VIRTUAL EYE GAZE TRACKING USING COMPUTER VISION

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***Abstract*— For individuals with physical disabilities, using traditional computer input devices like a mouse can be challenging, if not impossible. To address this, we propose a method that enables eye gaze tracking to enable hands-free computer operation, making the experience more accessible for those with limited mobility. The human eye, with its precise movements, can serve as a suitable replacement for standard input hardware.In this approach, a web or camera captures images of the user's eyes, focusing on detecting pupil movements to control the cursor. This is achieved by determining the Eye Pupil movements,which tracks blinking and eye movement patterns (left or right). We utilize open-source computer vision tools, like Mediapipe and OpenCV, for real time managing of cursor movement effectively.The primary goal of this technique is to enhance the computing experience for people with disabilities, providing them with a reliable and more approachable way to interact with computers, particularly by overcoming the challenges associated with using a mouse. This solution offers a pathway for enabling individuals who struggle with traditional devices to express themselves and use computers more independently.**

Keywords-

Physical Disabilities,MediaPipe,OpenCV,PyAutoGUI

I. INTRODUCTION

In recent years, there has been a growing interest in developing natural communication between humans and computers. Human-Computer Interaction (HCI) has seen various studies and experiments, with vision-based interfaces being one promising approach. These interfaces allow the extraction of motion data without the need for expensive equipment, relying solely on video input. Eye detection is a crucial aspect of this vision-based method, as it facilitates the development of multimodal human-computer systems. Eye-tracking, in particular, is vital for creating applications that allow individuals with disabilities to interact with computers using their eye movements

The need for effective human-computer communication has become increasingly important as technology advances. Individuals with physical disabilities, especially those who are unable to use traditional input devices like keyboards and mice, can benefit significantly from eye-tracking systems. By incorporating eye movement control into computers, users can operate devices independently, without relying on external assistance. This type of HCI system opens up opportunities for disabled individuals to engage with technology, granting them access to the digital world and a more inclusive Information Society.

The use of eye-tracking as a form of input has gained traction, especially for users with limited mobility. This real-time eye input method has been utilized in various intelligent applications tailored for people with physical impairments. Eye-tracking technology detects eye movements and translates them into commands, enabling users to perform tasks like navigation, selection, and interaction with digital environments. Vision-based systems, which rely on detecting and interpreting eye movements, offer a hands-free solution for interacting with computers, improving accessibility for those with disabilities.

The proposed system integrates various key components such as face detection, face tracking, and real-time interpretation of eye blinks. By replacing traditional methods of computer interaction, such as using a mouse, with eye movements, this system enables paralyzed and physically challenged individuals, especially those without hands, to control computers more easily. The process begins with a camera capturing the user's face, followed by the detection and tracking of the eyes. Through OpenCV code, the pupil is located, and the system identifies the eye's central position, enabling the user to control the interface seamlessly.

II .RELATED RESEARCH

The basic actions of a mouse are mouse click and mouse movement. The advance technology replaces this mouse movement by eye motion with the help of an OpenCV. The mouse button click is implemented by any of the facial expressions such as blinking eyes, opening mouth and head movement. This model introduces a novel camera mouse driven by 3D model based bias face tracking technique. In personal computer(PC) due to the standard configuration it achieves human machine interaction through faster visual face tracking and provides a feasible solution to hand-free control. The face tracker used here is based on 3D model to control the mouse and carry out mouse operations. Gaze estimation can be used in Head-mounted display (HMD) environments since they can afford important natural computer interface cues. This new gaze estimation is based on 3D analysis of human eye. There are various commercial products which use gaze detection technology. In this method, the user has to point only one point for calibration it will then estimate the gaze points. The facial features such as eyes and nose tip are recognized and tracked to avoid the traditional mouse movements with the human face for human interaction with the computer. This method can be applied to face scales in a wide range.

III. Methodology

The first step was to use a face detection algorithm locate the face on an image frame captured by an ordinary webcam. The next step was to detect only the eyes from this frame. We consider tracking only one eye movement for faster processing time. Then the iris movement was tracked. Since the color of the iris is black, its image has a significantly lower intensity compared to the rest of the eye. This helps us in easy detection of the iris region. Taking the left and right corners of the eye as reference points, the shift of the iris as the person changed his eyes focus was determined. The shift was then used to map cursor location on the test graphical user interface (GUI).

