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Virtual Mouse and Keyboard for Computer Interaction by Hand Gestures Using MachineLearning

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ABSTRACT: Human-computer interaction has changed since the advent of computer technology. Gestures are a useful way to communicate, and the Covid-19 era had an impact on us. Both the keyboard and the mouse are tools used to communicate with computers. Here, we've attempted to use hand gestures to interact with the mouse and keyboard. Eventually, get rid of the electronics. Consequently, use a virtual keyboard and your finger to move the mouse cursor. Using different hand gestures, actions like clicking, dragging, and typing data will be carried out.

A webcam is the IOT device required to accomplish this. The output from the camera will be displayed on the system's screen so that the user can fine-tune it. We employ tools like Python, Media- Pipe, and Open-CV. The Media-Pipe library offers features that improve the model's effectiveness and is particularly helpful in AI projects. The user will be able to move the computer cursor with various hand motions, type on the virtual keyboard while holding coloured caps or tapes, and left-click and dragobjects. In this research, we suggest a hand gesture detection system for a natural human computer interface that can control a virtual mouse and keyboard.

KEYWORDS: CNN, Gesture control, Human-computer interaction, Hand tracking, Hand gesture recognition, Virtual Mouse, Virtual Keyboard, Volume control.

INTRODUCTION

Human computer interaction is one of the most rapidly growing technologies, and hand gestures are very important for human-computer interaction. Thus, discovering various modules of HCI via hand gestures and implementing them to innovate is the goal. The proposed systems include projects such as Hand Tracking, Finger counting, gesture volume control, and finally AI Virtual Mouse and Virtual Keyboard.

The suggested model eventually throws away the electronics. Human hands will use the mouse and keyboard to perform their functions. The system needs a webcam as an input IOT device. The model recommends identifying the human hand and following its motions. The mouse and keyboard can be used in a number of different ways by making movements like pointing and touching the tips of your fingers. Additional gesture detection features include opening a notepad application and typing directly in the application.

The output from the camera will be displayed on the system's screen so that the user can fine- tune it. The Python prerequisites that will be used to build this system are NumPy and mouse. In projectphase one, implementation and exploration are done on a virtual mouse, and in project phase two, on a virtual keyboard. There are additional smaller projects like Hand Tracking, which follows the palm of the hand and shows frame rate, and Finger Counting, which counts fingers using a hand tracking module as a foundation. Later, Gesture Volume adjust was introduced, which extracts certain hand features to adjust volume.

These initiatives are intended to raise productivity. We employ tools like Python, Media-Pipe, and Open-CV. Google is the developer of Media-Pipe. It is rather effective and aids in offering speedy answers to AI initiatives.

A. LITERATURE SURVEY

Virtual hand gesture recognition can be used for industrial robot control, sign language translation, smart surveillance, lie detection, visual environment manipulation, and rehabilitation tools for those with physical impairments in their upper extremities. Systems that recognize virtual hand gestures may be a natural way to communicate with machines and are unobtrusive, making them an

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important type ofinput mechanism. A challenging aspect of this technology is its capability to accurately recognize movements from a variety of angles[2].

The hand gesture is the simplest and most natural way to communicate among the various gesture communication modalities, according to a survey and a study on sign language. Real-time vision-based hand gesture identification for Human-Computer Interaction is becoming more and more feasible because to recent advances in computer vision and pattern recognition.[4].

There are numerous quick access methods for hand and mouse gestures on laptops. With thehelp of our technology, we might utilize a laptop or webcam to recognize a hand motion, control the mouse, and perform basic mouse operations like selecting and deselecting items with a left click. The project's final product is a "Zero Cost" hand identification system for laptops that uses straightforward algorithms to identify the hand, track hand movements, and assign a purpose to each movement.

Python is a straightforward language that is platform independent, flexible, and portable, all of which are desirable qualities in a programme designed to create a Virtual Mouse and Hand Recognitionsystem[8], making the system we're building much more responsive and simple to implement.

In order to assign the system a task, Hand Gesture detects shapes and/or positions based on implementation. To uncover patterns in data and improve future decisions based on the examples we provide, the learning process begins with observations or data, such as examples, firsthand experience, or teaching. The primary objective of the study is to enable computers to learn independently and adapt their behaviour.

