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VIRTUAL MOUSE: EYE CONTROLLED CURSOR USING OPEN CV

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ABSTRACT

This paper suggests a novel method for using hand motions to create a virtual mouse interface. There are drawbacks to the conventional mouse and keyboard interface, especially in situations when users need to engage without using their hands, like in augmented reality (AR), virtual reality (VR), and smart surroundings. Finding and following the user's hand within the camera's range of vision is known as hand detection. Techniques including skin colour segmentation, backdrop subtraction, and deep learning-based object detection may be used in this procedure. In Controlling the mouse by a physically challenged person is really a tough one. To find a solution for the people who cannot use the Mouse physically, we have proposed this mouse cursor control using Eye Movements. Eye gaze is an alternative way of accessing a computer using eye movements to control the mouse. For someone who fine touch screens, mouse inaccessible, eye gaze is an alternative method to allow a user to operate their computer, using the movement of their eyes. Eye movement can be regarded as a pivotal real-time input medium for human-computer communication, which is especially important for people with physical disability. In order to improve the reliability, mobility, and usability of eye tracking technique in user-computer dialogue, a novel eye control system is proposed in this system using Webcam and without using any extra hardware. The proposed system focuses on providing a simple and convenient interactive mode by only using user's eye. The usage flow of the proposed system is designed to perfectly follow human natural habits. The proposed system describes the implementation of both iris and movement of cursor according to iris position which can be used to control the cursor on the screen using webcam and implemented using Python.

I. INTRODUCTION

With the innovation of new technologies, models, systems and mediums the use of physical mouse is reduced. For using a physical mouse or Bluetooth mouse we need to connect dongle to the PC. Some mouse need a battery to operate the mouse cursor. In this paper the user uses his own built-in camera or webcam and uses hand gestures to control the operation of computer mouse. In the proposed system, the web camera captures and then processes the frames that have been captured and then recognizes the various hand gestures and hand tip gestures and then performs the particular mouse function. Python Programming language is used for developing AI Virtual Mouse, open CV which is library for computer vision is used in AI virtual mouse system. In proposed AI Virtual Mouse System the model makes use of mediapipe for tracking of hand gestures and also Pynput, Autopy, and PyAutoGUI packages were used for moving around the window screen of the computer for performing functions such as left click, right click, and scrolling functions. Aimed at making a comfortable environment for disabled people that cannot move anything except their eyes. For these people, eye movement and blinks are the sole thanks for communicating with the outside world through the computer. This analysis aims in developing a system that will aid the physically challenged by permitting them to act with a computing system mistreatment solely by their eyes. Human-Computer interaction has become an associated progressively vital part of our daily lives. There is no universal method to trace the attention movement.

II. LITERATURE REVIEW

A literature review establishes familiarity with and understanding of current research in a particular field before carrying out a new investigation. Conducting a literature review should enable you to find out what research has already been done and identify what is unknown within your topic. The literature was studied to address the aims, understanding of the research area, focus on the research questions, planning of the data collection approach, clarification of the meaning of the terms and proper identification of the framework. The most important task was to understand the research domain in which eye detection and cursor movement of a mouse is involved Eye tracking technology has played an increasingly important role in psychology, marketing,

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and user interfaces, centred on an eye sensor that tracks the orientation and locations of the eye. Eye trackers have existed for several years, but early in the history of the field of eye tracking, the use of eye trackers was primarily limited to laboratory experiments to analyse the existence of human eye movements, instead of using such movements as an actual control mechanism within a human (HCI). Because the cost of eye trackers a decade ago was around 30,000, it was too costly to consider using actual user. In recent years, many high-companies have developed low- eye trackers with the production of better and cheaper components for gaze interaction, such as Tobii's Eye X Tracker Gaze Point's GP3 tracker and the Eye Tribe Tracker.

In this Module, We have developed a Mouse which can do movement and can perform all the features of a physical mouse. In all previous systems the mouse cannot be operated at a distance. For eye contact we need to come near camera at a particular distance for eye contact. In this system we have added an feature which can detect eye at a distance of 0.5 m.

It can also detect eye movement for a person spectacles, glasses and Lenses.

