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VIRTUAL MOUSE: FUSION OF HAND GESTURES AND EYE TRACKING

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Abstract : Developing a virtual mouse system that integrates hand gesture recognition and eye tracking technology, this initiative aims to revolutionize digital interaction. By harnessing the power of the MediaPipe library for hand gesture recognition in Python and incorporating eye tracking capabilities, users can control the cursor through intuitive hand gestures and eye movements. This system offers a seamless experience with digital interfaces, empowering users to execute actions like clicking, scrolling, and dragging effortlessly. The precision and efficiency of these control mechanisms enhance accessibility and usability, particularly benefiting individuals with mobility impairments. With its intuitive design and hands-free operation, the virtual mouse system represents a versatile and user-centric approach to digital interaction. Overall, this innovative integration of hand gesture recognition and eye tracking technology promises an intuitive, efficient, and immersive computing experience for diverse user demographics.

***Keywords* - Artificial Intelligence, Hand Gestures, Eye Tracking, Mouse Mapping, Virtual Cursor**

I. INTRODUCTION

The "Virtual Mouse: Fusion of Hand Gestures and Eye Tracking" project is a pioneering initiative in human-computer interaction, merging hand gestures and eye tracking to redefine cursor control and enhance user experience. By seamlessly integrating the natural expressiveness of hand movements with the precision of eye tracking technology, this system aims to provide intuitive and efficient control over digital interfaces.

Traditional input methods often impose limitations on users, from lack of precision to accessibility challenges for those with disabilities. The Virtual Mouse project addresses these issues by offering an alternative, more natural input modality. Through sophisticated algorithms and real-time processing, the system interprets hand gestures and eye movements, translating them into precise actions such as cursor movement, clicking, and scrolling on the screen.

This project caters to a diverse audience, including individuals seeking ergonomic and intuitive interaction methods, users with disabilities requiring alternative input options, professionals in design and creative fields demanding precise control, and researchers exploring innovative human-computer interaction techniques.

II. LITERATURE SURVEY

A. Hand Gesture-based Virtual Mouse using Open CV

AUTHORS: Gayatri Jagnade, Mitesh Ikar, Nikita Chaudhari, Maithili Chaware
YEAR: 2023

In a world full of technologies, everyone is trying to make human life easier with the help of new techniques. Therefore, for the sake of humanitarian relief, this paper has developed a technology that can help the user to use laptops/computers easily with less physical contact. The proposed system consists of functions like controlling the system with the help of hand gestures and blinking of eyes, scrolling with the help of yellow object detection and mouth opening, and volume control with the help of fingertips. For this project, media pipe, an Open CV application has been used. This system will be helpful for people with disabilities for doing their work more easily and with simplicity. Moreover, due to significant restrictions during pandemic, it can be said that contactless is a priority in today's world, and one of the best way to achieve this is provided in this prototype.

B. AI Virtual Mouse using Hand Gesture Recognition

AUTHORS: Joy Guha, Shreya Kumari , Prof. Shiv Kumar Verma
YEAR: 2022

The PC mouse is one of the wondrous developments of people in the field of Human-Computer Interaction (HCI) innovation. In new age of innovation, remote mouse or a contact less mouse actually utilizes gadgets and isn\'t liberated from gadgets completely, since it utilizes power from the gadget or might be from outside power sources like battery and gain space and electric power, likewise during COVID pandemic it is encouraged to make social separating and keep away from to contact things which gave by various people groups. Inside the projected AI virtual mouse utilizing hand signal framework, this constraint might be resolve by involving advanced camera or sacred camera for perceive the hand motions and fingers recognition abuse PC machine vision. The algorithmic rule used in the framework utilizes the man-made consciousness and AI algorithmic rule. Upheld the hand signals, the gadget might be controlled pretty much and might do left click, right snap, looking over capacities, and PC gadget pointer perform while not the utilization of the genuine mouse.

