Gesture Controlled Virtual Mouse With Support Of Voice Assistant

PROJECT PHASE-2 REPORT

Submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

Under the Guidance of

SUNAYANA S

(Assistant Professor, BMSCE)

B. M. S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019
2022-2023
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

Certified that the project entitled "**Gesture Controlled Virtual Mouse With Support Of Voice Assistant**" is a bonafide work carried out by **PRITHVI J**(1BM19CS122), **S SHREE LAKSHMI** (1BM19CS136), **SOHAN R KUMAR**(1BM19CS159), **SURAJ S NAIR** (1BM19CS163) in partial fulfillment for the award of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belagavi during the academic year 2022 -23. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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SUNAYANA S, Assistant Professor, Dept of CSE, B.M.S. College of Engineering	**Dr. JYOTHI S. NAYAK**, Professor and HOD, Dept of CSE, B.M.S. College of Engineering

Principal

Dr. S. Muralidhara
B.M.S. College of Engineering

External Viva

Name of the Examiners	Signature with Date
1.	
2.	

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ABSTRACT

Non - verbal communication in the form of gestures is utilized to convey a certain message. Hand gestures are one of the most natural and effortless way or method in communication. Here the basic concept is to make use of a simple camera instead of a standard mouse to control mouse cursor movements or functions.

The Virtual Mouse acts as an infrastructure between the user and the system with the help of a camera. It allows users to interact with machines without the usage of mechanical or any physical devices, and it even lets the user control mouse funtationalities. This study presents a method for controlling the cursor's position without the need for any electronic equipment. This study presents a camera vision system that's based on Hand movements taken from a camera using a color discovery approach to control the cursor While actions such as clicking and dragging things will be carried out using various hand gestures. As an input device, our suggested system will just need a webcam. The system will also require the use of OpenCV and Python as well as other tools. The camera's output will be presented on the system's monitor so that the user can further calibrate it.

DECLARATION

We, hereby declare that the Major Project Phase 2 work entitled **"Gesture Controlled Virtual Mouse With Support Of Voice Assistant"** is a bonafide work and has been carried out by us under the guidance of **SUNAYANA S,** Assistant Professor, Department of Computer Science and Engineering, B.M.S. College of Engineering, Bengaluru**,** in partial fulfillment of the requirements of the degree of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belagavi.

I further declare that, to the best of my knowledge and belief, this project has not been submitted either in part or in full to any other university for the award of any degree.

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Place: Bengaluru

Date:

Certified that these candidates are students of Computer Science and Engineering Department of B.M.S. College of Engineering. They have carried out the project work of titled "**Gesture Controlled Virtual Mouse With Support Of Voice Assistant**" as Major Project Phase-2 work. It is in partial fulfillment for completing the requirement for the award of B.E. degree by VTU. The works is original and duly certify the same.

Guide Name　　　　　　　　Signature

SUNAYANA S

Date:

ACKNOWLEDGMENT

We would like to express our sincere gratitude to several individuals and organizations for supporting us throughout our Major Project Phase 2. First, we wish to express sincere gratitude to our Guide, SUNAYANA S, for her enthusiasm, patience, insightful comments, helpful information, practical advice and unceasing ideas that have helped us tremendously at all times to think on new ideas, focus on the latest trends, and improve each time at our presentation skills. Her immense knowledge, profound experience and professional expertise has enabled us to learn and make several improvisions on the project. Without his support and guidance, this project would not have been possible. We could not have imagined having a better supervisor for guiding us through this project.

We also wish to extend our sincere thanks to the Department of Computer Science of B.M.S. College of Engineering for providing us the opportunity to work on this course titled “Major Project Phase 2”. Additionally, we would like to express our gratitude to all the department teachers and mentors, who have supported and encouraged us during our panel reviews by providing certain suggestions, reflecting upon our ideas and providing us a path for the successful completion of the same.

In addition, we would also like to extend our thanks to our fellow batchmates and also our seniors who have always been available and helped us by providing their suggestions.

Chapter 1

INTRODUCTION

- ## Overview

Non - verbal communication in the form of gestures is utilized to convey a certain message. The movements of a person's body, hands, or face can be used to send this message. Gestures have the ability to convey something when engaging with other individuals. From simple to incredibly complicated hand movements.

Gesture Controlled Virtual Mouse makes human computer interaction simple by making use of Hand Gestures and Voice Commands.The computer requires almost no direct contact. All i/o operations can be virtually controlled by using static and dynamic hand gestures along with a voice assistant.

- ## Motivation

The AI virtual mouse system is useful for many applications; it can be used to reduce the space for using the physical mouse, and it can be used in situations where we cannot use the physical mouse. The system eliminates the usage of devices, and it improves the human- computer interaction. Some of the areas where this technology serves its use include, corporate organizations, professional work environments, medical and healthcare industry, manufacturing and testing industry.

Along with this, here are few scenarios to where this technology is implemented :-

- amidst the COVID-19 situation, it is not safe to use the devices by touching them because it may result in a possible situation of spread of the virus by touching the devices, so the proposed AI virtual mouse can be used to control the PC mouse functions without using the physical mouse.
- The system can be used to control robots and automation systems without the usage of devices.
- 2D and 3D images can be drawn using the AI virtual system using the hands.

Objective

The objectives of Gesture Controlled Support System are as follows :

- The main goal is to implement and develop a support system which aids in simplifying burdensome tasks and aiding individuals with disabilities at several levels, in fulfilling their daily endeavours without any hassles.
- This is accomplished by the means of hand gestures and voice commands involving systematic approach as shown in figures.

Scope

The system is used to implement motion tracking mouse, a signature input device and an application selector. This system reduces the use of any physical mouse which saves time and also reduces efforts. To design motion tracking mouse which detect finger movements gestures instead of physical mouse.

Proposed System

Hand Gesture recognition and virtual mouse System along with addition of voice assistance.

The proposed Gesture Controlled Virtual Mouse system also includes a third module that leverages voice automation for wireless mouse assistance. This module allows users to perform mouse operations such as clicking, scrolling, and dragging, by simply giving voice commands. This feature is especially helpful for users who are unable to use hand gestures due to physical limitations. The voice automation module is implemented using state-of-the-art speech recognition algorithms that enable the system to accurately recognize the user's voice commands. The module is designed to work seamlessly with the other two modules of the system, allowing users to switch between hand gestures and voice commands effortlessly.

This module also adds a layer of convenience by allowing users to perform mouse operations from a distance, without the need for any direct contact with the computer. There are 2 Ways in which the user can control the mouse movements:

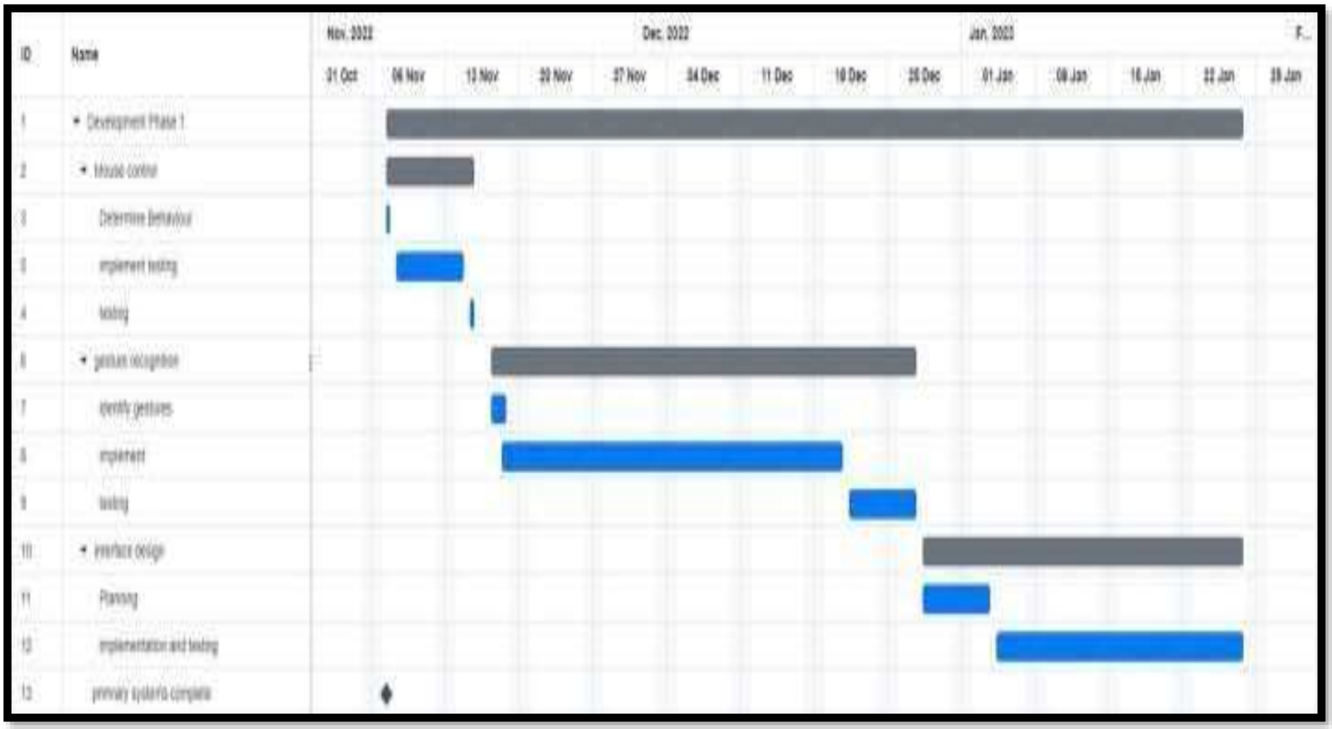
Using Colored Caps

Using Hand gestures

This makes it a useful tool for presentations, demonstrations, and other scenarios where the user needs to interact with the computer without being physically close to it.

Overall, the Gesture Controlled Virtual Mouse system is an innovative and user-friendly solution that simplifies human-computer interaction. With its advanced machine learning and computer vision algorithms, it offers a reliable and efficient way for users to control their computers using hand gestures, voice commands, or a combination of both.

- **Work Plan**


ID
Name
Nov, 2022
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Development Phase 1
Mouse control
Determine Behaviour
implement testing
testing
gesture recognition
identify gestures
implement
testing
interface design
Planning
implementation and testing
primary systems complete

Chapter 2

LITERATURE SURVEY

1. A FINGER-TRACKING VIRTUAL MOUSE REALIZED IN AN EMBEDDED SYSTEM.

Citation : Tsang, W.-W. M., & Kong-Pang Pun. (2005). A finger-tracking virtual mouse realized in an embedded system. 2005 International Symposium on Intelligent Signal Processing and Communication Systems. doi:10.1109/ispacs.2005.1595526

In this paper, a virtual mouse that is based on tracking the movement of a finger is presented. The idea is for users to control their computer or TV system simply by moving their fingers, without any contact on realistic objects. A fast and robust method that can trace the position of finger tip is proposed. The method consists of four steps. First, the skin-color pixels of figures are detected by color segmentation using the chrominance component of the input from a CMOS image sensor. Second, density regularization processes are carried out to reinforce the regions of skin-colour pixels. Third, an effective window search technique is applied for minimizing computational cost. Fourth, a finger-tip tracking algorithm is applied to find out the finger-tip position. Clicking action is also implemented by a specific movement. The virtual mouse has been designed in an embedded Linux system. The device works successfully, the response is quick and accurate positioning is obtained.

The mouse interface of a computer system or other electronic appliances is traditionally based on the direct contact of some realistic objects. The freedom of moving fingers through the air to control the computer is frequently imagined in some popular movies. The main objective of this work is to design a device which allows users to operate their mouse through the movement of their fingers in the air. We call this device as a "virtual mouse". The virtual mouse can find its applications in situations where physical contact is highly desirable, for instance, for use of disabled people. A main problem in designing the virtue mouse is the accurate positioning. In this paper we use the finger tip as the pointer of the mouse, and the movement of the finger is tracked by a fast and robust detection algorithm. Further more, the mouse clicking functions are also implemented. All these algorithms are realized in an embedded Linux system rather than in a powerful personal computer system.

THE FINGER TRACKING METHOD The proposed finger tracking method consists of five steps, namely, the RGB to YUV conversion, colour segmentation, density regularization, window searching and finger tracking as illustrated in Fig.1. The first three steps are used to extract the pixel of the same colour range with the input YUV parameter. The last two steps are applied to extract the finger (X,Y) coordinate.

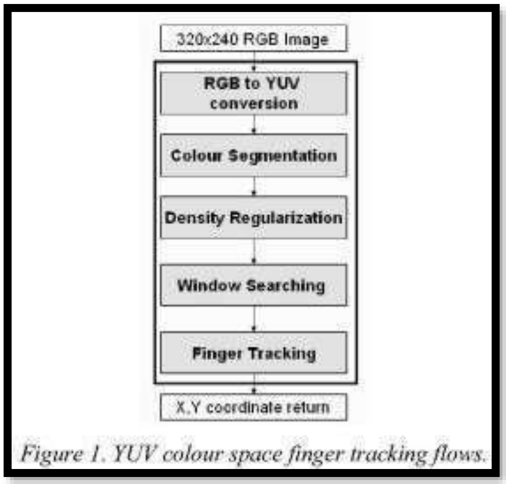


Figure 1. YUV colour space finger tracking flows.

Software System Architecture In the beginning, CMOS sensor driver is needed to initial the CMOS sensor. With particular setting and programming, the CMOS sensor will send out 320X240 16bit image raw data to the memory. With a suitable YUV range parameter, the YUV finger-tracking algorithm can process the input image to extract out the fingertip position as the mouse coordinate. With the mouse coordinate, clicking recognition can check if a specify click motion is done or not. Afterwards, two different output methods will be selected according to the purpose. For USB mouse, a GPIO (General Purpose IO) driver will be applied to initial the USB mouse controller interface. Then, the hardware can be - 782 - connected to the computer through USB cable to facilitate the functioning of a mouse. For TV system DEMO, a TV card driver is implemented to initial the TV-out card. By controlling the frame buffer, a GUI interface with a mouse pointer can be programmed for the TV OUTdisplay.

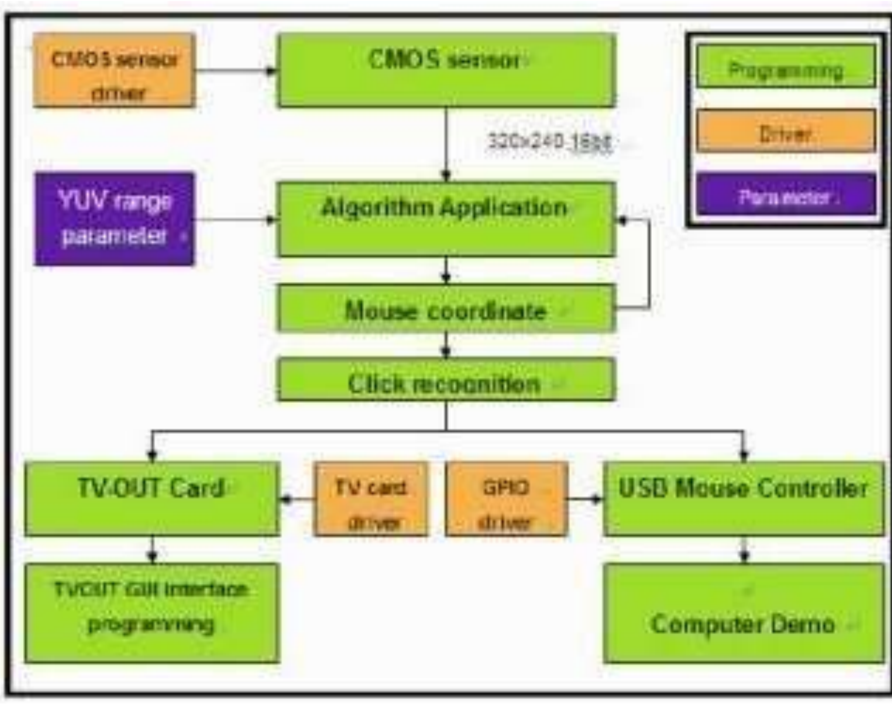


Figure:Software architecture

Hardware System Architecture In the development process, the base acts as the hardware system. All the software systems ands algorithms develop based on the hardware system. The processor is Freescale® i.MX21 application processor. It has an operating frequency of 266MHz and a core of ARM 9. The ADS development board of the i.MX21 has 2X32MB SDRAM and 2X32MB NOR Flash onboard which has installed an embedded linux. There is also one 300k pixel CMOS sensor attached with the ADS. For display, it can output to an LCD panel or a TV-OUT card.

