] Quam introduced an early hardware-based system; in this system, the user should wear a DataGlove. The proposed system by Quam although gives results of higher accuracy, but it is difficult to perform some of the gesture controls using the system.

[7] Dung-Hua Liou, ChenChiung Hsieh, and David Lee in 2010 proposed a study on "A Real-Time Hand Gesture Recognition System Using Motion History Image." The main limitation of this model is more complicated hand gestures.

[8] Monika B. Gandhi, Sneha U. Dudhane, and Ashwini M. Patil in 2013 proposed a study on "Cursor Control System Using Hand Gesture Recognition." In this work, the limitation is that stored frames are needed to be processed for hand segmentation and skin pixel detection.

[9] Chaithanya C, Lisho Thomas, Naveen Wilson, and Abhilash SS in 2018 proposed "Virtual Mouse Using Hand Gesture" where the model detection is based on colors. But only a few mouse functions are performed.

[10] Pooja Kumari and Saurabh Singh proposed a system where the cursor control using the hand gesture system can be implemented in MATLAB. The system was able to control the movement of a cursor by tracking the user's hand-bearing color caps. Cursor functions were performed by using different hand gestures.

CHAPTER 4

PROBLEM DEFINITION AND SCOPE

4.1 PROBLEM STATEMENT

To design a virtual mouse that detects hand gesture patterns without using any external hardware. To design an application (.exe file) with a user-friendly user interface that provides a feature for accessing motion tracking mouse features.

4.1.1 Goals and objectives

- The purpose of our project is to create a system that will comprehend hand gestures and control the computer/laptop using a webcam.
- For most laptops the touchpad is not the most comfortable and convenient so our system has the potential of being a viable replacement for the computer mouse.
- Reduce the cost of hardware.
- Our project is user-friendly. Since it mainly focuses on handling simple operations like left-clicking, right-clicking, scrolling, dragging, etc.

4.1.2 Statement of scope

- A description of the software with Size of input, bounds on input, input validation, input dependency, i/o state diagram, Major inputs, and outputs are described without regard to implementation detail.
- The scope identifies what the product is and is not, what it will and won't do, and what it will and won't contain.

4.2 MAJOR CONSTRAINTS

- Light Intensity
- Background Noise

4.3 METHODOLOGIES OF PROBLEM-SOLVING AND EFFICIENCY ISSUES

- Six Thinking Hats
- Fishbone Analysis
- SWOT Analysis

4.4 OUTCOME

- The system will successfully conduct all the computer mouse tasks such as Right click, Left Click, Double Click, Drag & Drop functions.
- System is used to build a virtual game and 3D hand tracking, Model.

4.5 APPLICATIONS

- 2D and 3D images can be drawn using the AI virtual system using the hand gestures
- AI virtual mouse can be used to play virtual reality- and augmented reality-based games without the wireless or wired mouse devices.
- Persons with problems in their hands can use this system to control the mouse functions in the computer.

4.6 HARDWARE RESOURCES REQUIRED

Sr. No.	Parameter	Minimum Requirement	Justification
1	CPU Speed	1.5 GHz	Remark Required
2	RAM	2 GB	Remark Required
3	Web Cam	1	Remark Required

Table 4.1: Hardware Requirements

4.7 SOFTWARE RESOURCES REQUIRED

Platform:

1. Operating System: Windows
2. IDE: PyCharm 2021.2.3, Unity 2021.3.1f1
3. Programming Language: Python, C#

CHAPTER 5

PROJECT PLAN

5.1 PROJECT ESTIMATES

Use Waterfall model and associated streams derived from assignments 1,2, 3, 4 and 5(Annex A and B) for estimation.

5.1.1 Reconciled Estimates

5.1.1.1 Cost Estimate:

- Webcam : Rs 399/- to Rs1500/-
- Laptop: Rs 30,000/- to Rs 50,000/-

5.1.1.2 Time Estimates:

- 07/08/2021 - 10/05/2022

5.1.2 Project Resources

A couple of resources have been used for developing our application. It includes both software and hardware both. In terms of software we have used PyCharm which is an IDE which is used for Python programming. Unity Hub which is a development platform used to create 2D and 3D models.

5.2 RISK MANAGEMENT W.R.T. NP HARD ANALYSIS

5.2.1 Risk Identification

A certain amount of risks and threats exist with every existing system. With respect to our system following certain risks are identified:

1. The system is restricted to the users who have access to the webcam. It does not support a system with no webcam
2. The system will not work properly in intense light conditions

3. This user will require a GPU to run this system smoothly.
4. Does the software engineering team have the right mix of skills?
5. Are project requirements stable?
6. Is the number of people on the project team adequate to do the job?
7. Do all customer/user constituencies agree on the importance of the project and on the requirements for the system/product to be built?

5.2.2 Risk Analysis

The risks for the Project can be analyzed within the constraints of time and quality

ID	Risk Description	Probability	Impact		
			Schedule	Quality	Overall
1	Webcam Crash	Low	Low	High	High
2	Hand out of sight	Medium	Low	High	High
3	System Crash	Low	Low	High	High
4	Too much background noise	Low	Low	Medium	Medium
5	Handicapped	Low	Low	Medium	Medium

Table 5.1: Risk Table

Probability	Value	Description
High	Probability of occurrence is	> 75%
Medium	Probability of occurrence is	26 – 75%
Low	Probability of occurrence is	< 25%

Table 5.2: Risk Probability definitions

Impact	Value	Description
Very high	> 10%	Schedule impact or Unacceptable quality
High	5 – 10%	Schedule impact or Some parts of the project have low quality
Medium	< 5%	Schedule impact or barely noticeable degradation in quality Low Impact on schedule or Quality can be incorporated

Table 5.3: Risk Impact definitions

5.2.3 Overview of Risk Mitigation, Monitoring, Management

Following are the details for each risk.

Risk ID	1
Risk Description	Webcam Crash
Category	Technical
Source	This was identified during early development and testing
Probability	Low
Impact	High
Response	Mitigate
Strategy	Better quality Webcam will resolve this issue
Risk Status	Identified

Risk ID	2
Risk Description	Hand out of sight
Category	Requirements
Source	This was identified during early development and testing
Probability	Low
Impact	High
Response	Mitigate
Strategy	Better practice will resolve this issue
Risk Status	Occured

Risk ID	3
Risk Description	System Crash
Category	Technical
Source	Hardware requirement Specification document
Probability	Low
Impact	High
Response	Mitigate
Strategy	Better system will resolve this issue
Risk Status	Identified

Risk ID	4
Risk Description	Too much background noise
Category	Requirements
Source	This was identified during early development and testing
Probability	Low
Impact	Medium
Response	Mitigate
Strategy	Better testing will resolve this issue
Risk Status	Occurred

Risk ID	5
Risk Description	Handicapped
Category	Requirements
Source	Requirement Specification document
Probability	Low
Impact	Medium
Response	Mitigate
Strategy	Training for such scenario to the computer
Risk Status	Identified

5.3 PROJECT SCHEDULE

1. Information Gathering and Literature Survey:

   This phase comprises research work. We first researched the existing needs of the market, available products, needs of the customer and so on. Based on this we gathered the information and came to this conclusion.

2. Problem Definition and Finalization :

   After finalizing our topic, we went ahead as to how to implement it, using what tools and technologies etc. Based on our topic various papers were searched and also the efficiency of the language on which we are using was checked.

3. Modeling and organizing tools/techniques:

   Once our topic was selected, we finalized on which area we needed to work and using which technology. The problem statement was thus defined. The problem was divided into various modules.

4. Implementation:

   The implementation of various modules started in this phase. The various features were implemented as per the implementation phases.

5. Testing:

Testing of the various modules of the system is done in this phase and also testing of the system as a whole was done.

6. Report submission:

A final report was prepared.

5.3.1 Project task set

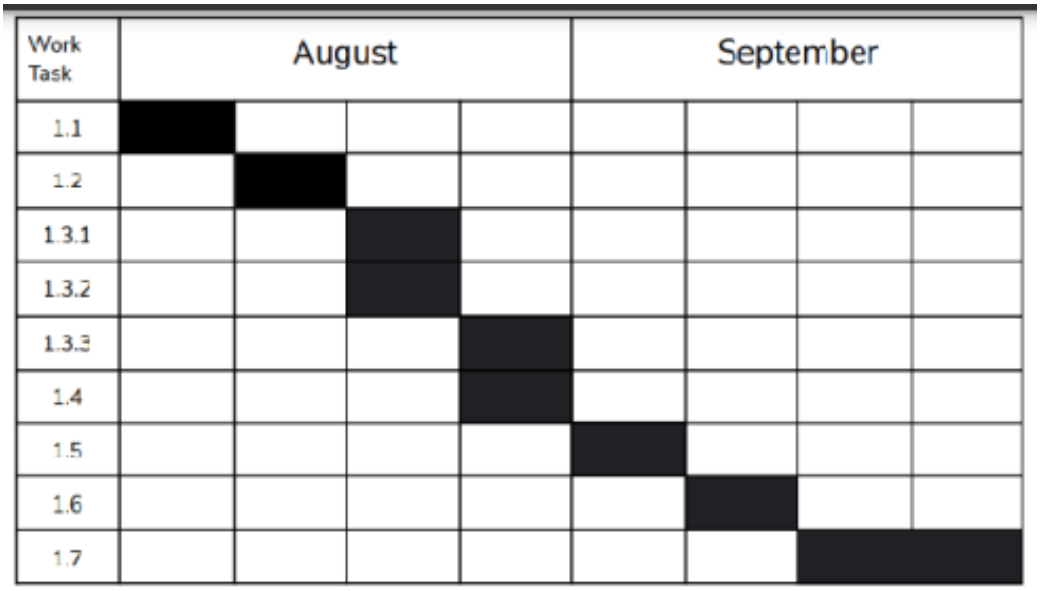
Major Tasks in the Project stages are:

- Task 1: Research and Analysis
- Task 2: Design
- Task 3: Implementation
- Task 4: Testing
- Task 5: Documentation

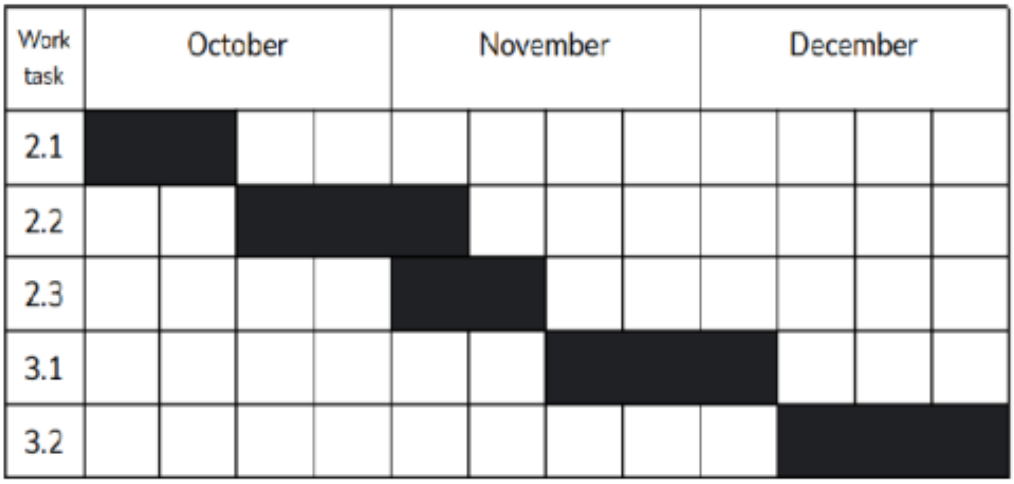
5.3.2 Task network

Project tasks and their dependencies are noted in this diagrammatic form.

