Comparative Study of Hand Gesture Recognition Techniques for Virtual Mouse Application

Prasun Tripathi[1], Saurabh Kumar[2]
[1]*Assistant Professor, Axis Institute of Technology and Management*
[2]*Undergraduate Student, Axis Institute of Technology and Management*

Abstract: **This paper presents the development of a desktop virtual mouse application that allows users to control their mouse movements and clicks using hand gestures and voice commands. The application takes input directly from a live camera frame, and it uses various Python libraries like cv2, pyautogui, tkinter, and speech recognition for its functionality. The proposed virtual mouse application has been developed to overcome the limitations of other virtual mouse programs, which require a high-end system to run smoothly. This application is designed to work seamlessly on low-end systems. Moreover, the application is easy to install, as there is no need to run the file in an integrated development environment (IDE) to show the result. One of the unique features of this application is its voice assistant capability. Users can perform specific actions like opening files, closing applications, and switching windows using voice commands. The application is trained to recognize different voices, and it can respond to a range of commands.**

Index Terms: **Desktop Application, Hand gesture recognition, Voice Assistant, cv2, Speech-Recognition.**

I. INTRODUCTION

Computer vision techniques have emerged as a potential alternative to touch screens, enabling the creation of virtual human-computer interaction devices such as mice or keyboards that can be controlled using a webcam. With the increasing demand for touchless interfaces, gesture recognition technology has become a promising solution for creating a more natural and intuitive user experience. By using computer vision algorithms to interpret hand movements and gestures, we can enable users to control devices and applications without the need for physical contact. This has significant implications for accessibility, particularly for people with disabilities that may have difficulty using traditional input devices such as a mouse or keyboard. In this study, we explore the potential of gesture recognition technology to improve human-computer interaction and demonstrate its application as a virtual mouse cursor. By leveraging the power of computer vision, we can create a more seamless and efficient user experience that is both intuitive and accessible to all.

II. LITERATURE SURVEY

The systematic review conducted has shed light on the diverse approaches that can be utilized and executed to attain accurate hand gesture recognition. Furthermore, it has facilitated comprehension of the strengths and weaknesses inherent in the various methodologies.

The use of virtual mouse control using hand gesture recognition has gained significant attention in recent years. In the first research paper, Reddy et al. (2020) developed a virtual mouse using colored fingertips and neural networks for hand gesture recognition. However, the limitation of this system is that it requires colored fingertips, which may not be practical in all situations [1]. In the second paper, Varun and Jacobi (2019) used OpenCV and deep learning techniques for hand gesture recognition. Although they achieved good results, the complexity of using color variation techniques can be a limitation [2]. Mohammed and Preetha (2018) developed a virtual mouse using MATLAB software and two cameras. Although they achieved a high detection rate under sufficient lighting conditions, the cost of using two cameras can be expensive, that's why the idea of using it in a low-end system was not efficient [3]. In the fourth paper, Mhetar et al. (2015) used hardware devices such as an IR camera, USB-HID, and IR pen to develop a virtual marker. This system was effective in teaching scenarios but was limited by its cost and use of hardware that increases the desk complexity [4]. Finally, Shetty and Daniel (2020) used an HSV technique and OpenCV in their virtual mouse system.

While they achieved good accuracy in plain backgrounds, their accuracy dropped significantly in non-plain backgrounds [5]. Overall, these studies demonstrate the potential of virtual mouse control using hand gesture recognition, but there are still limitations to be addressed, such as the requirement for colored fingertips or the cost of hardware devices. Future research can focus on improving accuracy and usability in a wider range of scenarios.

III. AIM OF RESEARCH

The aim of the research work is to develop a low-system virtual mouse application with a voice assistant feature that allows users to control their mouse movements and clicks using hand gestures and voice commands. The specific aims of the research work are as follows:

1) To design a desktop virtual mouse application that can be installed and run on low-end systems without any performance issues.
2) To use a live camera frame as an input method to control the virtual mouse, eliminating the need for additional hardware.
3) To develop a voice assistant feature that can recognize user commands and perform specific tasks, such as opening files, closing applications, and switching windows.
4) To compare the proposed virtual mouse application with existing virtual mouse research studies in terms of input method, system requirements, and voice assistant capability.

To demonstrate the feasibility and effectiveness of the proposed virtual mouse application through experimentation and evaluation.

