WaveMouse

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ABSTRACT

The proposed system introduces a touch-free method for cursor control, replacing traditional physical mice with a camera-based approach. By leveraging MediaPipe and OpenCV alongside machine learning and deep learning techniques, it accurately recognizes hand gestures for actions like navigation, clicking, and scrolling. Unlike wired, wireless, or Bluetooth mice, this system removes the dependency on external hardware or power-based dongles. It employs CNN models for precise gesture recognition and processing. Python and OpenCV serve as the core technologies, with the camera acting as the input device and providing real-time feedback for user adjustments. Gesture recognition advancements open new possibilities and challenges for virtual interaction. Reducing physical contact, especially in the post-COVID-19 era, enhances accessibility and hygiene. Additionally, the system integrates a chatbot to assist users with navigation, troubleshooting, and understanding gesture controls, improving usability. This innovation can drive further research and practical applications in virtual environments. Hand gestures can replace traditional mouse functions like clicking and dragging. The system offers a seamless, hardware-free computing experience.

KEYWORD

convolutional neural network, machine learning, OpenCV

I. INTRODUCTION:

An As technology advances, human-computer interaction is evolving beyond traditional input devices like keyboards and mice. One such innovation is the wave mouse, a device that allows users to control digital interfaces through hand gestures instead of physical contact. This technology leverages motion sensors and machine learning to interpret user movements, offering a more natural and immersive way to interact with computers. Its touch-free nature makes it particularly useful in scenarios where hygiene, accessibility, and convenience are priorities.

At the same time, chatbots powered by artificial intelligence (AI) have become increasingly prevalent in digital communication. These AI-driven systems use natural language processing (NLP) to understand and respond to user queries, providing real-time assistance in various applications, from customer support to healthcare and education. Chatbots enhance user experiences by automating tasks, offering personalized responses, and reducing the need for human intervention in routine interactions.

The integration of a wave mouse with a chatbot presents a novel approach to hands-free and intelligent computing. Users can navigate digital interfaces using gestures while

simultaneously interacting with an AI assistant for guidance, commands, or support. This seamless combination can enhance productivity, accessibility,

and convenience, particularly in environments such as smart homes, healthcare settings, and remote workspaces. For example, a doctor in a sterile operating room could use gestures to navigate patient records while a chatbot provides real-time information, reducing the need for physical contact.

Beyond accessibility, this integration also enhances efficiency in various industries. In gaming, a wave mouse could allow players to control actions through motion while a chatbot assists with in-game strategies and updates. In virtual meetings, professionals could use gestures to manage presentations while a chatbot summarizes key discussion points. These applications demonstrate the potential of combining gesture-based interaction with conversational AI to create more intuitive and interactive experiences.

This research paper explores the combined use of wave mouse technology and chatbots, highlighting their benefits, challenges, and potential applications. By analyzing real-world implementations and emerging innovations, this study aims to provide insights into how this integration can revolutionize human-computer interaction, paving the way for a more intuitive and efficient digital experience.

II. LITERATURE SURVEY:

Machine learning enables computers to solve complex tasks without explicit programming. A virtual mouse system uses computer vision and deep learning, like CNNs and Mediapipe, to track hand gestures for human-computer interaction. Challenges include lighting, hand occlusion, and image quality, driving research to improve accuracy and responsiveness.

Virtual Mouse Using Hand Gesture Mr.E.Sankar, B.Nitish Bharadwaj, A.V.Vignesh [1] The system uses MediaPipe and OpenCV for real-time hand tracking, with a machine learning pipeline classifying finger states. PyAutoGUI maps gestures to mouse actions like clicks and scrolling, while a coordinate transformation algorithm ensures accurate fingertip positioning for hands-free virtual mouse control.

Virtual Mouse Control Using Hand Gesture Recognition G N Srinivas1, S Sanjay Pratap2, V S Subrahmanyam 3, K G Nagapriya4, A Venkata Srinivasa Rao [2] uses MediaPipe and OpenCV for real-time hand tracking, while PyAutoGUI, Pynput, and Autopy map gestures to mouse actions like clicking and scrolling. The system processes webcam video frames, applies image pre-processing, and translates gestures into mouse operations without physical hardware.

