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Empowering Human-Computer Interaction with Multi Modal Virtual Mouse

Rohit Dodamani[1], Vaibhavi Govankop[1], Omkar Bhandurge[1], Prajakta Kerwadikar [1]and Jayshri[2]
Student, Department of CSE, Jain College of Engineering and Research, Belagavi, Karnataka, India [1]
Assistant Professor, Department of CSE, Jain College of Engineering and Research, Belagavi, Karnataka, India [2]

Abstract: The virtual mouse offers users a more comfortable and intuitive way to interact with their computers, especially for individuals who have injuries or disabilities that prevent them from using a traditional mouse. It is more accessible to a wider range of people thanks to the implementation of several modules, such as the hand gesture, eye movement, and voice recognition modules, which give users a variety of alternatives for manipulating the virtual mouse. The virtual mouse's potential advantages go beyond accessibility, as it can also be utilized to boost output and lessen physical fatigue brought on by continuous use of a real mouse.

IndexTerms **- Virtual Mouse, Hand Gestures, Iris Movement, Voice Recognition, Interface, Python.**

I.INTRODUCTION

An innovative technique that has made great strides in recent years is virtual mouse control using hand gestures, eye movement, and voice recognition. Without the use of a mouse or keyboard, this technology provides a more natural and intuitive approach to handle computer systems.

Using hand motions to move the cursor on the screen is known as virtual mouse control by hand gestures. This method employs a camera to record the hand movement and translate it into a cursor movement. Similar to eye movement, iris movement entails controlling the cursor on the screen with eye movement. An eye-tracking camera is needed for this method in order to track user eye movement and convert it to cursor movement. Another method for controlling the virtual mouse is voice recognition, which enables the user to speak commands to control the cursor motions.

Many advantages come with the usage of virtual mouse control via hand gestures, eye movement, and voice recognition, including improved user experience, increased productivity, and increased accessibility for those with disabilities. This technology, for instance, can help those with physical limitations who might not be able to use conventional mouse and keyboard commands. Also, to offer a more realistic and natural experience, this technology has been widely applied in gaming, virtual reality, and augmented reality applications.

In addition, the operation of a virtual mouse using hand gestures, iris movement, and voice recognition has potential uses in augmented reality, home automation, and the medical and educational domains. In contrast to how students can engage with educational materials using hand gestures or speech recognition, doctors and other medical professionals can swiftly and readily access patient information and medical records using this technology.

Overall, the utilization of speech recognition, eye movement, and hand gestures to control a virtual mouse has the potential to change how we interact with computers and make it feel more intuitive and natural. We may anticipate even more cutting-edge applications that will improve our daily lives as this technology advances.

II.BACKGROUND

The current virtual mouse control technology allows us to do standard mouse operations like mouse pointer control, left click, right click, drag, etc. utilizing a hand recognition algorithm. The hand recognition technology is not being used any further.

There are currently virtual mice that use voice recognition, eye movement, and hand gestures. Here are a fewexamples:

1. Myo Armband: The Myo armband is a wearable gadget that uses electromyography (EMG) sensors to capture hand and arm gestures. It enables users to manage their computers with hand gestures by detecting hand movements and translating them into cursor movements on a computer screen.

2.Eye Sight Technologies: A business called Eyesight Technologies has created a device called Eyesight that tracks head and eye motions to control a computer cursor. The program tracks the user's iris movements using infrared cameras and converts them into cursor movements on the screen.

3.Dragon Naturally Speaking: Using speech commands and voice recognition software, users of Dragon NaturallySpeaking may operate computers. It enables users to operate their computer without a keyboard or mouse and to dictate documents since it can recognize and respond to spoken words and phrases.
4.Leap Motion: Leap Motion is a gesture recognition system that can monitor hand motions in three dimensions. Users are able to manage their computer by making hand gestures since it can recognize finger movements and translate them into cursor movements on a computer screen. These systems are continuously evolving, and new technologies are being developed to improve their accuracy and usability.

III. STUDIES ON RELATED WORK

The Summary of Related works is presented in Table 1 below.

