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Convex Hull Algorithm based Virtual Mouse

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***Abstract*—This project promotes a human-computer interaction (HCI) approach where the movement of the cursor can be controlled by the camera in real time, it is an alternative to current methods including manual button entry or change the position of the physical computer mouse. Instead, it uses a camera and computer vision technology to control various mouse events and is capable performing all the tasks that a physical computer mouse can do. The Virtual Mouse color recognition program will continuously acquire in real time images, where the images go through a series of filters and conversions. Whenever the process is complete, the program will apply image processing technique to obtain the coordinates of the position of the targeted colors from converted frames. It then proceeds to compare the existing colors within the boxes with a list of color combinations where there are different combinations consists of various mouse functions. If the current color combination was found and match, the program will execute the mouse function, which will be translated into the actual function of the mouse to the user's computer.**

***Index Terms*— component, formatting, style, styling, insert (key words).**

I. INTRODUCTION

In terms of computing, a mouse is a pointing device that detects two-dimensional movements relative to the surface. This movement is converted to movement pointers on the display that allow you to control the graphical user interface (GUI) on a computer platform. There are many different types of mice that have already existed in modern technologies, there is a mechanical mouse that determines movements with a hard rubber ball that rolls like a mouse moved A few years later, an optical mouse was introduced to replace the hard rubber one ball to an LED sensor that detects the movement of the table top and then sends information to the computer for processing. In 2004, the laser mouse it was then introduced to improve the accuracy of movement of the smallest hand movement, overcomes the limitations of an optical mouse, which is difficulty tracking highly glossy surfaces. However, regardless of how accurate it may be, there are still limitations within the mouse itself both physically and on a physical scale technical term. For example, a computer mouse is a consumer hardware device as it requires replacement in the long term, the mouse buttons have degraded causing inappropriate clicks or the entire mouse was no longer detected the computer itself. Despite the limitations, computer technology continues to grow, as well as the importance of human-computer interactions. Since its introduction the world is a mobile device that can be controlled by touch screen technology, they begin to require the same technology to be applied to each technology equipment, this includes a desktop system. However, even if the touch screens the technology for a desktop system already exists, the price can be very high. That is, a virtual device for human-

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computer interaction that replaces the physical one mouse or keyboard using a webcam or any other image capturing device to be an alternative way for touch screen. This device, which is a web camera, will be constantly used by software that monitors the gestures entered by the user to process it and convert it into spike movement, similar to physical Mouse.

II. Review of Physical Mouse

It is clear that there are many different types of modern physical computer mice. We will explain the technology, types and differences below

A. Physical Mouse

Mechanical mouse- A ball known as a trackball mouse, commonly used in the 1990s. It is supported by two rolling rollers in the mouse for recognition. Self-detecting ball movement forward and backward with a roller. One detects movement and the other detects left and right movement. Ball inside the mouse is made of steel and covered with a layer of hard rubber. The detection is more accurate. Common features include left/right buttons and scroll wheels, however, due to constant friction, between the mouse ball and the roller itself, the mouse tends to worn. If you use it for a long time, the roller will be damaged, it cannot detect movement properly and becomes useless. Furthermore, the switches of the mouse buttons are no different, as is long-term use. Internal mechanisms may loosen and become unrecognizable. Click the mouse until you disassemble and repair. It requires a flat surface to operate.