This system uses a semi-supervised machine learning technique, which can improve learning accuracy significantly[11] when the acquired data necessitates using knowledgeable and pertinentresources for training and learning. The technology replaces the necessary pointing devices used in PCsto represent hand motions with a hand motion recognition system.

The goal of this project is to develop a remedy for a technological platform that automatically recognizes and categorizes sickness. Steps including picture loading, pre processing, segmentation, extraction, and classification are used to detect disease. Plant diseases are recognized via pictures of theleaves[12].

The mouse or pointer moves in response to the movements made by the hand being analyzed bythe computer's camera, including performing right and left clicks with various gestures. A one-finger motion to choose an alphabet and a four-figure gesture to swipe left and right are only two examples of the gestures that may be used to manage the keyboard [13]. It will function as an electronic mouse and keyboard without the need for cables or other accessories.

This study offers a virtual keyboard that gets over the problems with utilizing laptops and other common computing devices. The keyboard is based on a vision-based human-computer interaction concept, picture gathering, and image processing method, and it has virtual keys that are scaled to bethe same size as typical QWERTY keys. These keyboard's three main modules are image capture, character recognition, and device emulation[14].

A method for hand tracking has been suggested, and it is based on 3D models. The technology uses dense 3D data produced by a structured light system. We use a static reference image to get rid of the background. Each frame samples and compares the 3D hand model to the depth map, and the deformation parameters of the hand model are adjusted to reduce the Euclidean distance between the model and depth map surfaces[16].The goal of this work is to examine some of the most current developments in the field of hand gesture recognition as well as the virtual mouse detection for human- computer interaction.

B. RESEARCH MODEL

1. SOFTWARE TECHNOLOGY USED

1.1 OpenCV:

A programming function library called OpenCV (Open Source Computer Vision Library) is primarily focused on real-time computer vision.The Apache 2 Licence for Open-Source Software makes the library cross-platform and freely usable. OpenCV offers GPU acceleration for real-time activities starting in 2011.

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Application of OpenCV: It is utilized for window text change, image frame acquisition, and real-time object detection. Additionally, it functions well effectively in real-time software. Several crucial features are implemented, including

- imshow() - used to display an image in a window
- Use the putText() function to add text to any image. In our situation, frame rate was displayed.
- Users can display a window for a certain number of milliseconds or until a key is pushed by using the waitkey() function. In our example, we passed parameter as 1, which starts a while loop and displays the image continuously, creating the illusion of a video.It was discovered that MATLABis more difficult to develop and debug than OpenCV.

Challenges of OpenCV:We discovered that for the output accuracy, the frame rate (fps) should be 30. As a result, doing so is required. The OpenCV routines (CAP_PROP_FPS) do not determine the frame ratefor webcams; instead, we manually calculate the values by determining the past and current times.

1.2 MediaPipe:

Cross-platform ML solutions for live and streaming media are available from MediaPipe.[17] Machine learning pipelines are offered. A graph represents this perceptual pipeline. created by Google. Following its widespread release in 2019, MediaPipe provided researchers and developers with a wholenew range of possibilities for creating applications in the field of computer vision.

Application of MediaPipe: For identifying the hand landmarks and detecting the palm, MediaPipe is used.These models, which it developed, have been put into practice. Due to the thirty thousand palm images that MediaPipe has trained, it offers excellent accuracy. The library may construct a variety of functionalities using the 21 hand landmarks it can identify.

A hand class with methods is included in the code. The following are examples:

- Initialize the Hands class when media pipe is imported as mp using mp.solutions.hands method.