Sl.No.	Authors	Technology	Advantages	Limitations
1	Hritik Josi,Nitin Waybhase [1]	Informative algorithmic rule	Hand detection is transformed to binary image.	The system gets slow.
2	Anadi Mishra,Sultan Faiji,Pragati Verma,Shyam Dwivedi,Rita Pal [5]	CV2.VideoCapture, OpenCV And Mediapipe.	Able to control our screen by moving our fingers which will work as cursor.	Uses only the proper hand to perform gesture.
3	Mohamed Nasol,Mujeeb Rahman,Haya Ansari [7]	MATLAB	Eye detection movement.	Small decrease in accuracy.
4	Sunil Kumar Beemanapally,Chetan Kumar,Diksha Kumari [8]	Image Processing,Eye tracking,Hough transform.	It provides a clear and consise.	Deforms non-elastically as pupil changes size
5	Khushi Patel,Snehal Solaunde,Shivani Bhong [11]	Mediapipe,OpenCV	Hands free control.	Privacy Concerns
6	Likitha R,Kmaraswamy S,Revathi B [12]	Voice Assistant, Sapi 5.	Improved accessibility.	Environment factors.

Table 1: *Comparison of related work.*

IV. PROPOSED SYSTEM

The technologies stated above could be combined in a virtual mouse system that uses voice recognition, iris movement, and hand gestures to provide a more smooth and simple user experience. The following are some probable characteristics of such a system:
1. Hand gesture recognition: The system might capture hand movements and translate them into cursor movements on a computer screen using a can involve using your hands to point, click, or scroll.
2. Iris movement recognition: The system might also track the user's iris movements and convert them into cursor movements using an infrared camera or other technology. This would make it possible to manipulate the cursor more precisely and could especially helpful for those who have trouble moving around or using their hands deftly.
3. Voice recognition: The system might come with voice recognition software that enables users to speak commands to their computer. This might involve instructions for starting applications, utilizing menus, and even dictating text.
4. Software integration: The system may be made to work with current programs like media players, productivity programs, and web browsers. In the context of the program they are using, this would enable users to operate their computer using a combination of hand gestures, iris movements
5. User-adjustable settings: The system may have user-adjustable settings that let users modify the sensitivity of the software that recognizes hand gestures, eye movements, and vocalizations. Users might then modify the system to suit their unique requirements and tastes.
Overall, a system that integrates speech recognition, iris movement identification, and hand gesture recognition could give users a more flexible and natural way to operate their computer, especially for people with limited dexterity or mobility.

V. STUDIES ON RELATED WORK

A virtual mouse using different types of input modalities such as hand gestures, iris, and voice. In terms of related work, there have been several studies and research efforts in the area of gesture-based interfaces and input modalities. Some notable studies and research in this area include below:

1. Gesture-based interfaces for virtual reality: Several studies have explored the use of gesture-based interfaces for virtual reality applications. These interfaces typically use hand gestures or body movements to interact with virtual objects and environments.

2.Eye-tracking interfaces: Eye-tracking technology has been used to develop interfaces that allow users to interact with computers using their eyes. These interfaces can be particularly useful for individuals with motor impairments.

3.Voice-based interfaces: Voice-based interfaces, such as voice assistants like Siri and Alexa, have become increasingly popular in recent years. These interfaces allow users to interact with computers using natural language commands.

4. Multimodal interfaces: Many research efforts have focused on developing interfaces that combine multiple input modalities, such as gesture, voice, and touch, to create more natural and intuitive interaction experiences.

User experience design for gesture-based interfaces: There is also a growing body of research focused on designing effective user experiences for gesture-based interfaces. This research explores issues such as gesture recognition accuracy, gesture design, and user feedback.

VI. THE PROBLEMS

Based on the study, the following Problems are found in the existing systems:

1.Accuracy: If the hand gesture, iris, or speech recognition software is not accurate enough, the virtual mouse's accuracy could become a problem. The user may become frustrated as a result because they may find it challenging to move the pointer or choose items on the screen.

2.Compatibility: The virtual mouse may not work with all operating systems or gadgets, which could limit its applicability. For instance, if the virtual mouse is limited to a certain version of Windows, Mac users might not find it useful.