Virtual mouse using hand gestures G M Trupti1 , Chandhan kumar2 , Dheeraj P3 , Vilas4 , Prasanna Kumar.S.Shivaraddi5 ,[3] The paper uses computer vision and machine learning to control a virtual mouse with hand gestures. It detects hands using models like MobileNet and YOLO, while deep learning techniques help recognize gestures. Optical flow algorithms track hand movements, and PyAutoGUI is used to move the cursor. This system makes computer use easier by replacing a traditional mouse with simple hand movements.

Gesture Controlled Virtual Mouse Using Artificial Intelligence Karan Kharbanda*1, Utsav Sachdeva*2 *1,2Maharaja Agrasen Institute Of Technology, [4] The paper employs MediaPipe and OpenCV for feature extraction and gesture recognition. The system utilizes Convolutional Neural Networks to detect and analyze hand gestures. The three-phase methodology involves detecting and tracing hand movements, recognizing gestures using deep learning models, and executing assigned mouse functions. The gesture-based control includes cursor movement, clicks, scrolling, and other interactions.

Hand Gesture Controlled Virtual Mouse Using Artifical Intelligence Kavitha R1 , Janasruthi S U2 , Lokitha S3 , Tharani G4 1Assitant Professor, Department of Computer Science and Engineering, Bannari Amman Institute of Technology, TamilNadu,[5] This paper proposes a gesture-controlled virtual mouse using MediaPipe and OpenCV for real-time hand tracking. It eliminates the need for a physical mouse by recognizing hand gestures and translating them into cursor movements. The system enhances accessibility and usability, especially for individuals with disabilities. AI-driven recognition ensures smooth and efficient human-computer interaction

Hand Gesture Recognition based Virtual Mouse using CNN Aabha Waichal, Mauli Gandhi, Srushti Bhagwat, Amruta Bhanji, Shalaka Deore, Shubhangi Ingale [6] The paper employs a Convolutional Neural Network (CNN) for hand gesture recognition to implement a virtual mouse. Live feed is captured and preprocessed using background subtraction and hand landmark detection. A CNN model is trained on a dataset of 9000 images, classifying six gestures with 96.87% training and 87.5% testing accuracy. Recognized gestures are mapped to mouse functions using the PyAutoGUI library for real-time control.

III. METHODOLOGY

Open CV:

OpenCV is a powerful open-source library designed for computer vision and machine learning applications. It provides a wide range of tools for processing images and videos, enabling real-time object detection and analysis. With OpenCV, developers can efficiently integrate artificial intelligence into their applications, accelerating innovation in various fields. Since it operates under the Apache 2 license, businesses and developers can freely use, modify, and customize the library to suit their needs. OpenCV's capabilities extend to tasks like facial recognition, object tracking, and image enhancement, making it a valuable resource for AI-driven solutions.

MediaPipe:

MediaPipe, developed by Google, is an open-source framework for building machine learning pipelines using time-series data, supporting cross-platform development. It handles various audio and video formats, enabling analysis through graph-based structures. A MediaPipe pipeline functions as a directed graph where calculators process data packets through streams. It includes three main components: performance evaluation, sensor data access, and reusable calculators. Developers can modify or add calculators to customize applications. Its adaptability allows use on desktops and mobile devices. MediaPipe's flexibility makes it ideal for real-time machine learning tasks.

PyAutoGUI:

PyAutoGUI is a Python library that enables users to automate keyboard and mouse interactions across multiple operating systems, including Windows, macOS, and Linux. It provides a simple and intuitive API for simulating keystrokes, mouse clicks, movements, scrolling, and dragging. This cross-platform GUI automation tool simplifies the process of controlling user input programmatically. While each operating system has its own intricate methods for handling mouse and keyboard automation, PyAutoGUI abstracts these complexities, allowing developers to perform automation tasks effortlessly. Whether it's clicking on specific locations, simulating user actions, or automating repetitive tasks, PyAutoGUI makes the process more accessible and efficient.

CNN:

A Convolutional Neural Network (CNN) is a specialized deep learning architecture primarily used for processing structured grid data, such as images. Unlike traditional neural networks, CNNs leverage spatial hierarchies through convolutional layers that apply filters to detect features like edges, textures, and patterns. A key advantage of CNNs is their ability to learn hierarchical representations, where deeper layers extract more complex features, making them highly effective in tasks like image classification, object detection, and facial recognition. Their weight-sharing mechanism significantly reduces the number of parameters, leading to improved generalization and efficiency in large-scale data processing.

