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Hand Gesture Recognition without using Mouse

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ABSTRACT: The abstract introduces a hand gesture-controlled virtual mouse system using AI, providing an alternative interface for users with traditional input challenges. The system employs a camera and AI algorithms to recognize and translate hand gestures into virtual mouse movements. It is scalable, adaptable, and supports dynamic/static gestures and voice commands without additional hardware. Implemented with ML and Computer Vision, the system enhances accessibility, offering potential applications in hazardous environments and as an alternative to traditional hardware mice. It supports dynamic/static hand gestures and voice commands for controlling input operations, and its implementation involves machine learning and Computer Vision algorithms, specifically Convolutional Neural Networks (CNN) and the mediapipe framework. s innovative system serves as an alternative interface for individuals facing challenges with conventional mouse or keyboard usage. The technology employs a camera to capture and process images of the user's hand, utilizing AI algorithms trained on a dataset of hand .

KEYWORDS: Hand gesture recognition, Virtual mouse, Computer vision, MediaPipe, Accessibility technology.

I. INTRODUCTION

The introduction of hand gesture-controlled virtual mouse technology using AI enables users to navigate their computer mouse through hand gestures, eliminating the need for a physical mouse. This technology utilizes a camera-based vision system to track hand movements and execute mouse functions on the computer screen. Video input from a camera captures the user's hand movements, and computer vision algorithms analyze this data to identify and track hand movements. Machine learning models, trained to recognize specific gestures like pointing or swiping, translate these gestures into corresponding mouse movements. This cutting-edge technology offers numerous advantages, including enhanced accessibility and a more natural and intuitive user experience. It proves especially useful in situations where a physical mouse or touchpad is impractical or unavailable. Hand gestures replace traditional control mechanisms, providing a more intuitive and natural way to interact with computers. The applications of this technology span across gaming, virtual reality, and accessibility, making it an innovative and valuable addition to human-computer interaction.

II. LITERATURE SURVEY

Previous research highlights diverse applications of gesture recognition for human-computer interaction. Systems such as Rotake and Karmore's intelligent traffic control and Zhang and Yan's microcontroller-based systems demonstrate real-time interaction capabilities. Additionally, Haloi and Jayagopi’s robust lane detection system. These studies underscore the feasibility and potential of gesture-based interfaces in various domains.

Relevance to current Research

A notable study by H. M. G. A. Rahman et al. (2018) introduced a vision-based gesture recognition system that leveraged machine learning algorithms to accurately identify hand gestures. Their work highlighted the effectiveness of using convolutional neural networks (CNNs) for feature extraction and classification of hand gestures, marking a shift towards deep learning methodologies in this domain.

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Relevance to current Research

Another significant contribution came from M. H. A. S. Ahmad and Z. M. Z. Mohd (2020), who proposed a real-time hand gesture recognition system using a webcam and OpenCV. Their system demonstrated the feasibility of real-time processing for gesture recognition, allowing for the development of applications such as virtual mouse control and gesture-based commands.

Relevance to current Research

Moreover, research by K. J. Lee et al. (2021) focused on enhancing the robustness of gesture recognition systems in varying lighting conditions and backgrounds. They implemented advanced image processing techniques to improve hand detection and recognition accuracy, contributing to the practical applicability of gesture recognition systems in everyday environments.

III. SOFTWARE COMPONENTS

Mediapipe

Google introduced the open-source MediaPipe framework to facilitate the development of cross-platform, real-time computer vision applications. This framework provides a variety of pre-made tools and components for processing and analyzing video and audio streams, including object detection, pose estimation, hand tracking, and facial recognition. MediaPipe allows developers to quickly build complex pipelines that integrate multiple algorithms, executing in real-time on various hardware platforms like CPUs, GPUs, and specialized accelerators such as Google's Edge TPU. The framework also interfaces with popular machine learning libraries like TensorFlow and TensorFlow and PyTorch and supports multiple programming languages, including C++, Python, and Java. Key features of the MediaPipe framework for computer vision and machine learning tasks include:

1. Video and Audio Processing: MediaPipe offers tools for real-time processing and analysis of video and audio streams, covering functionalities such as video decoding, filtering, segmentation, and synchronization

2. Facial Recognition: The framework can detect and track facial landmarks, including eyes, nose, mouth, and eyebrows, in real-time. This feature is valuable for applications such as facial recognition, emotion detection, and augmented reality.