B. Optical Laser Mouse

The movement of an optical mouse, the most commonly used mouse these days, is reliable with light emitting diode (LED). A laser mouse is an optical mouse. Coherent laser light compared to its mechanical predecessor. Mice, optical mice no longer rely on rollers. Instead, use an imaging array of photodiodes. The purpose of implementation of this is to eliminate the limit of destruction that plagues it. The current predecessor is more durable and offers better performance clarity and accuracy, however, still have drawbacks. Optical mice work on most opaque diffuse surfaces, detects the movement of the polishing surface. In addition, no long-term use. Proper cleaning or maintenance will keep dust particles away. LED that activates both optical and laser mice with surface detection difficult Other than that, the buttons are still prone to damage. If the switch is not on, the mouse will not work properly.
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III. Problem Statement

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Each technology device has its own limitations.
Especially when it comes to computer devices. After various types of review, problems are identified and generalized. Physical mice are subject to mechanical wear and tear. Working with a physical mouse requires special hardware and levels. A physical mouse cannot easily adapt to different environments. Performance may vary depending on the environment. The mouse has limited functionality even in the current production environment. All wired and wireless mice have their own lifespan.
Project Scope - The virtual mouse will soon replace the physical computer. A mouse that maximizes comfort while allowing interaction and precise control computer system. For that software must be fast enough to take pictures, process all images to correctly track user movements. Therefore, in this project, we will use modern software to develop practical software. Software coding techniques and open-source computer vision libraries Known as OpenCV. The scope of the project is:

- Real-time applications
- User friendly program.
- Eliminate the need to use a physical mouse.

IV. LITERATURE REVIEW

As modern technology, human-computer interaction becomes more important for us. Different shapes and sizes of mice were invented. From ordinary office mice to serious gaming mice. However, there are some limitations because they are not as green as they appear. For example, a physical mouse needs a flat surface to work. A certain amount of space is required to fully utilize the functionality provided. In addition, some of these hardwares are completely useless in interacting with the computer cable length limitations prevent remote access.

A.Visual Panel

To overcome the stated problems, Zhengiu et al. (2001), proposed a link. A system called Visual Panel that uses any rectangular screen object. User can use any pointing tool on computer. Cross movements are recorded, analyzed and implemented chip marker position, resulting in precise and robust engagement of computer. The whole system consists of a panel detector, a chip pointer detector, holography, computing and updating, as well as action detectors and event generators Both mouse and keyboard can be emulated.

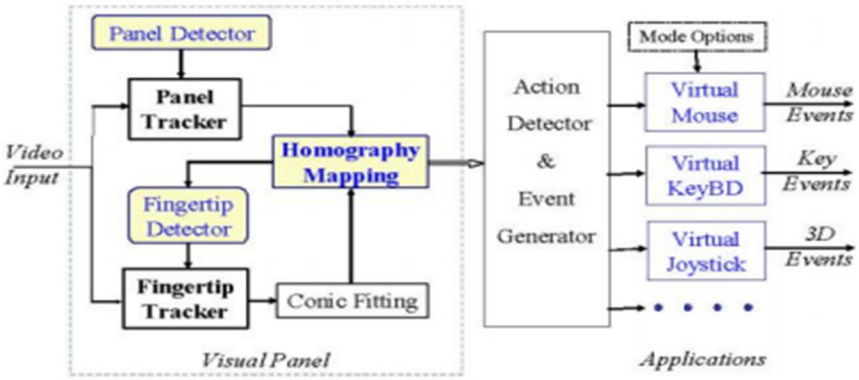


Figure 1: The system overview of Visual Panel

However, although the proposed system solved the cable length problem, it has limitations, it needs certain areas and materials to work. The system says it can accept any panel as long as it is square. In other words, forms other than those described are not allowed.

B.Mouse Simulation using two colored tapes

Kamran Niyazi et al. (2012), mentioned that to solve the stated problem, ubiquitous computing method is required. Thus, colour tracking mouse simulation was proposed. The said system tracks two colour tapes on the user fingers by utilizing the computer vision technology. One of the tapes will be used for controlling the movement of the cursor while the other will act as an agent to trigger the click events of the mouse.