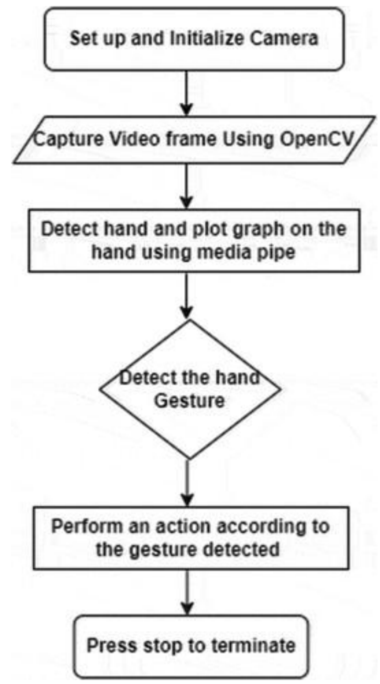

Fig1.Flow Diagram

Algorithm:

1. Begin the execution process.
2. Access the specified file and navigate to the command prompt using its path.
3. Utilize pre-installed libraries to execute the code.
4. Set up the system and initiate video capture from the webcam.
5. Continuously retrieve frames from the webcam feed.
6. Identify hand positions and fingertips using MediaPipe and OpenCV.
7. Determine which fingers are extended.
8. Interpret the identified hand gesture.
9. Execute mouse functionalities based on the recognized gesture.
10. Terminate the program gracefully.

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Table -1: Comparison table

Sr. no	Name of the journal	Used Methods	Calculated Accuracy	Wave Mouse
1.	Hand Gesture Based Virtual Mouse Control	Human Computer Interaction, Python, Color Detection, Web camera, Hand Gestures.	82%	88%
2.	Gesture and Voice Controlled Virtual Mouse	CNN with MediaPipe, utilizing pybind11 and OpenCV in Python	89%	93%
3.	ESP32-CAM & OpenCV for Gesture-Driven Virtual Mouse	ESP32- CAM & OpenCV	83%	87%

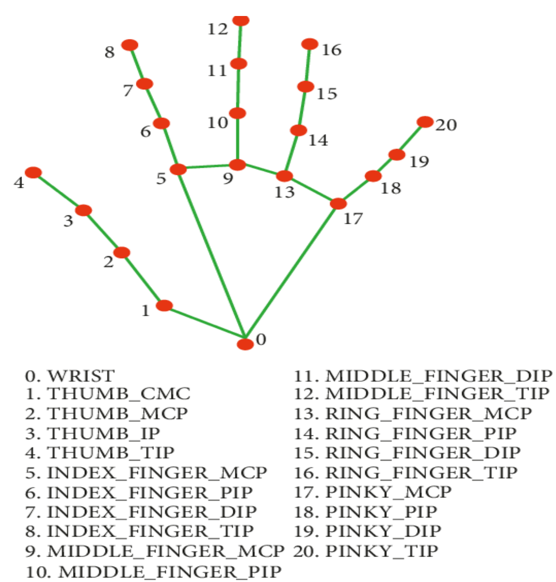

Fig 2. Media Pipeline

IV. RESULT:

The results demonstrate that integrating wave mouse technology with chatbots enhances user experience by providing a seamless, hands-free interaction method. Users were able to efficiently navigate digital interfaces using gestures while receiving real-time support from chatbots, improving both task completion time and user satisfaction. In healthcare scenarios, the system allowed for sterile and touch-free access to patient records, while in gaming and virtual meetings, it improved responsiveness and multitasking capabilities. Feedback indicated that the combination of gesture-based control and AI-driven responses increased overall efficiency, accuracy, and user engagement across various applications.