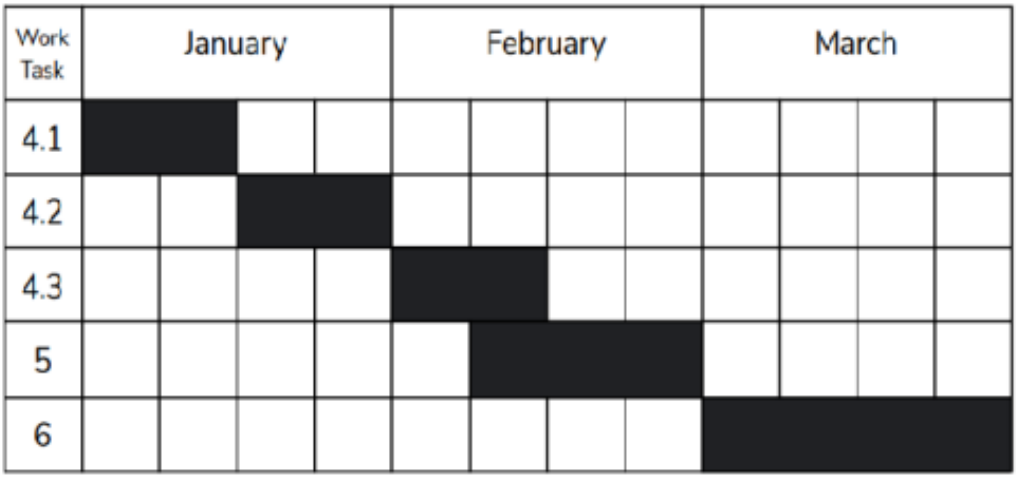
5.3.3 Timeline Chart:



Analytical Phase



Design Phase & Coding



Testing and Documentation

5.4 TEAM ORGANIZATION

The Whatever activities are done related to the project that we all showing all details log to our guide. All the reporting are noted to the guide.

5.4.1 Team structure

Project Co-Ordinator:	Prof. Rama Gaikwad.
Project Guide:	Dr. Sandeep Kadam
Team Lead:	Kedar Mane
Developer 1:	Sahil Bandal
Developer 2:	Sanket Kadam
Developer 3:	Sweety Gholwe

5.4.2 Management reporting and communication

Mechanisms for progress reporting and inter/intra team communication are identified as per assessment sheet and lab time table.

CHAPTER 6

SOFTWARE REQUIREMENT SPECIFICATION

6.1 INTRODUCTION

6.1.1 Purpose and Scope of Document

The purpose of SRS is to understand all the usage scenarios. This document will help in understanding the system with all of its features. Along with internal functions, class, and architecture used in the system are represented in this document.

6.1.2 Overview of responsibilities of Developer

The developer is mainly responsible for handling the responsibilities of the source files and their maintenance.

6.2 USAGE SCENARIO

This application has two usage levels

- Individual Level

  At an individual level, users can use this in daily work for more accessibility and efficiency.
- Commercial level

  At a commercial level, varied hospitals can use this during surgery for contactless work, and many companies can use this during presentations.

6.2.1 User profiles

The profiles of all user categories are described here.(Actors and their Description)

6.2.2 Use-cases

Sr.No.	Use Case	Description	Actors	Assumptions
1.	Use Case	Description	User	Assumption
			Device	
			Application	

Table 6.1: Use Cases

6.2.3 Use Case View

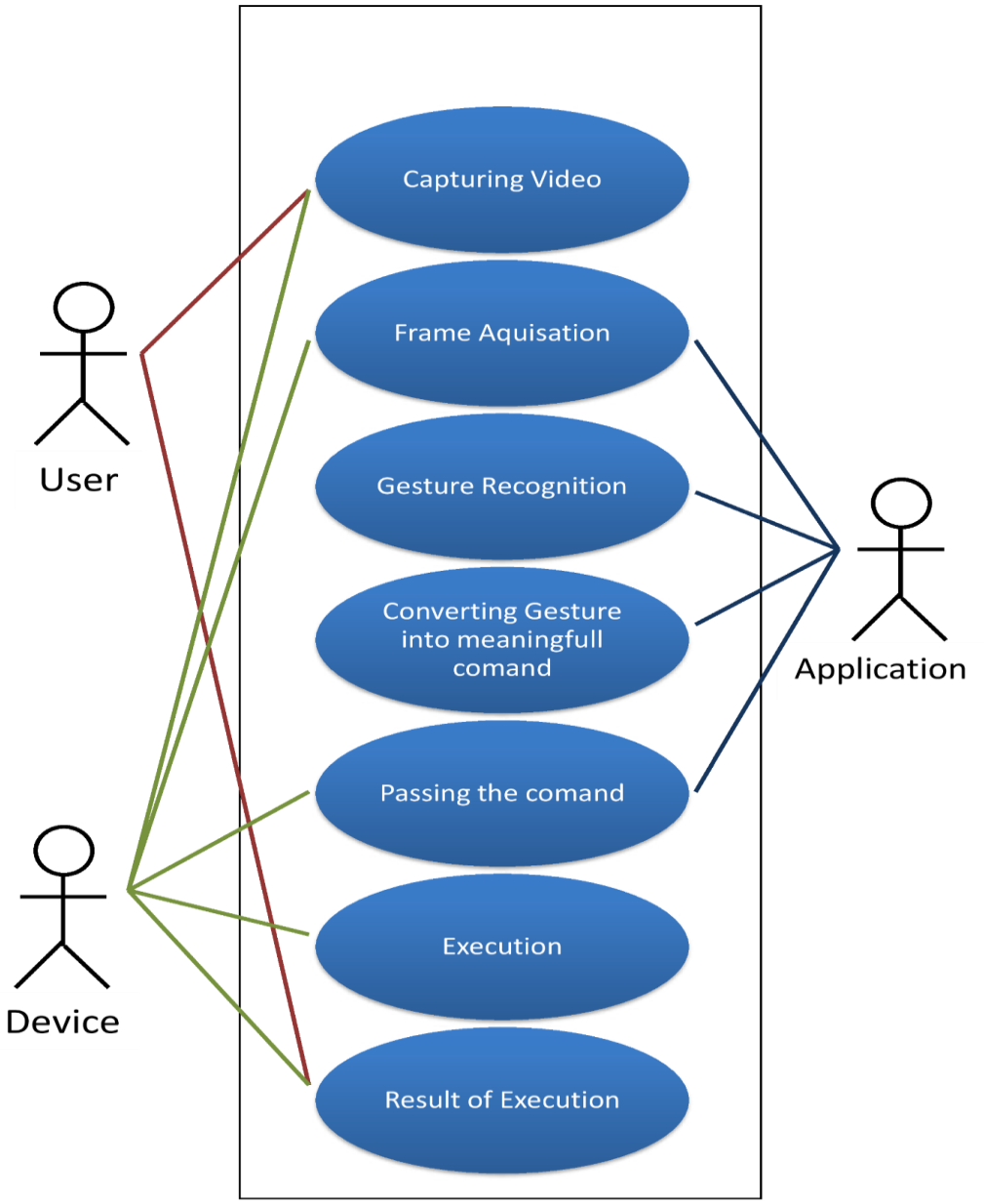


Figure 6.2: Use case diagram

6.3 DATA MODEL AND DESCRIPTION

6.3.1 Data Description

The hand tracking data used to support the findings of this study are included within the article. The study uses Google's framework; hence, no new data are needed to train the model.

6.4 FUNCTIONAL MODEL AND DESCRIPTION

A description of each major software function, along with data flow (structured analysis) or class hierarchy (Analysis Class diagram with class description for object-oriented system) is presented.