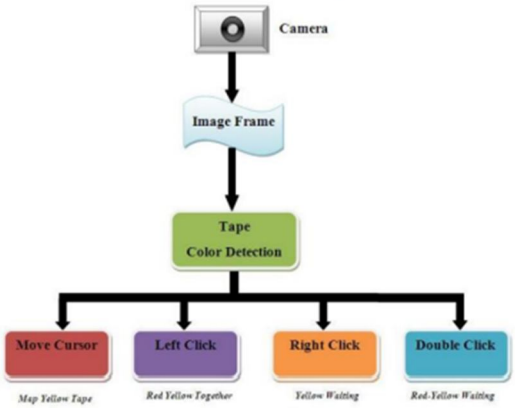


Figure 2 The system architecture of the mouse-simulation (Niyazi, 2012)

To detect the colours, the system are first required to process the captured image by separating the hand pixels from the non-hand pixels, which can be done by background subtraction scheme that segments the hands

movement information from the non-changing background scene. In order to implement this, the system requires to capture a pair of images to represent the static workplace from the camera view. When subtraction process is complete, the system will undergo another process that separates the RGB pixels to calculate the probability and differentiate the RGB values to determine which part are the skin and which are not. After the process is completed, it will start detecting the defined color in the image, the image RGB pixels will be converted into HSV color plane in order to eliminate the variation in shades of similar color. The resulting image will be converted to Binary Image and will undergo a filtering process to reduce the noise within the image. The proposed system solved most of the stated problems. Considering the limited functionality provided by the proposed system, it can be done simply, common functions like cursor movement, left/right click, double click.

V. IMPLEMENTATION

For the implementation of the project, we have used python language. The libraries used are Mediapipe, OpenCV and PyautoGUI. Each of these libraries are discussed below along with the elaboration of how it was used. The platform used is Jupyter Notebook.

A. Mediapipe

Mediapipe is an open-source library developed by google. It has many pretrained machine learning model realated to computer vision such as hand tracking, face detection, pose detection etc. In this project, the mediapipe library is used for hand tracking.

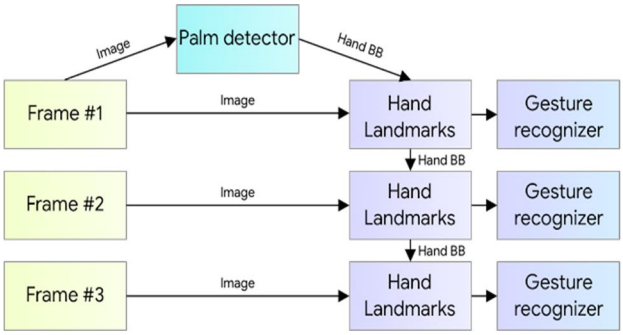


Figure 3:Hand perception pipeline overview

To detect initial hand the library uses BlazePalm. BlazePalm is a single shot detector model. Mediapipe works by firstly building a palm detector for efficiency and accuracy. After palm detection it builds hand landmarks using convex hull algotrithm. The algorithm works on he principal that intersection of all the points withh an N-dimensiona space would form a convex

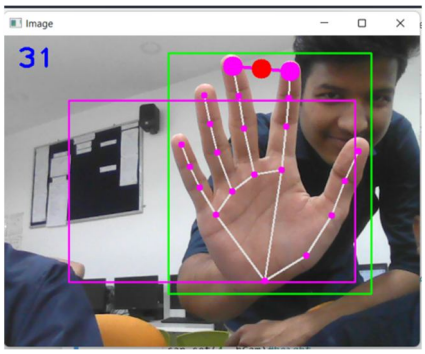
The algorithm iin mediapipe for hand tracking is used for tracking fingers and drawing points on the ojoints present in the fingers to easily represent aa human arm iin machines vision.eeKeep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

B. OpenCV

Define OpenCV stands for open-source computer vision. The library is majorly focused on computer vision programs. The library provides thousands of built-in functions or methods that make working with visual data comfortable. In this project we are using this library to read images form video captured on live webcam, drawing the hand landmarks and also to stop the program when needed. Individual frames from the video is captured and landmarks are drawn on hand. Two extra circles are also drawn on index and middle finger as the mouse left-click drag and drop will be performed by the intersection of the circles. The program will stop executing after the user presses the “Q” button from the device.