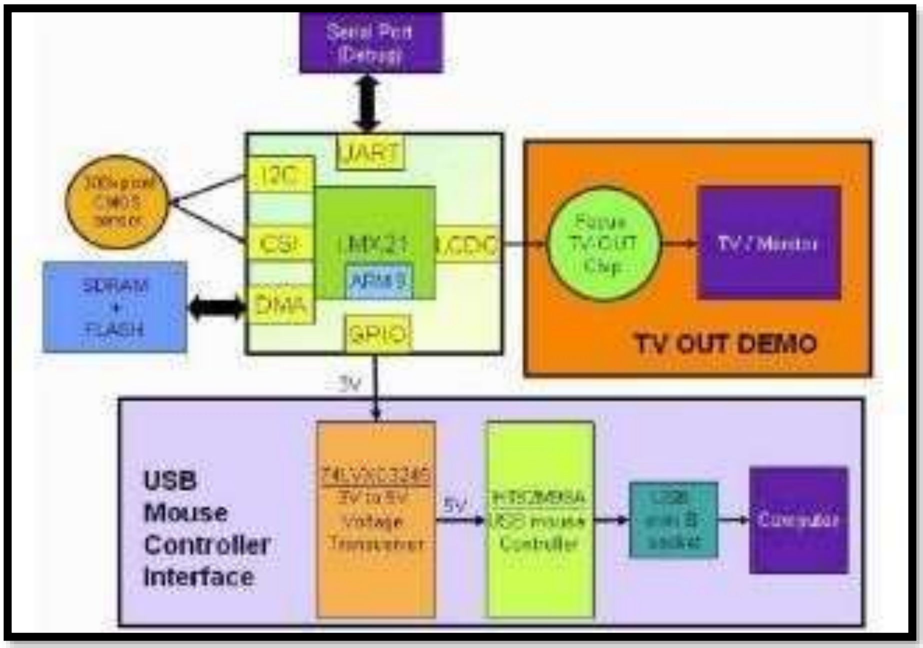


Figure: Hardware Architecture

Finger Tracking This method is to search the fingertip from the top of the searching window. When the finger appears in the searching window, the top of the finger tips will be tracked and returned the position as mouse coordinate. This method works when there is no similar colour object in the background or when the noise is very small. Or else, the mouse pointer will try to follow the other object instead of the finger if it finds another pixel within the same searching window.

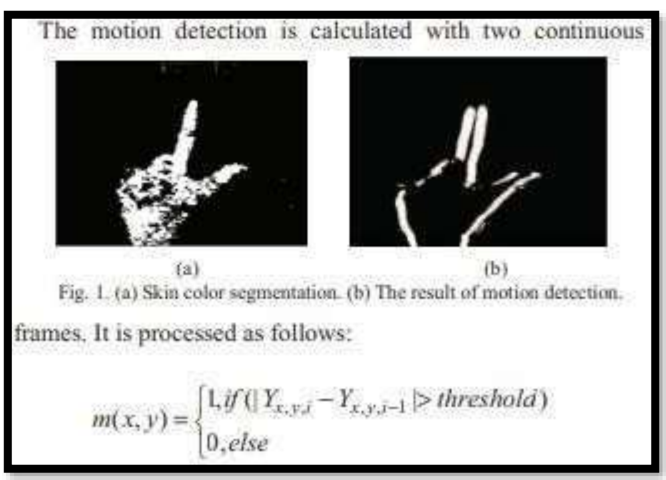
Figure: image before and after using figure tracking algorithm

2. Embedded Virtual Mouse System by Using Hand Gesture Recognition

Citation - Tsai, T.-H., Huang, C.-C., & Zhang, K.-L. (2015). *Embedded virtual mouse system by using hand gesture recognition. 2015 IEEE International Conference on Consumer Electronics - Taiwan.* doi:10.1109/icce-tw.2015.7216939
10.1109/icce-tw.2015.7216939

In the digital information time, daily life is inseparable with human-computer interface (HCI). Human computer interaction has a long history to become more intuitive. For human being, hand gesture of different kind is one of the most intuitive and common communication. However, visionbased hand gesture recognition is still a challenging problem. In this paper, an embedded virtual mouse system by using hand gesture recognition is proposed. There are several techniques involved in the proposed system. Skin detection and motion detection method are used to capture the region-of-interest and distinguish the foreground/background area. Connected component labeling algorithm is used to identify the centroid of an object. The removal on arm and the convex hull algorithm are used to recognize hand area as well as the related gesture. The result shows that our system can operate well even in some harsh environment.

In recent years, the applications such as human-computer interface (HCI) and robot vision have been activated in research areas. As in virtual environment (VE) applications, they offer the opportunity to integrate various latest technologies to provide a more immersive user experience. A virtual mouse with HCI arises much attention and it could substitutes the function of traditional mouse and touch panel. To realize this device, the techniques based on computer vision are involved. Some algorithms are even used with hand segmentation based on skin color. A vision-based HCI system with hand gesture analysis is introduced in. Our design on this work explores the low cost and high performance virtual mouse. All the functions on computer mouse are considered. We capture the hand gesture by a single web camera for natural and intuitive human-computer interaction.


The motion detection is calculated with two continuous

(a) (b)

Fig. 1. (a) Skin color segmentation. (b) The result of motion detection.

frames. It is processed as follows:

$$m(x,y)=\begin{cases}1, if(|Y_{x,y,i}-Y_{x,y,i-1}|> threshold)\\ 0, else\end{cases}$$

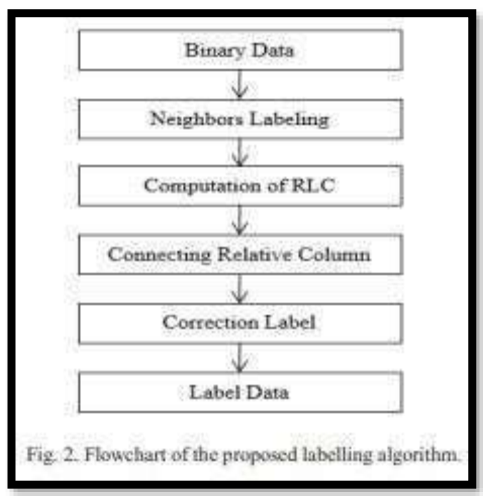


Fig. 2. Flowchart of the proposed labelling algorithm.

Removal Arm and Convex Hull According to the result on skin segmentation, the area with skin color is not exactly equal a palm area. Usually the arm area is included and marked. Here we need to remove it causes only the palm area is helpful to high recognition result.

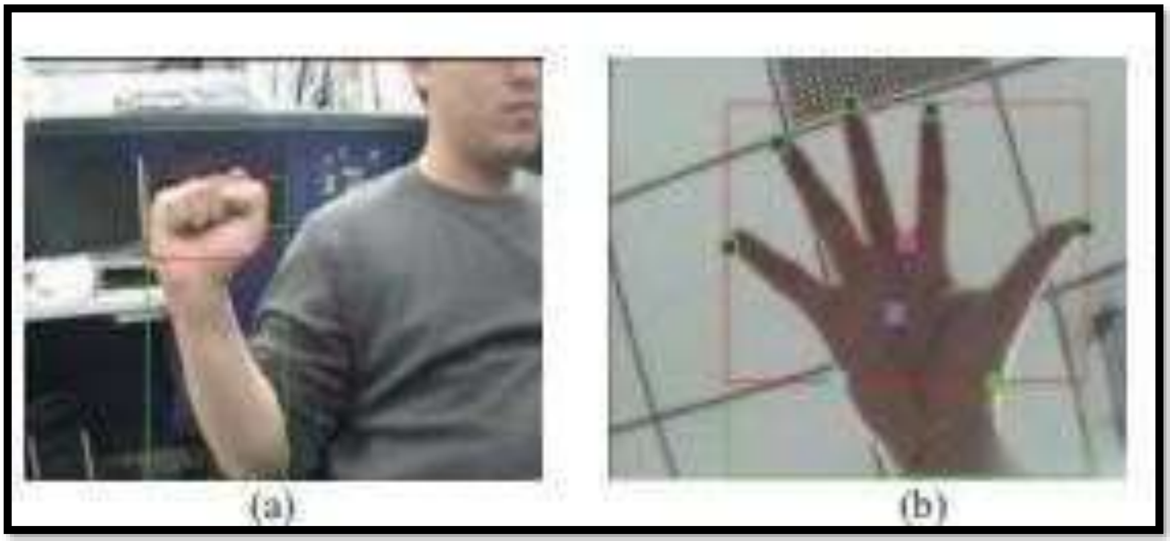
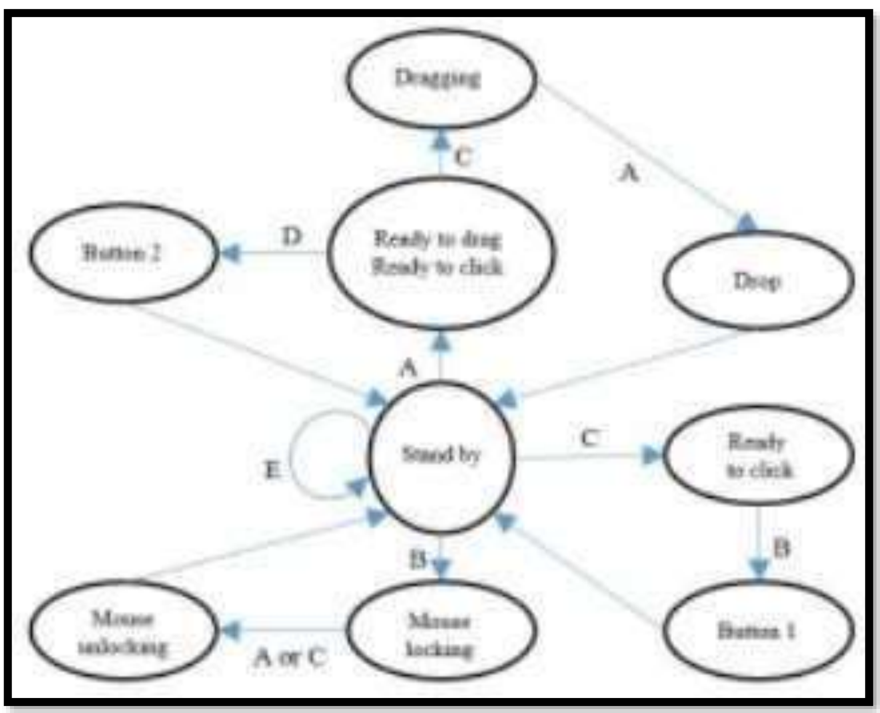


Figure:(a) Removal on arm and interception on palm. (b) The result of convex hall algorithm.

Figure: FSM of virtual mouse



Mouse Function Implementation In this application, the hand gesture motion detection and recognition will be implemented to replace the mouse function. We use four kinds of hand gesture, sequentially as a gesture A to gesture D. EXPERIMENT RESULTS We provide several types of hand gesture in Fig. 5. In each gesture, we test 500 times for each gesture and measure the accuracy of hand gesture recognition. The corresponding recognition rate is shown in Table I.

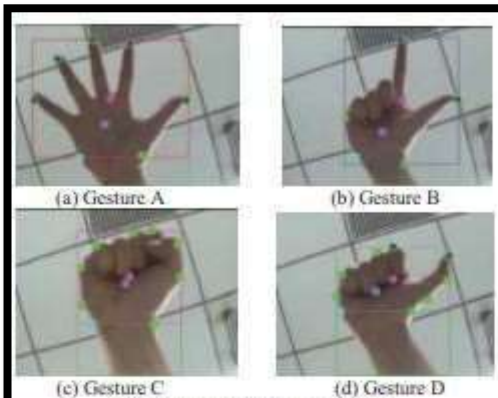


Fig. 5. Four kinds of hand gesture.

TABLE I
ACCURACY OF HAND GESTURE RECOGNITION

	Gesture A	Gesture B	Gesture C	Gesture D
Gesture A	**462**	0	0	4
Gesture B	4	**411**	0	0
Gesture C	0	4	**438**	0
Gesture D	1	0	0	**476**
Miss	33	85	62	20
Accuracy	**92%**	**82%**	**87%**	**95%**

3. A Virtual Mouse Interface Based on Two-layered Bayesian Network

Citation - Roh, M.-C., Huh, S.-J., & Lee, S.-W. (2009). *A Virtual Mouse interface based on Two-layered Bayesian Network. 2009 Workshop on Applications of Computer Vision (WACV).* doi:10.1109/wacv.2009.5403082
10.1109/wacv.2009.5403082

Recently, many studies on gestural control methods for substituting for keyboard and mouse devices have been conducted because of their conveniences and intuitiveness. This paper presents a Virtual Mouse interface which is a gesture-based mouse interface and Two-layered Bayesian Network (TBN) for robust hand gesture recognition in realtime. The TBN provides robust recognition of hand gestures, as it compensates for an incorrectly recognized hand posture and its location via the preceding and following information. Experiments demonstrate that the proposed model recognizes hand gestures with a recognition rate of 93.78% and 85.15% for a simple and cluttered background, respectively
The most general interaction devices used to control computers are keyboard and mouse. Recently more intuitive and convenient interaction methods have been proposed by many researchers, such as speech, gestures, etc. Gestures, especially hand gestures are a very powerful, expressive and intuitive means of communication. Consequently, significant and diverse hand gesture recognition studies have recently been conducted for Human-Computer Interaction (HCI). There are several challenging issues in applying a gesture-based interface for HCI.

rules for gestures. One-handed gestures usually use the trajectory of the hand, the number of fingers, and the hand postures. On the other hand, twohanded gestures usually use one hand for pointing, and the other for commanding . Finally, it must be capable of performing in real-time and guaranteeing reliable accuracy. This paper presents the Virtual Mouse interface, a gestural interface for a mouse device. The proposed interface provides the solution for real-time recognition of hand gestures in a cluttered environment. We propose a new probabilistic model to recognize hand gestures for a Virtual Mouse interface. The proposed model is composed of a two-layered framework: the lower-layer models hand postures with Bayesian Network (BN) and the upper-layer models hand gestures with Dynamic Bayesian Network (DBN). This hierarchical model provides a way to decouple the dependency between features for postures and gestures. Thus, the computational complexity of probabilistic inference and the number of training data can be reduced as compared with the standard HMM. Moreover, although a hand posture and its location may not be correct, the upper-layer DBN can complement these incorrectly recognized hand postures by time information. Therefore, this two-layered architecture provides more reliable performance, even in a cluttered environment.

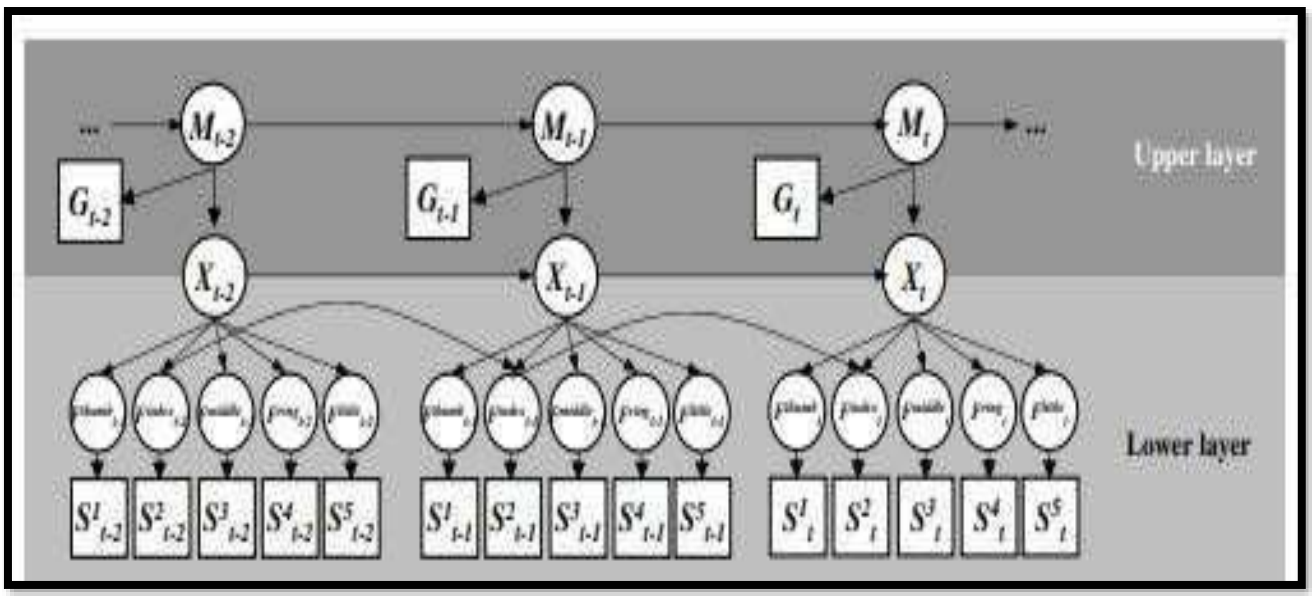


Figure: Graphical Representation of TBN

4. IMPLEMENTATION OF VIRTUAL MOUSE BASED ON MACHINE VISION

Citation - Li Wensheng, Deng Chunjian, & Lv Yi. (2010). *Implementation of virtual mouse based on machine vision. The 2010 International Conference on Apperceiving Computing and Intelligence* doi:10.1109/icacia.2010.5709921 10.1109/icacia.2010.5709921

A method to implement virtual mouse through machine vision are proposed. Firstly we present an efficient algorithm based on color to track the movement of fingertips in real time messages can be used to control the window based applications. We also presents a framework to help programmers realize human-computer interaction based on virtual mouse. The performance of vitual mouse shows a great promise that we will be able to use this methodology to control computers and Hand gesture recognition based on machine vision can provide a more natural method of human-computer interaction compared with keyboard and mouse, and make it more convenient and intuitive for people to use the computer . Rehg and Kanade presented “DigitEyes”, a model-based hand tracking system that uses two cameras to recover the state of a hand. Kjeldsen and Kender suggested a simple visual gesture system to manipulate graphic user interface of a computer. Andrew et al. presented a method for tracking the 3D position of a finger, using a single camera placed several meters away from the user . Most of these approaches are highly complicated and time-costing. Also, they are sensitive to hand variations, scales, rotations and illuminations. Color-based target tracking methods are normally based on various target-color filters and region segmentation techniques . These methods have many advantages. First, processing color is much more computationally inexpensive. Second, color models are scale/orientation/rotation invariant. These properties are particularly important for a real-time hand/face tracking system. Bradski’s CamShift is representative of a group of algorithms that exploit the color information to locate and subsequently track a human hand/face in a video sequence.

