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VIRTUAL MOUSE USING OPEN CV

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Abstract:

The Virtual Mouse using OpenCV project presents an innovative solution to human-computer interaction by computer vision techniques. Traditional computer mice have been the primary interface for human computer interaction, but they have limitations in certain contexts, such as gesture-based or remote interactions. This project proposes a approach to overcome these limitations by implementing a virtual mouse controlled through hand gestures captured by a standard webcam. The core technology behind this system is OpenCV (Open-Source Computer Vision Library), a popular open-source computer vision and machine learning software library. This project enables real-time hand tracking and gesture recognition. The system captures hand movements and translates them into corresponding cursor movements on the computer screen, effectively emulating the functionality of a physical mouse.

Keywords — **Virtual Mouse, Open CV, Hand-Tracking, Gesture Recognition, Deep Learning, Image Processing.**

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I. INTRODUCTION

A virtual mouse is a software application that allows users to control the computer cursor without using a physical mouse. Instead, it utilizes computer vision techniques to track the user's hand movements or gestures through a camera and translates those movements into cursor actions on the screen. OpenCV (Open-Source Computer Vision Library) is a widely used open-source computer vision and machine learning software library that provides tools to develop such applications. Using OpenCV, developers can create a virtual mouse system that detects hand or gesture movements, tracks them in real-time, and

converts these movements into corresponding cursor movements and clicks on the screen. Virtual Mouse is a software that allows users to give inputs of a mouse to the system without using the actual mouse. To the extreme, it can

also be called hardware as it uses an ordinary camera. A virtual muse can usually be operated with multiple input devices, which may include an actual mouse or computer keyboard. The virtual mouse uses a web camera with the help of different image processing techniques. Using figures detection methods for instant Camera access and a user-friendly interface makes it more easily accessible. The system is used to implement a motion-tracking mouse, a physical mouse that saves time and also reduces effort. The hand movements of a user are mapped into mouse inputs. A web camera is set to take images continuously. Most laptops today are equipped with webcams, which have recently been used in security applications utilizing face recognition. To harness the full potential of a webcam, it can be used for vision-based CC which would effectively eliminate the need for a computer mouse or mouse pad.

II. LITERATURE SURVEY

V.K Sharma, V Kumar, M Iqbal, S Tawara, V Jayaswal Gis Science Journal et.al [1], proposes a way to control the position of the cursor with the bare hands without using any electronic device. While the operations like clicking and dragging of objects will be performed with different hand gestures. The proposed system will only require a webcam as an input device. The software's that will be required to implement the proposed system are OpenCV and python. The output of the camera will be displayed on the system's screen so that it can be further calibrated by the user. The python

dependencies that will be used for implementing this system are NumPy, math, and mouse.

In R. Annachhatre, M Tamakuwal ,et.al[2], Research is touching screens are found on most mobile devices. However, this technology is currently too expensive to be employed on desktop computers. As an alternative to the touch screen, a virtualized human-computer interface gadget like a mouse can be developed using a camera and some computer vision algorithms. A virtual mouse application based on finger tracking has been conceived utilizing a normal webcam in this study. The goal was to construct a virtual human-computer interface device and an object.

In A Mhetar, BK Sriroop et.al [3], AGS Kavya research, the major aspect in today's e-learning is the improvement in the methods of teaching by using technology dependent resourceful products to have a better communication and interaction between the teacher and the student. The existing Virtual Marker is modified to function more than a marker and act as a mouse pointer also giving it the advantage of all the functionality of a mouse. In this paper, we have proposed a hardware implementation of a Virtual Mouse which has an improvement in performance of the existing "Virtual Marker" by making it highly responsive in real time.

The project described in the paper "Virtual Mouse Implementation using Color Pointer Detection" by D.S. Suresh and I.V. Bhavana et.al [4] appears to be focused on developing a virtual mouse system that uses color-based pointer detection to control the cursor on a computer screen. In this approach, a coloured object, such as a specially coloured finger, marker, or pointer, is detected by the camera, and its movement is tracked to simulate mouse movements and actions like clicking, dragging, and scrolling.