3. Hand Tracking: MediaPipe enables real-time tracking of hand movements, allowing for hand gesture recognition and interaction with virtual objects.

4. Object Detection: The framework can detect and track objects in real-time using machine learning models, benefiting applications such as augmented reality, robotics, and surveillance.

5. Pose Estimation: MediaPipe is capable of estimating the poses of human bodies in real-time, supporting applications like fitness tracking, sports analysis, and augmented reality

Implementation Methodology

The implementation and release of AV requires it to meet all safety standards [2]. Our suggestion to solve this issue is to introduce the concept of safe state that is whenever AV faces critical scenarios move it to a safe state designed with the help of infrastructure. Make sure that there is a possibility of movement to such states provided by the infrastructure (Like the third line concept of Autobahns in Euro rail systems).

The safe state concept will enable the automobile makers to create AV and prove that it can be practically released into real world scenarios. Details will be Anoop Thomas et al. / Procedia Computer Science 115 (2017) 375–382 381 Anoop Thomas,Juergen Trost/ Procedia Computer Science 00 (2017) 000–000 7 developed during the planned initiative by Aalen University (Germany), Rajagiri School of Engineering & Technology & Kerala Technical University. The release issue or to prove that AV can deal with all possible environment scenarios is something which is hugely researched all around the world. Once the safe state is implemented at the infrastructure level the test case scenarios can be relatively reduced as lots of test cases can be grouped together and the proof required will be movement to safe state rather than any action. Along with this we have the kill switch option which is an ability to externally move the vehicle to safe state, so altogether both these features will make the autonomous system a very safe and provable technology. The European Union has already made legislations to include a kill switch option in all systems which use artificial intelligence [13]. The major technical advantage of this method of implementation is that

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for all the safety critical cases instead of going back to the driver in the case of driver assisted autonomous vehicles, it will look for an infrastructure setting which will help the vehicle to move to a safe state. The safe state can be defined and build in such a way that it will work when anything and everything of AV fail.

Capturing the Video and Processing

The capturing of the frame was done with the AI virtual mouse system until the program termination.Then the video captured has to be processed to find the hands in the frame in each set. The processing takes places is it converts the BRG images into RGB images,which can be performed with the below code, image = cv2.cvtColor(cv2.flip(image, 1), cv2.COLOR_BGR2RGB) image.flags.writeable = False results = hands.process(image) This code is used to flip the image in the horizontal direction then the resultant image is converted from the BRG scale to RGB scaled image.

OPEN CV

OpenCV provides bindings for several programming languages such as Python, Java, and MATLAB and is primarily written in C++. Its applications span various fields like robotics, self-driving cars, augmented reality (AR), and medical image analysis. Key features and operations of OpenCV include:

Loading and Preprocessing Image/Video: OpenCV can load images or videos from diverse sources like files, cameras, or network streams. Preprocessing involves applying filters or transforming images, such as converting color images to grayscale. Feature Detection and Description: OpenCV is capable of detecting and extracting features like edges, corners, and blobs from images or videos.

These features can be used for object identification or motion tracking, and OpenCV provides algorithms for feature description. Object Detection and Recognition: OpenCV facilitates object detection and recognition in images or videos using various techniques like template matching, Haar cascades, or deep learning-based methods. Tracking: OpenCV supports object tracking, enabling the monitoring of an object's movement over consecutive frames or images

The Camera Used in the AI Virtual Mouse System The proposed AI virtual mouse system is based on the frames that have been captured by the webcam in a laptop or PC. By using the Python computer vision library OpenCV, the video capture object is created and the web camera will start capturing video.