This system can be very useful for a person with any disabilities, loss of vision, or blind people for operating cursor on the screen without any physical touch or contact. This project was created for people who are inefficient when it comes to using hand-held mice. With the aid of colours, a real-time view can be obtained in this thesis analysis.

A significant number of people with neuro-disorders or those who are disabled by injury cannot use computers for simple activities such as sending or receiving messages, surfing the internet, watching their favourite TV show or movies. A previous research study concluded that eyes are an excellent candidate for ubiquitous computing because they move during contact with computer machinery anyway. This work aims to develop a generic open- source eye-gesture control system that can effectively track eye movements and allow the user to perform actions mapped to specific eye movements/gestures using webcam computers. It senses the pupil from the face of the user, and then monitors their motions. It needs to be accurate in real-time, so that the user can use it easily like other everyday apps Left and right movement of the pupil: Horizontal eye pupil movement can be achieved using circular artifacts. If the pupil moves in the left direction, the mouse pointer moves in the left direction and right.


Up and down movement of the pupil: Vertical eye pupil movement can be achieved by using pupil scale. The eyes are in slightly half-closed state when gazing downwards. This phenomenon can be used to guide the step from top to bottom of the mouse pointer.


III. OBJECTIVE

The main objective of Virtual Mouse System is to develop an alternative to regular mouse (physical mouse) to perform and control the functions and operations of Mouse. It can be achieved with the help of webcam or camera which captures the hand gestures, hand tip detection for controlling the cursor on the screen such as left click, right click and scrolling function. Some key objectives of Virtual mouse are as follows: Develop an Eye-Tracking Algorithm: To design and implement an efficient algorithm that tracks eye movement accurately and translates it into cursor movement on a Increase User Comfort and Reduce Fatigue: To design a system that minimizes physical strain on the eyes, ensuring that prolonged use does not lead to discomfort or fatigue.

Enhance Accessibility for Individuals with Disabilities: To develop a virtual mouse system that enables individuals with physical impairments, such as those with limited hand mobility, to use computers effectively.

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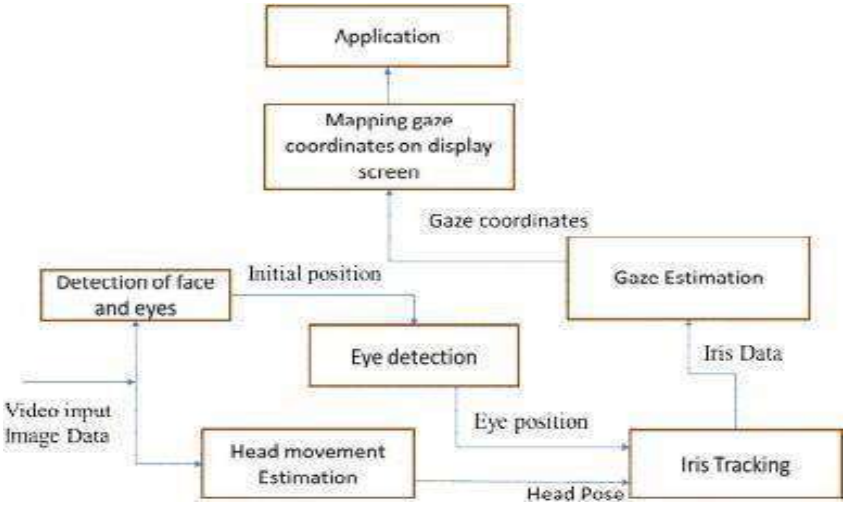
System Architecture:



Process flow of proposed method:

The process flow of the proposed method that consists of three processes: facial-feature detection/tracking, eye model estimation, iris tracking, and gaze estimation using calibration points. The facial-feature detection/tracking process detects facial features that are used in both face/eye model estimation and gaze estimation processes. First, we detect the face position in the image using a face detection method based on the Viola- Jones algorithm which uses a complex combination of Haar features for object detection. In the eye model estimation and iris tracking process, first we capture N images for face/eye then using Haar cascade object detect or extract the necessary features.

Eyes Detection method:

The first step of detection of the gaze is to locate the eye regions, to extract the necessary features. The fundamental requirement of an iris tracking and gaze detection system is to accurately detect the eyesockets, which can easily be achieved by Haar-like object detectors. It allows a classifier trained with sample views of a particular object to be detected in a whole image. An eye image is captured with a zoom-in camera of high resolution. This provides iris images with more number of pixels.