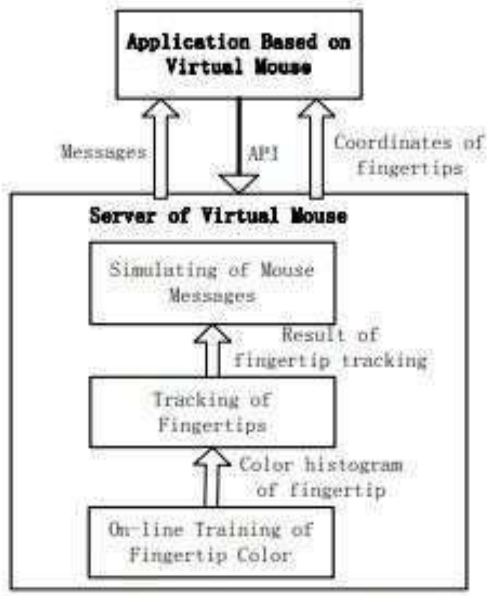


Figure. 1. The application framework based on virtual mouse

Table 2 List of simulated mouse messages

Mouse Message	Trigger
Left Button Down	trigger when two fingertips are approaching, and the distance is less than a certain threshold
Left Button Up	trigger when two fingertips are further away, and the distance is more than a certain threshold
Move	trigger When two fingertips move in parallel, we use the midpoint of two fingertips as mouse pointer
Drag and Drop	Combination of Left button Down, Move, Left Button Up
Double-Click	Combination of two consecutive operations of Left Button Down and Left Button Up

In this work, we put forward a method to implement virtual mouse based on fingertip tracking that simulate mouse operation through hand gesture and make it possible for user to control the window based applications by hand gesture. First, we present an efficient algorithm based on color to track the movement of multiple fingertips in real time. Second, we solve the problem due to the difference of resolution between the input image from the camera and the monitor in order to make the motion of the mouse pointer on the monitor s mooth. Third we present a set of messages that are generated according to the result of fingertip tracking. These messages can be used to control window-based applications. We also present a framework to help programmers realize human-computer interaction based on the proposed virtual mouse.

5. A Fingertip Detection and Tracking System as a Virtual Mouse, a Signature Input Device and an Application Selector

Citation: Choi, O., Son, Y.-J., Lim, H., & Ahn, S. C. (2018). Co-recognition of multiple fingertips for tabletop human-projector interaction. IEEE Transactions on Multimedia, 1–1. doi:10.1109/tmm.2018.2880608.

A vision-based fingertip detection and tracking system on a 2D plane has been developed. The system is used to implement a virtual mouse, a signature input device and an application selector. Tip pointers such as a stylus or a pen can be used in place of the fingertip. The fingertip is a 2D object of arbitrary shape with a uniform color and a uniform shape, which acts as the interface link between the user and the computer. The system comprises a panel, a camera and an array of sensors to detect and track the tip of the finger. Good lighting and good acoustics are required for accurate panel detection. In place of the traditional fingertip, arbitrary pointing devices such as pens or other pointing devices of suitable thickness can beused.

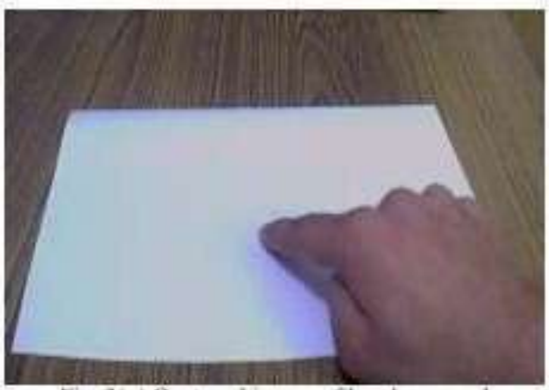


Fig. 3(a) Captured image of hand on panel

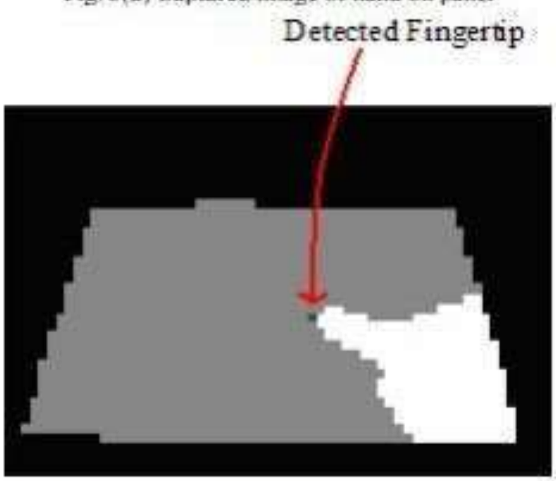


Fig. 3(b) Fingertip detected in the corresponding virtual image

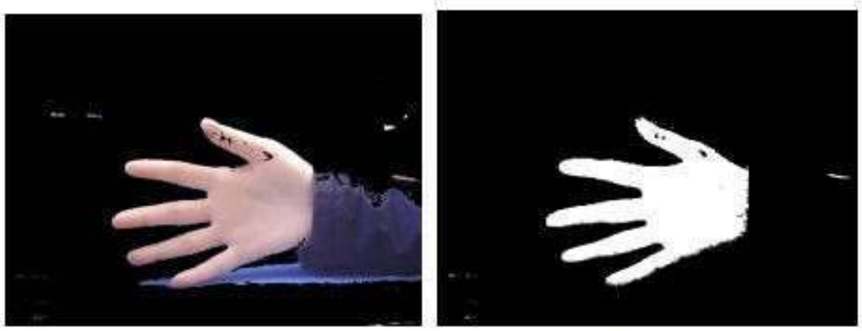
Fig. 2(a) Captured image of panel

Fig. 2(b) Corresponding virtual image of panel

6.A Six-degree-of-freedom Virtual Mouse based on Hand Gestures

Citation: Jyothilakshmi P, Rekha, K. R., & Nataraj, K. R. (2015). A framework for human- machine interaction using Depthmap and compactness. 2015 International Conference on Emerging Research in Electronics, Computer Science and Technology (ICERECT). doi:10.1109/erect.2015.7499060.

The virtual mouse is an important topic in Human Computer Interaction (HCI) technology. This paper presents a six-degree-of-freedom virtual mouse based on hand gestures. It can provide computer access for disabled people who cannot bend their fingers at all with severe disabilities. A six-degree-of-freedom virtual mouse based on non-hand gestures in a complicated background is proposed. The skin color of a hand can be a clue of the hand tracking and segmentation. Skin color is an apparent and important character of a hand. This paper uses the HSV color system, which is more appropriate to human vision than the RGB system. The background of a webcam image can influence the speed and accuracy of the hand tracking technology.



(a) (b)

.

In this paper, we use the information of the skin color of the user's hand to work out the difference between the two.

7. Design and Development of Hand Gesture Based Virtual Mouse

Citation: S. Vasanthagokul, K. Vijaya Guru Kamakshi, Gaurab Mudbhari, T. Chithrakumar, "Virtual Mouse to Enhance User Experience and Increase Accessibility",
4th International Conference on Inventive Research in Computing Applications (ICIRCA), pp.1266-1271, 2022, doi:10.1109/ICIRCA54612.2022.9985625.

Design and Development of Hand Gesture Based Virtual Mouse by Kabid Hassan Shibly,
M. Aminul Islam, Shahriar Iftekhar Showrav, Samrat Kumar Dey, Dhaka International.

Interaction) technology. This paper proposes a virtual mouse system based on HCI using computer vision and hand gestures. This paper proposes a system that could make some the devices go latent in the future that is the future of HCI (Human-Computer Interaction) The aim is to control mouse cursor functions using only a simple camera instead of a traditional or regular mouse device. System captures frames using a webcam or built-in cam and processes them to make them track-able. It then recognizes different gestures made by users to perform the mouse function. The Virtual Mouse works as a medium of the user and the machine only using a camera. It helps the user to interact with a machine without any mechanical or physical devices. This system has the potential to replace the typical mouse and also the remote controller of machines.

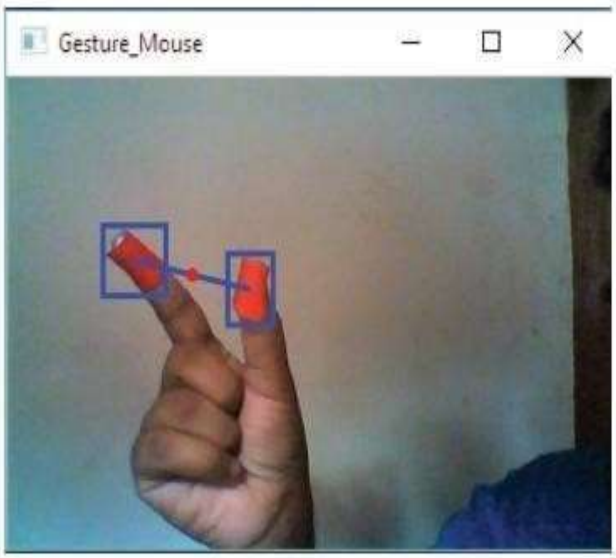


Fig. 2. Mouse Movement (Open Gesture)

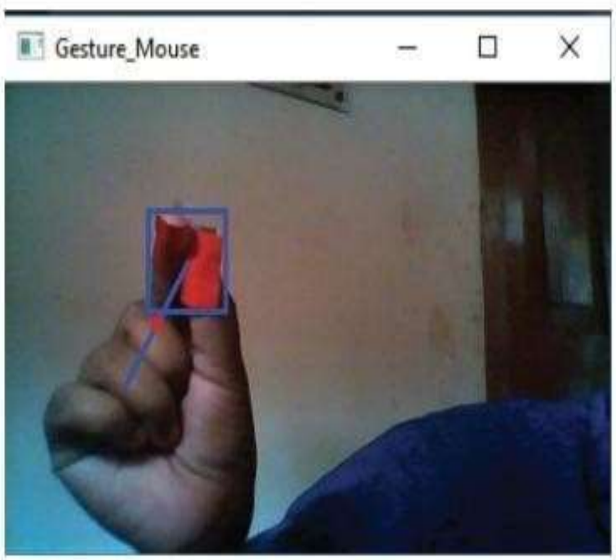


Fig. 3. Left Button Click (Close Gesture)

Fig. 4. 5 Seconds Perform Double Click (Close Gesture)

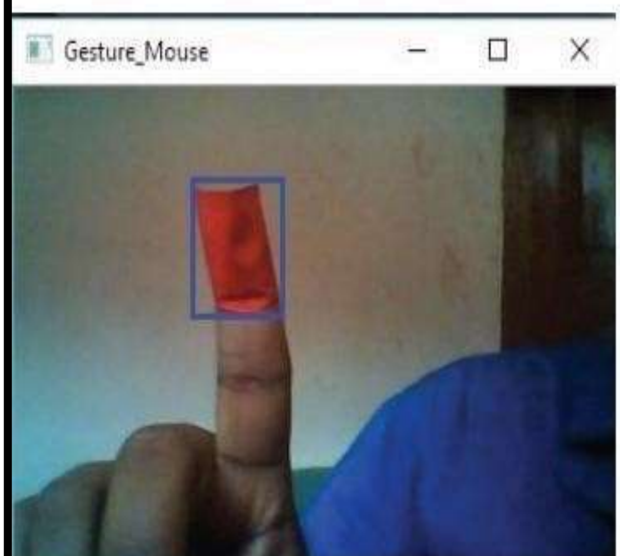


Fig. 5. Right Button Click (Open Gesture)

8. Hand Gestures - Virtual Mouse for Human Computer Interaction

Citation: Shajideen, S. M. S., & Preetha, V. H. (2018). Hand Gestures - Virtual Mouse for Human Computer Interaction. 2018 International Conference on Smart Systems and Inventive Technology (ICS-SIT). doi:10.1109/icssit.2018.8748401.

Hand gestures are significant components of human-computer interface modules. It is challenging to obtain precise values for finger pointing in three dimensions. The goal of this project is to leverage hand gestures in 3-D space to improve human-computer interaction systems by positioning two cameras at different angles. The hand gesture is approximated and transferred to the coordinate system of the screen. In addition, we employ additional hand motions to execute mouse-like actions. To point to the screen, we use our hands, and we also utilise other motions, such selecting a folder or an object.

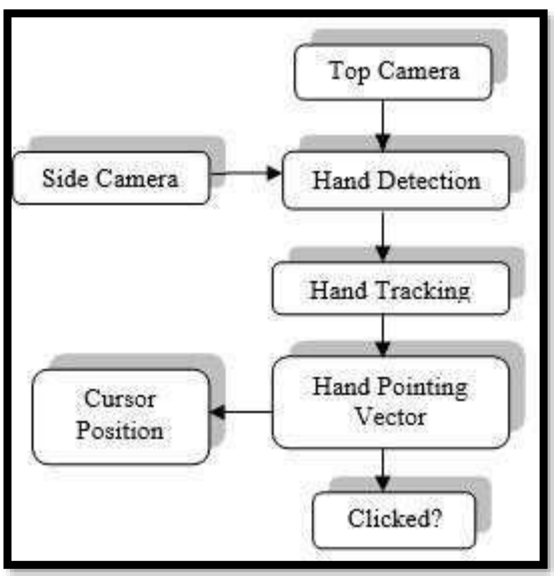


Fig. System overview.

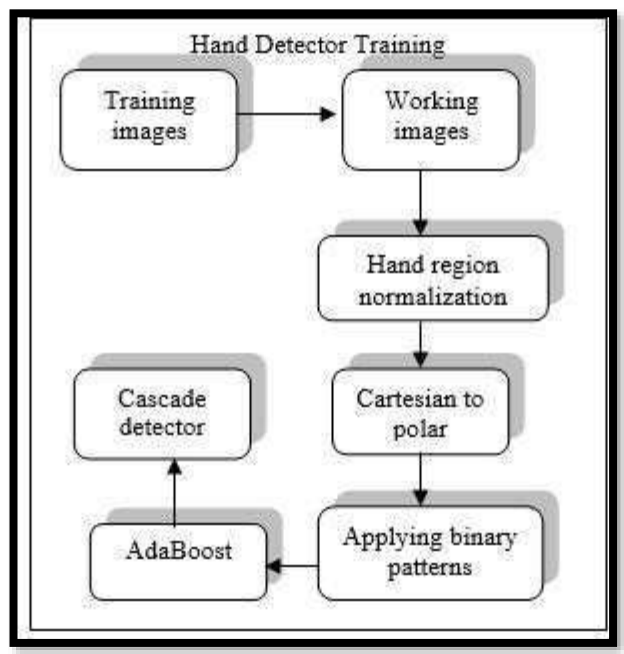


Fig:Hand Detector Training Process

9. Adaptable Virtual Keyboard and Mouse for People with Special Needs

Citation: Henzen, A., & Nohama, P. (2016). Adaptable virtual keyboard and mouse for people with special needs. 2016 Future Technologies Conference (FTC). doi:10.1109/ftc.2016.7821782.

Assistive technologies enable persons who are unable to speak or write to communicate through other means and equipment. Alternative communication is the field of research that deals with these technologies. Using sensors attached to a user's body part in which it retains motor control, this study aims to propose a novel approach that enables individuals with disabilities to use all the functions of the keyboard and mouse. The software programme created is an adjustable and configurable keyboard and mouse emulator called ETM (Emulator Keyboard and Mouse). Through the modification of the contacts of the buttons on a joystick, the programme gathers trigger signals linked to the USB (Universal Serial Bus). utilising a command processor and a specialised key layout.