C. Hand Mouse Interface using Virtual Monitor Concept for Natural Interaction

AUTHORS: Changhyun Jeon, Oh-Jin Kwon, Dongil Shin, Dongkyoo Shin
YEAR: 2017

The growing interest in human-computer interaction has prompted research in this area. In addition, research has been conducted on a natural user interface/natural user experience (NUI/NUX), which utilizes a user's gestures and voice. In the case of NUI/NUX, a recognition algorithm is needed for the gestures or voice. However, such recognition algorithms have weaknesses because their implementation is complex, and they require a large amount of time for training. Therefore, steps that include pre-processing, normalization, and feature extraction are needed. In this paper, we designed and implemented a hand-mouse interface that introduces a new concept called a "virtual monitor", to extract a user's physical features through Kinect in real time. This virtual monitor allows a virtual space to be controlled by the hand mouse. It is possible to map the coordinates on the virtual monitor to the coordinates on the real monitor accurately. A hand-mouse interface based on the virtual monitor concept maintains the outstanding intuitiveness that is the strength of the previous study and enhances the accuracy of mouse functions. In order to evaluate the intuitiveness and accuracy of the interface, we conducted an experiment with 50 volunteers ranging from teenagers to those in their 50s. The results of this intuitiveness experiment showed that 84% of the subjects learned how to use the mouse within 1 min. In addition, the accuracy experiment showed the high accuracy level of the mouse functions [drag (80.9%), click (80%), double-click (76.7%)]. This is a good example of an interface for controlling a system by hand in the future.

III. DESIGN & MODULE DESCRIPTION

A. System Architecture

An allocated arrangement of physical elements which provides the design solution for a consumer A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. System architecture can comprise system components, the externally visible properties of those components, the relationships (e.g. the behavior) between them. It can provide a plan from which products can be procured, and systems developed, that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture; collectively these are called architecture description languages (ADLs).

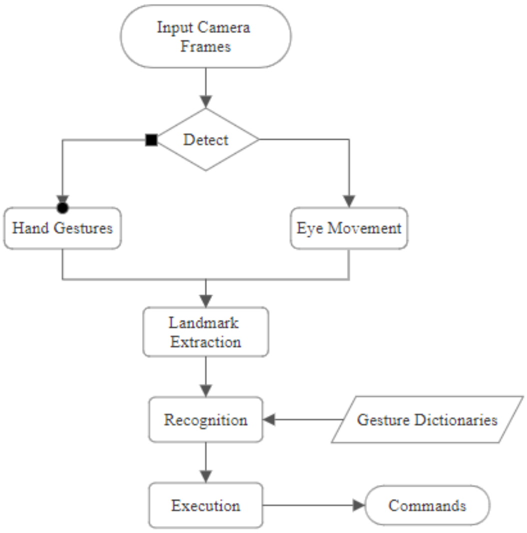

Fig 1. system architecture

B. Modules

- Hand Gesture Recognition
- Eye Tracking
- Cursor Control Integration

C. Module Description

Hand Gesture Recognition: - Utilizes the MediaPipe library to recognize a variety of hand gestures, translating them into cursor movements and actions such as clicking and scrolling.
Eye Tracking: - Captures and analyzes eye movements to determine the user's gaze position, enabling precise cursor control based on eye movements.
Cursor Control Integration: - Integrates outputs from hand gesture recognition and eye tracking modules to manipulate the cursor's position and perform actions seamlessly.

IV. IMPLEMENTATION

This project was implemented with python libraries like OpenCV, MediaPipe, PyAutoGUI which are briefly explained below

OpenCV

OpenCV (Open Source Computer Vision) is an open-source library focused on computer vision and image processing tasks. It provides a broad range of functionalities for analyzing and manipulating images and videos. Key features of OpenCV include image filtering, transformation, and feature extraction, making it suitable for tasks like edge detection, object recognition, and facial detection. OpenCV supports various algorithms for feature detection, including Haar cascades for object detection and keypoints detection for image matching. It also includes tools for camera calibration, stereo vision, and optical flow analysis. With its integration capabilities with Python and other programming languages, OpenCV is widely used in applications such as robotics, augmented reality, autonomous vehicles, and medical image analysis. Its extensive documentation and active community support make it a popular choice for both research and practical computer vision projects.

MediaPipe

MediaPipe is an open-source framework by Google, facilitating the development of perception-based applications. It offers ready-to-use modules and tools for tasks like hand tracking, face detection, object recognition, and pose estimation. Notably, its hand tracking module provides accurate 3D hand pose estimation, aiding in gesture recognition and interaction. Face detection and recognition features enable identifying faces, extracting landmarks, and tracking emotions. MediaPipe's object detection and tracking capabilities are vital for tasks like object counting and AR applications. The framework's efficient media processing pipelines ensure real-time performance across devices, including mobile platforms. Its cross-platform support and customization options allow developers to integrate custom models and extend functionality, making it a versatile choice for building ML and CV applications with optimized resource usage and scalability.