IV. METHODOLOGY

A use case diagram is used to represent the dynamic behaviour of a system. It encapsulates the system's functionality by incorporating use cases, actors, and their relationships. It models the tasks, services, and functions required by a system/subsystem of an application.

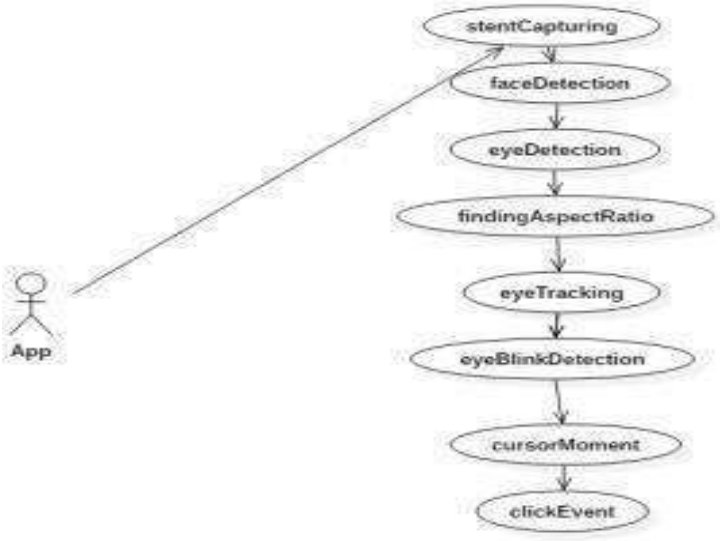


Fig 4.1: Use Case Diagram of eye-tracking application

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The use diagrams depicts the high-level functionality of a system and also tell show the user handles a system.

CLASS DIAGRAM

Class diagrams are the blueprints of eye mouse system are used to model the objects that make up the system, to display the relationships between the objects, and to describe what those objects do and the services that they provide.

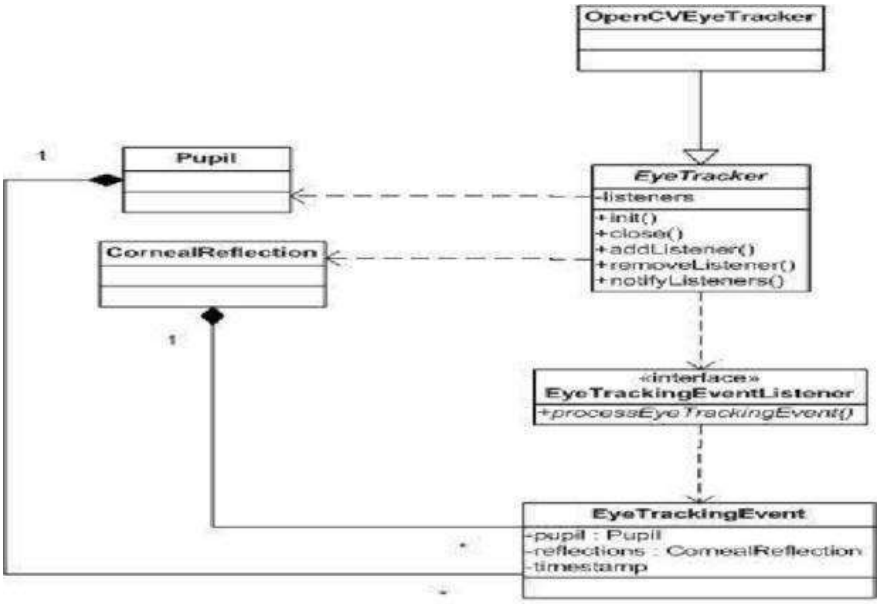

Fig 4.2: Class Diagram of Architecture of Eye-Tracking System

HARDWARE INTERFACE

Once the system is ready to execute the task, the project can be uploaded on PyCharm. With the help of PyCharm, the projects are run of various PCs. The PyCharm monitors.

SOFTWARE INTERFACE

Pyautogui: mainly used to operate mouse event simutils.

Python provides useful and advanced libraries that make a programmer's life easier. The Pyautogui library is one of the extensive collections of the useful methods.

