Controlling laptop working with hand gestures

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Abstract

In Human-Computer Interaction (HCI), the traditional mouse, a remarkable invention in computer technology, encounters limitations in modern Bluetooth and wireless models due to battery dependence and PC connectivity via dongles. These challenges are tackled by the proposed AI-driven gesture-based virtual mouse. By capturing hand movements via a camera, this innovation employs gestures as a potent communication mode. It allows the computer to replicate functions like left and right-click, scrolling, and cursor control without a physical mouse, aiding in COVID-19 prevention and reducing bias in computer control. This system, integrated with voice commands and utilizing ML and Computer Vision algorithms, eliminates extra hardware requirements, enhancing accessibility and user interaction in diverse environments.

Keywords :- Human Computer Interaction (HCI), Webcam, OpenCV, Mediapipe , CNN, Virtual Mouse.

I. Introduction

Computers have seamlessly integrated into our daily routines, simplifying human-computer interaction (HCI). However, individuals with disabilities face distinct challenges in utilizing these devices effectively. This study introduces a gesture-based AI virtual mouse system, leveraging computer vision to execute mouse tasks using hand movements and fingertip detection. The system's core objective is to replace the conventional mouse with a web or built-in camera, enabling cursor control and scrolling through hand gestures.

Python, along with the OpenCV computer vision library, forms the foundation of the gesture-based AI virtual mouse framework. MediaPipe aids in tracking hand and fingertip positions, while Autopy facilitates window navigation, left and right clicking, and scrolling actions. Notably, the model demonstrates exceptional accuracy and efficacy, particularly on CPU-based systems, extending its practicality to real-world scenarios.

Hand gestures are universally recognized as a potent form of human expression. This project taps into this natural mode of communication, proposing a low-cost USB web camera setup for input. The paper introduces a real-time hand gesture system, incorporating techniques such as preprocessing, background subtraction, and edge detection to achieve effective gesture segmentation. By employing the Python language and OpenCV, the AI virtual mouse system is

crafted, further enhanced by MediaPipe, Pynput, Autopy, and PyAutoGUI packages for precise hand tracking, cursor movement, and diverse operations.

This paper presents a comprehensive approach to bridging accessibility gaps through a gesture-driven AI virtual mouse, ushering in a new era of intuitive human-computer interaction.

II. LITERATURE SURVEY

Existing System

The Virtual Mouse Control System, employing colored fingertip detection and hand gesture recognition, enables cursor manipulation without requiring direct physical contact or sensors. This approach involves identifying vibrant fingertip colors and tracking their movements, with the potential to substitute different hand gestures for colored caps. The system facilitates a range of mouse functions, including scrolling, single and double-clicking on the left side, and more. Diverse arrangements of colored caps cater to various tasks, adapting to different users and lighting conditions. The system's adaptability is demonstrated by adjusting skin tone detection based on the user and environment. By analyzing program output during hand motions, the unused area within the hand's convex hull is approximated. In well-lit settings like offices, where brightness ranges from 500 to 600 lux, colors like Red, Green, and Blue exhibit around 90% detection accuracy. The system overcomes these challenges by incorporating hand gesture recognition technology that detects hand contours, effectively enabling mouse operations through colored fingertips. This system comprises two main methods: finger detection via colored fingertips and gesture recognition. It employs video processing and background subtraction, leveraging colored finger caps for detection, followed by color and circle identification . The recognized gestures trigger various mouse actions. In essence, the Virtual Mouse Control System revolutionizes hands-free cursor manipulation through colored fingertip tracking and hand gesture interpretation, significantly enhancing user interaction and accessibility .

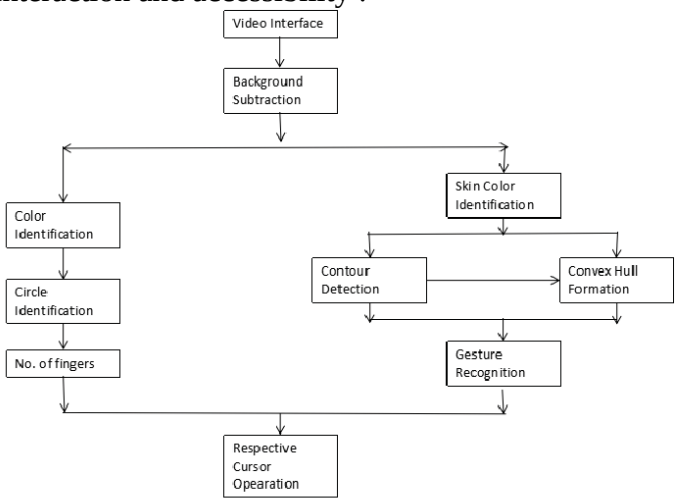

Fig : - Virtual Mouse Control using Colored Fingertips and Hand Gestures Recognition

Proposed System

Creating a hardware-independent virtual mouse eliminates the need for additional equipment and colored fingertip markers. Instead, our approach utilizes the existing web camera on the user's device to capture real-time feeds. The system's workflow commences by initiating the video interface through the device's web camera. Subsequently, the system detects hand gestures, facilitating mouse interaction and executing diverse cursor operations. This virtual mouse solution is characterized by its portability, user-friendliness, and affordability. The system incorporates "Mediapipe" technology, specifically its hand landmark detection functionality. Mediapipe, developed by Google, is a versatile toolkit that empowers applications with AI-driven features such as hand tracking and gesture recognition. This integration enhances the virtual mouse's capabilities and precision, contributing to an improved user experience.