IV. Architecture

The architecture of a system that enables cursor movement through eye-tracking for mobility-impaired or disabled individuals is designed to capture, process, and interpret real-time visual data from the user's eyes. At the core, the system employs a webcam or camera module to capture live video input of the user's face and eyes. This video stream is processed using OpenCV, a popular computer vision library, to handle tasks like face and eye detection. Mediapipe, a specialized framework for machine learning pipelines, is then used for precise eye tracking, including the detection of key facial landmarks. By leveraging these two tools, the system can pinpoint the user's eye gaze and track movements accurately.

Once the eyes are detected and tracked, the gaze direction and blink patterns are interpreted as input signals. Mediapipe extracts key data such as the position of the pupils and the direction of the gaze. These signals are continuously analyzed to determine where the user is looking on the screen. PyAutoGUI, a Python library for controlling the mouse and keyboard, takes over at this stage. PyAutoGUI maps the user's eye movements to corresponding cursor movements on the screen, effectively translating gaze direction into mouse motion. Blinks can also be interpreted as mouse clicks, allowing the user to perform selection actions. This integration allows the entire system to function in real time, providing seamless control for users with mobility impairments.

The system architecture is designed to be modular and scalable, allowing for further enhancements and fine-tuning based on the user's needs. The camera captures video frames that are processed through OpenCV for initial eye detection, while Mediapipe ensures high accuracy in tracking subtle eye movements. PyAutoGUI then provides an interface between the detected eye movements and the operating system's cursor control, effectively creating an intuitive, non-invasive input method. This architecture enables mobility-impaired or disabled individuals to control the computer cursor using only their eye movements, offering a practical and accessible solution for hands-free computing.

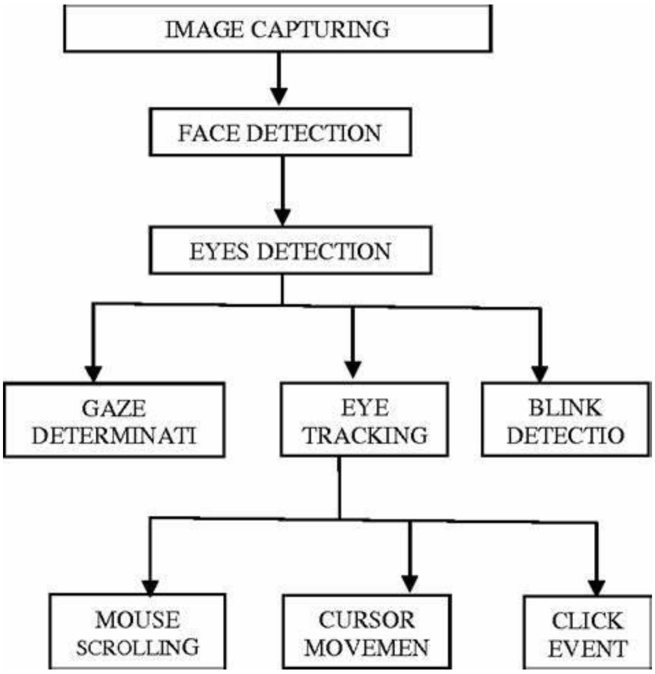


Fig Flow Chart

The system for enabling cursor movements using eye-tracking for mobility-impaired or disabled individuals starts by capturing live video of the user's face through a webcam. OpenCV is used to detect the face and isolate the eye region, while Mediapipe tracks the position and movements of the eyes by analyzing facial landmarks and pupil positions. The system continuously interprets eye gaze direction and blink patterns, which are translated into real-time cursor movements and clicks using PyAutoGUI. This seamless workflow allows users to control the computer entirely through eye movements, providing hands-free navigation and interaction.