PyAutoGUI

PyAutoGUI is a Python library designed for automating GUI tasks by emulating mouse and keyboard inputs. It provides functionalities to control the mouse cursor, perform clicks, drags, and simulate keyboard actions such as typing and hotkeys. PyAutoGUI is platform-independent, working seamlessly on Windows, macOS, and Linux systems. It's particularly useful for automating repetitive tasks, creating automated tests, and building virtual input systems for UI testing. With its intuitive API, developers can easily script interactions with GUI elements, capture screenshots, and perform image recognition tasks. PyAutoGUI simplifies GUI automation in Python, making it accessible and efficient for a wide range of automation needs across different operating systems.

V. RESULTS AND DISCUSSION

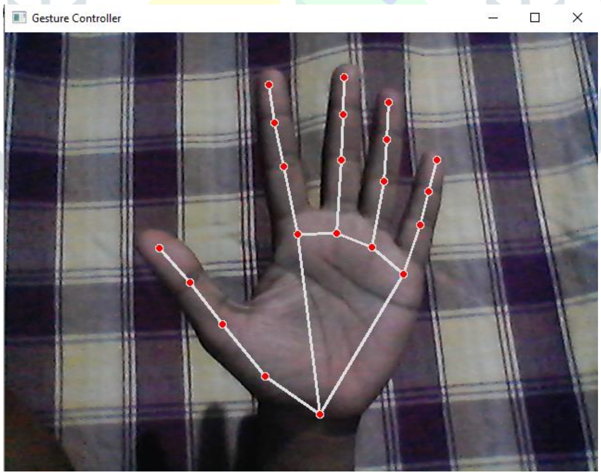

Fig 2: Cursor at stable state

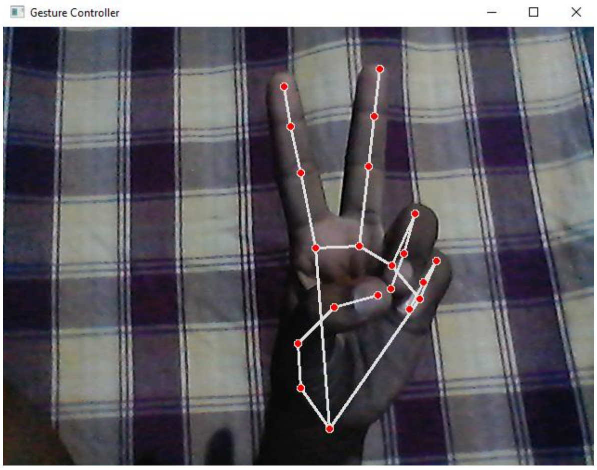

Fig 3: For Moving Cursor

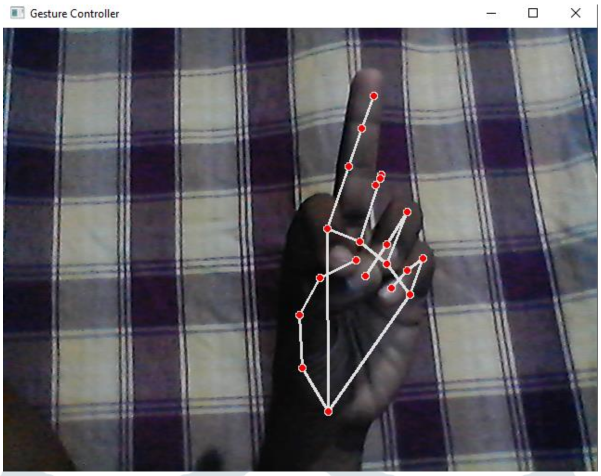

Fig 4: For performing Left-Click

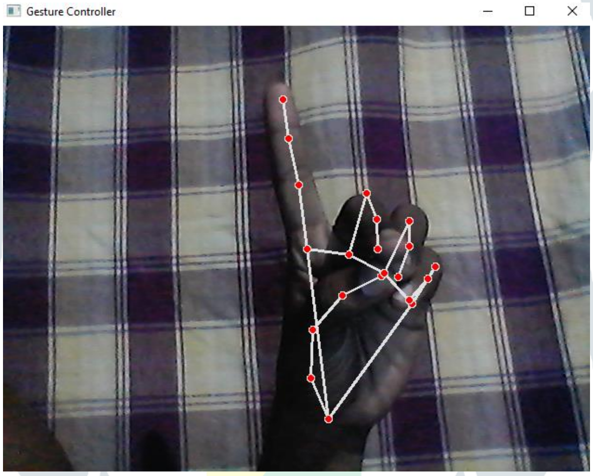

Fig 5: For performing Right-Click

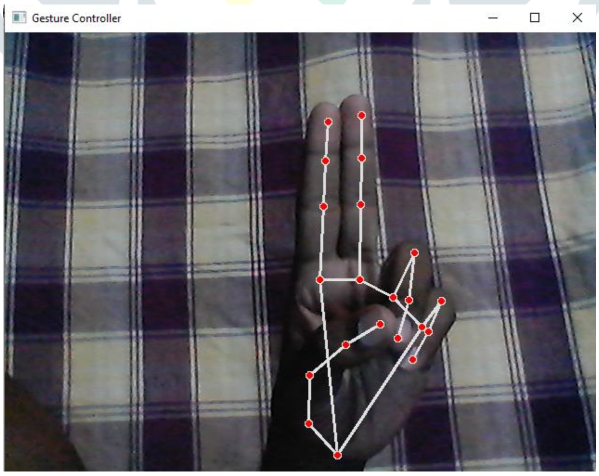