3.Learning curve: Using the virtual mouse efficiently may require users to pick up new movements or vocal instructions, which can be difficult for certain people.

4.Accessibility: Some users may struggle to utilize the virtual mouse because of physical impairments such restricted hand movement or poor vision. This may prevent a sizeable section of the population from using the virtual mouse.

5.Processing power: The virtual mouse could use a lot of processing power, which could make the user's computer or gadget run more slowly. Frustration and decreased productivity may result from this.

6.Privacy: There may be worries about data security and privacy if the virtual mouse uses speech recognition or iris scanning. If users believe that their personal information is not being appropriately protected, they could be reluctant to use the virtual mouse.

7.Cost: Depending on the technology utilized, developing and implementing a virtual mouse may be expensive, which could limit consumers' access to it. This can make it challenging for people or organizations to justify the expense if they don't expect to gain much from utilizing the virtual mouse.

VII.SYSTEM DESGIN

Designing a system for a virtual mouse that utilizes interface, hand gestures, iris movement, and voice assistant involves integrating several components to create a seamless user experience. Here is a high-level overview of the system design:

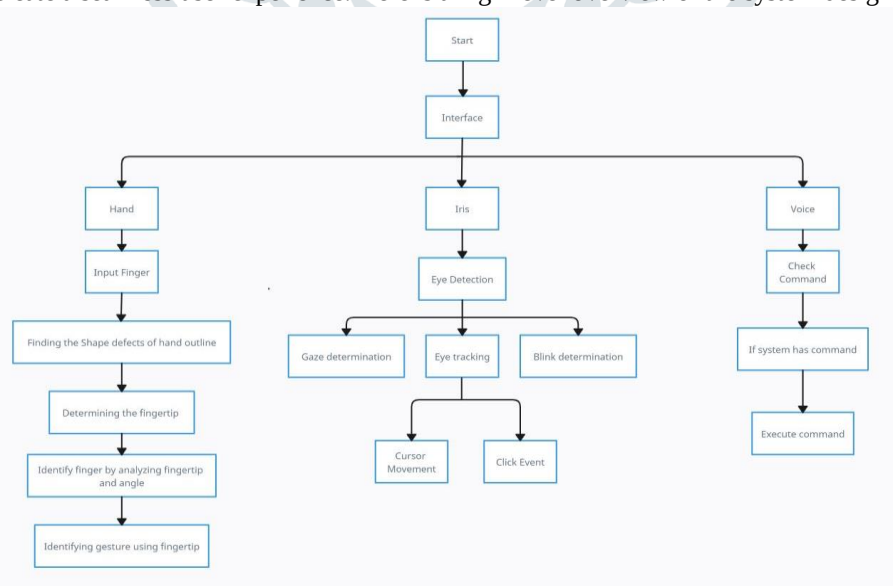


Fig System Design

Interface: The system will have a graphical user interface (GUI) that displays the virtual mouse and allows the user to interact with it using various input methods.
Hand Gestures: The system will use a hand tracking module to detect the user's hand movements and translate them into mouse pointer movements. This can be achieved through various hand gestures, such as pointing, swiping, and clicking.
Iris Movement: The system will also use an eye tracking module to detect the user's iris movement and translate it into mouse pointer movement. This allows the user to move the mouse pointer without using their hands.
Voice Assistant: The system will have a voice assistant that can be activated by voice commands to perform various tasks such as opening applications, switching windows, and scrolling.