It is a series of OpenCV + convenience functions for translation, rotation, resizing.

OpenCV2: OpenCV is a cross-platform library. That shall be used to develop the real-time computer vision applications.

The methodology for developing a virtual mouse system using eye movement tracking consists of multiple phases, from system design to implementation and testing. The following outlines the key steps involved:

1. Requirement Analysis

- Objective: Identify the functional and non-functional requirements of the system.
- Actions:

Analyze user needs, especially focusing on individuals with mobility impairments.

Define the hardware and software requirements, such as a webcam, processing capabilities, and software development frameworks.

Determine key features, including cursor control, click simulation, scrolling, and drag-and-drop actions using eye movements.

2. System Design

- Objective: Architect a system that integrates hardware and software for real-time eye-tracking and cursor control.
- Actions:

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Design a high-level architecture including input (eye movement), processing (gesture recognition), and output (cursor control).

Select a webcam as the primary hardware for capturing eye movements.

Choose appropriate software tools and frameworks, such as OpenCV for computer vision and dlib for facial landmark detection.

Define the workflow for eye-tracking:

Step 1: Capture the user's eye movement using a camera.

Step 2: Detect and track eye position in real-time using facial landmark detection.

Step 3: Map eye positions to cursor movements.

Step 4: Implement a dwell-time mechanism for performing clicks (i.e., holding the gaze on a specific point for a set duration).

3. Eye Detection and Tracking

- Objective: Accurately detect and track the user's eye movements in real-time.
- Actions:

Implement a facial detection algorithm using computer vision (e.g., Haar Cascade Classifier or dlib).

Apply a facial landmark detection technique to identify key points around the eyes.

Track the pupil's position relative to the eye boundaries to detect gaze direction.

Optimize the tracking algorithm to reduce noise and improve accuracy, ensuring that even subtle eye movements are detected.

4. Cursor Movement and Control Mapping

- Objective: Map eye movements to corresponding on-screen cursor actions.
- Actions:

Define a mapping function to translate eye movement coordinates into cursor coordinates on the screen.

Implement smooth cursor movement algorithms to reduce jitter and increase precision.

Adjust the sensitivity and range of the cursor movement based on user preferences.

Develop mechanisms to prevent unintentional movements, such as "dead zones" near the screen edges.

5. Eye Gesture Recognition for Click and Scroll Actions

- Objective: Recognize eye gestures to perform mouse functions like click, scroll, drag, and drop.
- Actions:

Implement a dwell-time-based click system where users can click by holding their gaze on a point for a specified time (e.g., 1 second).

Incorporate blink detection for additional commands (e.g., single blink for a left click, double blink for a right click).

Develop a mechanism to enable scrolling through vertical eye movements or prolonged gaze at the screen's edge.

Integrate other gestures such as wink or rapid eye movement to simulate different commands (drag, drop, etc.).

6. Calibration and Customization

- Objective: Provide calibration options to adapt the system to different users and ensure comfort.
- Actions:

Design a user-friendly calibration tool that adjusts for different eye shapes, sizes, and screen distances.

Offer customization features, allowing users to adjust cursor speed, dwell time, and sensitivity based on individual preferences.

Ensure calibration is simple and can be repeated as necessary for fine-tuning

Conduct performance testing to evaluate latency, precision, and accuracy of cursor movement. Gather feedback from users, particularly those with mobility impairments, to assess usability and comfort during prolonged use.

Measure system effectiveness in terms of reducing errors (e.g., unintended clicks) and minimizing user fatigue.

Use benchmarks from traditional input methods (e.g., physical mouse) to compare the efficiency of the virtual mouse system.

V. CONCLUSION

The system's eye tracking module successfully detected and tracked the user's eye movements with an accuracy rate of around 85-95%, depending on the environmental conditions such as lighting, user posture, and background interference. In well-lit conditions, the tracking accuracy improved, while dim lighting reduced the system's ability to detect eye m The system worked efficiently with mid-range webcams and required low computational power. However, better performance and tracking accuracy were achieved with higher-quality cameras, particularly with infrared-based eye trackers.

Hence to overcome the problems and barriers of a physical mouse we have developed an Eye-Cursor controlled mouse using OpenCV which can be used with Sunglasses, Spectacles and Contact Lenses also. The Eye-Controlled Movement

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