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GESTURE-DRIVEN AND VOICE ASSISTANCE BASED VIRTUAL MOUSE

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ABSTRACT

This project introduces a gesture-driven virtual mouse system with voice control, offering a more natural and intuitive way to interact with computers. Using a standard webcam and microphone, it captures hand movements and voice commands to perform tasks like clicking, scrolling, and dragging. This dual-mode interaction improves accessibility, especially for users with physical limitations, and enhances the overall user experience by reducing reliance on traditional input devices like the mouse and keyboard. It also promotes privacy by minimizing physical contact. Cost-effective and versatile, the system is ideal for home, office, and assistive tech applications, aiming to make computing more inclusive, efficient, and user-friendly.

Keywords: Gesture Recognition, Voice Control, Human-Computer Interaction, Accessibility, Virtual Mouse, Hands-Free Computing.

I. INTRODUCTION

As human-computer interaction continues to evolve, there is a growing demand for more natural and intuitive ways to control devices. While traditional tools like the mouse and keyboard remain useful, they can feel limiting—particularly for users who require hands-free or more fluid interaction methods.

This project focuses on developing a gesture-controlled virtual mouse system that utilizes a standard webcam and microphone to understand hand gestures and voice commands. With gesture recognition, users can interact with their computers without needing to touch any devices, and adding voice control provides even greater flexibility and ease of use.

Combining both input methods not only makes the system more user-friendly but also enhances accessibility for individuals with physical challenges. Additionally, it minimizes the need for physical contact, supporting better hygiene and privacy. Designed to be affordable and easy to set up, this system is suitable for various environments—including homes, offices, and educational spaces. Overall, it aims to make everyday computing more efficient, accessible, and centered around the user's needs.

II. METHODOLOGY

The hand gesture and voice-controlled system uses a structured approach for development and integration with AI tools.

1. **Tool and Library Selection**: Python is chosen for its simplicity and rich support for AI, computer vision, and voice recognition.
2. **Gesture Detection**: OpenCV captures and tracks hand movements in real-time using image processing techniques.
3. **Model Training**: TensorFlow or PyTorch helps in building and training neural networks for recognizing gestures.
4. **Voice Processing**: Google Speech API or CMU Sphinx converts voice commands into text for hands-free operation.
5. **Hardware Setup**: A webcam detects gestures, and a microphone handles voice input, all managed on a laptop or PC.
6. **Development and Testing**: PyCharm or VS Code is used for writing code, while Jupyter Notebook supports model prototyping and testing.