WORKFLOW DIAGRAM

Using Interface: -

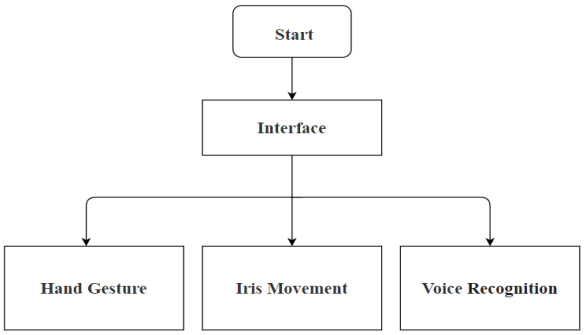


Fig Workflow of Interface

The interface for a virtual mouse that connects with hand gesture, iris movement, and voice assistant would work. The interface would use a hand tracking module and an eye tracking module to detect hand gestures and iris movement, respectively. The interface would also have a voice assistant that can be activated by voice commands. The hand gesture, iris movement, and voice assistant modules would be integrated into the interface in such a way that the user can switch between input methods seamlessly. The interface would provide feedback to the user to indicate that their input has been registered. The interface would need to be designed to provide a seamless and intuitive user experience that allows the user to switch between input methods based on their preference and convenience.

Using Hand Gesture

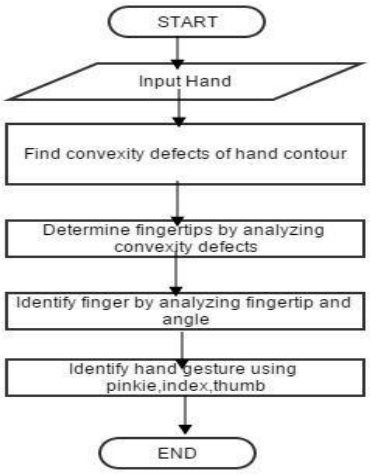


Fig Workflow of Hand Gesture

i) Rectangular Region for Moving through the Window

The AI virtual mouse system makes use of the transformational algorithm, and it converts the co-ordinates of fingertip from the webcam screen to the computer window full screen for controlling the mouse. When the hands are detected and when we find which finger is up for performing the specific mouse function, a rectangular box is drawn with respect to the computer window in the webcam region where we move throughout the window using the mouse cursor

ii) Detecting Which Finger Is Up and Performing the Particular Mouse Function

In this stage, we are detecting which finger is up using the tip Id of the respective finger that we found using the MediaPipe and the respective co-ordinates of the fingers that are up, as shown in Figure 6, and according to that, the mouse function is performed.

iii) For the Mouse Cursor Moving around the Computer Window

If the index finger is up with tip Id = 1 or both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up, the mouse cursor is made to move around the window of the computer using the AutoPy package of Python.

iv) For the Mouse to Perform Right Button Click

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is lesser than 40 px, the computer is made to perform the right mouse button click using the pynput Python package

v) For the Mouse to Perform Scroll up Function

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is greater than 40 px and if the two fingers are moved up the page, the computer is made to perform the scroll up mouse function using the PyAutoGUI Python package.

vi) For the Mouse to Perform Scroll down Function

If both the index finger with tip Id = 1 and the middle finger with tip Id = 2 are up and the distance between the two fingers is greater than 40px and if the two fingers are moved down the page, the computer is made to perform the scroll down mouse function using the PyAutoGUI Python package.

Using Iris Movement

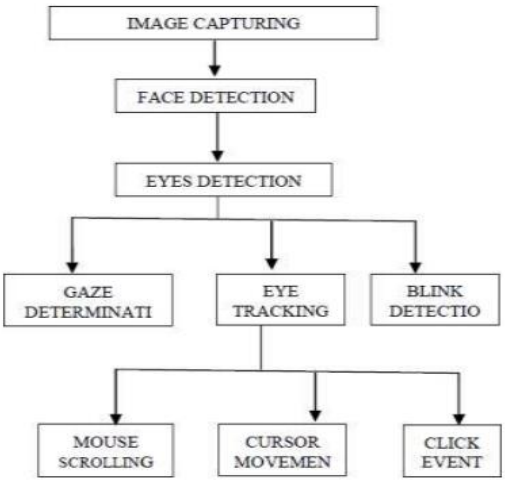


Fig Workflow of Iris Movement

The first step was to use a face detection algorithm locate the face on an image frame captured by an ordinary webcam. The next step was to detect only the eyes from this frame. We consider tracking only one eye movement for faster processing time. Then the iris movement was tracked. Since the color of the iris is black, its image has a significantly lower intensity compared to the rest of the eye. This helps us in easy detection of the iris region. Taking the left and right corners of the eye as reference points, the shift of the iris as the person changed his eyes focus was determined. The shift was then used to map cursor location on the test graphical user interface (GUI).