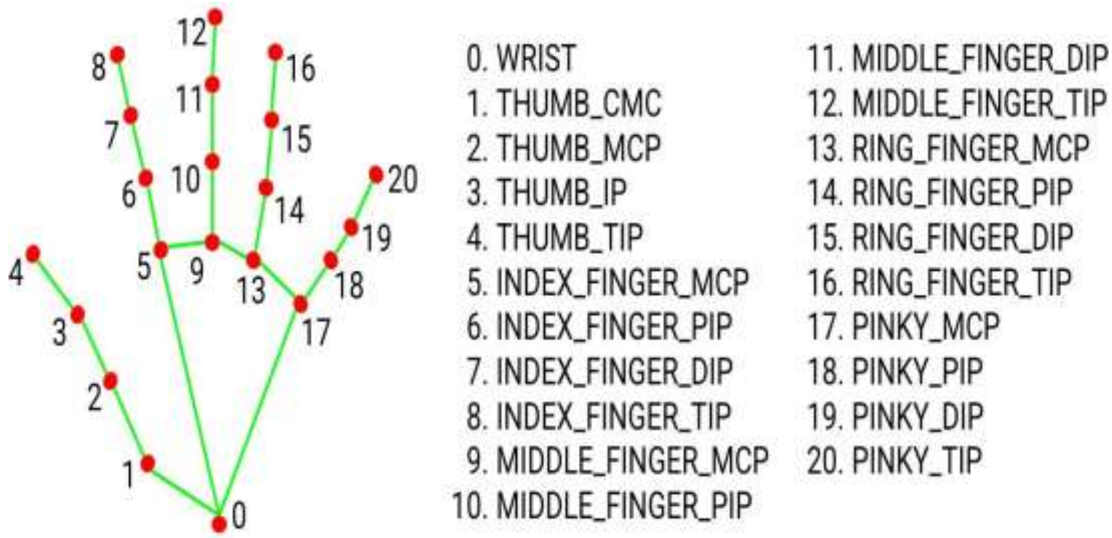

Figure 1: Hand Landmarks by MediaPipe

Challenges of MediaPipe: We must ensure that the image collected in the image frame is in RGB format while developing the MediaPipe library because BGR is the default format obtained. As a result, we must convert it.

1.3AutoPy and NumPy:

It is a straightforward Python GUI automation library that is cross-platform. It features cross-platform, effective, and basic features for managing the keyboard and mouse, identifying colors and bitmaps on- screen, and showing alarms.

- Mp.solutions.drawing_utils is in charge of drawing all hand landmarks that our Hands function recognized on the output image manner. We employed the virtual mouse and keyboard control functions in our module.

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Application of Autopy: The mouse module in Autopy has routines for obtaining the current status andvirtually controlling the mouse cursor.
Among the few implemented features are:

- The function Autopy.mouse.move (x, y) moves the mouse in accordance with the imputed x and ycoordinates.

NumPy:Mathematical operations on arrays, matrices, and linear algebra are performed using libraries. The core library for scientific computing in Python, this computing library is made to integrate with Python.

Application of NumPy: Our module uses NumPy's computing capability to implement AI Virtual mouse while locating the screen's coordinates. The fingertip's coordinates in the size (640 * 480) will be returned by the webcam. Thus, it is necessary to convert these coordinates so that they are equivalent tothe user's screen when using NumPy for mathematical computation.

2. HARDWARE

Web Camera: A webcam is a video camera that transmits live video or images to or through acomputer network, like the Internet. This IOT device may be a high-resolution external webcam or the laptop's built-in camera. The minimum resolution of the camera should be(720p)or (4mp). Used to capture the image

Challenges of Webcam:The implemented Video Capture() function should contain parameter 0if the camera is built into or incorporated into a laptop. The option passed must be 1 if the webcam is an external device in order to detect the video.

C. MPLEMENTATION OF THE MODELS1 OVERVIEW

With the use of an IoT device, namely a webcam, the goal is to develop a free hand recognition system for controlling laptops and PCs.By recognizing the hand motion, we were able to control the mouse cursor and carry out fundamental mouse pointer and cursor control operations as well as mousecapabilities like left and right clicks. The concept also implies that the sort of click will depend on the gestures made with the fingers. If only the tip of the index finger is recognized, the cursor will behaveas though the finger were moving like a mouse. Small and simple hand motions are used. As a result, the system is also made to be simple to use.

Similar to a human keyboard, an AI keyboard's implementation method begins with designing the keyboard's keys and overall layout on the screen. In order to type on the text area on the screen oron external programs like notepad, the tips of the finger are also utilized to choose the alphabets off the screen.In addition to the AI virtual mouse, the system also focuses on creating other tiny feature modelslike hand tracking, finger counters, and gesture volume control in order to boost results and provide more results from a single project.