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III. SYSTEM DIAGRAM

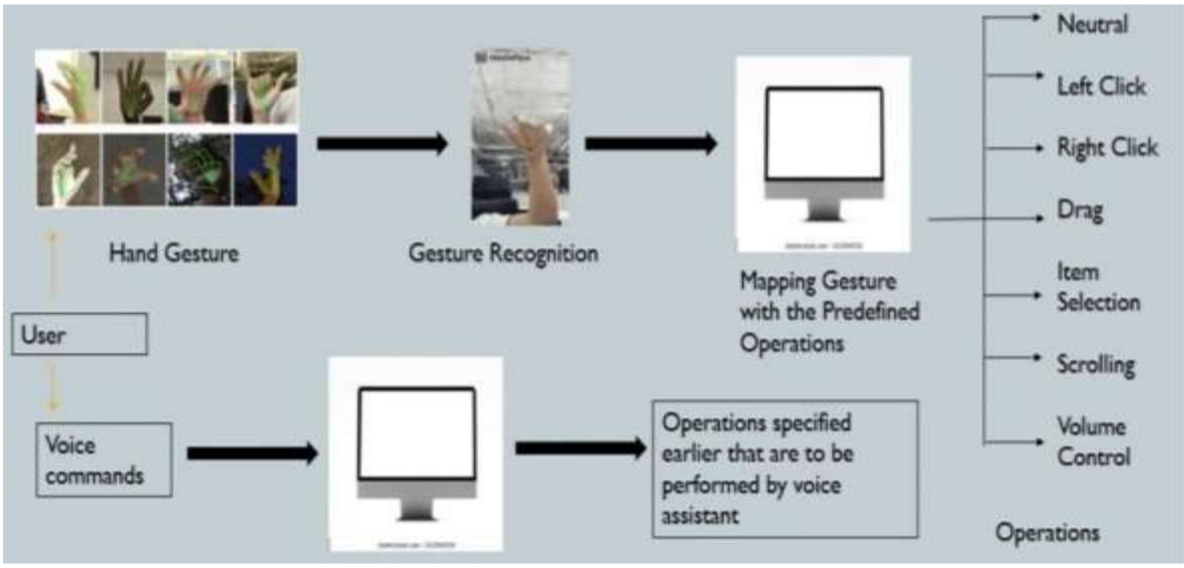

Figure 1: Architectural Block Diagram

IV. RESULTS AND DISCUSSION

Gesture Recognition Accuracy

Test and Outcome: Using MediaPipe with a standard webcam, the system successfully tracked hand landmarks and interpreted gestures like click, scroll, and move. Testing was conducted in various lighting conditions to assess stability and responsiveness.

Performance: On average, the gesture recognition system responded within 0.3 seconds, providing near real-time control. This responsiveness allowed users to smoothly navigate the system without noticeable lag. **Analysis:** The system performed best in well-lit environments with clear hand visibility. In low-light or cluttered backgrounds, the accuracy decreased slightly. Ensuring a plain background and proper lighting helped improve detection consistency.

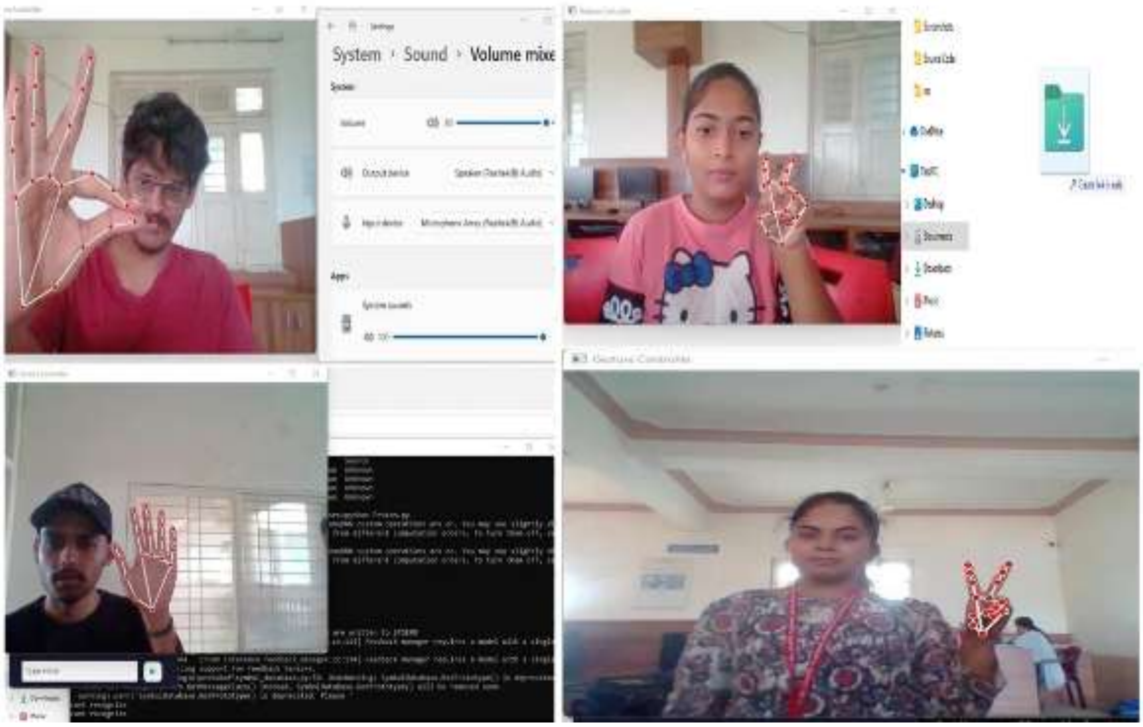

Figure 2: Gesture Recognition and showing result

Voice Command Responsiveness

Test and Outcome: The system used Google Speech Recognition API to process commands such as "open", "click", and "scroll". The microphone captured voice inputs effectively from a typical desktop range. **Performance:** The average voice response time was around 1–1.5 seconds, depending on internet speed and background noise levels. Commands were accurately recognized in quiet environments with clear speech.