S. U. Dudhane's et.al [5] paper titled "Cursor control system using hand gesture recognition" was published in the International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), volume 2, issue 5, in 2013. You can view it on platforms like Google Scholar and the publisher's site for more details.

The paper by J. Katona et.al [6] provides a comprehensive overview of the fields of human–computer interaction (HCI) and virtual reality (VR) within the context of cognitive information communications (CogInfoCom). It discusses recent research trends, developments, and innovations, highlighting the growing significance of these fields in the era of advancing computer technology.

The paper titled "Hand Gesture Recognition for Human Computer Interaction" by A. Haria, A. Subramanian, N. Asokkumar, S. Poddar, and J. S. Nayak et.al[7] was published in Procedia Computer Science, volume 115, on pages 367–374 in 2017. You can access it through the publisher's site for more detailed information.

Table 2.1 summarization of virtual mouse using open CV

Technology	Author	Advantages	Limitation
Control the position of the cursor with the bare hands without using any electronic device	VK Sharma, V Kumar, M Iqbal, S Tawara, V Jayaswal et.al[1]	• No Additional Hardware Required • Hands-Free Control	• Limited Accuracy and Precision • Lighting Conditions
Virtual Mouse Using Hand Gesture Recognition	R. Annachhatre, M Tamakuwal et.al [2],	• No Need for Physical Input Devices • Cost-Effective	• Limited Gesture Set • Calibration and Setup
Virtual mouse	A Mhetar, BK Sriroop et.al[3]	• Enhanced Interaction • No Need for Physical Mouse	• Accuracy Issues • Lighting Conditions
Virtual Implementation using Color Pointer Detection	D.S. Suresh and I.V. Bhavana. et.al[4]	• Cost-Effective • Increased Accessibility	• Color Detection Limitations • Limited Gesture Detection
Cursor control system using hand gesture recognition	S. U. Dudhane's etc.al[5]	• Hands-Free Operation • Ergonomics	• Need for Calibration • **User Fatigue**
human-computer interaction (HCI) and virtual reality (VR)	J. Katona etc.al[6]	• In-depth Exploration of HCI and VR. • Relevance to Modern Technological Trends	• Challenges in Real-World Implementation • Dependency on

			Advanced Hardware

III. SYSTEM DESIGN

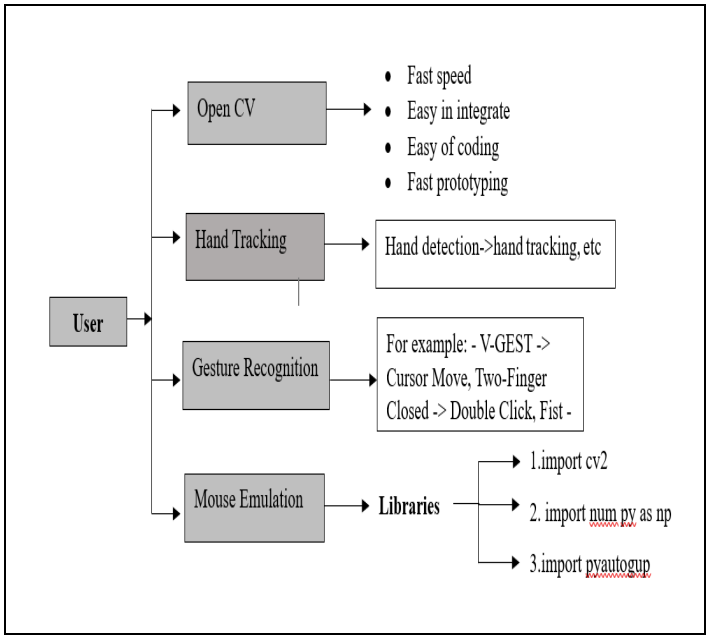

Fig 3.1: Architecture Diagram- Virtual Mouse

OpenCV:
OpenCV is a cross-platform library designed for developing real-time computer vision applications, primarily focusing on image processing and video analysis. It allows developers to perform tasks such as object detection, including identifying faces and cars, as well as analysing video for motion estimation, background subtraction, and object tracking.