IV. PRINCIPLE OF WORKING

1) The algorithm uses computer vision to detect a hand in the camera frame.
2) It tracks the position of the hand and calculates the movement of the hand.
3) The algorithm creates a boundary box to limit the movement of the hand.
4) It checks the fingers of the hand to determine whether to move the cursor or perform a click.
5) If the index finger is up and the middle finger is down, it moves the cursor based on hand movement.
6) The algorithm uses a smoothening factor to make the cursor movement more fluid.
7) If the index finger and the middle finger are up, it checks the distance between them.
8) If they are close enough, it performs a mouse click.
9) The algorithm calculates and displays the frame rate of the video stream.
10) It displays the camera feed with hand detection and cursor movement overlay.

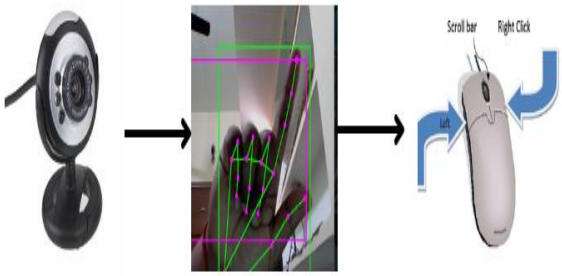

Figure 1. Demonstration of Working

V. RESULT AND DISCUSSION

The Result shows that the application is designed to work seamlessly on low-end systems and uses a live camera frame as an input method to control the virtual mouse, eliminating the need for additional hardware. The proposed virtual mouse application also features a voice assistant capability that can recognize user commands and perform specific tasks. The paper compares the proposed virtual mouse application with existing virtual mouse research studies and demonstrates its feasibility and effectiveness through experimentation and evaluation. The principle of working of the algorithm involves computer vision to detect a hand in the camera frame, track the position of the hand, calculate the movement of the hand, create a boundary box to limit the movement of the hand and perform cursor movement and clicks based on finger positions. The paper highlights the potential of gesture recognition technology to improve human-computer interaction, particularly for people with disabilities who may have difficulty using traditional input devices such as a mouse or keyboard.

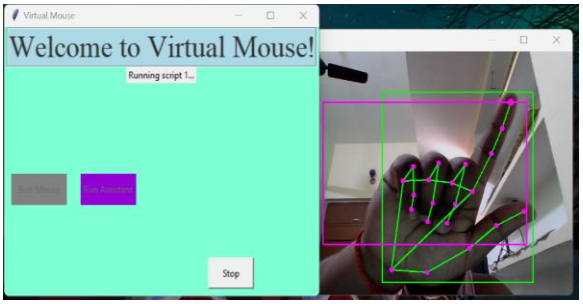

Figure 2. Result of the Mouse Activity

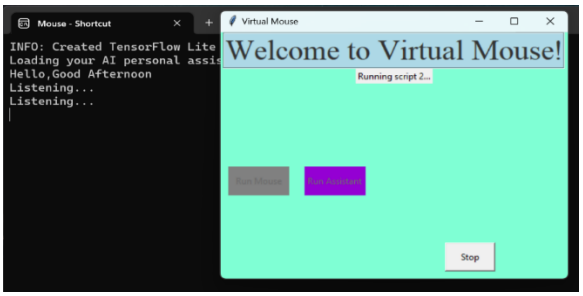

Figure 3. Result of the Assistant Activity

VI. CONCLUSION

In conclusion, this paper presents a low-system virtual mouse application with a voice assistant feature that allows users to control their mouse movements and clicks using hand gestures and voice commands. The proposed system can work seamlessly on low-end systems and provides a more user-friendly experience. The voice assistant feature adds an additional layer of functionality, making it easier for users to perform specific tasks. The comparison with other virtual mouse research studies shows that our proposed system has better system requirements and voice assistant capability. Future work will focus on improving the accuracy of the voice recognition module and adding more functionalities to the application.

REFERENCE

[1] "Real-Time Hand Gesture Detection and Recognition Using OpenCV" by Pranav Khiste, Aniket Dhumal, and Swapnil Dharmadhikari. International Journal of Engineering Research and Technology, 2017.

[2] "A Hand Gesture Recognition Interface for Virtual Mouse Control" by P. R. Pardhi and P. R. Bakshi. International Journal of Computer Applications, 2016.

[3] "A Vision-Based Approach for Virtual Mouse Control Using Hand Gestures" by S. S. Abdallah, M. E. Mohammed, and A. E. Hassanien. Journal of Ambient Intelligence and Humanized Computing, 2019.

[4] "Virtual Mouse Control Using Hand Gesture Recognition" by K. L. Chawngthu, P. Lalthanmawia, and H. Lalrinawma. International Journal of Scientific & Engineering Research, 2018.

[5] "Hand Gesture Recognition for Virtual Mouse Control" by H. M. Al-Fahhad, H. T. Al-Hassani, and S. S. Al-Kharusi. International Journal of Computer Science Issues, 2018