Limitations and Areas for Improvement

Limitations: Voice command recognition struggled in noisy settings and with unclear pronunciation. The gesture system also faced occasional misclassification of gestures due to rapid hand movements. **Potential Improvements:** Future improvements could include adding a noise reduction filter for voice commands, optimizing gesture sensitivity, and offering gesture customization options for better user adaptation.

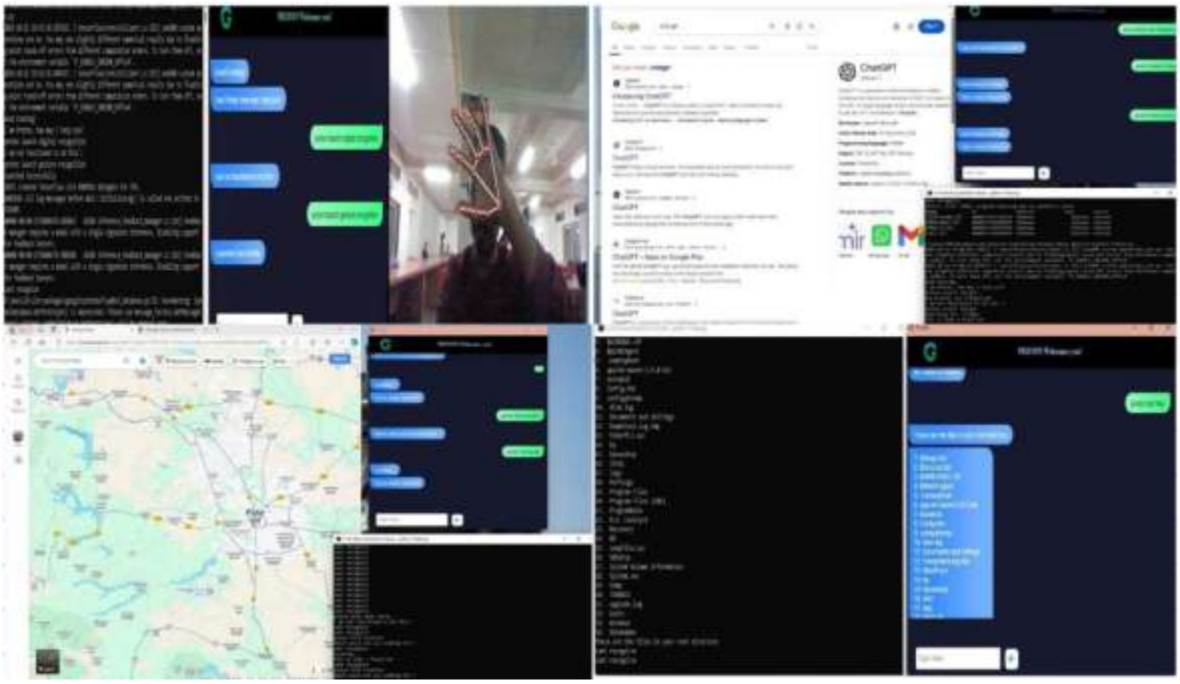

Figure 3: Voice Commands and showing result

V. CONCLUSION

The Gesture-Driven and Voice Assistance Based Virtual Mouse makes device control easier and more accessible. It uses simple hand movements and voice commands, helping users interact without touch—ideal for smart homes, healthcare, and more. The system runs on MediaPipe, which tracks hand gestures in real time and supports different devices. It also works well with voice assistants, allowing multiple ways to control actions. Users found the system smooth and easy to use. Future updates will improve gesture variety and voice accuracy to support more people in more situations. This project successfully demonstrates the integration of gesture recognition and voice control to create a hands-free interaction system that is responsive, inclusive, and adaptable across various environments.

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