6.4.1 Data Flow Diagram

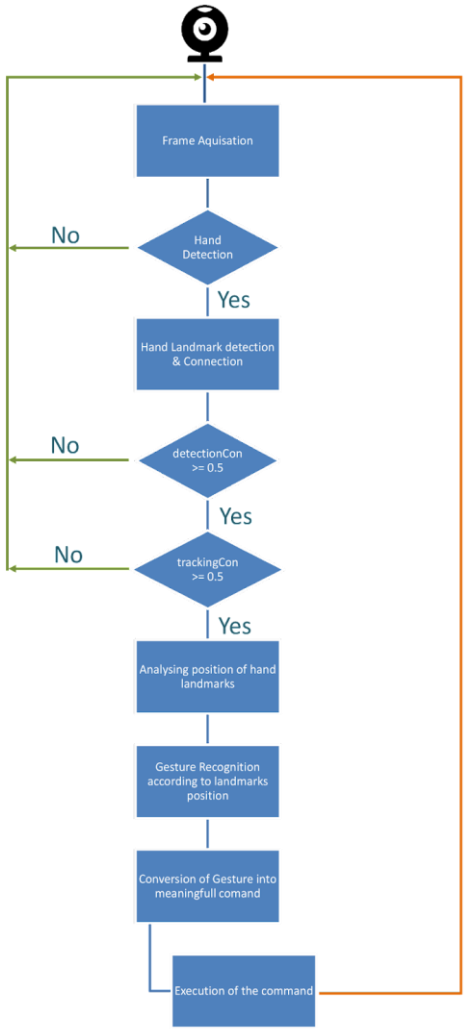
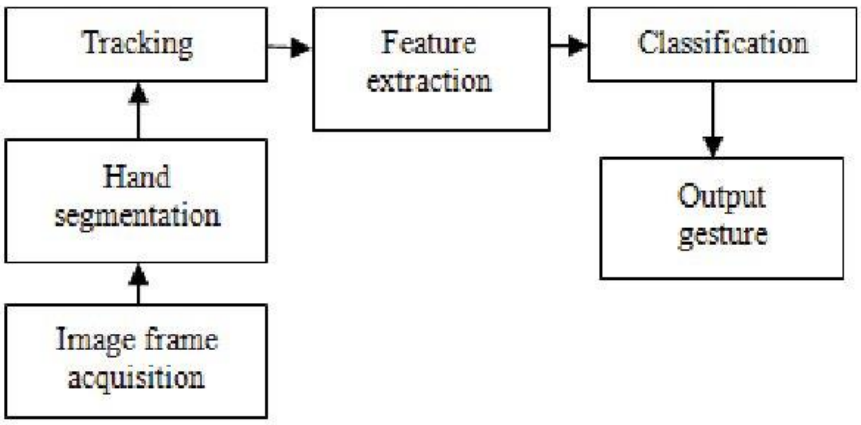


Figure 6.3: Data Flow Diagram

6.4.2 Activity Diagram:



6.4.3 Non Functional Requirements:

- The gestures should be easy and specific.
- Any updates should not decrease the performance of the system
- System should give consistent performance.

6.4.4 State Diagram:

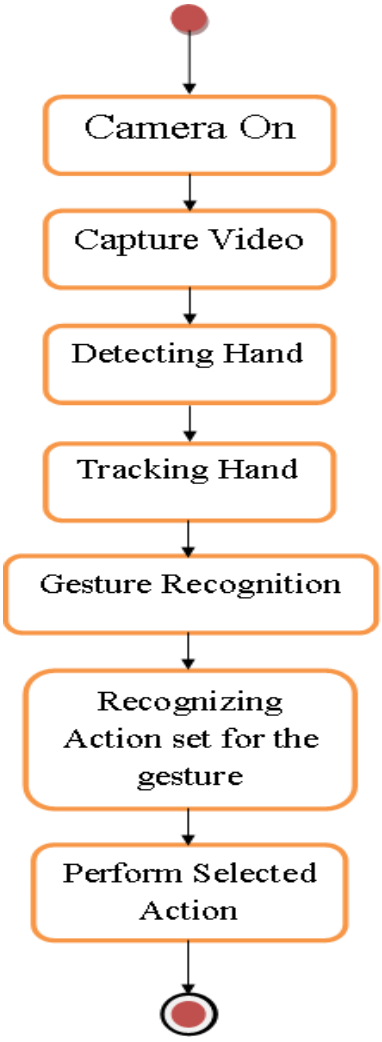


Figure 6.4.: State Diagram

6.4.5 Design Constraints

The important design constraints are 30fps webcam, Integrated graphics, stable background lights.

CHAPTER 7

DETAILED DESIGN DOCUMENT USING APPENDIX A AND B

7.1 INTRODUCTION

The architecture of our Project. There are Four Layers in the architecture which are Interface Layer, the Process layer, the Data Manipulation layer, the Data layer:

- Interface Layer:

  At this layer input will be taken from the camera the system will convert it to frames and will pass it on to the process layer

- Process Layer:

  The frame will be processed for Correction Check where it will check for any noise correction in the frame. The cleaned frame will be further transferred for capturing the gesture and it will recognize the hand gesture afterwards in the data manipulation layer

- Data Manipulation layer:

  The recognized gesture will be converted into meaningful command and the command will be executed by the system.

- Data Layer:

  The output such as (single click, double click) will be displayed on the user screen and this whole process will run in a loop until the program is terminated.

7.2 ARCHITECTURAL DESIGN

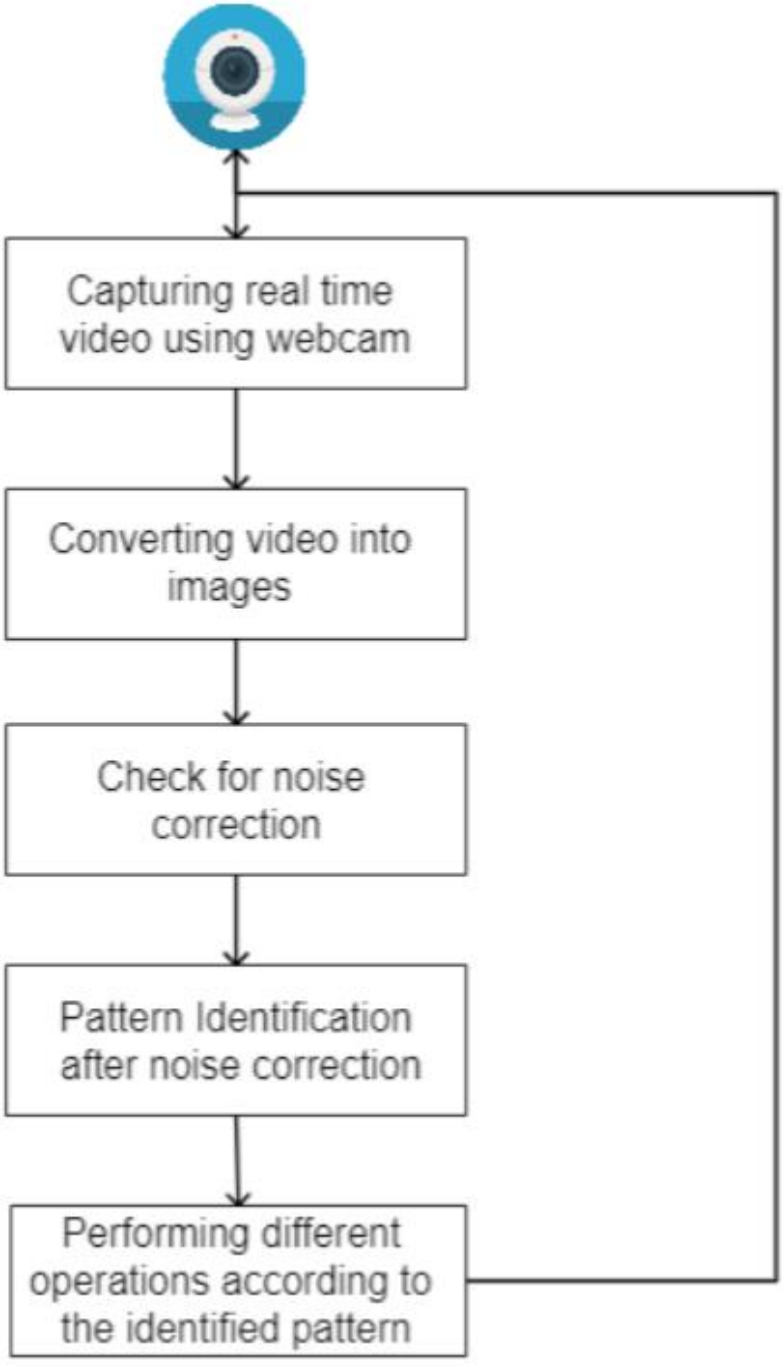
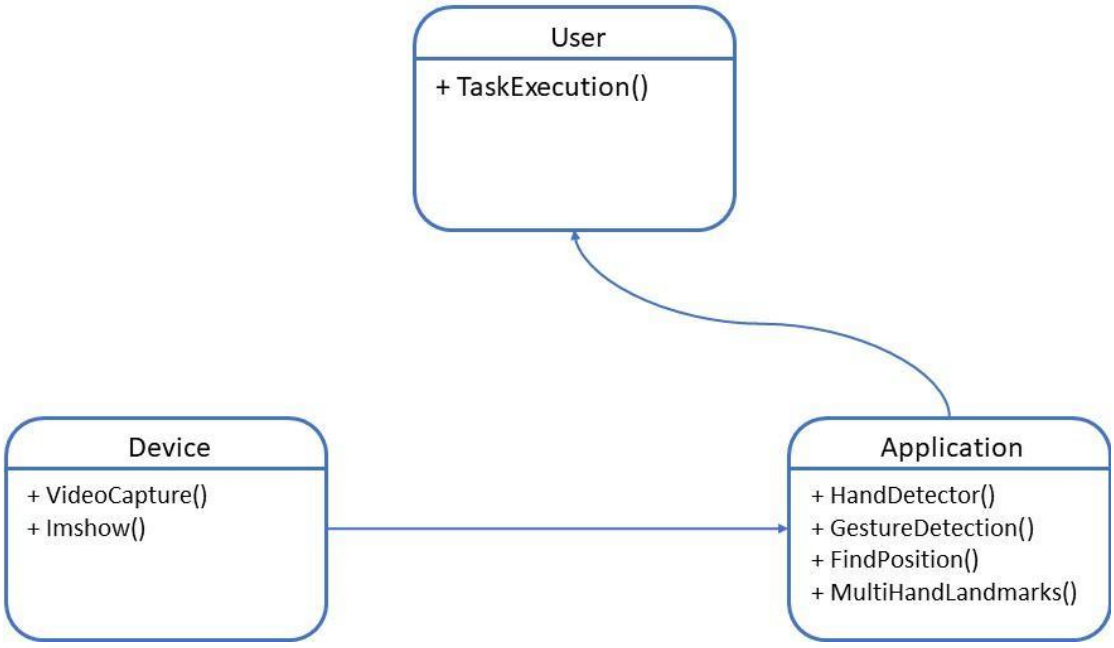


Figure 7.1: Architecture diagram

7.3 COMPONENT DESIGN

Class diagrams, Interaction Diagrams, Algorithms. Description of each component description required.