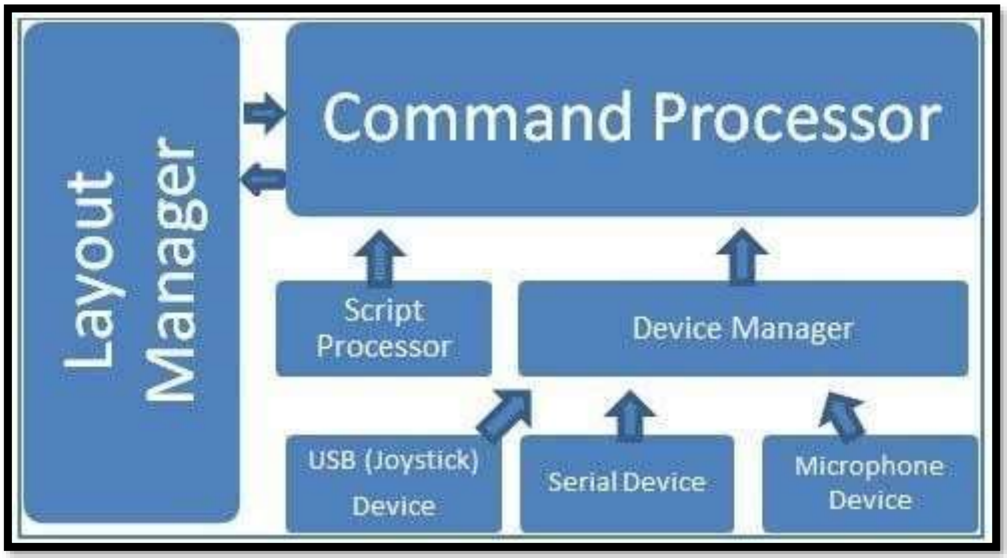


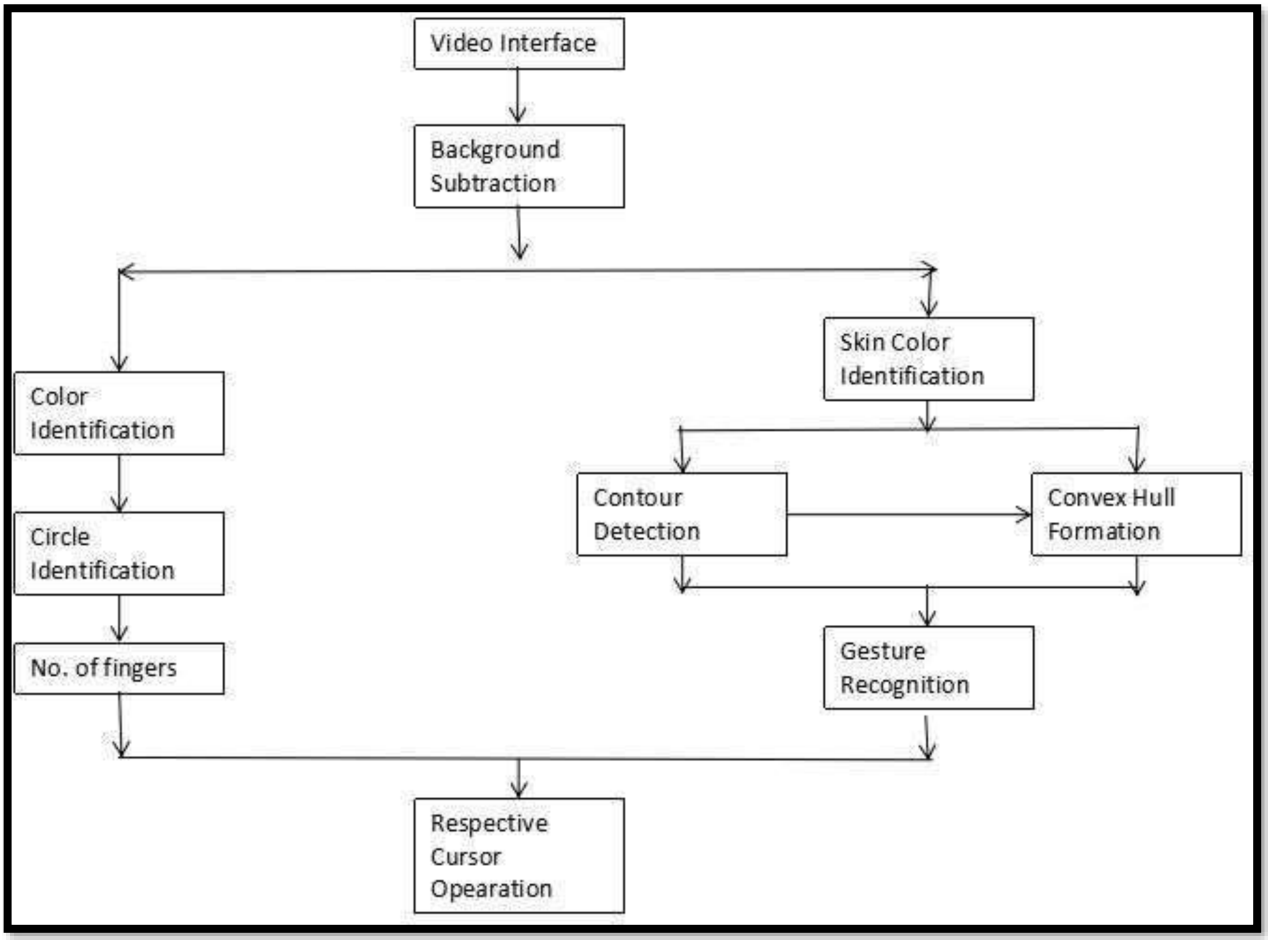
Figure:ETM internal architecture

10. Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition

Citation: Reddy, V. V., Dhyanchand, T., Krishna, G. V., & Maheshwaram, S. (2020). Virtual Mouse Control Using Colored Finger Tips and Hand Gesture Recognition. 2020 IEEE-HYDCON. doi:10.1109/hydcon48903.2020.9242677 .

The implementation of a virtual mouse with finger tip identification and hand motion tracking based on an image in a live video is one of the research in human-computer interaction. This work proposes finger tip identification and hand motion detection for virtual mouse control. In gesture recognition. There are three essential phases in this process: monitoring hand gestures, finger detection utilising colour identification, and cursor implementation. In the current work, hand gesture tracking is produced by detecting the contour and creating a convex hull around it. With the area ratio of the produced hull and contour, hand features are retrieved.

Figure:Overall system block diagram



11. Mouse Using Object Tracking

Citation: Shetty, M., Daniel, C. A., Bhatkar, M. K., & Lopes, O. P. (2020). Virtual Mouse Using Object Tracking. 2020 5th International Con-ference on Communication and Electronics Systems (IC-CES). doi:10.1109/icces48766.2020.9137854.

Using hand motions that are recorded via a camera using an HSV colour detection approach, the system that is being suggested is a computer vision-based mouse cursor control system. Through the use of coloured caps or tapes that the computer's camera records, this method enables users to move the system pointer and carry out mouse actions like left-, right-, computer vision in Python and the OpenCV package. On the monitor, the camera output is displayed.

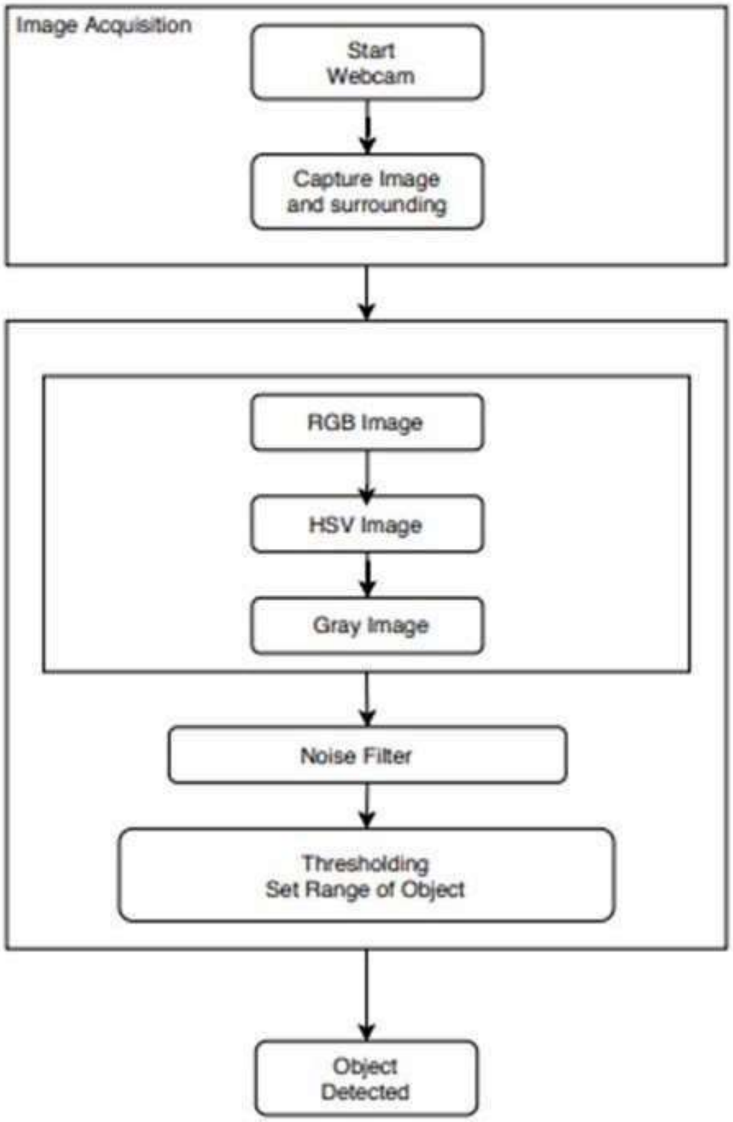


Figure: Design Flow Diagram

12.A Robust Low Cost Virtual Mouse Based on Face Tracking

Citation: Xu, G., Wang, Y., & Feng, X. (2009). A Robust Low Cost Virtual Mouse Based on Face Tracking. 2009 Chinese Conference on Pattern Recogni-tion. doi:10.1109/ccpr.2009.5344072

In this study, a non-contact virtual mouse that tracks facial movement is introduced. It is especially made for those with disabilities who have upper-limb movement issues. The common web camera is the foundation of the entire piece. It is suggested to locate the face characteristics identified by the active appearance model in order to improve the optical flow algorithm. It is resilient to diverse background and environmental light, according to experiments. When the face moves quickly over a broad field of view, it can still successfully follow the features.

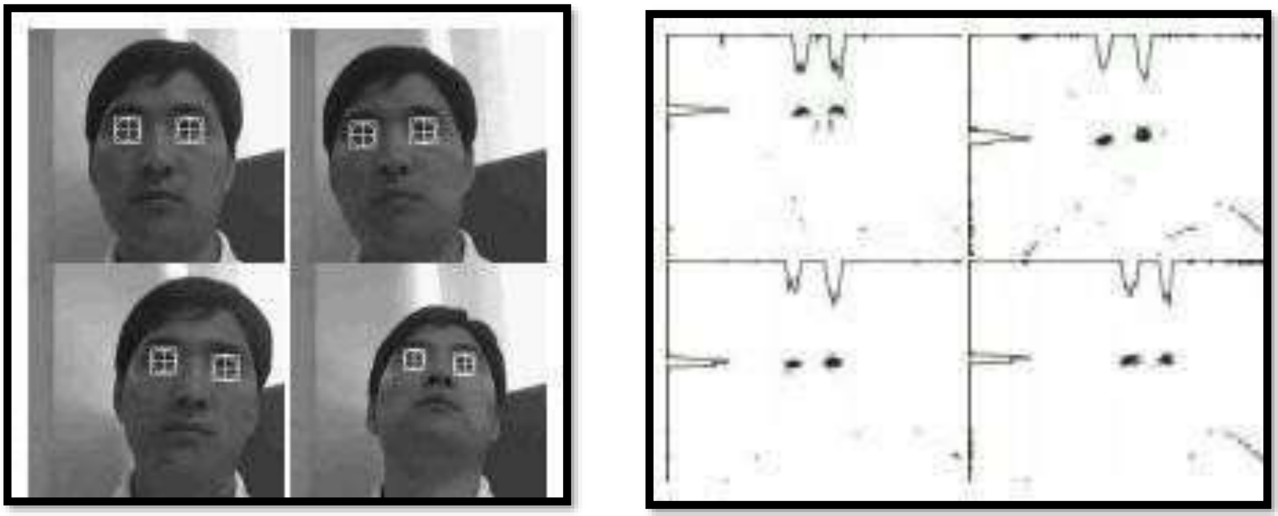


Figure: Face movement independent eye tracking and Blink detection of the local eye area

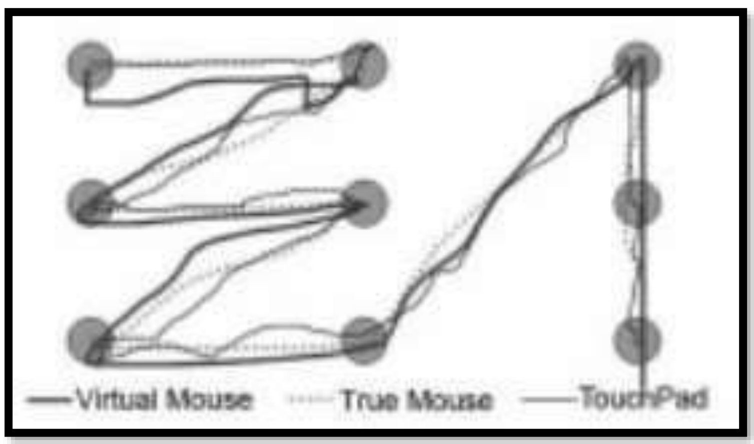


Figure:Trajectory of different devices

Chapter 3

REQUIREMENTS ANALYSIS AND SPECIFICATION

Functional requirements

- interactive movement
- displaying the movement
- conditional navigation
- camera position and orientation

Non-Functional Requirements

- user friendliness
- easy usability
- easy accessibility
- efficient performance

Hardware Requirements

- System : Pentium i3 Processor.
- Hard Disk : 500 GB.
- Monitor : 15’’ LED
- Input Devices : Keyboard, Mouse
- Ram : 4 GB

Software Requirements

- Windows 10/11
- Python 3.8
- Open CV Library
- Media pipe framework

Cost Estimation

Need to only invest on Desktop/Pc with webcam

Direct cost

Labour, material and equipment, facilities (3rd party).

Indirect Cost

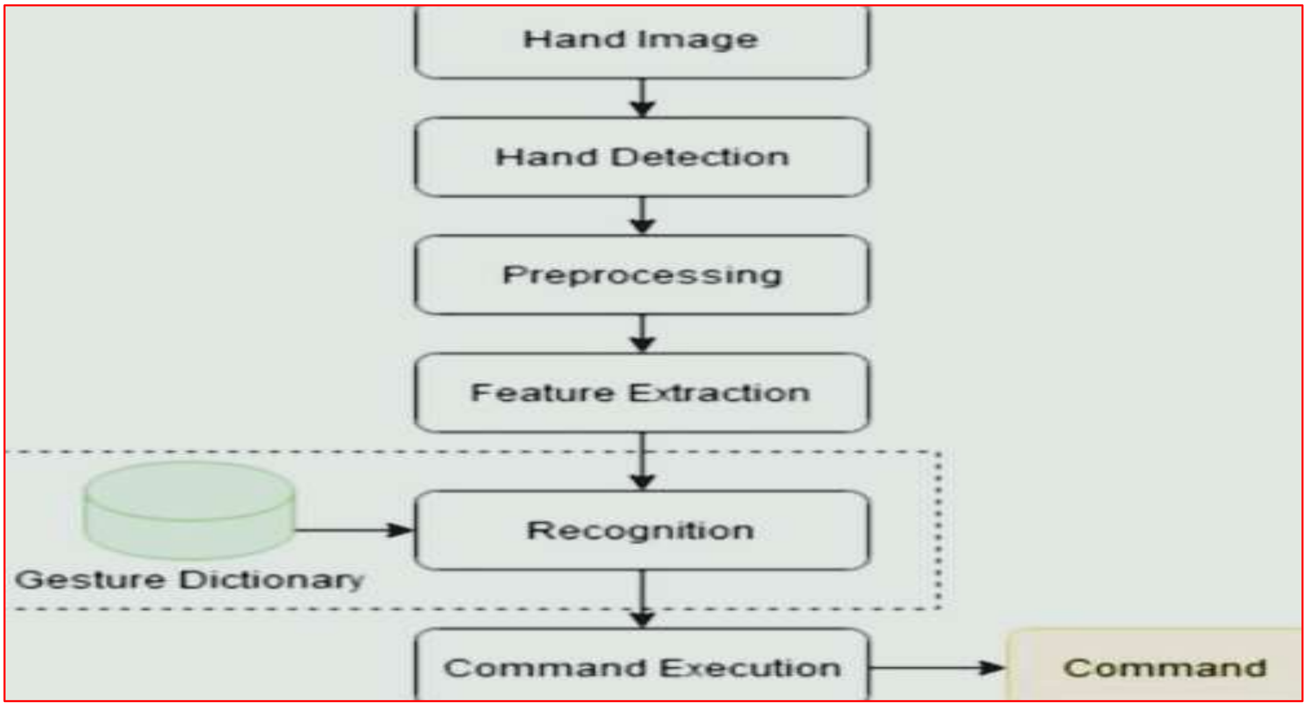
(Quality control and assurance) , vendors - third party distributors , risk assessment & prevention.