Fig 6: For performing Double-Click

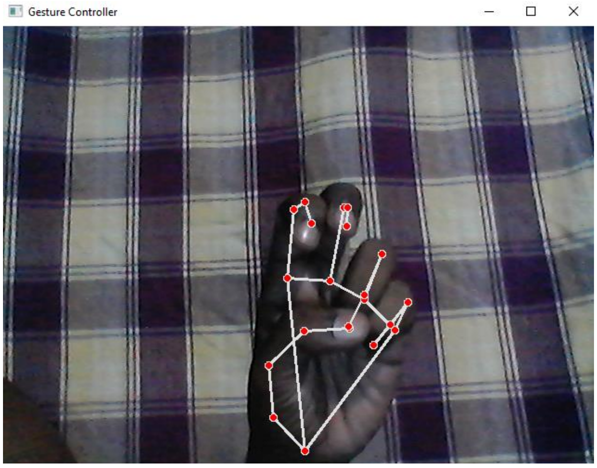

Fig 7: For performing Drag & Drop

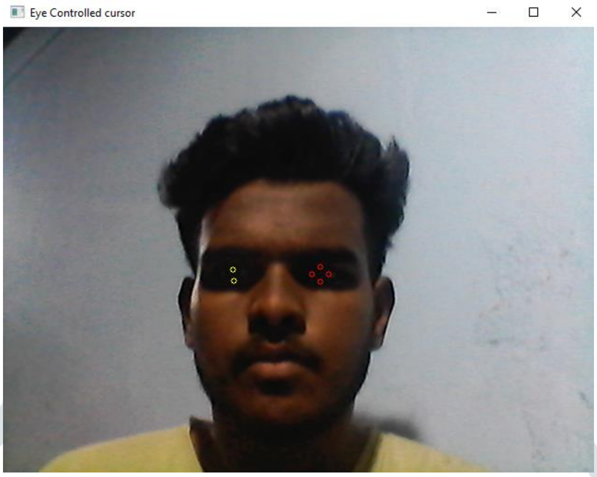

Fig 8: Eye Controlled Cursor

VI. CONCLUSION AND FUTURE WORK

The project's conclusion marks the successful integration of hand gesture recognition using OpenCV and eye tracking with MediaPipe, creating a versatile virtual mouse system. With PyAutoGUI facilitating cursor control, the system provides a seamless and intuitive user experience. Its modular design allows for future enhancements and customizations. Overall, this project demonstrates the potential of combining technologies for efficient human-computer interaction, paving the way for advanced virtual input systems.

Future enhancement:

Enhance the system with advanced algorithms to recognize a broader range of hand gestures accurately, allowing for more precise and intuitive control. Incorporate machine learning capabilities to enable the system to learn and adapt to individual user behaviors, improving interaction accuracy and customization.

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