7.3.1 Class Diagram:



CHAPTER 8

PROJECT IMPLEMENTATION

8.1 INTRODUCTION

Python programming language is used to improve the AI mouse system, and, in addition, the OpenCV computer library is used in the AI mouse system. In the proposed visual AI mouse system, the model uses the MediaPipe package to track hands and fingerprint tracking, and also, PyAutoGUI packages are used to navigate the window screen. A computer for performing tasks such as left-clicking, right-clicking, and scrolling functions. The results of the proposed model show a very high level of accuracy, and the proposed model can work very well in real-world applications with CPU usage without using a GPU.

8.2 TOOLS AND TECHNOLOGIES USED

8.2.1 MediaPipe:

The ability to see hand movements and movements can be an important factor in improving user experience across all technical fields and platforms. For example, it can form the basis for understanding sign language and controlling hand gestures, and it can enable the accumulation of digital content and information in the real world in augmented reality. Although it comes naturally to humans, strong real-time visualization of the hand is a very challenging computer vision task, as the hands often close themselves or by themselves (e.g., finger/palm closure and handshake). It uses machine learning (ML) to understand 21 3D landmark points from just one frame. our approach achieves real-time performance on mobile phones, even scale in many hands. We hope that providing this visual aid in a comprehensive research and development community will lead to the emergence of creative applications, which encourages new applications and new research methods.

8.2.2 OpenCV:

OpenCV is a computer vision library that contains image processing algorithms for object detection. OpenCV is a language library for python programs, and real-time computer vision applications can be developed using a computer library. The OpenCV Library is used for image and video processing and analysis such as face detection and object detection.

8.3 METHODOLOGIES DETAILS

8.3.1 Detection Confidence & Tracking Confidence:

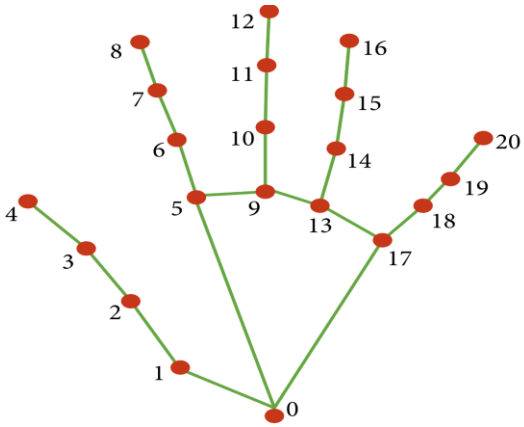
The detection confidence is the threshold value set in the program for better the accuracy and performance to detect the hand. It's currently set to 0.5 for hand detection.If the detection confidence is less than 0.5 the program will retry to detect the hand and if the detection confidence is more than 0.5 the program will stop detecting the hand and start tracking it.This value can be adjusted according to the background noise and light intensity.

The tracking confidence is the threshold value set in the program for better accuracy and performance.It's currently set to 0.6 for hand tracking.If the tracking confidence is less than 0.6 the program will stop tracking the hand and will detect the hand first according to the detection confidence and if the tracking confidence is more than 0.6 the program will keep tracking the hand. This value can be adjusted according to the FPS (Frames Per Second) of the inbuilt webcam.

8.3.2 Hand Landmark Points:

After the palm is found over the whole image our next handwriting model makes a precise key point for 21 3D hand wrists within the obtained hand circuits, which is a prediction of direct connection. The model learns to represent a stable internal hand shape and is strong even to the point of being slightly visible and self-closing.

The points are :



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

CHAPTER 9

SOFTWARE TESTING

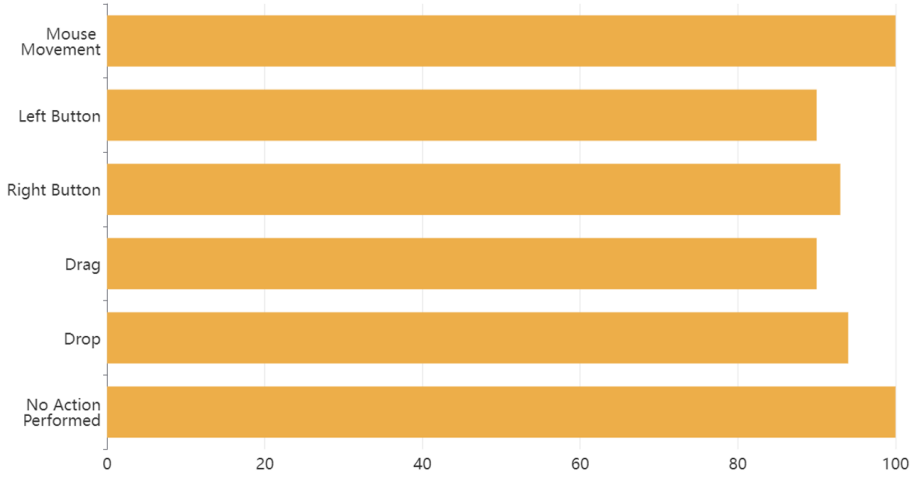
9.1 TYPE OF TESTING USED

The following type of testing is done in the system

- Performance Testing:

	CPU	RAM	GPU	Power Usage
PyCharm	18%	0.75 GB	0%	Very Low
Unity	5%	0.12 GB	10%	Moderate

The test was performed 25 times by 4 persons. And this test has been made in different illuminance conditions and at different distances from the camera, and each person tested the virtual mouse system 10 times in normal light conditions, 5 times in close distance from camera, and 5 times in long distance from camera, 5 times in low light environment.



Graph of Accuracy.

- Functionality Testing:

1. Volume Control.
2. Drag, Drop & Click.
3. Virtual Game.
4. 3D Hand Tracking Module.

9.2 TEST CASES AND TEST RESULTS

· Functionality Testing:

1. Volume Control:

Test Case ID	TC-01	**Test Case Description**	Controlling Volume using Hand Gestures
Version	1.0	**Test Case**	Pass

Sr. No.	**Prerequisites**
1	Access to Webcam

Test Scenario	Controlling Volume using Hand Gesture

Step	**Step Details**	**Expected Result**	**Actual Result**	**Test Case**
1.	Open a Webcam	Webcam should open	Webcam Opened	Pass
2.	Detection & Tracking of Hand	Hand should be detected & tracked around the frame	Hand tracked & detected	Pass

3.	Volume Control Gesture Recognition	Master Volume should be controlled using hand gesture	Master volume controlled	Pass

2. Drag, Drop & Click :

Test Case ID	TC-02	**Test Case Description**	Performing Drag & Drop Functions
Version	1.0	**Test Case**	Pass

Sr. No.	**Prerequisites**
1	Access to Webcam

Test Scenario	Performing Drag & Drop Functions

Step	**Step Details**	**Expected Result**	**Actual Result**	**Test Case**
1.	Open a Webcam	Webcam should open	Webcam Opened	Pass

2.	Detection & Tracking of Hand	Hand should be detected & tracked around the frame	Hand tracked & detected	Pass
3.	Drag & Drop	Drag & Drop Functions performed given that thumb should be on the palm	Drag & Drop Functions performed	Pass
4.	Click function	Click function performed given that thumb should open	Click function performed	Pass

3. Virtual Game:

Test Case ID	TC-03	**Test Case Description**	Ping-Pong Game
Version	1.0	**Test Case**	Pass

Sr. No.	**Prerequisites**
1	Access to Webcam

Test Scenario	Ping-Pong Game

Step	Step Details	Expected Result	Actual Result	Test Case
1.	Open a Webcam	Webcam should open	Webcam Opened	Pass
2.	Detection & Tracking of two Hand	Left & Right Hands should be detected individually & tracked around the frame	Both Hands are tracked & detected	Pass
3.	Game Execution	Both players should be able to play the game and should be able to restart the game after losing	Game Executed	Pass

4. 3D Hand Tracking Module:

Test Case ID	TC-04	Test Case Description	3D Hand Tracking Module
Version	1.0	Test Case	Pass

Sr. No.	Prerequisites

1	Access to Webcam

Test Scenario	3D Hand Tracking Module

Step	**Step Details**	**Expected Result**	**Actual Result**	**Test Case**
1.	Open a Webcam	Webcam should open	Webcam Opened	Pass
2.	Detection & Tracking of Hand	Hand should be detected & tracked around the frame	Hand tracked & detected	Pass
3.	Connectivity between unity project and python file	Connectivity through UDP port	Connection established	Pass
4.	3D modules should be seen in unity project according to the hands landmarks quardinates	3D hand module should be seen	3D hand model seened	Pass
5.	Confirmation of 3D hand tracking	3D hand model should be able to crash the given tower of cubes	3D Model crashed the towers	Pass

5. Distance Module:

Test Case ID	TC-05	**Test Case Description**	Measuring the distance of hand from webcam
Version	1.0	**Test Case**	Pass