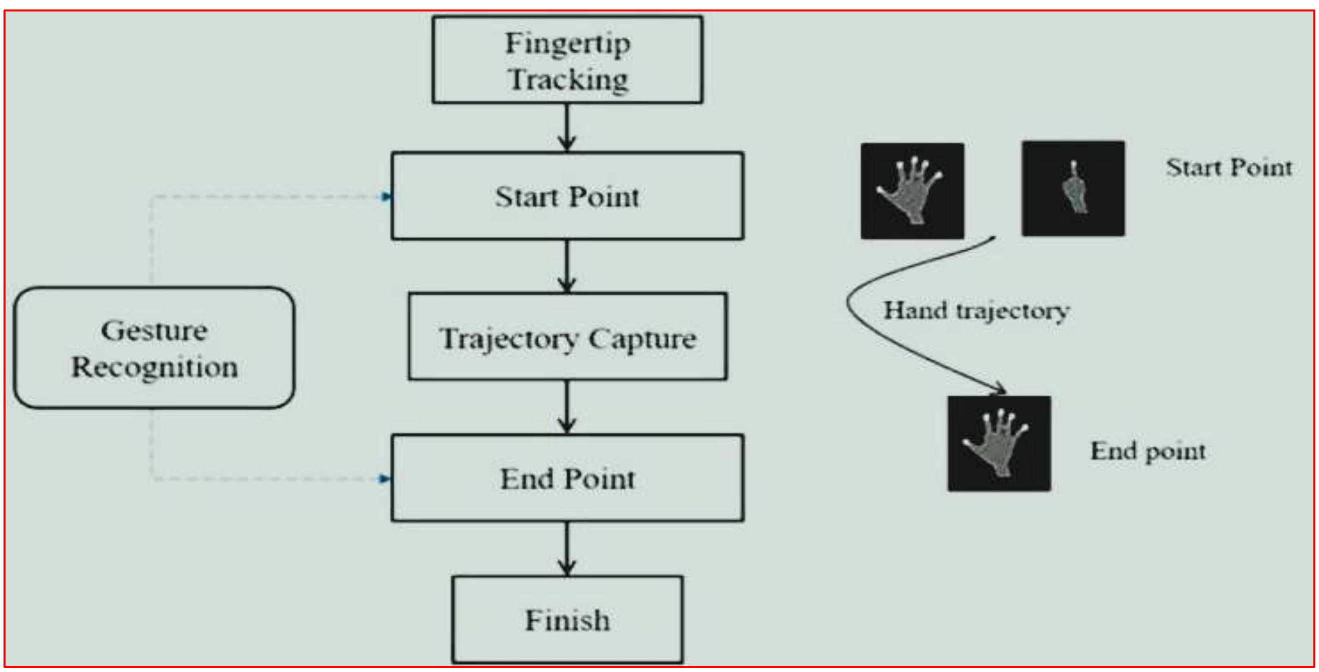
Chapter 4

DESIGN

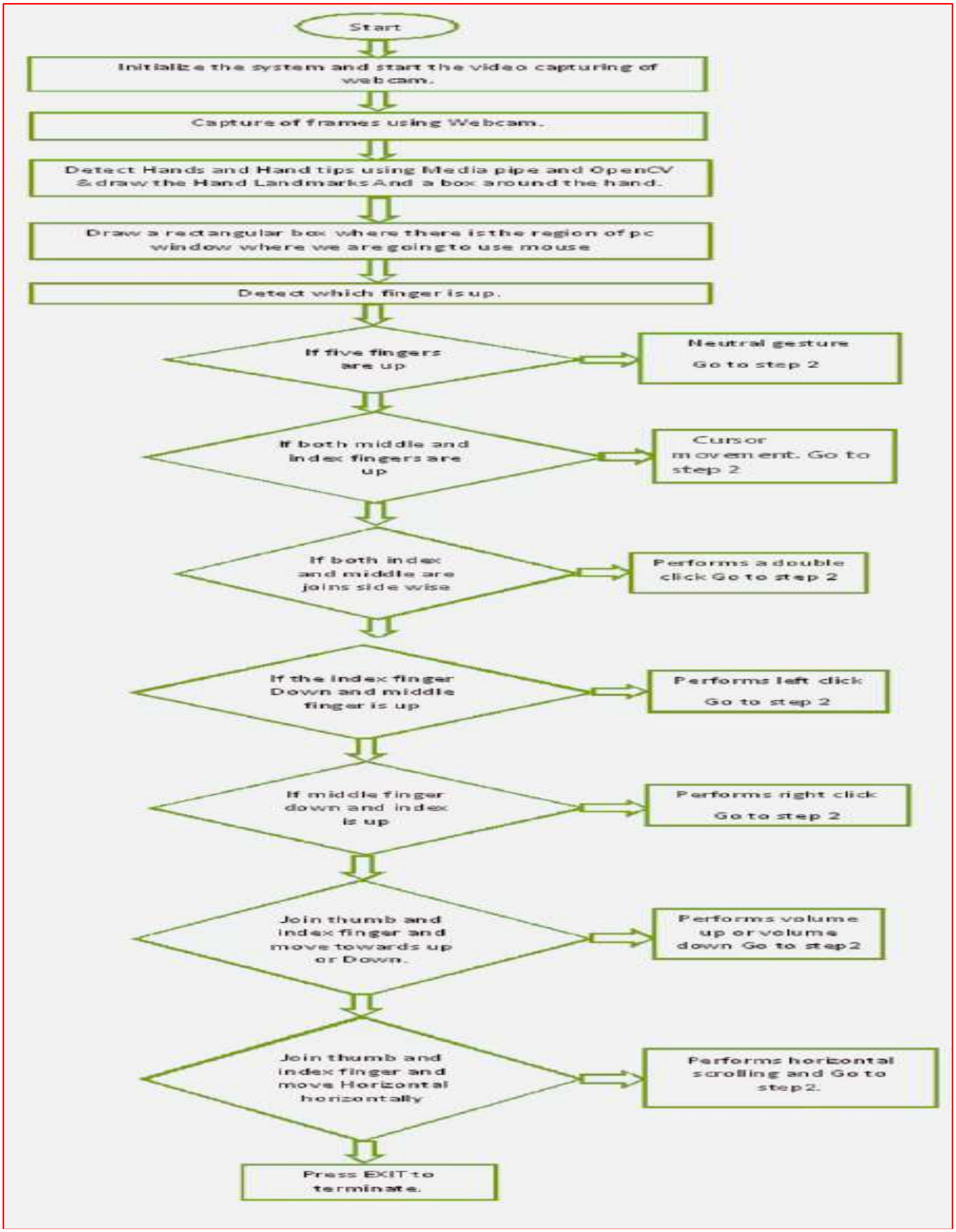
4. High level design

4.1. High level design for mouse using hand gestures:



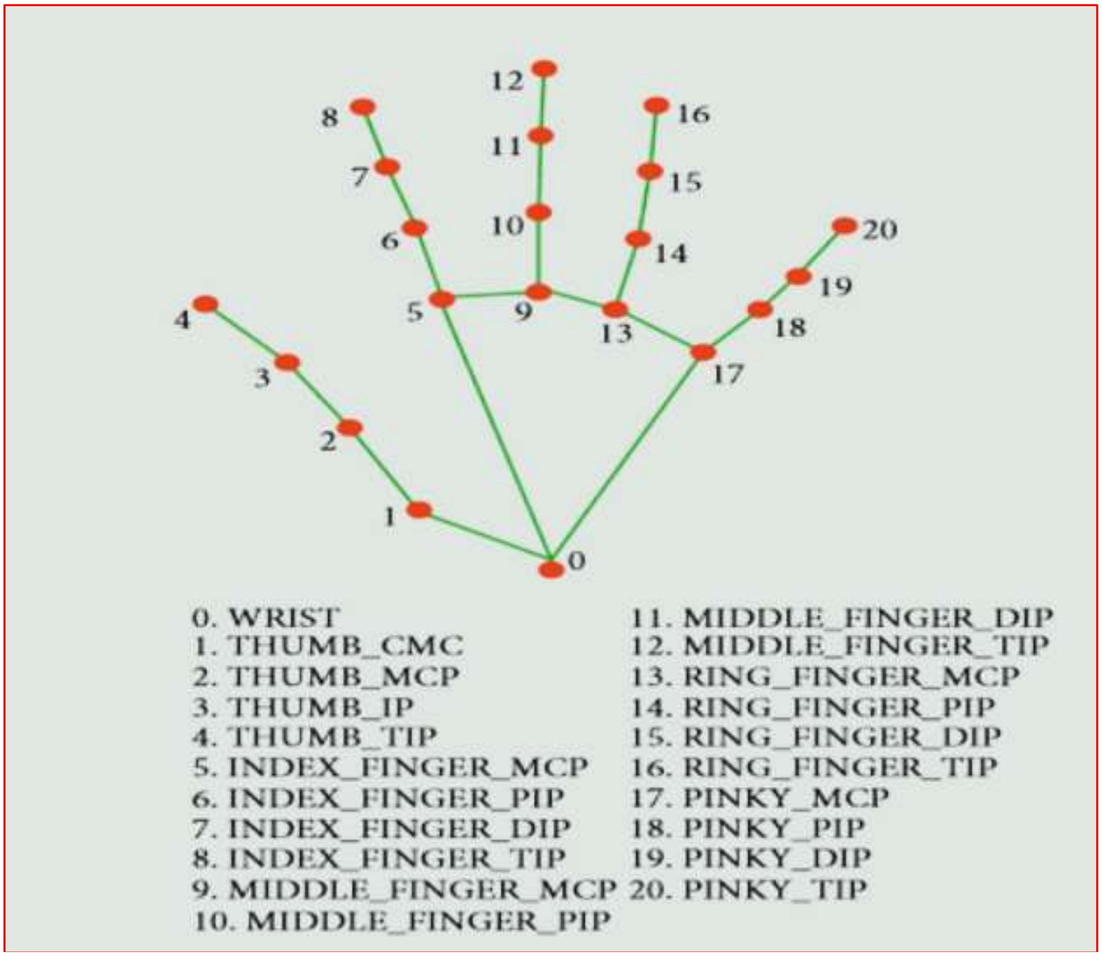


Flow Chart:

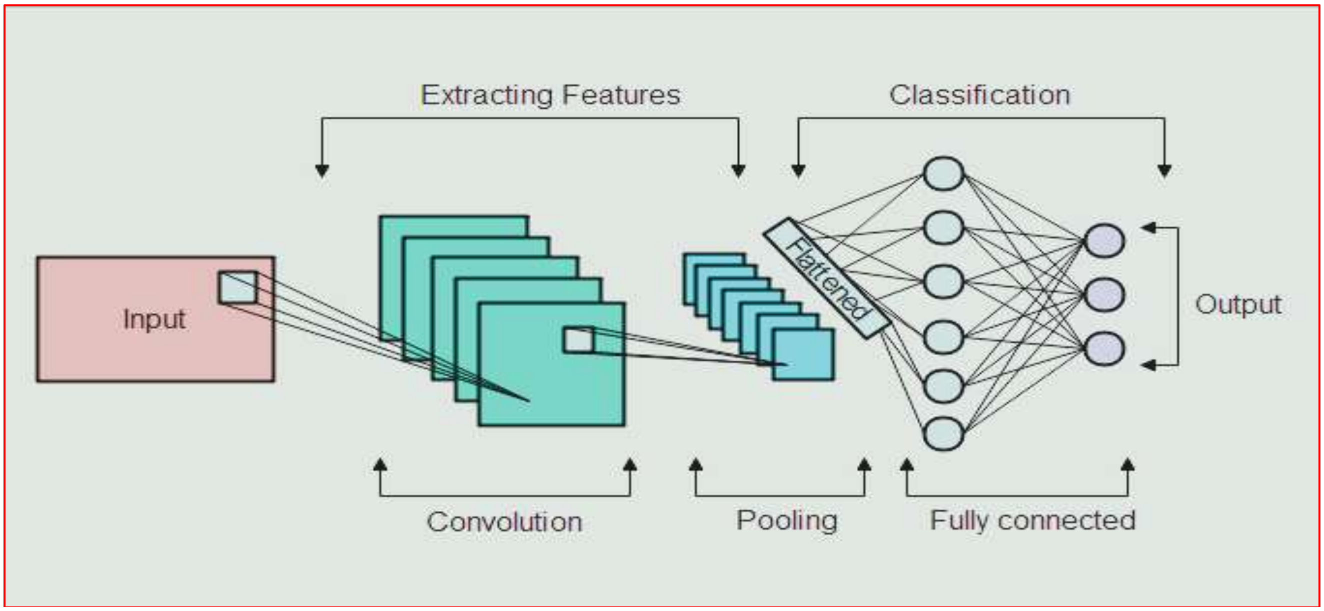


Start
Initialize the system and start the video capturing of webcam.
Capture of frames using Webcam.
Detect Hands and Hand tips using Media pipe and OpenCV & draw the Hand Landmarks And a box around the hand.
Draw a rectangular box where there is the region of pc window where we are going to use mouse
Detect which finger is up.
If five fingers are up
Neutral gesture
Go to step 2
If both middle and index fingers are up
Cursor movement. Go to step 2
If both index and middle are joins side wise
Performs a double click Go to step 2
If the index finger Down and middle finger is up
Performs left click
Go to step 2
If middle finger down and index is up
Performs right click
Go to step 2
Join thumb and index finger and move towards up or Down.
Performs volume up or volume down Go to step 2
Join thumb and index finger and move Horizontal horizontally
Performs horizontal scrolling and Go to step 2.
Press EXIT to terminate.