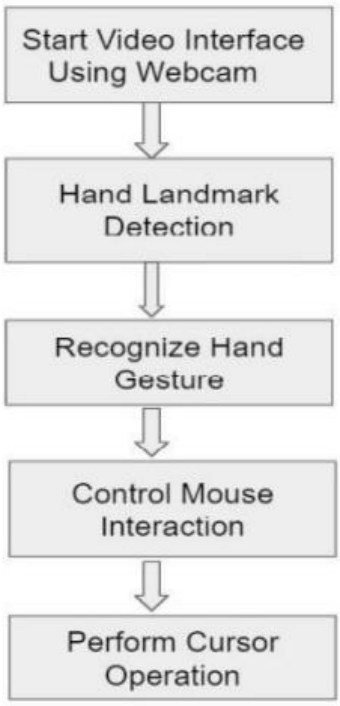

Fig : - Virtual mouse using hand gesture recognition

III. METHODOLOGY

OpenCV :
OpenCV, a Python-based computer vision library, encompasses object detection and image processing algorithms. It's integral for real-time computer vision applications, image/video processing, and tasks like face and object detection.

Mediapipe :
MediaPipe, an open-source Google framework, serves as a versatile tool for machine learning pipelines, particularly for cross-platform development due to its time series data compatibility and multimodal capabilities.

PyAutoGUI :
PyAutoGUI is a Python library for automating tasks by simulating mouse and keyboard inputs. It allows users to create scripts to control and interact with the computer's graphical user interface programmatically.

Capturing the video :-
This AI virtual mouse system utilizes laptop or PC images, employing the Python computer vision tool OpenCV to create a video capture object. A web camera records frames, subsequently processed by the virtual AI system.

Analysing the video for hand gesture :-
The AI virtual mouse system employs a webcam to capture frames throughout the program execution. These images are converted to RGB, facilitating hand identification on a frame-by-frame basis.

Hand recognising Landmarks :-
Employing hand coordinate movement between the webcam and computer window, the AI virtual mouse method facilitates transformative mouse actions. After finger tip and hand recognition, identified fingers for cursor movement can generate a reference box on the screen, enabling observable cursor movements within the window.

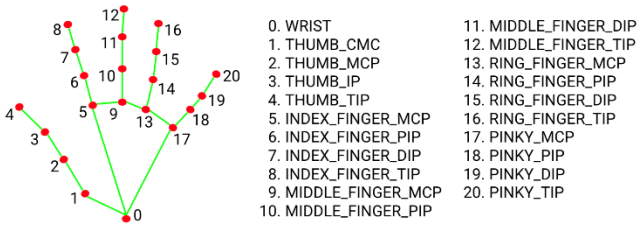

Fig :- Landmarks in Hand

Checking the finger which is up and performing mouse operation :-
For seamless hand coordinate transfer from webcam to full-screen computer window, the AI virtual mouse employs a transformative approach. Once hands are detected and specific finger movements recognized, a rectangular box forms in the camera's region referencing the computer window. This allows easy mouse pointer movement within the window.

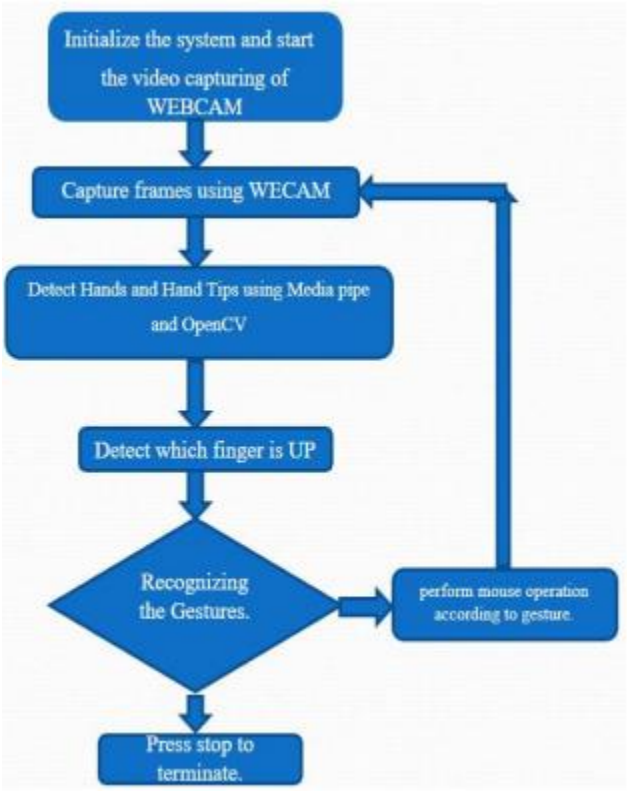

Fig :- The real-time gesture-based virtual mouse system's flowchart

IV. RESULTS

For testing the implementation on a personal computer, we have shown the various gestures that can be used to control the computer mouse