i) Face Detection Methods

Face detection is the step stone for all facial analytical algorithms, including facial orientation, facial mapping, face recognition, facial recognition / authentication, facial expression tracking / recognition, gender recognition.

ii) Feature Based Methods

The characteristic-based approach is to identify faces by extracting facial structural features. It is first classifier and then used to distinguish between facial and non-facial regions. The aim is to transcend the limitations of our instructive awareness of faces. This method is divided into many phases and images of several faces.

iii) Eye Detection Methods

There are some detection methods that undergo various stages, such as the positioning of the face and eyes from different locations.

iv) Pupil Track

Pupil tracking is a gaze-detection technique that is often used in combination with other methods. The eye is much more than a tool for moving the cursor at high speeds. Input of eye movement is obviously faster than input of any factors. Until any mechanical pointing system is controlled, the user typically looks at the destination to which he or she wants to travel.

Using Voice Assistant

With the aid of a voice assistant and a virtual mouse, users can operate their computer's cursor and carry out tasks without actually using a mouse or trackpad. Instead, they can imitate the movement and clicks of a conventional mouse using voice commands. The user usually has to have a compatible voice assistant programmer like Siri, Alexa, or Google Assistant installed on their computer in order to utilize a virtual mouse with a voice assistant in order to enable the functionality of the virtual mouse, they might also need to install extra software or add-ons. The user can engage the virtual mouse by speaking a command to their voice assistant after installing the relevant software. They can then direct the device via vocal commands.The utilization of speech recognition, eye movement, and hand gestures to control a virtual mouse has the potential to change how we interact with computers and make it feel more intuitive and natural. We may anticipate even more cutting-edge applications that will improve our daily lives as this technology advances.