2 MINI MODELS

The mini models include:

- Hand tracking
- Volume Control

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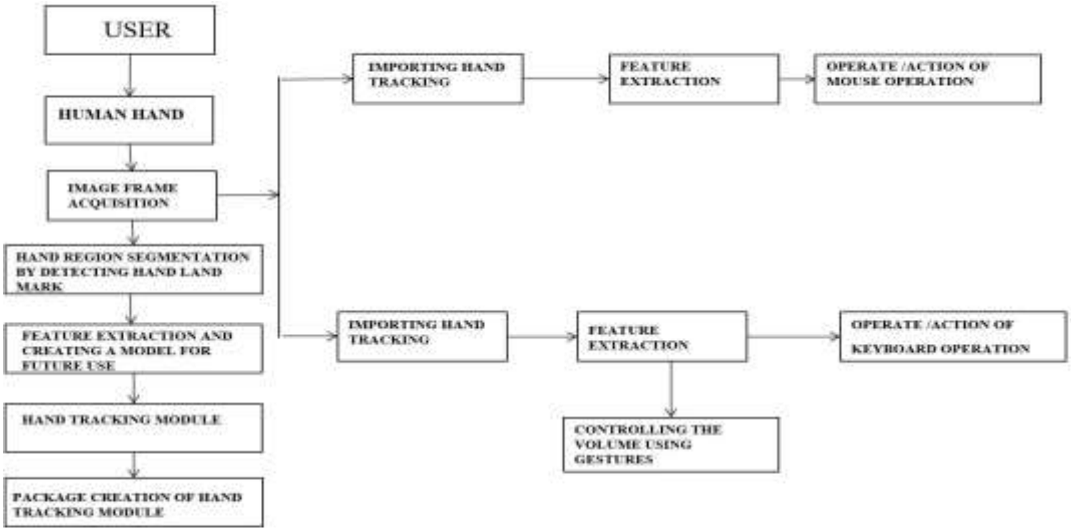

Figure 2: Block diagram of Mini Models

2.1 HAND TRACKING

The palm detection and hand tracking modules from the MediaPipe back-end will be used by the Hand Tracking model landmarks. The palm is precisely located in the image by cropping it as part of the palm recognition process. Find 21 different landmarks on the cropped image using the "Hand Landmarks" technique. In order to track the hand, the MediaPipe library divides it into a category of 21 attributes.

- The package designed to track hands was the output.
- Hand Tracking Model Flowchart

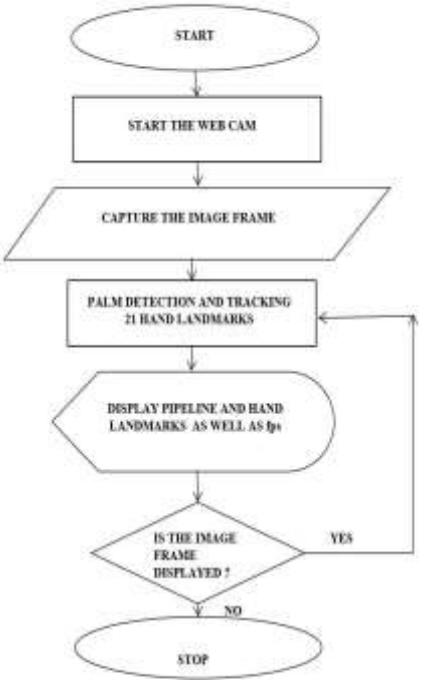

Figure 3: Flow of Hand tracking Model

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Result of Hand Tracking

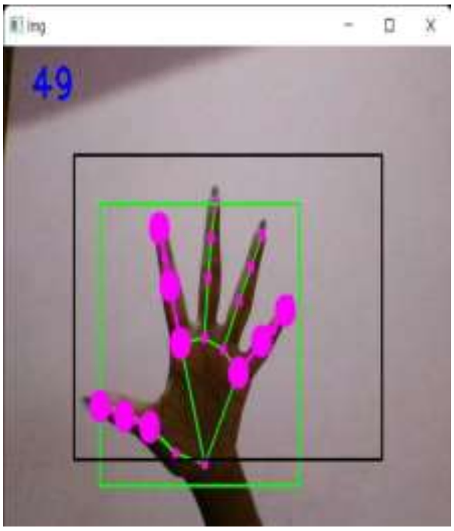

Figure 4: Result of Hand Tracking Model

2.2. GESTURE VOLUME CONTROL

Additionally, this model will import Hand tracking modules. using the thumb and index finger to detectthe volume. Detecting the pinky finger can also be used to adjust loudness. This project's goal is to extract the necessary landmarks utilizing 21 hand landmark attributes and programme them appropriately to produce the desired results. Here, gesture recognition and finger detection were used.