Sr. No.	**Prerequisites**
1	Access to Webcam

Test Scenario	Measuring the distance of hand from webcam

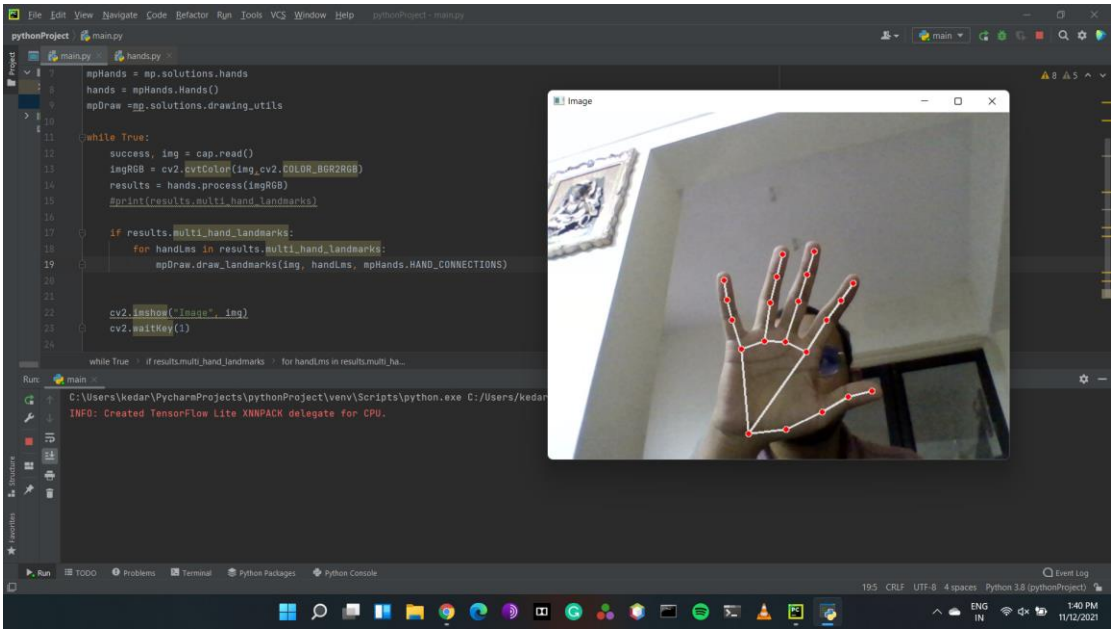
Step	**Step Details**	**Expected Result**	**Actual Result**	**Test Case**
1.	Open a Webcam	Webcam should open	Webcam Opened	Pass
2.	Detection & Tracking of Hand	Hand should be detected & tracked around the frame	Hand tracked & detected	Pass
3.	Distance of hand from webcam	Aproximate Distance (in cm) of hand from webcam should	Distance displayed	Pass

		be detected		

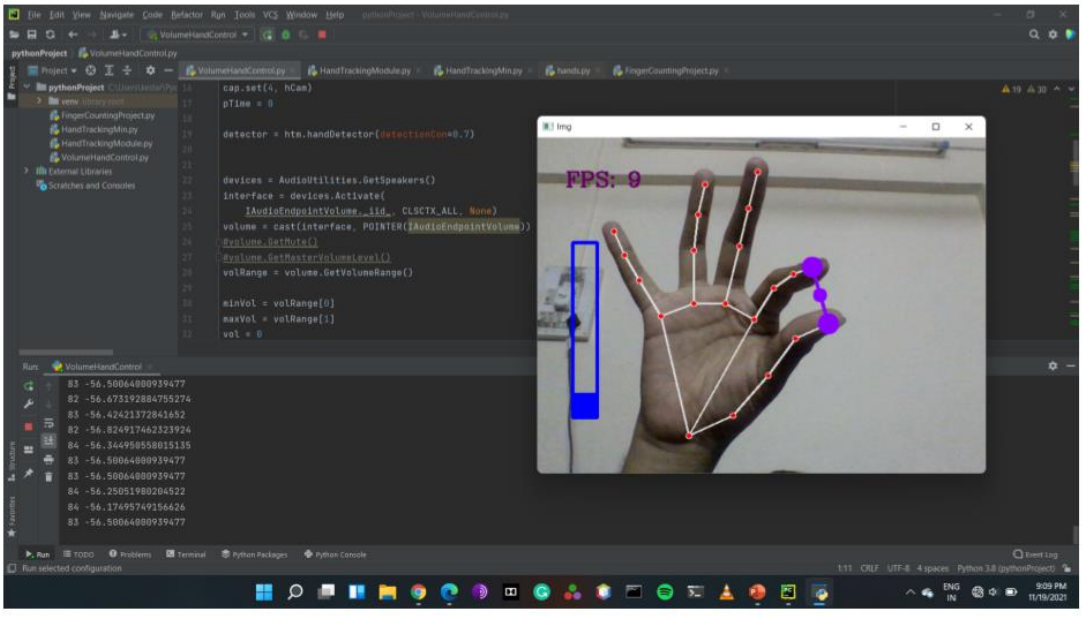
CHAPTER 10

RESULTS

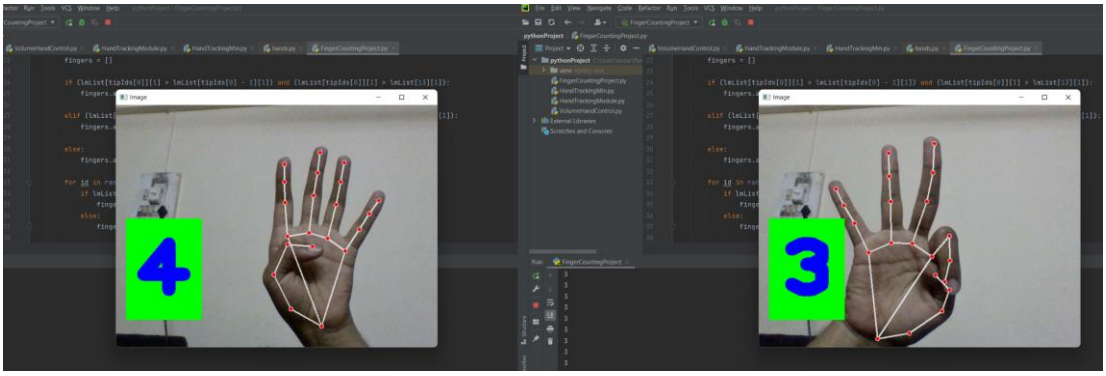
10.1 OUTPUTS



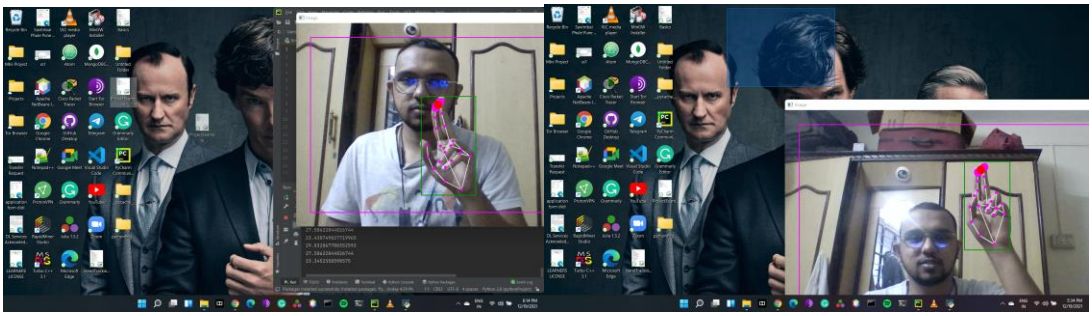
Hand Landmark Points Detection



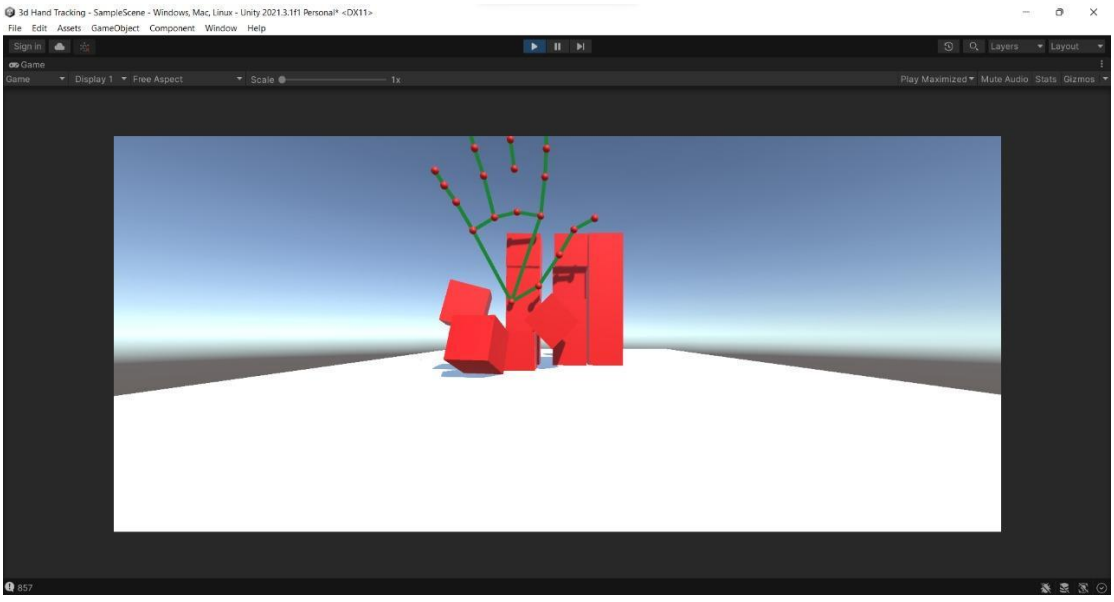
Volume Control



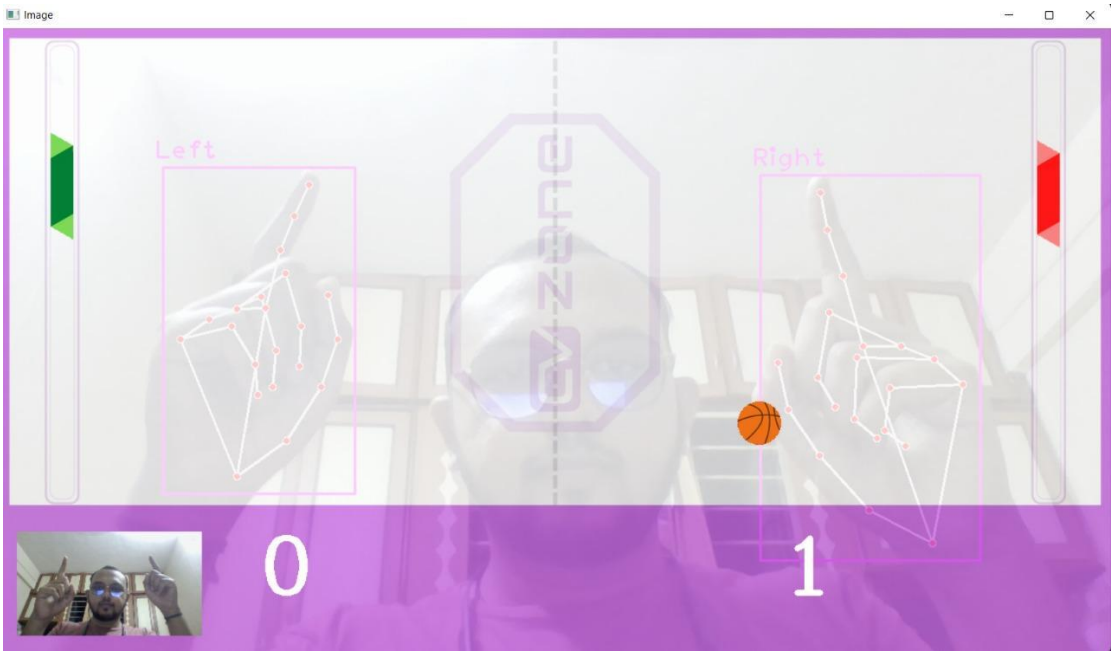
Finger Counter Left and Right hand.