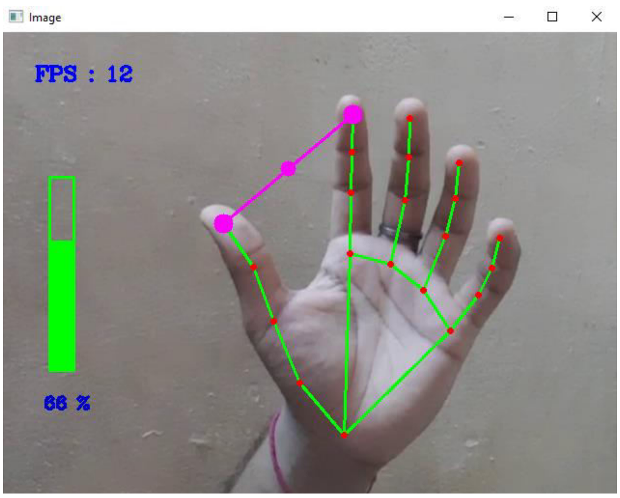

Fig 4. Volume decreasing

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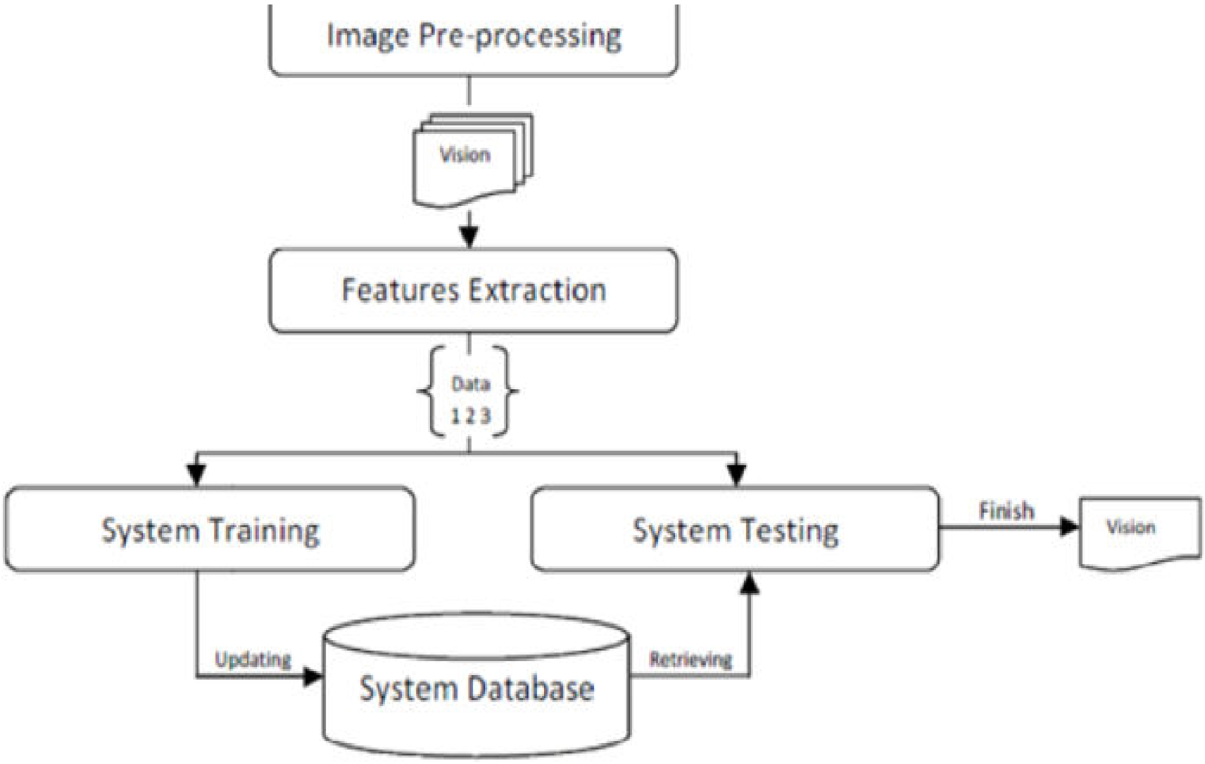

IV. CONCLUSION

The AI-driven virtual mouse system provides a practical, adaptable, and accessible alternative to traditional hardware. Its hand gesture and voice command compatibility expand its usability across diverse demographics, establishing a promising approach to human-computer interaction. This innovative system represents a step forward in the realm of accessible technology, offering both usability and functionality.

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