- Output attained: Learning how to build functionality using gestures.
- Gesture Volume Control Model Flowchart

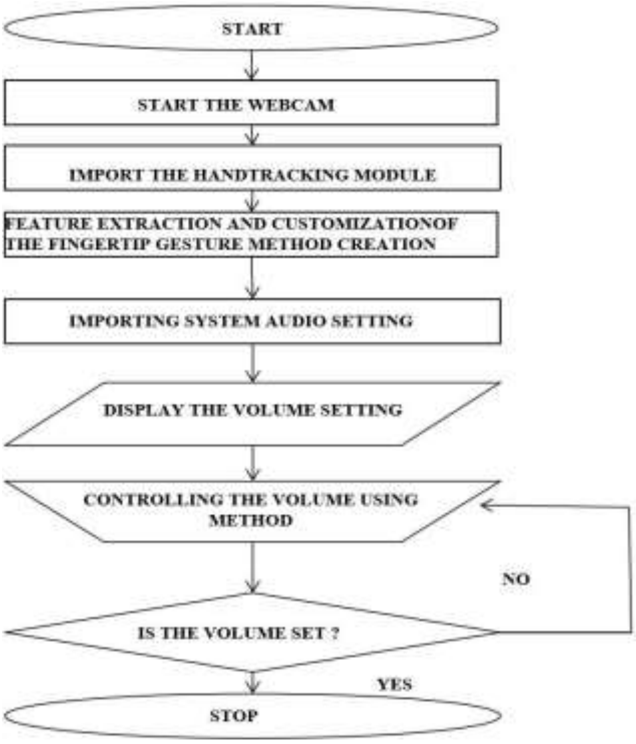

Figure 5: Flow of Gesture Volume Control Model

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Result Of Gesture Volume Control Model:

Figure 6: Result of volume control Model

D. VIRTUAL AI MOUSE

A system called an AI mouse has been proposed, in which a finger would operate the mouse via a camera. The hand tracking model will be used once more. The goal is to track the hand, extract 21 hand landmarks, and programme the system so that only the movement of the index finger will be recognized.The virtual mouse is implemented using the index finger as a pointer to the mouse cursor. When index and thumb and index and middle finger touch motions were identified, the right and left click capability was executed, accordingly.