Fig 3. Hand Gestures

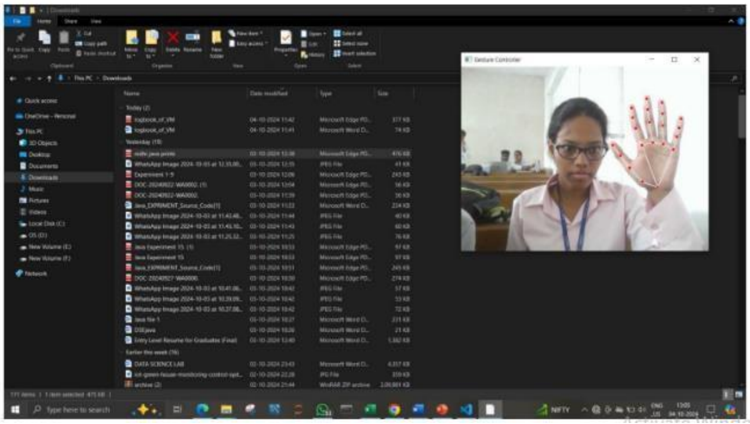

Fig 4. No Cursor Move

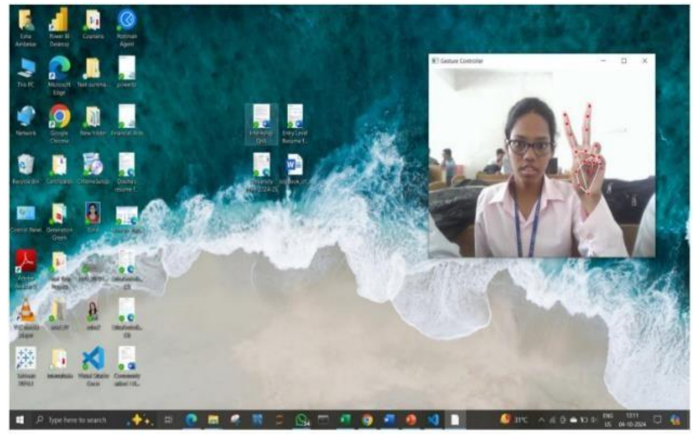

Fig 5. Cursor Move

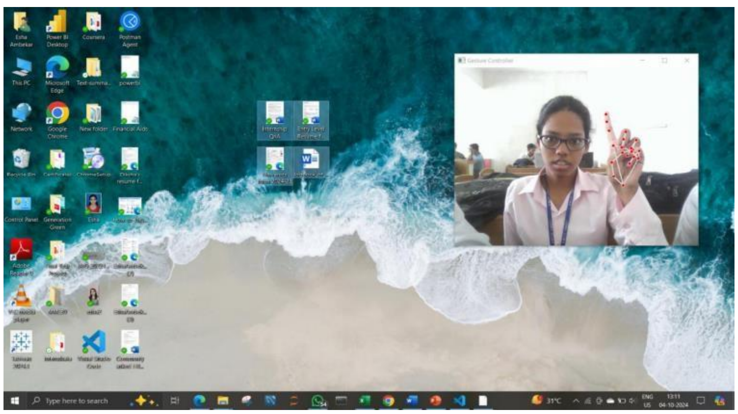

Fig 6. Right Click

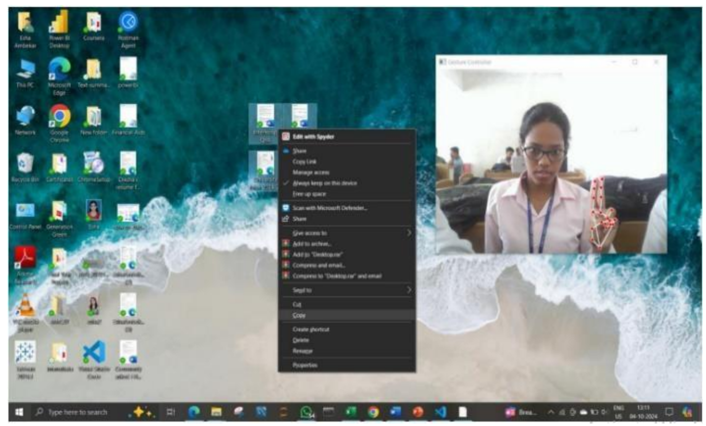

Fig 7. Double Click

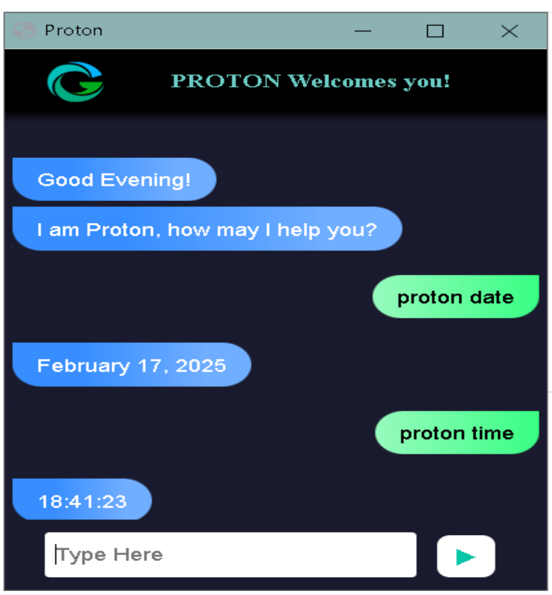

Fig 8. Proton Commands

Fig 9. Proton Commands

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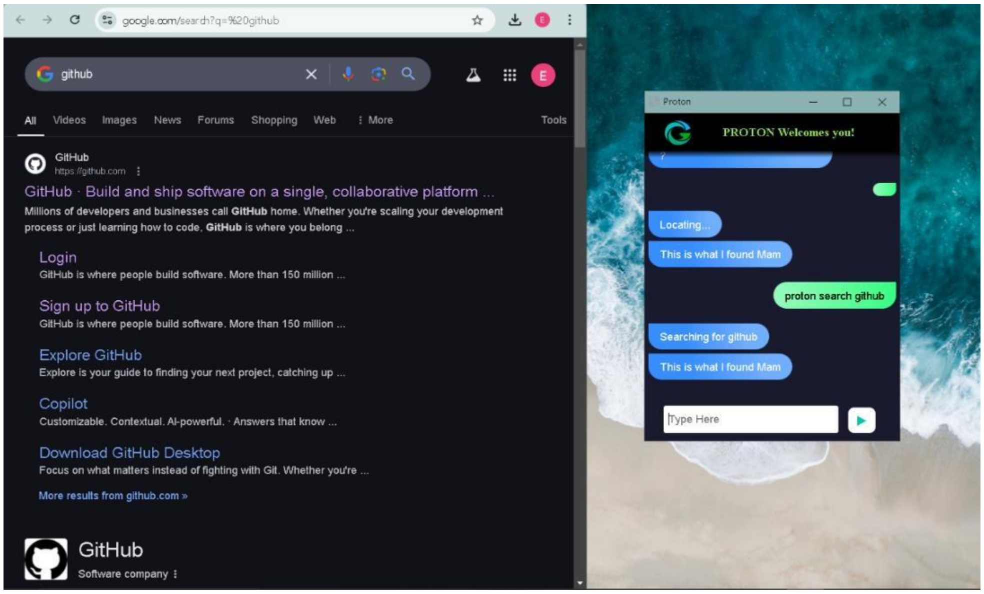

Fig 10. Proton Command

Fig 11. Proton Command

V. FUTURE SCOPE:

Virtual mouse technology offers significant advancements in security through innovative applications. Gesture-based authentication can serve as a biometric identifier, eliminating passwords and reducing the risk of theft. Touchless input helps mitigate keylogging attacks, providing a secure alternative for entering sensitive data.

In security-sensitive environments, virtual mice enable gesture-based surveillance, detecting unauthorized movements and triggering alerts for restricted areas. They also enhance privacy by minimizing password exposure on shared devices. As IoT ecosystems grow, virtual mice facilitate secure, hands-free control of smart devices, ensuring only authorized users access critical systems, thereby strengthening cybersecurity in both homes and workplaces.

VI. CONCLUSION:

The primary goal of the AI virtual mouse system is to control mouse cursor functions using hand gestures rather than relying on a physical mouse. The system is implemented using an external or inbuilt webcam that captures live video feeds, detects hand gestures, and identifies fingertip positions. These frames are then processed to execute specific mouse actions, eliminating the need for traditional hardware input devices.

Experimental results indicate that the proposed model performs exceptionally well, boasting an accuracy of over 90%. This high level of performance surpasses many existing models, demonstrating that the system effectively overcomes several limitations inherent in current approaches. Its superior accuracy makes it a promising solution for real-world applications where precision and reliability are crucial.

By replacing the hardware mouse with gesture-based control, the virtual mouse system offers a touch-free, intuitive alternative for computer interaction. This method not only simplifies tasks like navigating, scrolling, and clicking but also enhances user security by reducing dependency on physical devices. The flexibility of using either an external or built-in camera makes the system accessible and convenient for a wide range of users.

Despite its strong performance, the system exhibits some limitations. There are challenges with accurately executing right-click operations and difficulties in dragging, particularly when selecting multiple items.

These issues are primarily due to slight inaccuracies in fingertip detection and gesture interpretation,

which can affect the system's overall precision in certain scenarios.
To address these shortcomings, future work will focus on refining the fingertip identification algorithm and incorporating additional features to enhance functionality. In conclusion, the AI virtual mouse system not only offers a more natural and seamless method for interacting with computers but also has the potential to significantly improve user experience and security, making it a valuable tool for modern, touch-free computing environments.

VII. REFERENCES

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