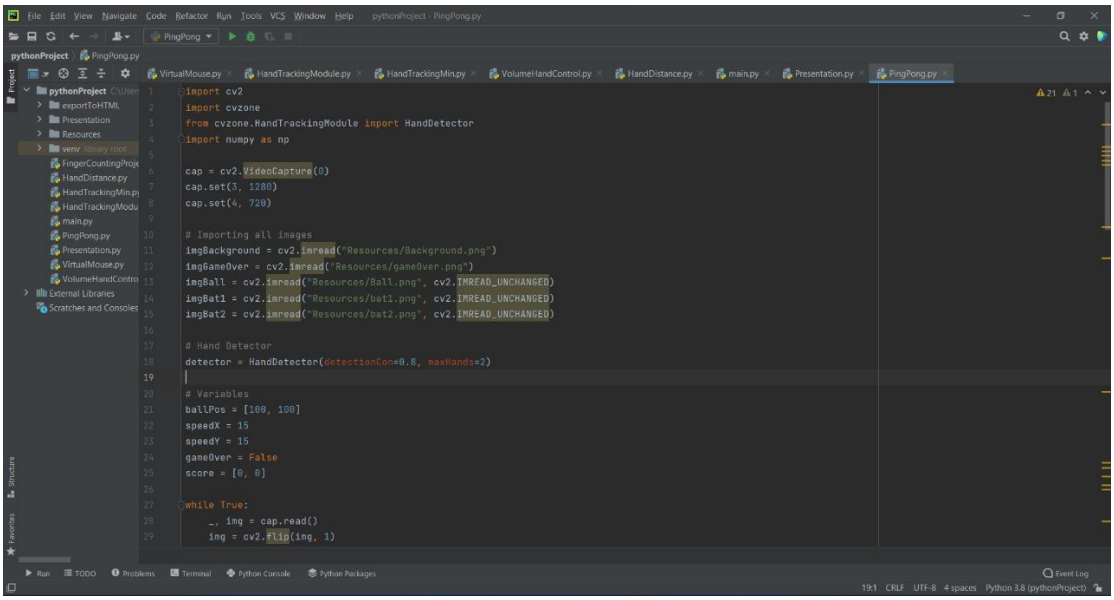
Drag and drop function



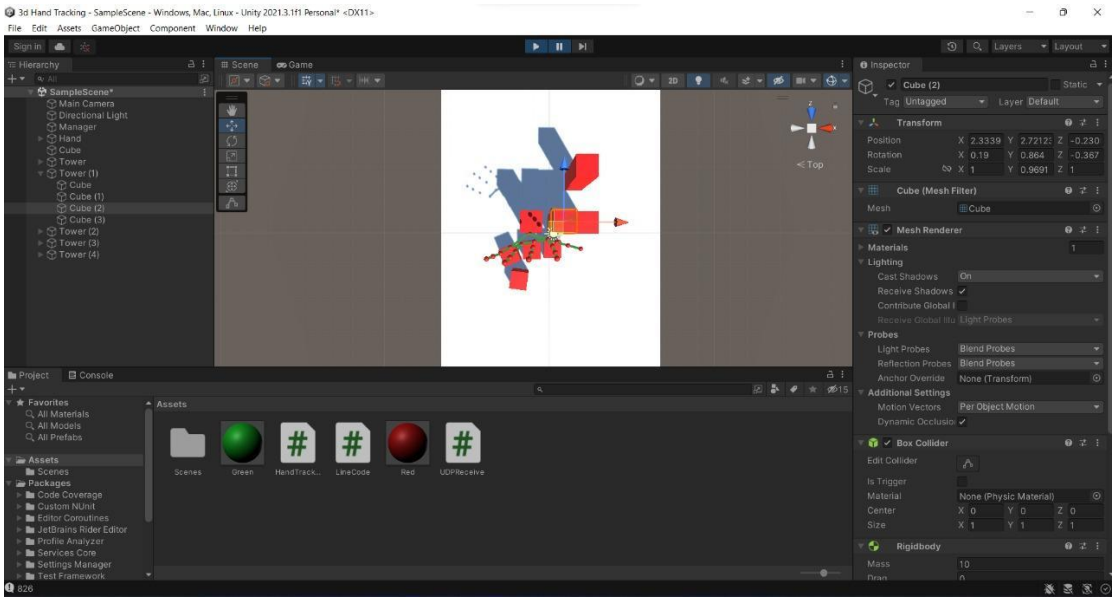
3D Model



Ping Pong Game



Ping Pong Code ScreenShot



3D model code unity

CHAPTER 11

DEPLOYMENT AND MAINTENANCE

11.1 INSTALLATION AND UNINSTALLATION

11.1.1. Following installation process were done for this project

1. Install Python 3.8.10
2. Add the python to the system path for all users
3. Install PyCharm 2021.2.3.
4. Use the added path of Python for PyCharm.
5. Create a project in PyCharm
6. Install the following Libraries:
    - pip install opencv
    - pip install math
    - pip install mediapipe
    - pip install socket
    - pip install pyautogui
    - pip install pycaw
7. Create basic module HandTrackingMin to import in other functionalities
8. Install Unity for 3-D hand Tracking module.
9. Import pyinstaller to convert project into Executable file.

CHAPTER 12

CONCLUSION AND FUTURE

SCOPE

1.1. Conclusion:

Hand Gesture recognition provides the best communication between people and the machine. Hand Gesture recognition is also important to improve personal computer interaction further methods. Allows the person to connect to the machine in a more natural way. Hand Gesture recognition can be used for many applications such as sign language recognition for the deaf and dumb people, robot control, etc. The system was able to control Cursor movement by tracking the user's hand. Cursor operations are performed using different hand gestures. The system is capable of being a replacement for a computer mouse.

1.2. Future Scope:

The proposed AI visual mouse has some limitations such as a slight decrease in the accuracy of the right-click function and the model has difficulty using click and drag to select text. These are some of the visual mouse system limitations of the proposed AI, and these limitations will be overcome in our future work.

In addition, the proposed method can be upgraded to handle keyboard functionality and mouse functionality which is probably another future course of Human-Computer Interaction (HCI).

ANNEXURE A

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ANNEXURE B

PROJECT PLANNER

Project Planner:

1. Information Gathering and Literature Survey:

   This phase comprises research work. We first researched the existing needs of the market, available products, needs of the customer and so on. Based on this we gathered the information and came to this conclusion.

2. Problem Definition and Finalization :

   After finalizing our topic, we went ahead as to how to implement it, using what tools and technologies etc. Based on our topic various papers were searched and also the efficiency of the language on which we are using was checked.

3. Modeling and organizing tools/techniques:

   Once our topic was selected, we finalized onto which area we needed to work and using which technology. The problem statement was thus defined. The problem was divided into various modules.

4. Implementation:

   The implementation of various modules started in this phase. The various features were implemented as per the implementation phases.

5. Testing:

Testing of the various modules of the system is done in this phase and also testing of the system as a whole was done.

6. Report submission:

A final report was prepared.

ANNEXURE C

Reviewers Comments of Paper Submitted

Paper Title:

1. Mouse Cursor Control Using Hand Gestures
2. Mouse Cursor Control Using Hand Gestures Based on Detection and Tracking Confidence Score

Name of the Journal where paper submined:

1. IJSREM (International Journal of Scientific Research in Engineering and Management)
2. ADBU (Assam Don Bosco University)

Paper accepted/rejected:

1. Accepted with ISSN: 2582-3930
2. Submitted

Published Paper & Certificates:

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 12 | Dec - 2021 ISSN: 2582-3930

Mouse Cursor Control Using Hand Gestures

Kedar Mane[1], Sahil Bandal[2], Sanket Kadam[3] Sweety Gholwe[4]

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[2]*Sahil Bandal Comp Department & APCOER*
[3]*Sanket Kadam Comp Department & APCOER*
[4]*Sweety Gholwe Comp Department & APCOER*

Abstract - Using hand gestures is a natural method of interaction between humans and computers. We use gestures to express meaning and thoughts in our everyday conversations. Gesture-based interfaces are used in many applications in a variety of fields, such as smartphones, televisions (TVs), video gaming, and so on. With advancements in technology, hand gesture recognition is becoming an increasingly promising and attractive technique in human–computer interaction. Gesture recognition allows humans to communicate with the machine directly without any external devices. Our system will allow the user to navigate the computer cursor using their bare hands. The proposed system will only require a webcam as an input device. The result of the camera will be displayed on the system's screen so that it can be future calibrated by the user. This system could be a very comfortable method to control the mouse. It also has the potential of being a viable replacement for the computer mouse.

Key Words: : 1] Human-Computer Interaction. 2]Pattern Recognition. 3]Virtual Mouse. 4]Hand gestures.

1. INTRODUCTION

We all are living in a digital world in which we are dealing with different technologies. The most important inventions are computers, laptops, and mobiles, etc. which have become part and parcel of our life. We complete all our tasks with the help of these technologies. Because of this, our life becomes faster, easy and more relaxed. In the present-day scenario, most mobile phones are using touch screen technology to interact with the user. Also, we are using different devices like mouse, joysticks in order to handle laptops, computers. But these are all hardware devices, and these may get damaged over a period of time. We need to handle such devices very carefully in order to overcome such hardware problems. As computer technology continues to develop, people have smaller and smaller electronic devices. Increasingly we are recognizing the importance of human computing interaction (HCI) and in particular vision-based gesture and object recognition. In our project, we propose a novel approach that uses a video device to control the mouse system (Mouse tasks). We employ several image processing algorithms to implement this. For most laptops, the touchpad is not the most comfortable and convenient, so our system has the potential of being a viable replacement for the computer mouse it also reduces the cost of hardware. Our project is user-friendly. Since it mainly focuses on handling simple operations like left-clicking, right-clicking, scrolling, dragging, etc

2. Propose System

In the proposed method, when a user performs some gestures in front of a web camera that is present on a laptop, the webcam captures the real-time video at a fixed frame rate and resolution which is determined by the hardware of the camera. We have proposed the following system:

i) Mouse Cursor Control
ii) Multimedia player control.
iii) Virtual paint.