1. Flow Diagram Of Working Of Virtual Mouse:

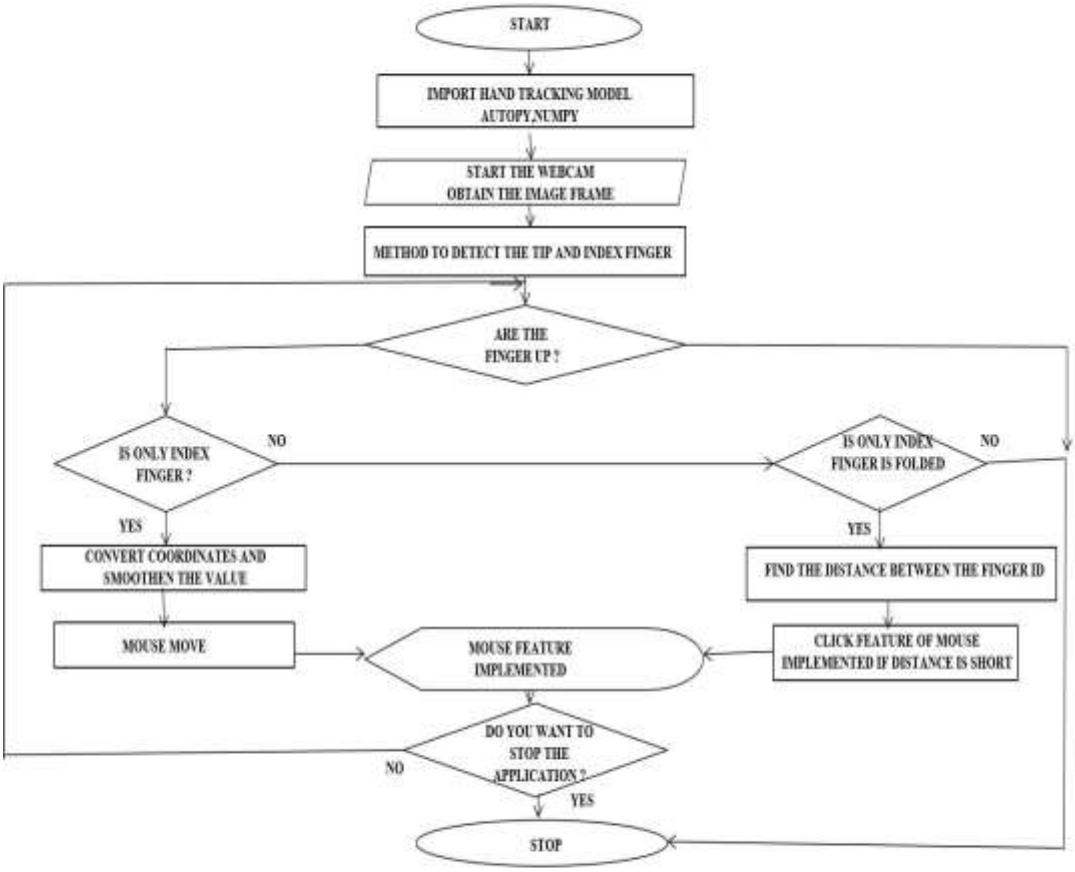

Figure 7: Flow of Virtual Mouse

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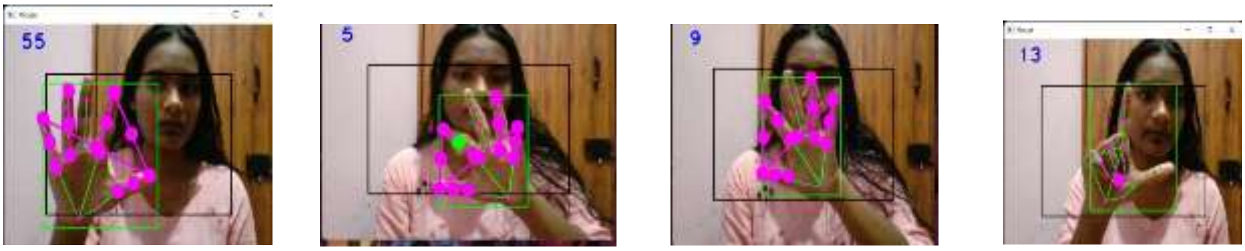
2. Result:



(a)Pause scrolling (b) Click (c) Right click (d) Start scrolling

Figure 8: Result of Virtual Mouse

E. VIRTUAL AI KEYBOARD

A virtual keyboard is simulated on the screen for our use in a system called an AI keyboard. When a finger is held over the alphabet on the screen, the letters are recognized. With a touch of the middle and index fingers, the letter is typed. The integrated AI keyboard is very adaptable. The web camera's imageframe acquisition must be modified because the keyboard is relatively large.