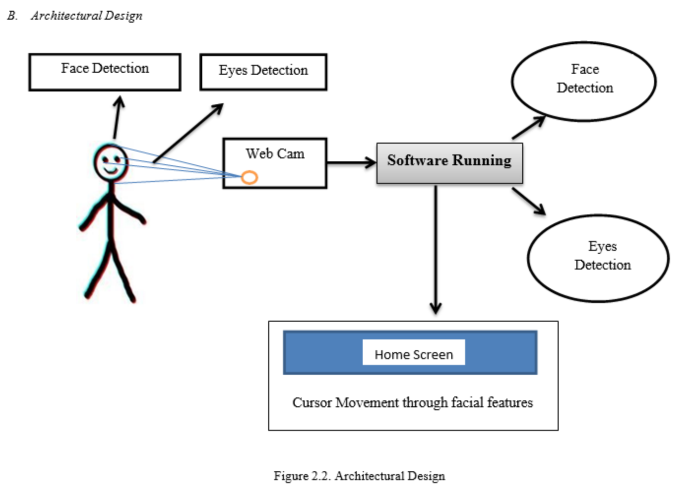


Fig: : Design Architecture

V. Evaluation

To evaluate a system that uses OpenCV, Mediapipe, and PyAutoGUI for eye-tracking and cursor control for disabled individuals, a structured approach is essential. First, accuracy testing should be conducted to determine how well the system detects the eyes and tracks gaze direction. This can be measured by comparing the predicted eye positions and movements with ground truth data from manually annotated video frames. OpenCV and Mediapipe offer tools to capture and analyze real-time video, ensuring precise tracking of eye movements.Next, the system should undergo usability testing with a focus group of users, particularly those with mobility impairments. This phase evaluates how intuitive and efficient the system is in practice. The ease of navigating through interfaces, the responsiveness of cursor movements to eye tracking, and the precision of mouse clicks via blinks can all be assessed using PyAutoGUI. Feedback from users helps in identifying potential improvements.

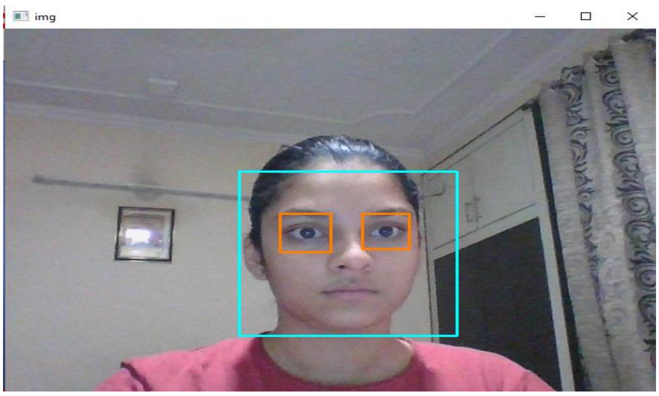
After initiating the OS the operation starts. At first PIR sensor is used to detect the presence of individual in front of system. If the person is detected then camera will ON, where image will be captured by USB Camera. Focus on eye in image is shown in Fig. 2. Now the center position of pupil is detected in OpenCV. Take the exact position of pupil as reference, and then the next the different value of X, Y coordinates will be set for accurate command.

This comprehensive evaluation helps ensure that the system is accurate, usable, and efficient, providing a practical solution for hands-free computing.

VI. RESULT

. The experimental aimed is to move cursor just by the movement of eye. The project is divided three section image capture processing and mouse movement. Adequate illumination need to be used for capturing an image which will provide a well defined shape of the pupil

The Hough transform is a technique which can be used to isolate features of a particular shape within an image. Because it requires that the desired features be specified in some parametric form, the classical Hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc.



VII. CONCLUSION

From the process implemented it is cleared that the cursor can be controlled by the eyeball movement i.e., without using hands on the computers. This will be helpful for the people having disability in using the physical parts of the computers to control the cursor points. Because the cursor points can be operated by moving the eyeballs. Without the help of others disabled people can use the computers. This technology can be enhanced in the future by inventing more techniques like clicking events as well as to do all the mouse movements and also for human interface systems using eye blinks. Technology also extended to the eyeball movement and eye blinking to get the efficient and accurate movement.

VIII. References

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