The in-built webcam is used to capture live video and the application is used to extract required frames from the live video. The application uses OpenCV for image processing and object detection. OpenCV detects the hand and uses the HAND_LANDMARK module to identify the 21 landmark points on the hand. Furthermore, the module draws the connections between the points to create a hand mesh which makes the gesture recognition more efficient and accurate.

OpenCV uses BGR images for processing. In order to convert RGB format to BGR, the application uses the BGR2RGB module and again converts it to RGB format. The system also uses NumPy to work with landmark points. The system also used mathematical functions to perform some mathematical operations such as distance formula for gesture recognition, Fourier transforms for noise correction, and Coordinate system to track the position of hands. the application recognizes the gestures according to the landmark positions and executes the respective command.

The program files will be converted into an executable file(.exe file) that can run on any pc which meets the minimum hardware requirement.

3. Results

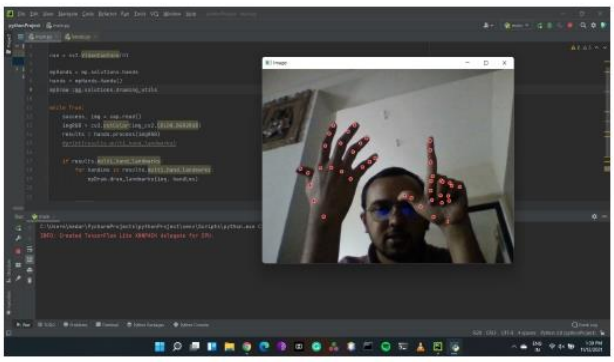

Fig. - 1 : Detection Of Landmar

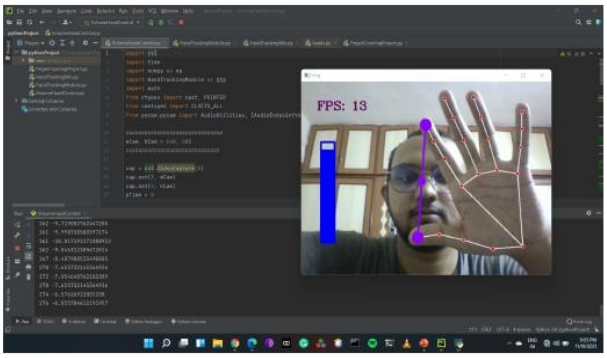

Fig. - 2 : Performing Volume Control

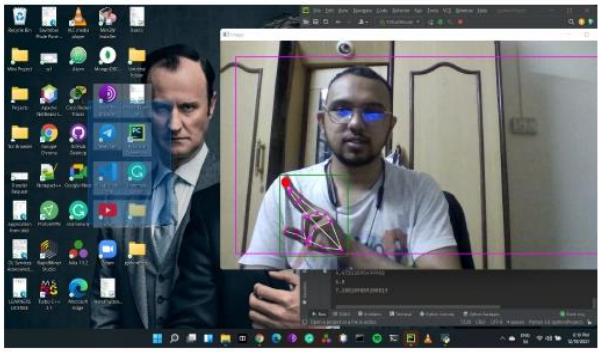

Fig. - 3 : Performing Multiple Select Operation

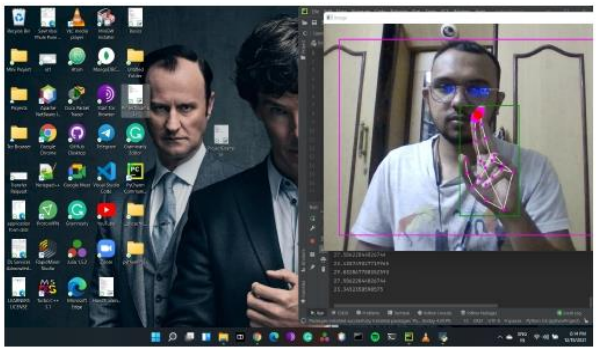

Fig. - 3 : Performing Drag Operation

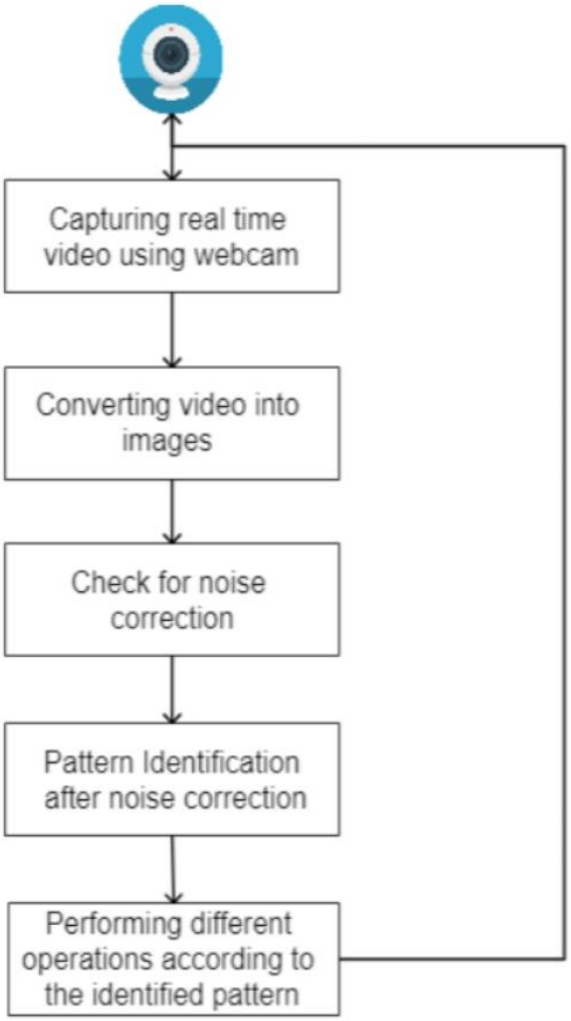

Fig. - 3: Flowchart of Proposed System

3. Applications of Proposed System

This project can be useful for presentations and for reducing the workspace and burden of extra hardware devices. It can help them to interact with computing machines. Critical events like a battleground, operation theater, mining fields can be controlled by gesture mouse.We can also use Mouse cursor functionalities such as right-click, left-click, scrolling, dragging,etc.

4. Litureature Survey

1] Dipankar Gupta has published An Interactive computer system with gesture-based mouse and keyboard paper in which they have proposed a system that helps paralyzed people by providing a virtual mouse and a keyboard to ease their work instead of a physical mouse and keyboard. This system uses OpenCV for object detection and image processing along with the built-in function of the Image processing Toolbox in MATLAB and a mouse driver, written in java. They used color tapes to recognize the user's fingers

and this system achieved 78%-90% accuracy but it did not work efficiently in a rough and complex background.

2] Kanya Krishi published a Hand gesture recognition using Machine Learning Algorithms paper in which the proposed system uses OpenCV and TensorFlow object detector for capturing and processing hand gestures. It describes how hand images can be interpreted as gestures to perform operations like switching pages and scrolling up and down the page.

3] Vijay Kumar proposed a system in their virtual mouse control using hand class gestures that detect the hand gestures in which if the angle between any two fingers is less than 15 degrees then left-click is performed. they have used python dependencies such as NumPy, math, wx to develop the system along with the kernel function which identifies the skin colour using RGB parameters.

4] Kamlesh Patil and Atharv Kasodekar published a Virtual mouse application paper that proposed an executable application of virtual mouse which was developed with the help of OpenCV and Tkinter package.

5. CONCLUSION

Gesture recognition gives the best interaction between human and machine. Gesture recognition is also important for developing alternative human computer interaction modalities. It enables human to interface with machine in a more natural way. Gesture recognition can be used for many applications like sign language recognition for deaf and dumb people, robot control etc. The system was able to control the movement of a Cursor by tracking the user's hand. Cursor functions were performed by using different hand gestures. The system has the potential of being a viable replacement for the computer mouse.

6. ACKNOWLEDGEMENT

It gives us great pleasure in presenting the preliminary project report on Mouse Cursor Control Using Hand Gestures. We would like to take this opportunity to thank our internal guide Asst. Prof. Pranali Mahadik for giving us all the help and guidance we needed. We are really grateful to him for his kind support. Their valuable suggestions were very helpful.We would like to express our deepest appreciation towards principal Dr. Sunil Thakare, ABMSP's Anantrao Pawar College of Engineering Research, and we are grateful of Prof. Rama Gaikwad , Head of Computer Engineering Department, ABMSP's Anantrao Pawar College of Engineering& Research, for his indispensable support, suggestions and for providing us infrastructure for our project.In the end, our special thanks to Lab Assistants Mrs. Sheila Nagpure for providing us various resources such as laboratory with all needed software platforms, continuous Internet connection, for Our Project.

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ISSN: 2582-3930

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Mouse Cursor Control Using Hand Gestures

published in Ijsrem Journal Volume 05 Issue 12 December 2021

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ISSN: 2582-3930

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published in Ijsrem Journal Volume 05 Issue 12 December 2021

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ISSN: 2582-3930

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Mouse Cursor Control Using Hand Gestures based on Detection and Tracking Confidence

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Abstract*: *Using hand gestures is a natural way of interacting with people and computers. We use physical gestures to express meaning and ideas in our daily conversations. Gesture-based visual connectors are used in many applications in a variety of fields, such as smartphones, televisions (TVs), video games, and more. With the advancement of technology, touch detection has become a promising and attractive way in which humans interact with computers. Gesture detection allows people to communicate directly with the machine without any external devices. Our system will allow the user to navigate to a computer screen using empty hands. The system will require a webcam as an input device. The camera effect will be displayed on the system screen for future reference by the user.It also has the potential of being a viable replacement for the computer mouse.