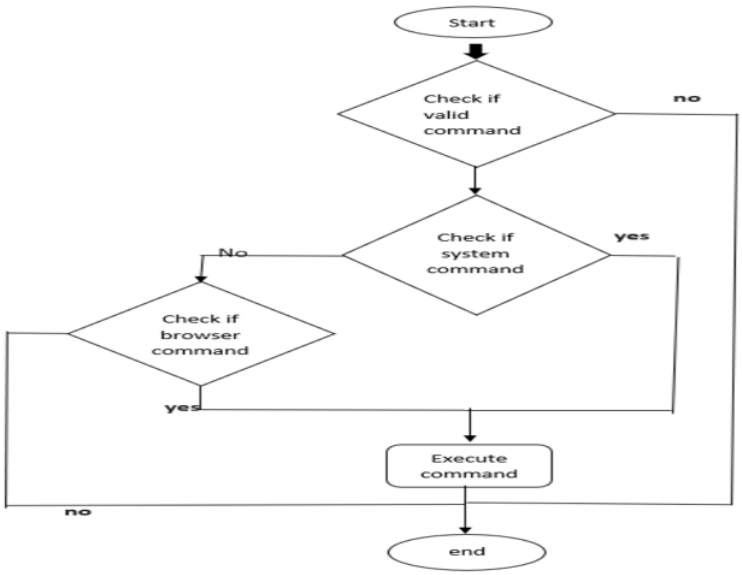


Fig Workflow of Voice Assistant

VII.RESULTS

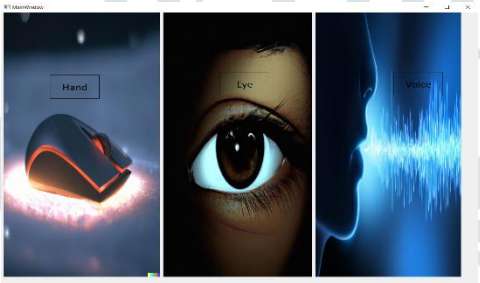


Fig: Interface

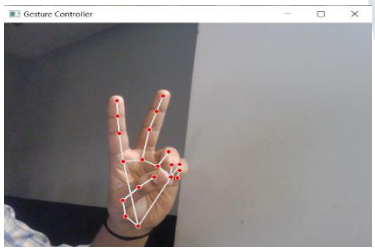


Fig: Using Hand Gesture Move Cursor

Fig: Using Hand Gesture Double Click

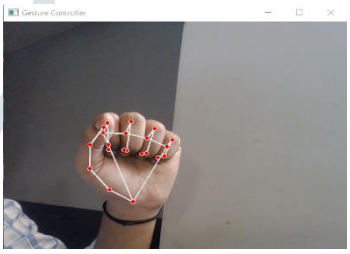


Fig: Using Hand Gesture Drag and Drop

Fig: Using Hand Gesture Right Click

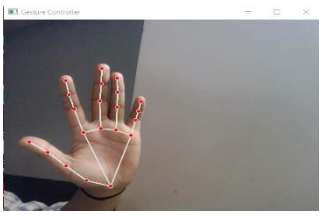


Fig: Using Hand Gesture Hault

Fig: Using Iris Movement Move Cursor

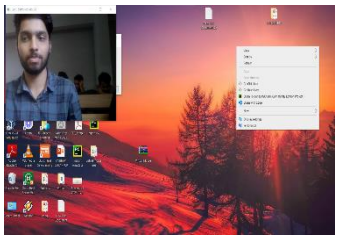
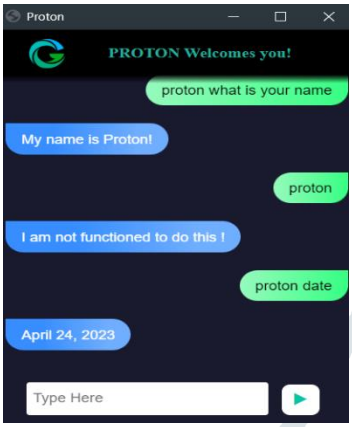


Fig: Using Iris Movement Right Click



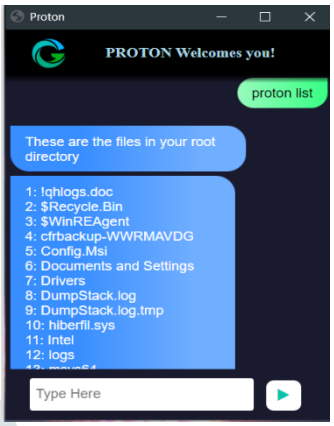


Fig: Using Voice Assistant Opening Date **Fig: Using Voice Assistant Opening Time** **Fig: Using Voice Assistant Listing Files**

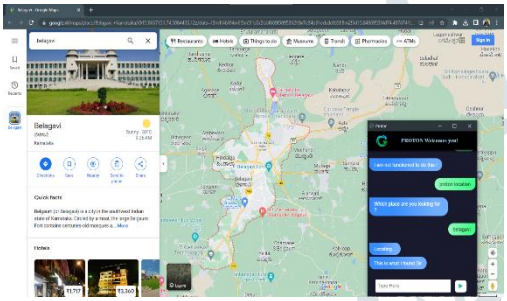


Fig: Using Voice Assistant Opening Location

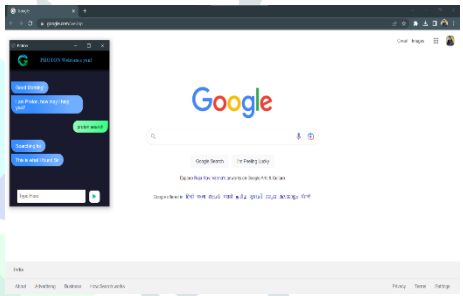


Fig: Using Voice Assistant Search

VIII. CONCLUSION

In conclusion, a virtual mouse that can be operated via hand gestures, eye movement, and voice assistant technologies might make using computers and other devices more natural and effective. For people with impairments who might find it challenging to operate a conventional mouse or keyboard, this kind of technology can be extremely useful.Although this technology is still in its early stages of development, encouraging developments have been made. Virtual mouse technology has the potential to become a commonplace means of human-computer interaction with additional study and development, offering a more smooth and natural user experience.

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