1. Flowchart of the working of the keyboard:

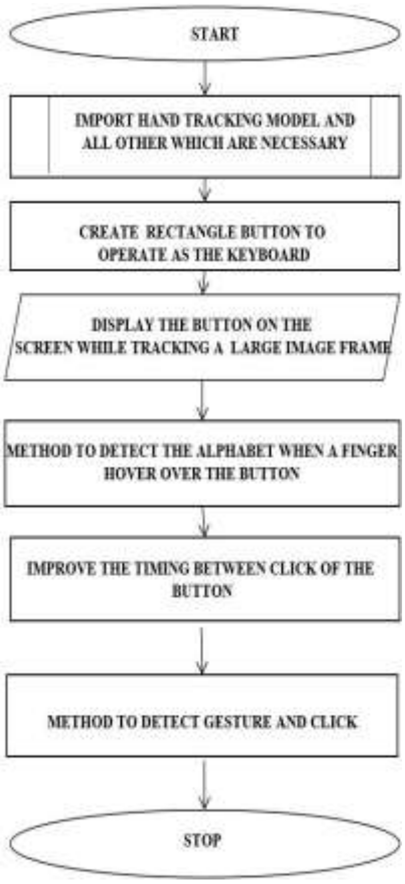


Figure 9: Flow of Virtual Keyboard

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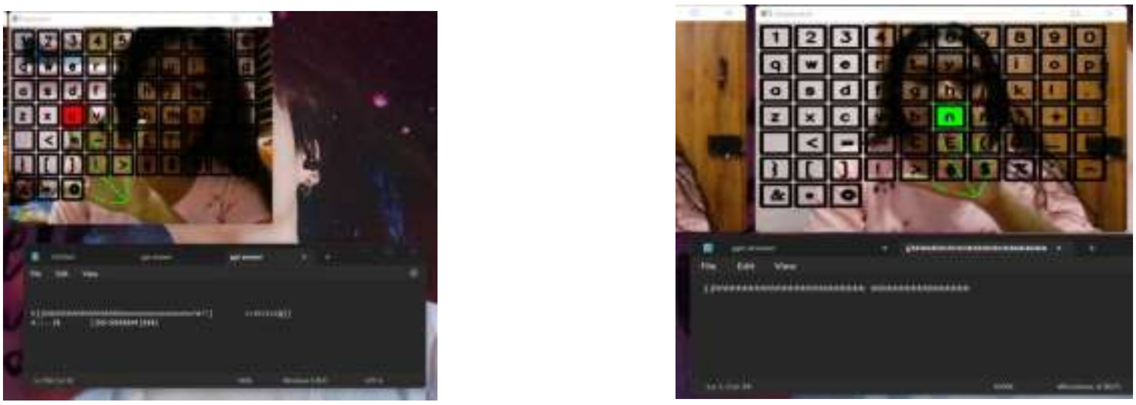
2. Result Of Virtual Keyboard



(a). Indicate the key (b). Key has been clicked

Figure 10: Performing the key press on the virtual keyboard

F. RESULT OF VIRTUAL MOUSE AND KEYBOARD

Figure 11: Performing the mouse and keyboard actions

G. SYSTEM TESTING

Functional testing: This involves testing the basic functionalities of the virtual mouse and keyboard, such as clicking, dragging, scrolling, and typing. The system would be tested to ensure that it responds appropriately to different hand gestures, and that the machine learning algorithms are accuratelyrecognizing and interpreting the gestures.

Performance testing: This involves testing the performance of the system under different conditions, such as different lighting environments, different hand positions, and different speeds of gesture input. The system would be tested to ensure that it can accurately recognize and respond to hand gestures in a timely and efficient manner.

H. APPLICATIONS

Education: The technology can be used in classrooms or educational settings where multiple students share a single computer. The use of hand gestures can help reduce the spread of germs and bacteria and can also provide an engaging and interactive learning experience for students.

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Medical Sector: The virtual mouse and keyboard can be used in healthcare settings, such as operating rooms or hospitals, where the use of physical input devices like a mouse or keyboard can be difficult due to hygiene concerns.

Diseases in which virtual mouse and keyboard is usedCerebral Palsy
Multiple SclerosisSpinal Cord Injury

I. CONCLUSION

We have tried to implement AI virtual mouse and keyboard using a real-time camera, hand detection, and tracking. It includes a variety of features, for example, the mouse has buttons for right and double left clicks. The mouse is built on computer vision techniques and is made to function just like a real mouse. The alphabets are correctly aligned and the keyboard simulates a real keyboard. The outcome consists of key presses as well as backspace and space bar key functions.

A light room, hands, and an HD webcam are the only requirements for the system to function in all environments and produce superior results quickly. The effectiveness of the system will enable us to cut plastic waste by doing away with the keyboard and mouse and free up space at work. It will also bea breakthrough that opens up better opportunities.

J. FUTURE WORK

One of its best qualities is how simple it is to use. The focus of upcoming work will be on improving algorithms by combining the developed models to create a complete virtual system handler that can control the volume, brightness, and other features as well as function as a virtual mouse and keyboard.It also features keyboard improvements. There will soon be a caps-lock button. Moreover, there should be a button that converts keyboard characters into special characters so that they can be used when necessary. The virtual keyboard and mouse can be used together in airport kiosk check-in machines for touch less check-in experience. The passengers can enter the PNR without touching the screen and get their boarding passes. When such a system is implemented.

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