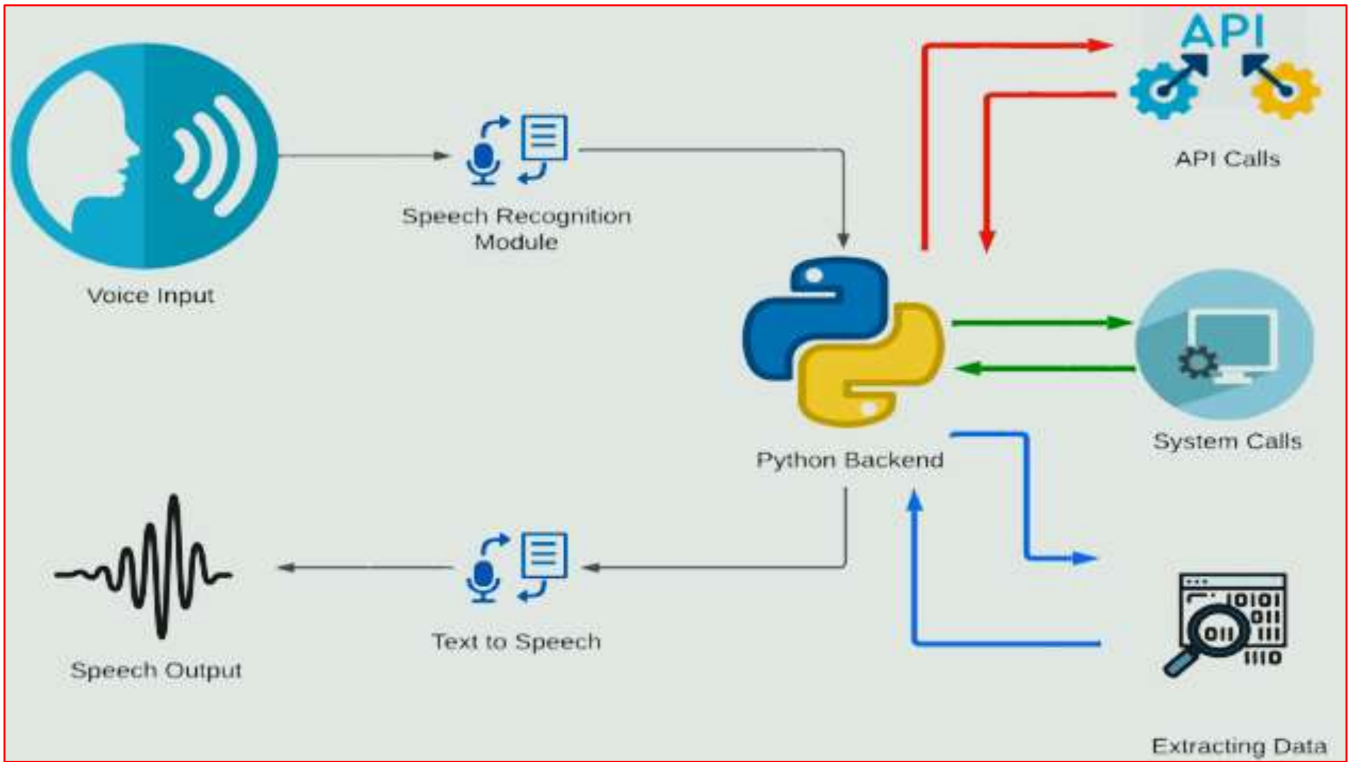
Hand Key Points:



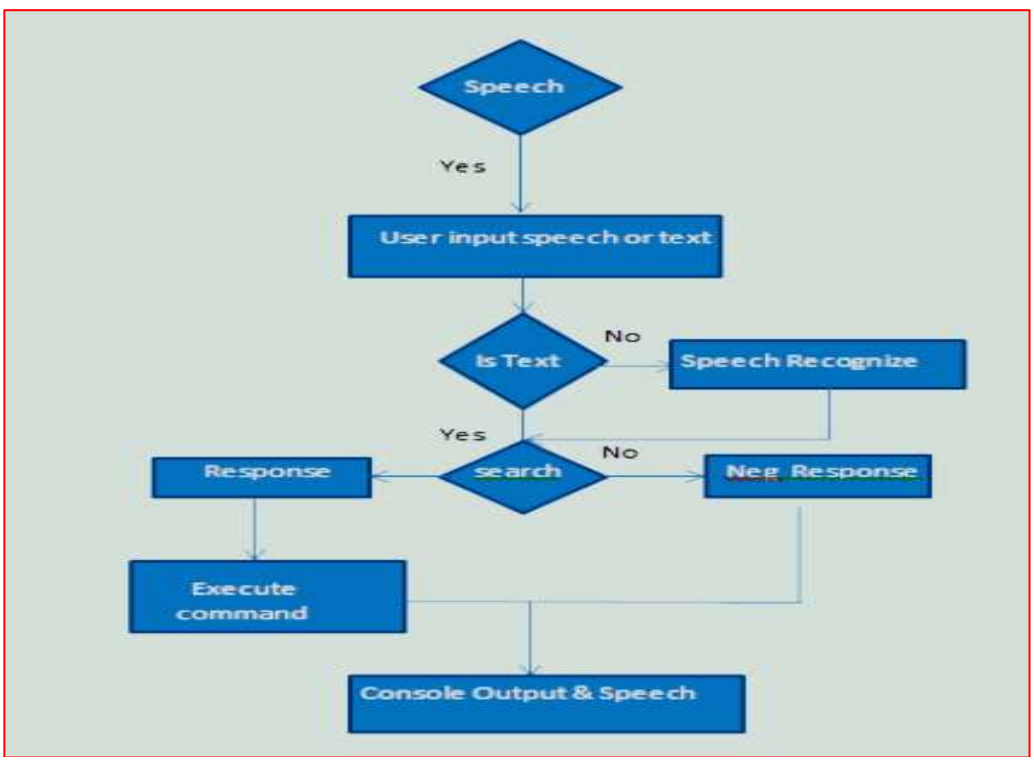
CLASSIFICATION MODEL(CNN):



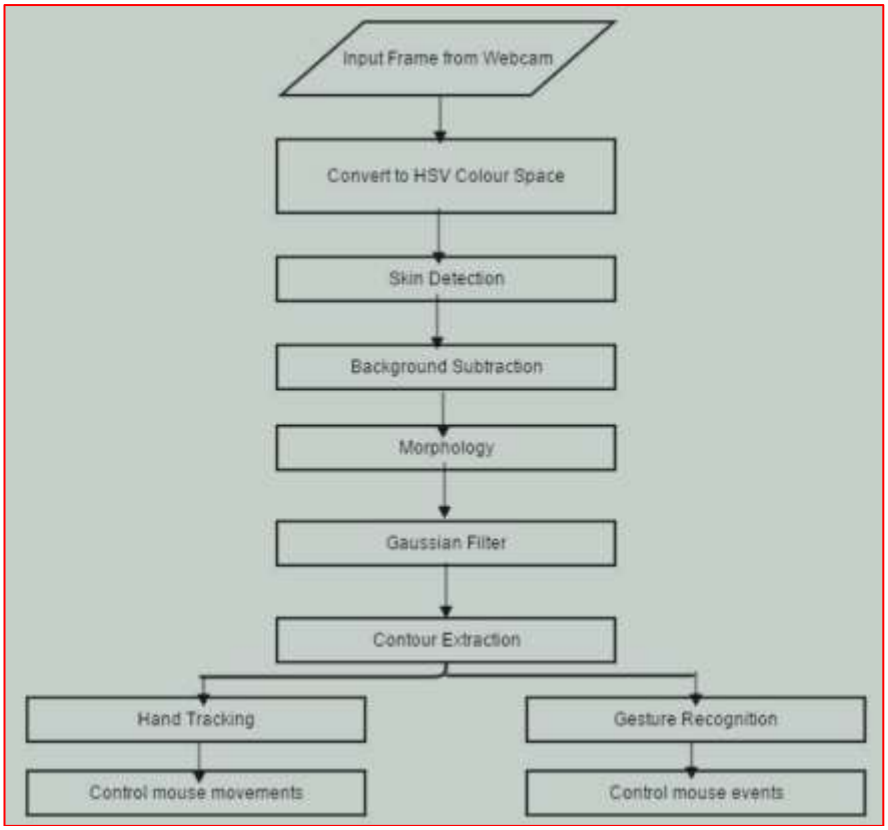
High level design for voice assistance:

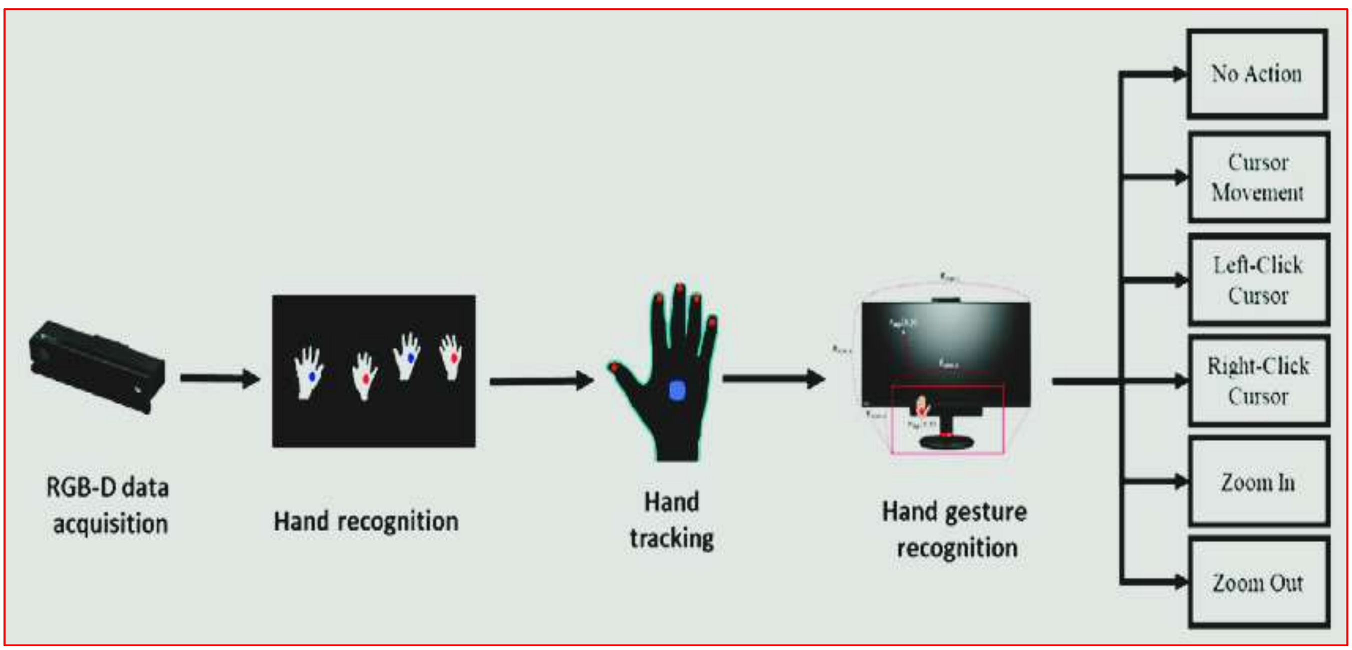


Flow Chart:



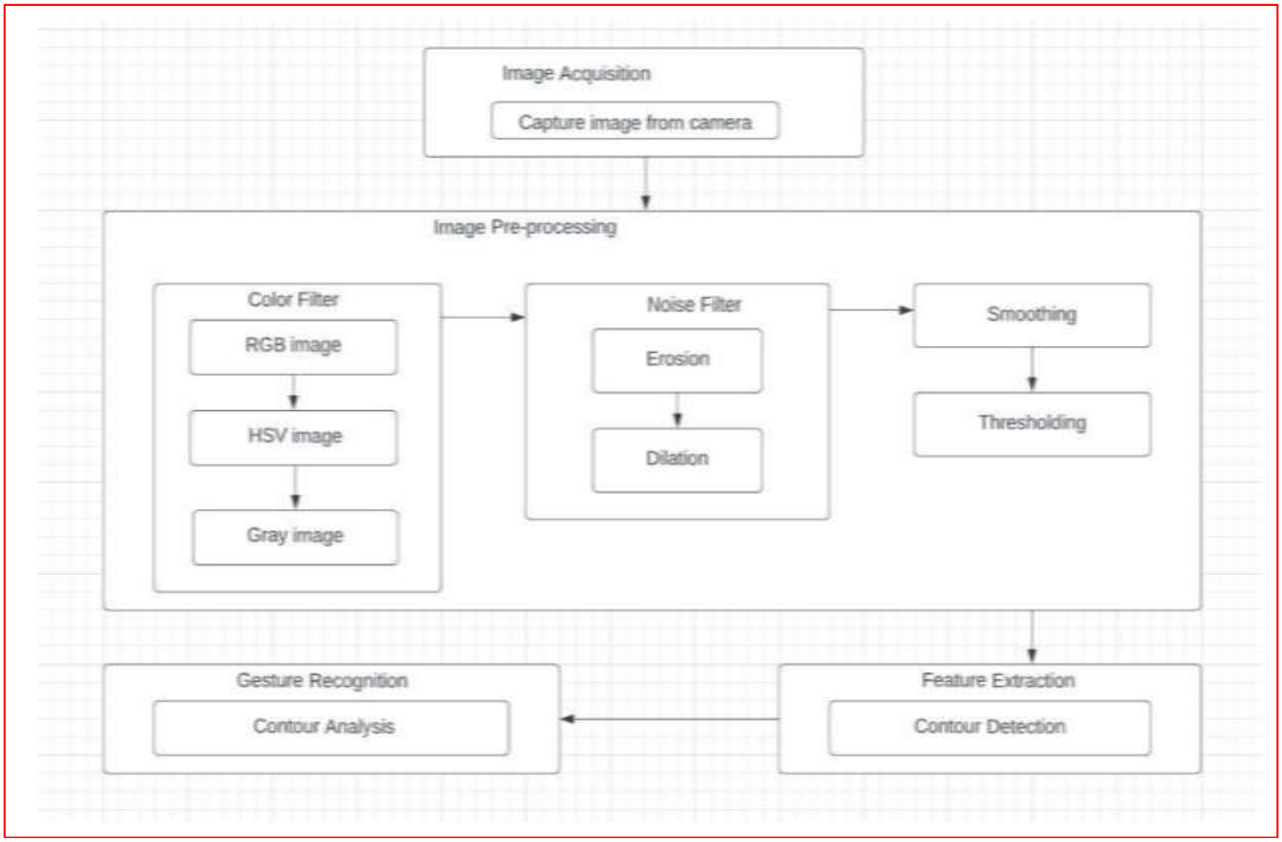
High level design for mouse using Colored Caps :



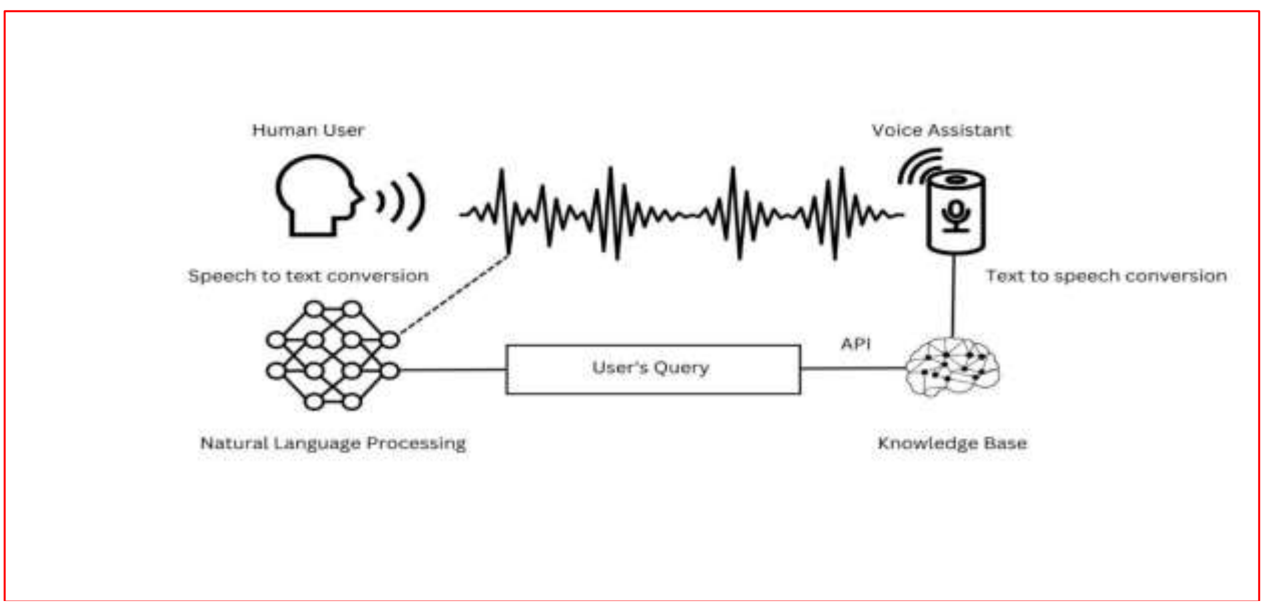


4.2 System Architecture:

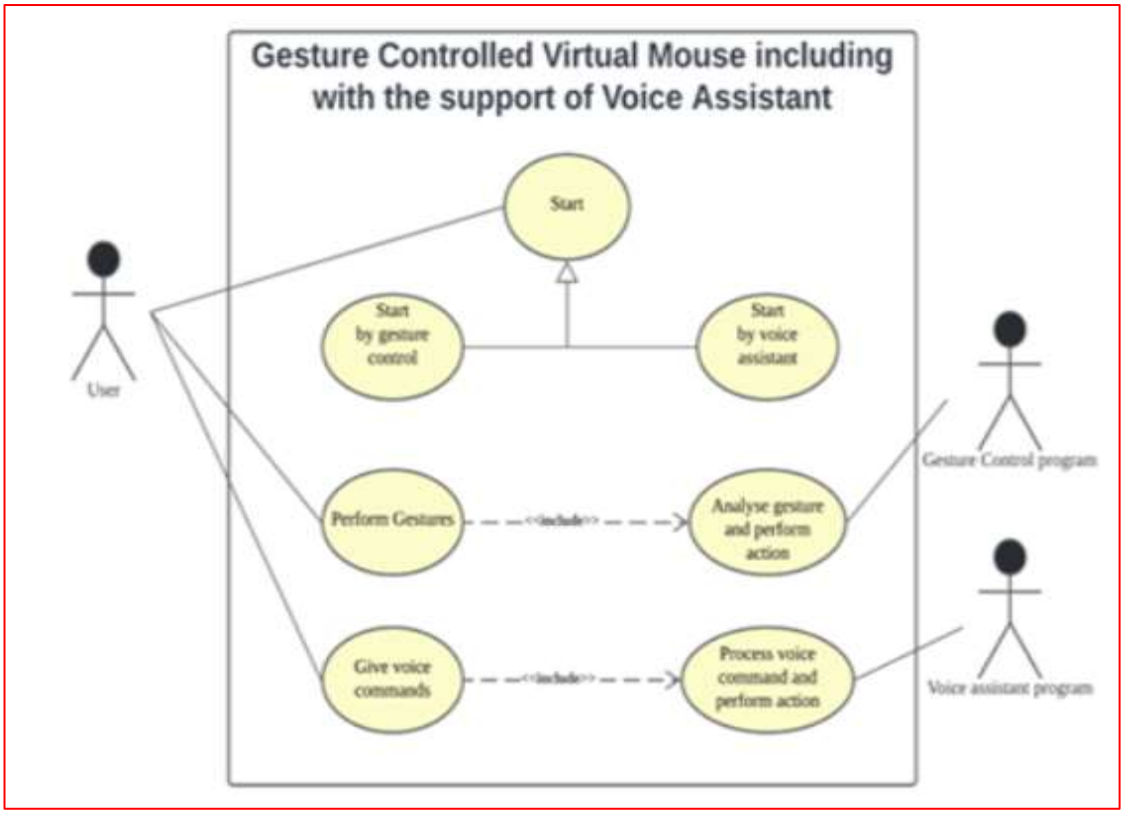
Gesture Controlled Mouse:



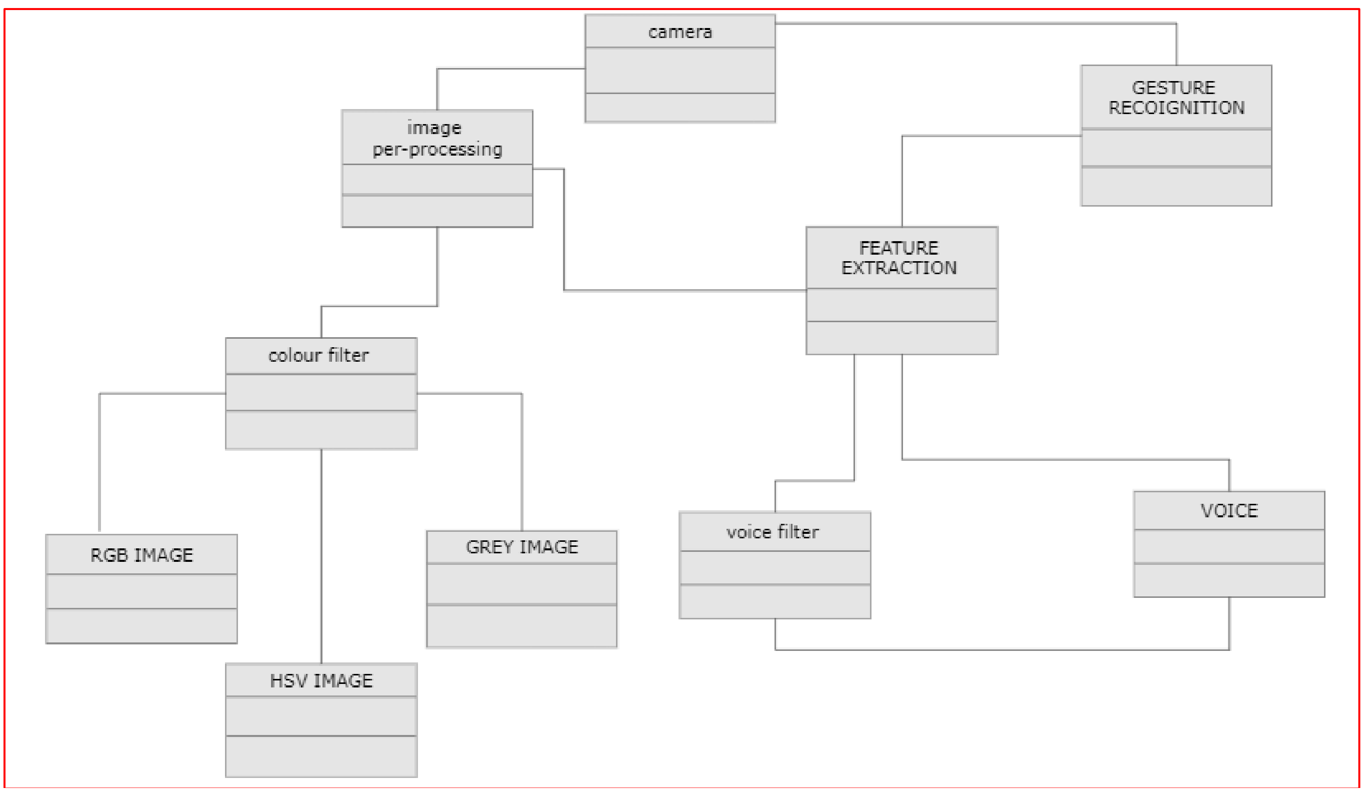
Voice Assistant :



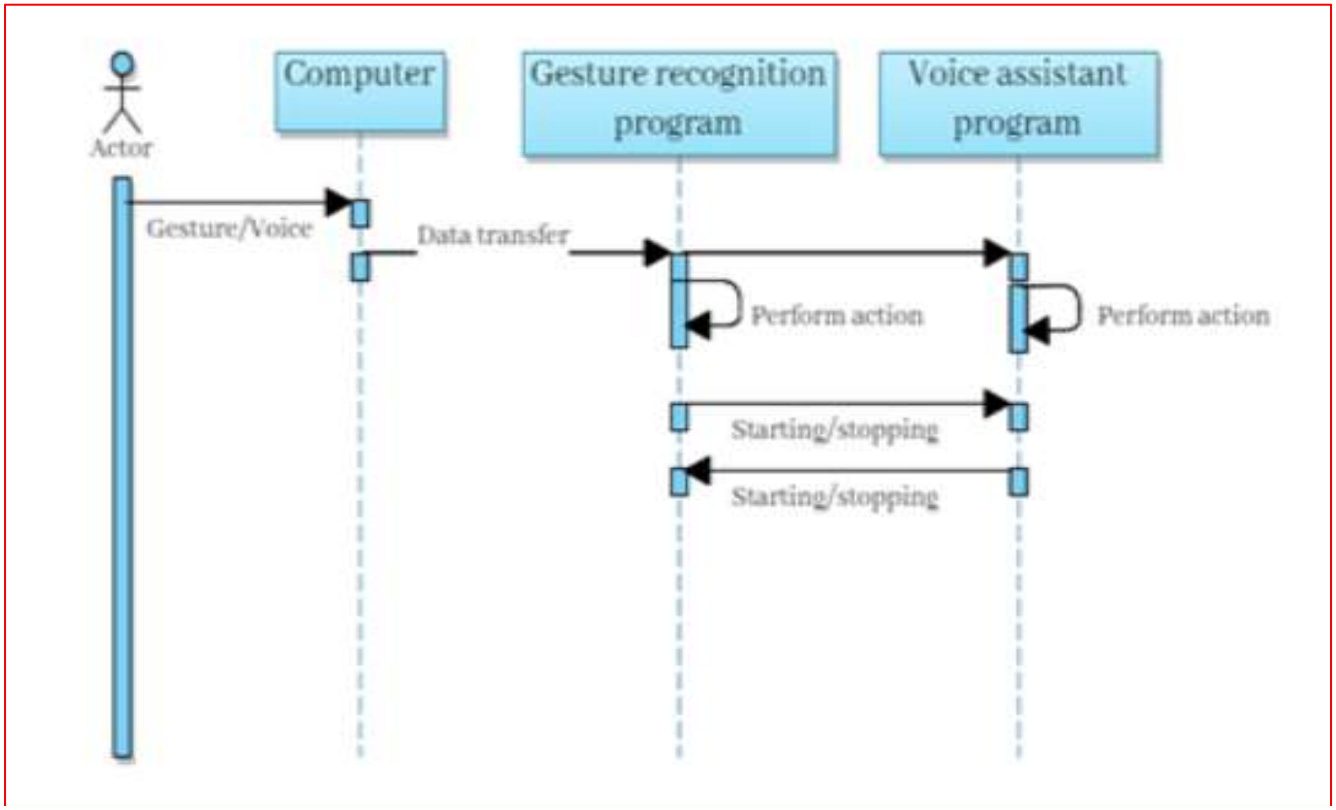
4.3 Use Case Diagram:



4.4 Class Diagram:



4.5 Sequence Diagram:



Chapter 5

IMPLEMENTATION

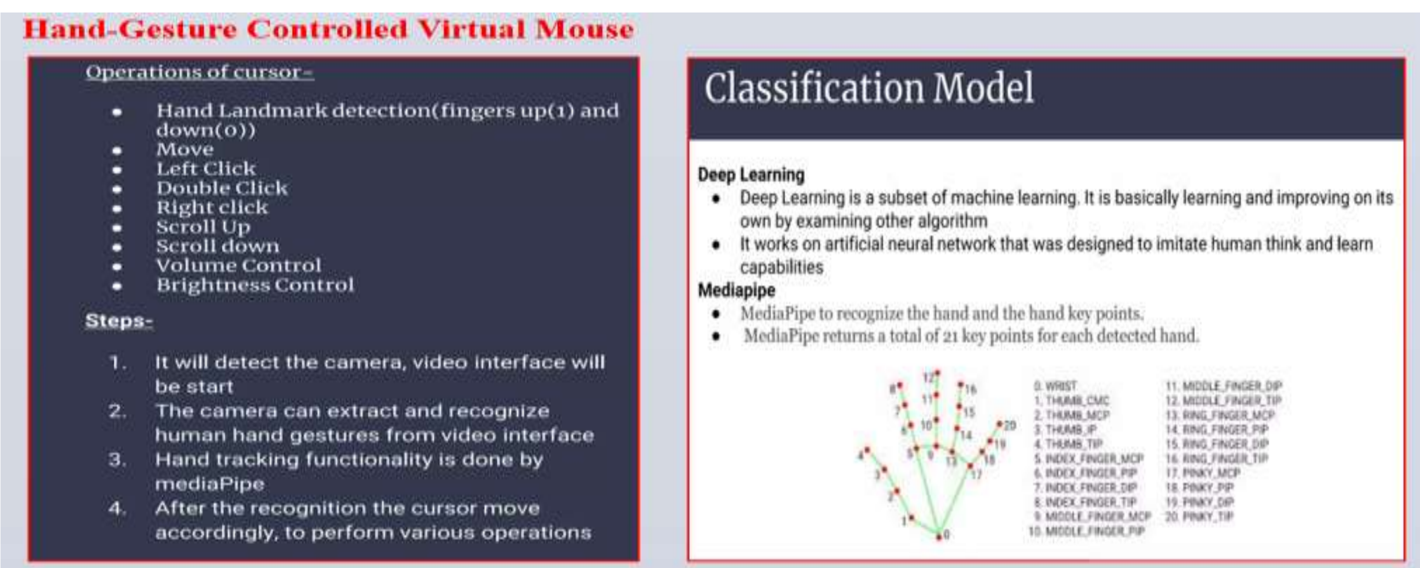
5.1 Overview of Technologies Used

- Windows 10/11
- Python 3.8
- Open CV Library
- Media pipe framework
- System : Pentium i3 Processor.
- Hard Disk : 500 GB.
- Monitor : 15’’ LED
- Input Devices : Keyboard, Mouse
- Ram : 4 GB

5.2 Implementation details of modules

- pyttsx3==2.71
- SpeechRecognition==3.8.1
- pynput==1.7.3
- pyautogui==0.9.53
- wikipedia==1.4.0
- opencv-python==4.5.3.56
- mediapipe==0.8.6.2
- comtypes==1.1.11
- pycaw==20181226
- screen-brightness-control==0.9.0

IMPLEMENTATION



Coloured Caps Controlled Virtual Mouse

Steps:

a. Obtain input video feed

b. Retrieve useful data from the image to be used as input

c. Filter the image and identify different colors.

d. Track the movement of colors in the video frame.

e. Implement it to the mouse interface of the computer according to predefined notions for mouse pointer control.

Voice Assistant(ECHO)

Speech Recognition module

The system uses Google's online speech recognition system for converting speech input to text. The speech input Users can obtain texts from the special corpora organized on the computer network server at the information centre from the microphone is temporarily stored in the system which is then sent to Google cloud for speech recognition. The equivalent text is then received and fed to the central processor.

Python Backend:

The python backend gets the output from the speech recognition module and then identifies whether the command or the speech output is an API Call and Context Extraction. The output is then sent back to the python backend to give the required output to the user.

API calls

API stands for Application Programming Interface. An API is a software intermediary that allows two applications to talk to each other. In other words, an API is a messenger that delivers your request to the provider that you're requesting it from and then delivers the response back to you.

Content Extraction

Context extraction (CE) is the task of automatically extracting structured information from unstructured and/or semi-structured machine-readable documents. In most cases, this activity concerns processing human language texts using natural language processing (NLP). Recent activities in multimedia document processing like automatic annotation and content extraction out of images/audio/video could be seen as context extraction TEST RESULTS.

Text-to-speech module

Text-to-Speech (TTS) refers to the ability of computers to read text aloud. A TTS Engine converts written text to a phonemic representation, then converts the phonemic representation to waveforms that can be output as sound. TTS engines with different languages, dialects and specialized vocabularies are available through third-party publishers.

5.3 Difficulties encountered and Strategies used to tackle

It might be difficult to recognise a variety of movements accurately. Robust algorithms must be created in order to handle this, which requires substantial study and testing. The system may be trained on different gestures using machine learning techniques, which will increase accuracy over time.speech Accurate speech recognition in the presence of background noise is essential. Accuracy may be increased by using powerful voice recognition models and advanced noise filtering methods. Reliable voice aid benefits from methods like neural networks and signal processing.Users must become used to the system and learn new movements in order to use gesture control. Users may learn more quickly and more effectively with the help of interactive lessons and adaptive algorithms.

It's critical to take disability-related requirements into account. A variety of user needs are accommodated with customizable gesture mapping and voice command settings.

Chapter 6

TESTING AND EXPERIMENTAL ANALYSIS AND RESULT

The hand gesture and colored caps controlled virtual mouse along with voice recognition system incorporate various gestures like: neutral gesture, moving cursor, left click, right-click, double click, scrolling, drag and drop, multiple item selection. The voice assistant performs launch/stop gesture recognition, and content search on Google, identifies a location, navigates files, displays the current date and time, copies and pastes, sleeps/wakes up, and exit actions. The webcam is positioned at various distances from the user to monitor hand motions and gestures to detect fingertips, Gesture's ability is assessed under diverse lighting conditions such as bright light settings, low-light configurations, at a much farther distance from the camera, at a closer distance from the camera, with a left hand, right hand, both hands in camera, different backgrounds, and different hands of individuals of varying ages. The Voice Assistant is tested by providing diverse input via the mic and executing various functions such as location, file navigation, current time and date, copy and paste, sleep/wakeup, google search, and start and exit under various conditions.

Using hand gestures to control a mouse can increase productivity and ease of use, particularly for individuals with disabilities or those who find traditional mouse controls difficult. The automated training machine learning model accurately detects and classifies hand gestures, allowing for smooth and precise cursor control. While further research and testing may be necessary to optimize the system's performance, the results thus far suggest that a hand gesture-controlled mouse could become a valuable tool for computer users in the future.

Test Name	Cursor control
Test Description	To test cursor control functions.
Input	Camera image as input.
Expected Output	Cursor functions should be implemented using index and the middle finger.
Actual Output	Cursor functions are implemented accordingly.
Test Result	Success

Fig: Hand-Gesture Controlled Virtual Mouse Unit-Testing

Test Name	Cursor control
Test Description	To test cursor control functions.
Input	Camera image as input.
Expected Output	Cursor functions should be implemented using coloured Caps on finger tips.
Actual Output	Cursor functions are implemented accordingly.
Test Result	Success

Fig: Virtual Mouse Controlled Using Coloured Caps Unit-Testing

Test Name	control
Test Description	To Test Voice Assistant(ECHO's) Control Functions
Input	Voice/Text as Input
Expected Output	User requested functions should be implemented using ECHO
Actual Output	requested functions implemented accordingly
Test Result	Success

Fig: Voice Assistant ECHO Unit-Testing

For App's performance, following parameters are considered,

- Start-Up: When the user clicks the first screen will be loaded in 5-10s seconds.
- Usage with Other Apps: When the app is running in parallel with other apps, then there is no interference observed.
- App's in background: When the app that is running in the background is retrieved, it has remained in the same state as it was before.
- Surroundings: The Background does affect the app's performance

Fig: Application Performance

Chapter 7

CONCLUSION & FUTURE ENHANCEMENTS

7.1 Conclusion

Gesture recognition one of the best ways for humans to interact with the machine. Gesture recognition is also used for developing alternative human computer interaction modalities. It enables human to interact with the machine in a more natural way. Gesture recognition can be useful for many applications like sign language recognition for deaf and dumb people, robot control etc.

This technology has wide applications in the fields of augmented reality, computer graphics, computer gaming, prosthetics, and biomedical instrumentation as well.This technology can be used to help patients who don’t have control of their limbs. In case of computer graphics and gaming this technology has been applied in modern gaming consoles to create interactive games where a person’s motions are tracked and interpreted as commands.