***Keywords*: Gesture recognition, Human-Computer Interface, Image Processing, Pattern Recognition, Virtual Mouse.**

I. Introduction

We all live in a digital world where we are exposed to a variety of technologies. The most important inventions are computers, laptops, cell phones, etc. which have become a part of our lives. We complete all our work with the help of this technology. As a result, our lives become simpler, easier, and more comfortable. In today's world, many mobile phones use touch screen technology to interact with the user. Also, we use different devices like mouse, and joysticks to hold laptops and computers. But these are all hardware tools, and these can be damaged for a period of time. We need to handle such equipment carefully to overcome such hardware problems. As the era of computer technology advances, people have become smarter. We are increasingly seeing the importance of human-computer interaction (HCI) and in particular the concept-based touch and object recognition. In our project, we propose a new method that uses a video device to control the mouse system (Mouse functions). We use a few image processing algorithms to do this. For maximum laptops, the touchpad isn't the maximum snug and convenient, so our project has the ability to be a possible alternative for the laptop mouse it additionally reduces the fee of hardware. Our challenge is user-friendly. Since it especially focuses on dealing with easy operations like left-clicking, right-clicking, scrolling, dragging, etc

The main advantage of using hand gestures is to interact with the computer as a non-contact human-computer input modality.We can use this system for gaming operations, paint, and in difficult situations such as medical operations.The utilization of virtual mouse appears in space-saving situations or in movement situations.

In the proposed method, when a user performs some gestures in front of a web camera that is present on a laptop, the webcam captures the real-time video at a fixed frame rate and resolution which is determined by the hardware of the camera. We have proposed the following system:

1)Mouse cursor control system
2)Volume control
3)Virtual game
4)Presentation module

The built-in webcam camera is used to capture live video and the program is used to extract the required frames for live video. The app uses OpenCV for image processing and object acquisition. OpenCV receives and uses the HAND_LANDMARK module to identify 21 landmarks in hand. In addition, the module draws connections between hand landmark points to create a hand mesh that makes pattern detection more efficient and accurate.

OpenCV uses BGR images for processing. To convert RGB format to BGR, the application uses the BGR2RGB module and converts it to RGB format. The program also uses NumPy to work with 21 points. The system used mathematical functions to perform operations such as distance formula, Fourier transforms to check and reduce noise from the acquired frame, and the Coordinate system to track patterns and hand movements. the program detects the pattern and gives the appropriate command.

I. SYSTEM MODEL

A. Methodologies

1) SVM:

Support Vector Machine or SVM is a machine learning algorithm that looks at data and organizes it into one of two categories. Support Vector Machine is a supervised and line-based Machine Learning algorithm that is commonly used to solve classification problems and is also called Vector Support Design.

2) MediaPipe:

The ability to see hand movements and movements can be an important factor in improving user experience across all technical fields and platforms. For example, it can form the basis for understanding sign language and controlling hand gestures, and it can enable the accumulation of digital content and information in the real world in augmented reality. Although it comes naturally to humans, strong real-time visualization of the hand is a very challenging computer vision task, as the hands often close themselves or by themselves (e.g., finger/palm closure and handshake). It uses machine learning (ML) to understand 21 3D landmark points from just one frame. our approach achieves real-time performance on mobile phones, even scale in many hands. We hope that providing this visual aid in a comprehensive research and development community will lead to the emergence of creative applications, which encourages new applications and new research methods.

3) Detection Confidence:

The detection confidence is the threshold value set in the program for better the accuracy and performance to detect the hand. It's currently set to 0.5 for hand detection.If the detection confidence is less than 0.5 the program will retry to detect the hand and if the detection confidence is more than 0.5 the program will stop detecting the hand and start tracking it.This value can be adjusted according to the background noise and light intensity.

4) Tracking Confidence:

The tracking confidence is the threshold value set in the program for better accuracy and performance.It's currently set to 0.6 for hand tracking.If the tracking confidence is less than 0.6 the program will stop tracking the hand and will detect the hand first according to the detection confidence and if the tracking confidence is more than 0.6 the program will keep tracking the hand. This value can be adjusted according to the FPS (Frames Per Second) of the inbuilt webcam.

5) Hand Landmark Points:

After the palm is found over the whole image our next handwriting model makes a precise key point for 21 3D hand wrists within the obtained hand circuits, which is a prediction of direct connection. The model learns to represent a stable internal hand shape and is strong even to the point of being slightly visible and self-closing.The points are :

0. WRIST	10. MIDDLE FINGER_PIP
1. THUMB_CMC	11. MIDDLE FINGER DIP
2. THUMB_MCP	12. MIDDLE FINGERTIP
`3. THUMB_IP	13. RING FINGER MCP
4. THUMB_TIP	14. RING FINGER PIP
5. INDEX FINGER MCP	15. RING FINGER DIP
6. INDEX FINGER PIP	16. RING FINGER TIP
7. INDEX FINGER_DIP	17. PINKY MCP
8. INDEX FINGER TIP\	18. PINKY PIP
9. MIDDLE FINGER_MCP	19. PINKY DIP
20. PINKY TIP	

B. Mathematical Equations

1) Distance & Mid-point Formula:

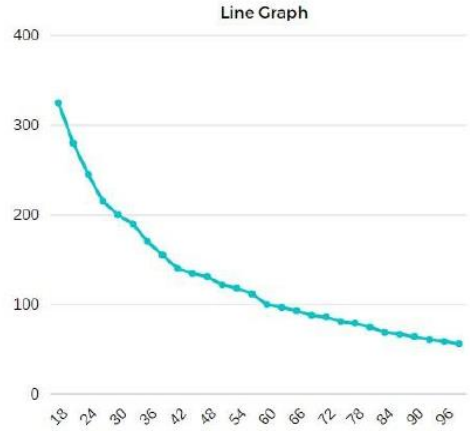
$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

This formula is used in the program to calculate the distance between the landmark points which is further used for pattern recognition. based on the distance formula calculations gestures are defined such as volume control. In volume control the distance formula is used to calculate the distance between INDEX FINGER_TIP and THUMB_TIP

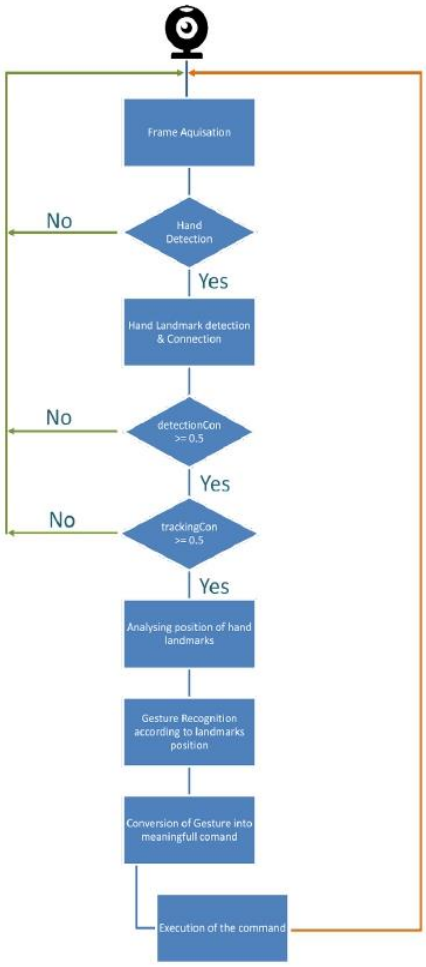
2) 2 Degree polynomial function:

$$y = ax^2 + bx + c$$

This equation is used to calculate the distance of the hand from the webcam. By using the polyfit() function from the Numpy library we get A, B, and C constants after processing the data.



C. Data flow Diagram



III. Experimental Results.

The proposed procedure is implemented in Python using OpenCV, and NumPy Library.The application was tested on different illuminance levels and different backgrounds.

Gesture Made	Gesture Recognized	Successful Recognition Rate	Illuminance level [lux]
15	0	0%	0
15	10	66.66%	8
15	14	93.33%	25
15	15	100%	55...400

Table.1.
Successful gesture recognition rates.

By analyzing the data from the table the application works at best for illuminance levels bigger than 25lx, the successful recognition rate is 100% for all performed patterns. For a low illuminance level (25lx) the minimum successful recognition is 93.33%. for 7lx the gesture made had a low success rate of 66.66%..For given illuminance levels the number of detected hand gestures for left click and right click was more successful compared to the double click and drag and drop.

IV. Conclusion

Hand Gesture recognition provides the best communication between people and the machine. Hand Gesture recognition is also important to improve personal computer interaction further methods. Allows the person to connect to the machine in a more natural way. Hand Gesture recognition can be used for many applications such as sign language recognition for the deaf and dumb people, robot control, etc. The system was able to control Cursor movement by tracking the user's hand. Cursor operations are performed using different hand gestures. The system is capable of being a replacement of computer mouse.

V.Acknowledgment

It gives us great pleasure in presenting the preliminary project report on 'Mouse Cursor Control Using Hand Gestures.'. We would like to take this opportunity to thank our internal guide Asst. Prof. Pranali Mahadik for giving us all the help and guidance we needed. We are really grateful to him for his kind support. Their valuable suggestions were very helpful.We would like to express our deepest appreciation towards principal Dr. Sunil Thakare, ABMSP's Anantrao Pawar College of Engineering Research, and we are grateful to Prof. Rama Gaikwad, Head of Computer Engineering Department, ABMSP's Anantrao Pawar College of Engineering& Research, for his indispensable support, suggestions and for providing us the infrastructure for our project.In the end, our special thanks to Lab Assistants for providing us with various resources such as a laboratory with all needed software platforms, and a continuous Internet connection, for Our Project.

VI.References

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ANNEXURE D

PLAGIARISM REPORT

D1. PLAGARISM CHECK REPORT

Chapter Number	Chapter	Uniqueness
1	Synopsis	
2	Technical Keywords	
3	Introduction	
4	Problem Definition and Scope	
5	Project Plan	
6	Software Requirements Specification	
7	Detailed Design Document	
8	Project Implementation	
9	Software Testing	
10	Result	
11	Deployment and Maintenance	
12	Conclusion Future Scope	

ANNEXURE E

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