International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

HAND GESTURE CONTROLLED VIRTUAL MOUSE USING OPENCV,MEDIAPIPE IN PYTHON

Thirugnanaskandhan S, Jashwanth R, Jayavarshan S, Chandru M

[1]Student, Dept. of Computer Science and Engineering, Anna University, IN

[2]Student, Dept. of Computer Technology, Anna University, IN

[3]*Student, Dept. of* Computer Technology, *Anna University, IN*

[4]*Student, Dept. of* Computer Technology, *Anna University, IN*

Abstract - *Hand gesture recognition offers a natural, touchless method for controlling digital devices, enhancing accessibility and user experience. This project implements a virtual mouse using Python, OpenCV, and MediaPipe to track hand movements through a live video feed, enabling real-time actions like movement, clicks, and screenshots. Leveraging MediaPipe's pre-trained hand landmark models, the system ensures accurate gesture detection, providing responsive, hands-free interaction for users with limited mobility or in touch-restricted environments. With applications in virtual and augmented reality, gaming, and remote control, this project highlights the potential of computer vision and machine learning to deliver efficient, non-invasive human-computer interfaces.*

Key Words: *Hand Gesture Control, Virtual Mouse, OpenCV, MediaPipe, Python.*

1. INTRODUCTION

Human-computer interaction (HCI) has transformed significantly with technological advancements, creating innovative ways to interact with digital devices. Among these
advancements, touchless interfaces have emerged as an appealing alternative to traditional input devices like keyboards and mice, especially in environments where physical contact is impractical or undesirable. This project introduces a virtual mouse system operated through
hand gestures, utilizing OpenCV and MediaPipe in Python to interpret real-time hand movements. By enabling touchless interaction, this system opens new possibilities in fields like
healthcare, virtual reality, and accessibility.

This project introduces an innovative hand gesture-controlled virtual mouse that combines Computer Vision with Machine Learning to enable touchless and intuitive human-computer interaction. Using Python, OpenCV, and MediaPipe, the system employs a live video feed to track hand movements and gestures in real time, performing actions such as cursor control, clicks, and screenshots.

1.1 Background of the Work

Traditional input devices like mice and keyboards can be limiting in environments requiring touchless interaction or for individuals with mobility challenges. While existing gesture-based systems provide some solutions, they often lack real-time responsiveness and precision. Advances in computer vision, particularly through frameworks like OpenCV and MediaPipe, combined with machine learning, offer a promising approach to overcome these challenges, enabling accurate and intuitive gesture recognition for seamless human-computer interaction.

1.2 Motivation and Scope of the Proposed Work

The motivation for this project arises from the increasing demand for touchless, intuitive interaction methods in both accessibility-focused applications and modern computing environments. Traditional input devices can be restrictive in situations requiring hands-free operation or for users with mobility impairments. This project aims to address these challenges by developing a real-time hand gesture-controlled virtual mouse system using computer vision and machine learning.

The proposed system leverages a webcam for live video input, OpenCV for image processing, and MediaPipe's pre-trained hand landmark model for precise gesture detection. It translates hand movements into virtual mouse actions such as cursor control, clicks, and screenshots. The user interface, built using Python, provides real-time visual feedback, enhancing usability and interactivity.

This system offers a responsive, non-invasive, and flexible solution suitable for diverse applications, including virtual and augmented reality, gaming, and remote device control. By promoting accessibility and touchless interaction, the project supports the development of innovative human-computer interfaces and contributes to a future where technology is more inclusive and adaptable.

2. METHODOLOGY

The methodology for this project follows a structured workflow that integrates computer vision, real-time video processing, machine learning models, and user interaction components. Each step is designed to ensure seamless hand gesture recognition, enabling precise virtual mouse control, with actions like movement, clicks, and screenshots being accurately detected and executed in real time.

2.1 System Architecture

The architecture of the proposed system consists of a camera for real-time video input, MediaPipe's pre-trained hand landmark model for gesture recognition, OpenCV for image processing, and a Python-based interface for user interaction. This design enables continuous tracking of hand movements and gestures, allowing for responsive and intuitive virtual mouse control, with seamless integration of all components to ensure accurate real-time functionality, as illustrated in Fig-1.

2.2 Data Acquisition

To enable hand gesture recognition, a live video feed is captured using a webcam or other camera device. The video frames are processed in real time using OpenCV, and MediaPipe's pre-trained hand landmark models identify key hand features and gestures. The system continuously tracks hand movements and converts detected gestures into corresponding virtual mouse actions. This real-time processing ensures responsiveness, while the use of efficient algorithms minimizes computational load, enabling smooth and accurate gesture-based interactions.

2.3 Gesture Recognition Model

The gesture recognition component leverages MediaPipe's pre-trained hand landmark model, which is highly effective for real-time hand tracking and feature extraction. The model identifies 21 key points on the hand, enabling precise recognition of gestures. These gestures are mapped to virtual mouse actions such as cursor movement, clicks, and screenshots. The system's design ensures accurate detection of subtle hand movements, providing a seamless and intuitive user experience while maintaining high responsiveness and reliability for effective interaction.

2.4 User Interface

The user interface, developed using a Python-based GUI framework, serves as the primary interaction point for users. It provides a real-time display of the camera feed, highlights detected hand gestures, and maps them to virtual mouse actions such as cursor movement, clicks, and screenshots. The interface ensures ease of use, offering visual feedback to confirm gesture recognition and executed commands. This intuitive design enhances accessibility, allowing users to control their devices seamlessly without the need for physical input devices.