Mediapipe:
The MediaPipe framework is a powerful open-source tool developed by Google for real-time hand gesture detection and hand tracking.

Colours' Coordinates Acquisition:
For every object within the binary threshold, the program will highlight the overall shape of the object (cvRenderBlobs(const IplImage imgLabel, CvBlobs & blobs, IplImage imgSource, IplImage imgDest, unsigned short mode=0x000f, double alpha=1.);), where it will calculate the area of the shape and the coordinates of midpoint of the shapes.

Hand Tracking Algorithm:
Hand tracking is a critical component of developing a virtual mouse using OpenCV. Various algorithms can be employed for hand tracking, each with its strengths and weaknesses.
Here are some commonly used hand tracking algorithms:

- **Background Subtraction**: This algorithm identifies the hand by detecting the foreground object (hand) against a static background. Capture an initial frame without the hand, then subtract subsequent frames from this background.
- **Contours and Convex Hull**: Hand contours are identified, and convex hull algorithms are applied to find the convexity defects, allowing detection of fingers and palm.
- **Skin Color Segmentation**: This method relies on the fact that human skin color falls within a specific range in the color space. Convert the image to a color space like HSV (Hue, Saturation, Value) and filter out the pixels corresponding to skin color.
- **Mean-Shift Tracking**: A tracking algorithm that iteratively adjusts a window to find the peak in color distribution (mean) within that region. Initialize a window around the hand and iteratively adjust it to track the hand movement.

Cursor Control by using Hand:
Cursor control involves translating hand movements into corresponding movements of the on-screen cursor. The calculated hand position can be mapped to cursor movements using mathematical transformations. OpenCV can be used to determine the distance and direction of hand movements and adjust the cursor position accordingly.

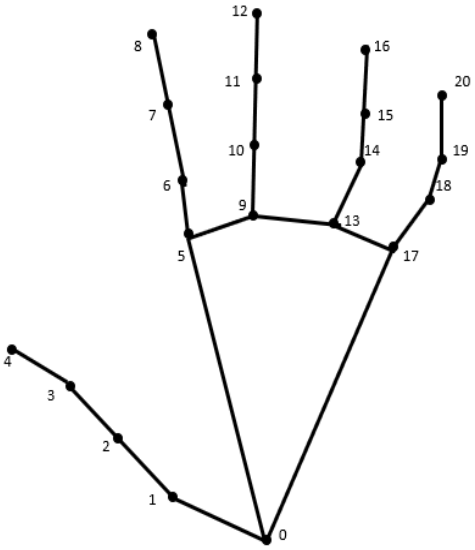

Fig 3.2: Co-ordinates or landmarks in the hand using Mediapipe

1) **FIST:** Pressing the fist triggers a mouse click. (left button)
2) **V-GEST:** Moves the mouse cursor to the tracker position.

3) **TWO FINGERS CLOSED**: Double-click when the gesture is detected.
4) **INDEX:** Right-click when the gesture is detected.

IV. CONCLUSIONS

The Virtual Mouse not only simplifies user interaction but also opens new avenues for innovation in touchless control systems, making it a promising technology for future applications in a digital-first world. Using OpenCV, developers can create a virtual mouse system that detects hand or gesture movements, tracks them in real-time, and converts these movements into corresponding cursor movements and clicks on the screen. The virtual mouse accurately tracks hand movements and performs mouse functions. The virtual mouse provides an alternative input method for individuals with limited mobility. A webcam or built-in camera can be used to detect hand gestures and hand tips, and process the frames to perform mouse functions. Successfully created a virtual mouse using OpenCV.

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V. FUTURE SCOPE

The future scope of the Virtual Mouse using OpenCV includes improved gesture recognition through AI, multimodal interaction with voice and eye tracking, and integration with AR/VR for immersive experiences. Enhanced AI and machine learning will enable smarter cursor control, while cross-platform compatibility will extend its use to mobile devices, smart TVs, and IoT systems. Additionally, it will improve accessibility for disabled users, making hands-free computing more efficient and widely applicable.

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