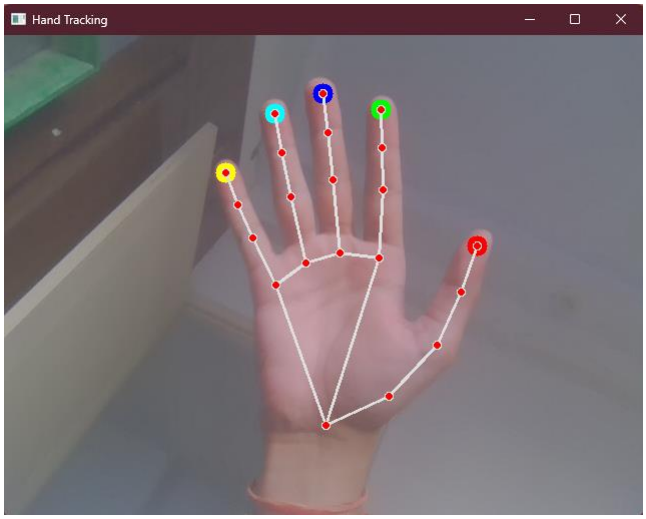

Fig :- Open hand

This shows the open hand with colored finger tips which makes it easier to differentiate different fingertips

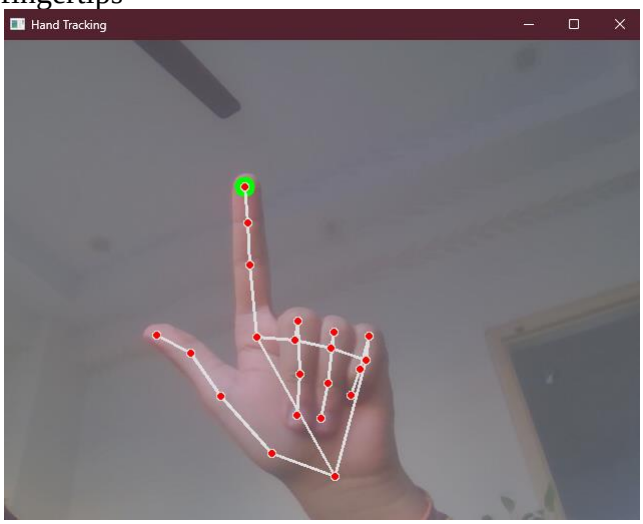

Fig:- index finger

Index finger is being used to move the cursor, hence the that finger is highlighted, movement of the finger is reflected by the relative movement of cursor on the screen

Also if we fold the middle finger, then we can execute left click.

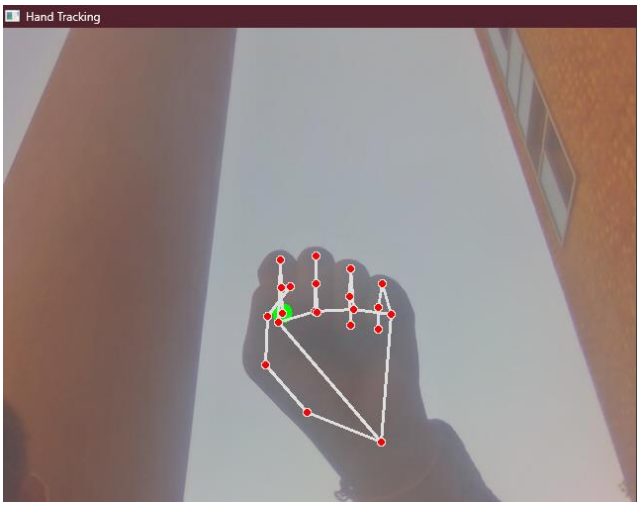

Fig:- closed fist

When there is need to close the application after usage, We can form a closed fist , and that kills and stops the process.

V. Conclusions

In conclusions, the development of a virtual mouse through hand gestures represents an exciting frontier in computer interaction. Leveraging computer vision and machine learning, real-time hand gesture detection and mapping to mouse functions using PyAutoGUI opens up innovative possibilities for users to control applications intuitively. The integration of Mediapipe has streamlined and enhanced hand tracking. This technology has the potential to transform computer interaction into a more natural and instinctive experience. With further refinement, virtual mouse control with hand gestures may become a widely adopted technology across various applications, from gaming to productivity tools.

VI. Future Scope

The future of virtual mouse technology holds significant promise in enhancing PC understanding and achieving diverse objectives. Despite current limitations in right-click precision and text selection, ongoing research aims to address these issues. Additionally, incorporating keyboard functionality for simultaneous keyboard and mouse operations is a prospective advancement. Future developments may expand gesture options, allowing users to efficiently accomplish a broader range of tasks. Potential improvements include utilizing both hands for various gestures, opening doors to enhanced applications through rapid advancements in hand gesture recognition systems.

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