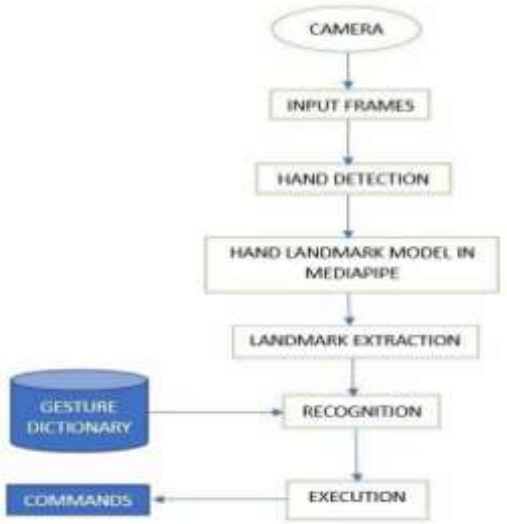

Fig -1- Flowchart

3. CONCLUSIONS

This project introduces a hand gesture-controlled virtual mouse system, leveraging computer vision and machine learning to provide an innovative, touchless method of human-computer interaction. The system effectively integrates real-time video processing with gesture recognition to achieve accurate and responsive control. Key results highlight its precision in gesture detection, seamless execution of virtual mouse actions, and ease of use through an intuitive user interface. This approach enhances accessibility, promotes hands-free interaction, and opens new possibilities for applications in fields such as gaming, virtual reality, and remote device management, contributing to the evolution of intuitive and inclusive technology solutions.

Suggestions for Future Work

1. **Expanding Gesture Recognition Capabilities**: Training the system on a wider variety of hand gestures and user profiles could improve its accuracy and adaptability for different users and environments.
2. **Real-time Feedback and Customization**: Implementing a feature that allows users to customize gesture-to-action mappings could further enhance the system's flexibility and usability.
3. **Cross-Platform Support**: Expanding the system to support various devices and platforms, such as smartphones or smart TVs, would increase its applicability across different use cases.

REFERENCES

[1] Alper, M. A., & Kara, B. (2020). Real-time hand gesture recognition for human-computer interaction: A comprehensive survey. Journal of Ambient Intelligence and Humanized Computing, 11(4), 1415-1440. https://doi.org/10.1007/s12652-019-01419-8

[2] Bhuvaneswari, D., & Vasanthi, T. (2020). A novel approach for hand gesture recognition using deep learning techniques. Journal of King Saud University - Computer and Information Sciences. https://doi.org/10.1016/j.jksuci.2020.07.009

[3] Borkar, R., & Bhatia, S. (2021). Hand gesture recognition using computer vision and deep learning. International Journal of Recent Technology and Engineering, 9(1), 3403-3407. https://doi.org/10.35940/ijrte.A1031.1091219

[4] Chen, C., Xu, Z., & Liu, W. (2020). A robust hand gesture recognition method based on improved deep learning. Sensors, 20(17), 4912. https://doi.org/10.3390/s20174912

[5] Dehghani, M., & Asl, B. S. (2020). A survey on hand gesture recognition systems: Analysis, challenges, and future directions. Artificial Intelligence Review, 53(3), 1945-1965. https://doi.org/10.1007/s10462-019-09794-2

[6] 6. Dorr, M., & Dreiling, A. (2021). Hand gesture recognition for real-time human-computer interaction. Journal of Real-Time Image Processing, 18(4), 1201-1213. https://doi.org/10.1007/s11554-020-00989-6

[7] Fu, Y., Huang, J., & Zhang, D. (2019). Hand gesture recognition using CNN with temporal information. Expert Systems with Applications, 117, 45-54. https://doi.org/10.1016/j.eswa.2018.09.007

[8] Gopikrishnan, K., & Bhargavi, G. (2020). Gesture recognition using OpenCV and Python for human-computer interaction. International Journal of Computer Applications, 975, 1-7. https://doi.org/10.5120/ijca2020920225

[9] Guo, C., Yang, H., & Li, X. (2021). A review of hand gesture recognition methods based on deep learning. International Journal of Information Technology, 13(1), 195-206. https://doi.org/10.1007/s41870-020-00403-6

[10] 10.Hossain, M. S., & Goni, M. S. (2021). A real-time hand gesture recognition system using Mediapipe and OpenCV. International Journal of Computer Applications, 975, 12-17. https://doi.org/10.5120/ijca2021921206

[11] Hu, Y., Liu, C., & Wu, L. (2019). Hand gesture recognition with depth images for human-computer interaction. Multimedia Tools and Applications, 78(8), 11585-11602.

[12] Kalita, A., & Tiwari, A. (2020). A survey on real-time hand gesture recognition techniques. Journal of Computer Virology and Hacking Techniques, 16(2), 159-171. https://doi.org/10.1007/s11416-019-00350-y

[13] Kaur, M., & Ranjan, P. (2021). A study on hand gesture recognition using deep learning techniques. Journal of Artificial Intelligence and Soft Computing Research, 11(2), 125-133. https://doi.org/10.21595/jaisc.2021.22237

[14] Khan, S. A., & Iqbal, M. (2021). Real-time hand gesture recognition using OpenCV and Python. International Journal of Advanced Computer Science and Applications, 12(4),120-126. https://doi.org/10.14569/IJACSA.2021.0120416