C. PyautoGUI

This library is used for automation using python. As the name suggests it provides a GUI for operations related to the operation systems. The library also helps to control cursor operations such as performing clicks and creating dialogue boxes and designing apps. In the project, we have used pyautogui collaboratively with opencv to control mouse with hand gestures. As in the figure below shown below.



Result 1: control mouse with hand gestures

VI. METHODOLOGY

The whole system is divided into 5 parts:

a. Image resizing
b. Hand detection and hand tracking
c. Gesture Recognition
d. Control Mouse
e. Image resizing

The screen of the webcam needs to be mapped with the whole screen of the device so that each and every corner can be reached by the mouse. And the hand too should make effective work within a sophisticated environment. The openCV library is used for performing the above mentioned objective.

A. Hand detection and hand tracking

The hand now needs to be separated from a complex background. Mediapipe is very helpful for this step. As mentioned above, mediapipe has pretrained models for hand detection and tracking. The methods and applications applied have also been mentioned in the implementation section.

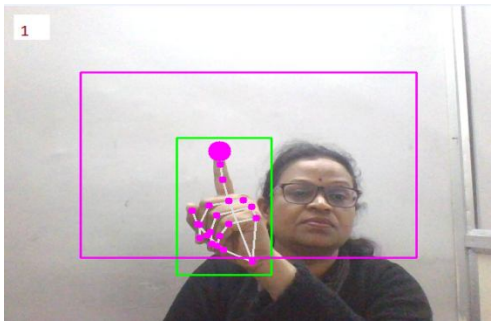
B. Gesture Recognition

After tracking and detection we specified to the model that if a certain gesture is performed by the hand, then, necessary action should be taken by the mouse. For specifying this we used the middle and index finger of the hand and enlarged their tracking circle so as to make the gesture clearly visible. A figure for same is shown in the implementation section. We tackled this objective with the help of OpenCV library. OpenCV functions such as DrawCircle helps to draw circle on an image. And the fingers are differentiated using mediapipe.

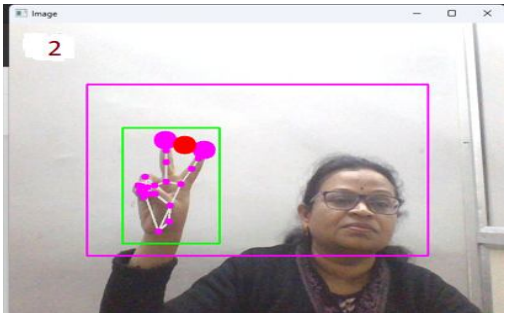
C. Control Mouse

This is the last part of the project, the pyautogui library is extensively used for this step. The cursor follows the path of the index and middle finger of the hand. If the two fingers cross each other than cursor performs the right click operation.

VII. RESULT



Result 2::Mouse function- when the red appears it specifies that mouse function is on hold and ready to select or use right click mouse function



Result 3: Mouse function – When the green colored dot appears on display it specifies that right click has happened

VIII. CONCLUSION

The main objective of this project is to replace the regular mouse. This system requires webcam for running the model. The presence of webcam at the front of the user is more preferable as the gesture would never collide.
From the results, we can state that the model performed well for a complex background. The number of hands that would be detected has been setup to two, but the gesture of only one hand was recognized for better performance of the model. The project covers the drawbacks of traditional mouse as the user needs not to carry a mouse everywhere.
The proposed system has various applications such as improving the social distancing by making less use of mouse at public cyber cafes. The model can also be used to access the device from large distance. The hand tracking system can also be used for controlling robot arms with a virtual environment. The project can also be used in the meta-world for better user experience.
The project also finds its application in detecting the hand signs of mute people. The communication gap can be easily covered with it.

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