7.2 Future Enhancements

Gesture recognition technology has been improved in terms of responsiveness and accuracy. Use cutting-edge computer vision and machine learning algorithms to more accurately detect and comprehend hand gestures, orders, and other body language.

Expanded Gesture Set: Add more gestures that may be customised or that are predetermined to accomplish different functions. Users should be given the option to design their own gestures and link them to certain commands or functions.

Multi-modal engagement: Give consumers the option to mix voice instructions with gestures for a more flexible and intuitive engagement. For instance, users can use a gesture to start the speech recognition mode and then speak commands to execute particular tasks.

User Customization: Give users the chance to make the gesture-controlled mouse and voice assistance their own. To meet their own requirements and interests, let them establish their own hand gestures, voice commands, and preferences.

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10.1109/icssit.2018.8748401

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10.1109/ftc.2016.7821782

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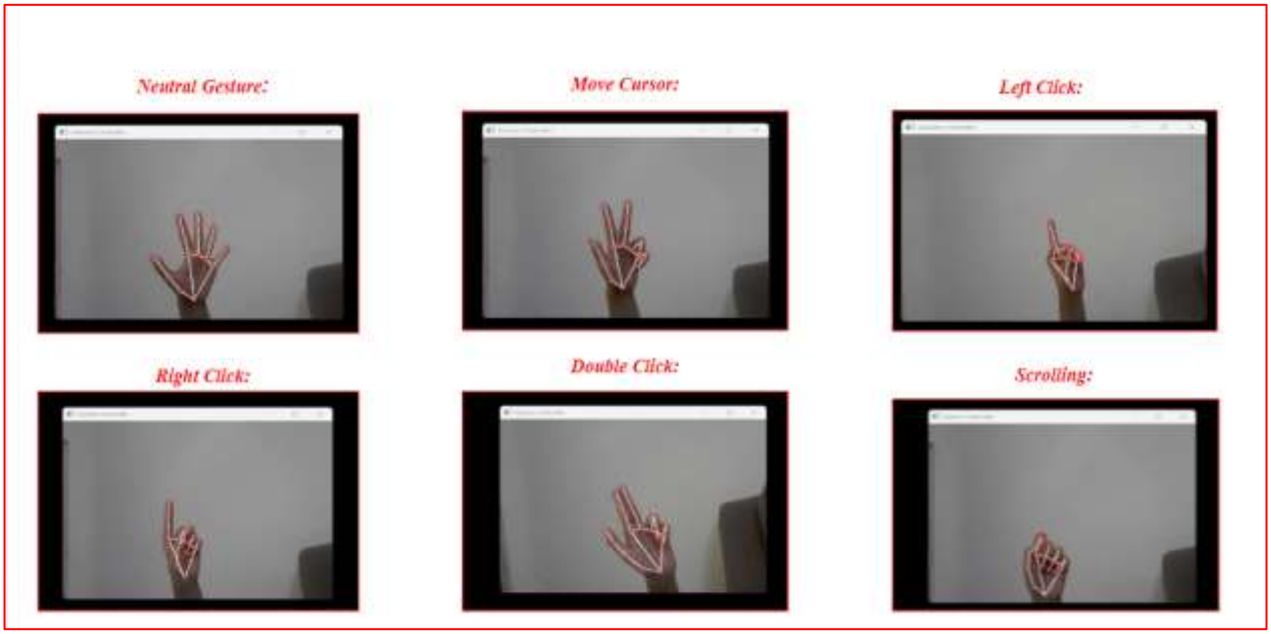
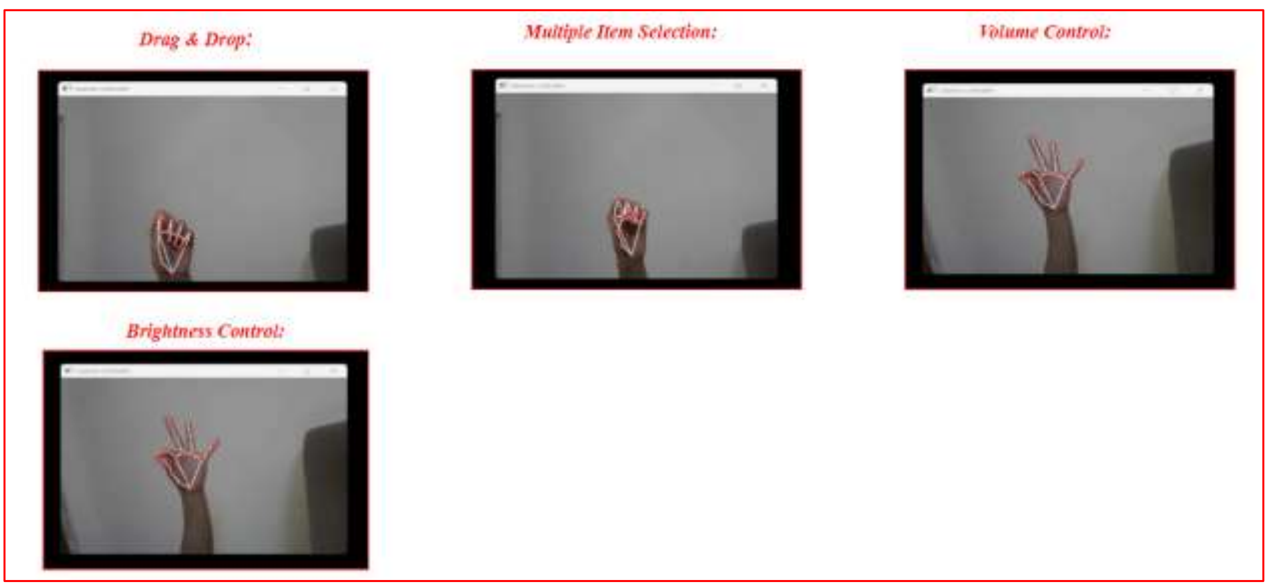
APPENDIX A

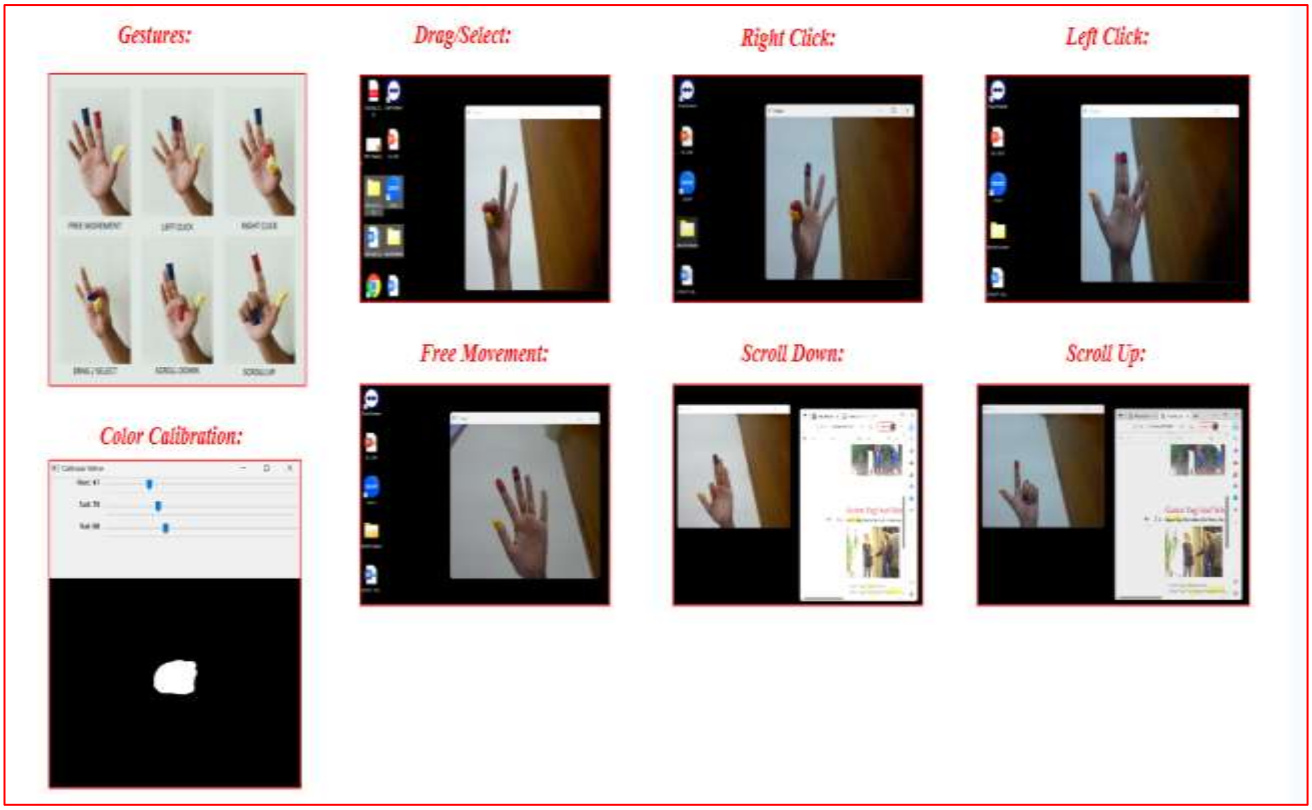
SNAPSHOTS

Output Snapshots for mouse using hand gestures:





Output Snapshots for mouse using Colored Caps:



Output Snapshots for Voice Assistant:

APPENDIX B

Details of list of publications related to this project

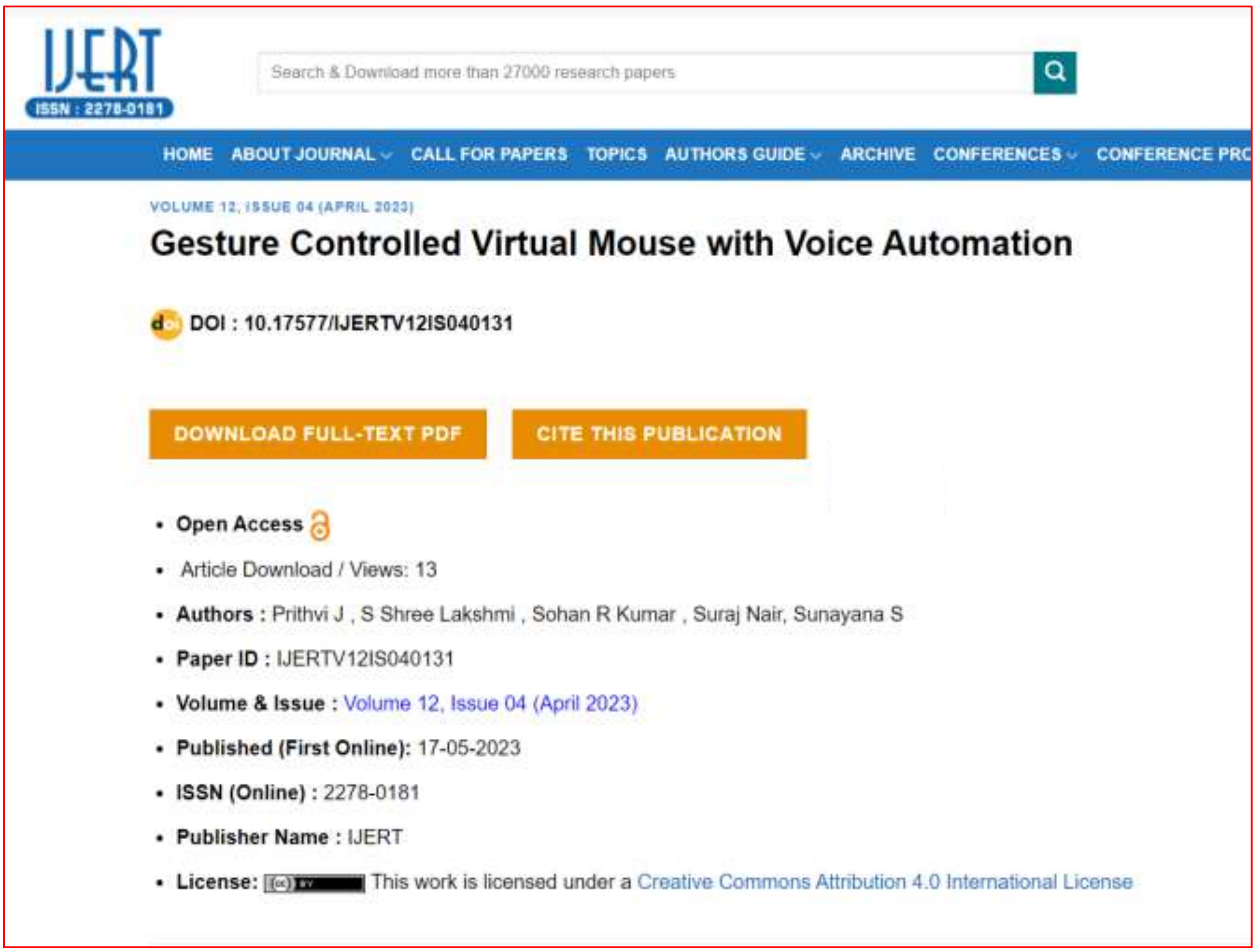
Author Names: Prithvi J , S Shree Lakshmi , Sohan R Kumar , Suraj Nair, Sunayana S

Paper Title: Gesture Controlled Virtual Mouse with Voice Automation

Name of the Conference or Journal: INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT)

Place of the conference or Vol No. , Issue No. , Page No.s of Journal: Volume 12, Issue 04 (April 2023)

Date of Conference or Date of Publication: 04 (April 2023)



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Gesture Controlled Virtual Mouse with Voice Automation

DOI : 10.17577/IJERTV12IS040131

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Author Names: Prithvi J , S Shree Lakshmi , Sohan R Kumar , Suraj Nair, Sunayana S

Paper Title: Gesture Controlled Virtual Mouse using Colored Caps

Name of the Conference or Journal: INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT)

(ISSN: 2278-0181)

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Your Manuscript details are as follow:

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APENDIX C

Attainment of Programme Outcomes and Programme Specific Outcomes

Batch no. : 03 Date:15-06-23

Project Title: Gesture Controlled Virtual Mouse with Voice Automation

PROGRAMME OUTCOMES	Level (1/2/3)	Justification if addressed
PO1	3	Used various algorithms of mathematics for calculations during frame segmentation
PO2	2	Analyzed complex image mapping problems using various mapping algorithms
PO3	3	Design of this model aims to benefit society by reducing the return rate.
PO4	2	Analysis was carried out to find the shortcomings in the already existing solutions.
PO5	2	Modern tools and latest technology including image processing and computer vision are being used.
PO6	3	High focus has been on creating a mutual bond between the engineer and the user, so that the user problems are directly understood by the user.
PO7	2	Environment and sustainability has been addressed by taking care of reducing the packaging effort, costs and also tremendous return rates.
PO8	2	Ethics and responsibilities should be justified and taken care by engineers during implementation of any products.
PO9	3	Coordination between individuals as a team resulted in better outcomes.
PO10	3	Effective and regular communication maintained between users by providing contact support.
PO11	2	Management and finance to be taken care of by a team lead.
PO12	2	Different technologies used and various problems tackled become a part of lifelong learning.
PSO1	2	Software engineering methods such as agile development have been used
PSO2	2	Error free and highly efficient apps have been developed for customer benefit
PSO3	2	Image mapping and frame coordination has been done using efficient algorithms.

APENDIX D

Plagiarism report

DrillBit

The Report is Generated by DrillBit Plagiarism Detection Software

Submission Information

Author Name	shree lakshmi
Title	gesture controlled mouse with voice automation
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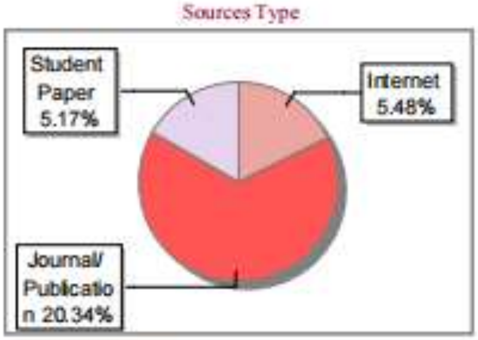

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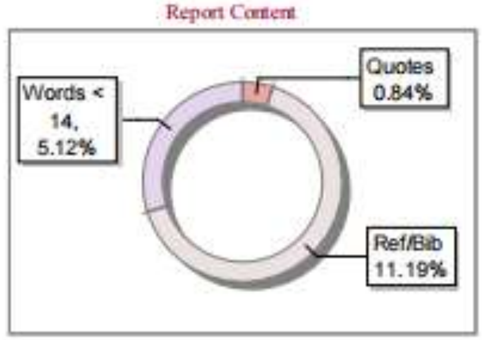

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