

REAL-TIME EYE CONTROLLED MOUSE SYSTEM USING OPEN CV

¹U.N. Subhadra Devi, ²CH.Adithya Vara Lakshmi, ³G.Netajee, ⁴J. Lokesh, ⁵B. Sowjanya

¹Associate Professor ^{2,3,4,5}Student,

^{1,2,3,4,5}Electronics and Communication Engineering,

^{1,2,3,4,5}Maharaj Vijayram Gajapathi Raj College of Engineering (Autonomous),
Vizianagaram, India.

Abstract: A person with physical disabilities to control the mouse is quite difficult. The research study suggested employing eye movements to control the mouse pointer to provide a solution for individuals who are unable to utilize a physical mouse. An alternate method of utilizing a computer is called eye-controlled mouse, which uses eye movements to operate the mouse, which is crucial for those with physical disabilities. This system proposes a revolutionary eye control method that uses a webcam and doesn't require any additional hardware. The suggested method explains how to utilize a webcam and Python to control the pointer movement on the monitor. The project's goal is to develop an open-source, free eye-controlled mouse system that precisely tracks eye movements. The first step to reach this goal is detecting the center of the pupil by using a pupil detection process with OpenCV, as cursor movement is directly linked to it, enabling users to perform cursor motion through eye motions and opening the file through eye blink captured by the computer webcam. All these actions done when the human face is in the square frame which is generated on screen through python. The system identifies the user's pupil on the face and monitors its movements in real-time for comfortable use.

Keywords: OpenCV, Mouse cursor control, Eye movements, Pupil detection, Frame, Blink.

I. INTRODUCTION

In today's technology-driven world, computers have become an essential part of daily life, supporting communication, education, work, and entertainment. However, not everyone can easily use these technologies. People with physical disabilities, especially those with limited hand or arm movement, often struggle to operate traditional input devices like a mouse and keyboard. Millions of individuals worldwide are affected by conditions such as paralysis, limb loss, or other motor impairments. Some are born with limb deficiencies, while others lose mobility due to accidents or diseases. This creates a major barrier to accessing the digital world and limits their independence.

Although some assistive solutions exist, such as specialized hardware or using sticks held in the mouth, these methods are often uncomfortable, costly, or inefficient. Therefore, there is a growing need for a simple, affordable, and user-friendly alternative that allows people with disabilities to interact with computers more easily. One innovative solution is the use of eye-tracking technology. Human eyes naturally indicate where a person is looking and what they intend to do. By tracking eye movements, it is possible to control a computer cursor without using hands. This project focuses on developing a virtual mouse system that works entirely through eye movements. Using a standard webcam along with technologies like OpenCV and facial landmark detection, the system identifies the position of the eyes and translates it into cursor movement in real time. This approach eliminates the need for expensive hardware and makes the system accessible to a wider range of users. It allows individuals with severe physical limitations to operate computers independently, improving their ability to learn, work, and communicate. At the same time, this technology can also be useful for people without disabilities as an alternative and modern way of interacting with computers.

Although challenges such as accuracy, calibration, and user differences exist, continuous improvements in eye-tracking technology are making such systems more reliable. Overall, this work aims to create a more inclusive and accessible digital environment for everyone.

II. LITERATURE SURVEY

In 2023, A. Syed Haroon et al. proposed an affordable eye-controlled mouse system using OpenCV and Media Pipe. Media Pipe enhances accuracy by detecting detailed facial landmarks, including eye and pupil positions. Their system tracks gaze direction to move the cursor and uses blinking actions to perform mouse clicks, improving usability and interaction efficiency.

Earlier work by Neil Castellino and Michelle Alva (2017) focused on developing an image-based assistive system for paralytic patients. Their system uses a Eye-tracking technology has gained significant attention in recent years as an effective solution for improving human-computer interaction, especially for individuals with physical disabilities. Various researchers have proposed systems that enable users to control computer functions using eye movements, eliminating the need for traditional input devices.

In 2025, Karthik T. et al. developed a real-time eye-controlled mouse system using OpenCV. Their approach uses a webcam to capture video, detect the user's face and eyes, and track eye movements to control the cursor. The system is designed to be simple, accessible, and cost-effective, making it suitable for users with limited hand mobility. The use of OpenCV allows the system to work efficiently with standard cameras.

In 2024, N. Vinutha and R. P. Vishwas conducted a comprehensive survey on different eye gaze tracking techniques. Their study analyzed methods such as Electrooculography (EOG), infrared tracking, and camera-based systems. They found that while EOG and infrared methods provide high accuracy, they require specialized equipment and can be expensive or uncomfortable. In contrast, camera-based approaches are more affordable and practical for everyday use.

camera and image processing techniques to detect eye movements and convert them into computer commands, helping users with severe disabilities operate computers independently.

Additionally, in 2013, Florina Ungureanu et al. proposed an eye-tracking mouse system to enhance HCI. Their work used pupil detection and gaze tracking to control cursor movement and introduced methods such as blinking and gaze holding for performing mouse clicks.

METHODOLOGY

The methodology of this project explains the step-by-step process used to develop an eye-controlled mouse system. The main goal is to enable users to control the computer cursor using eye movements and blinking, without relying on a physical mouse.

The first step is setting up the software environment. The system is developed using the Python programming language because it provides strong support for image processing and computer vision. Important libraries used include OpenCV, Media Pipe, and py auto GUI. OpenCV is used to capture and process images from the camera, Media Pipe is used to detect facial landmarks and eye positions, and py auto GUI is used to control the mouse cursor on the screen.

After setting up the environment, the system captures real-time video using a laptop camera or webcam. The camera continuously records the user's face, and each frame is processed to detect the face and locate the eyes.

Next, facial landmark detection is performed using Media Pipe. It identifies key points on the face, such as the eyes, eyelids, and iris. These landmarks help the system understand the user's gaze direction.

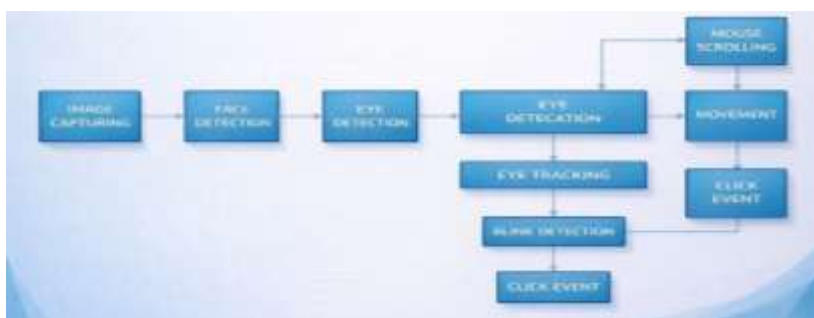
Once the eyes are detected, eye movement analysis is carried out. The system tracks the movement of the iris to determine where the user is looking and maps this movement to cursor coordinates on the screen.

To perform clicking actions, blink detection is used. A deliberate blink for a specific duration is recognized as a mouse click command, allowing the user to select items or open applications.

Finally, the detected eye movements are converted into cursor movements using PyAutoGUI. The system processes video frames continuously in real time to ensure smooth and accurate control.

This methodology results in a simple, low-cost, and efficient hands-free interaction system.

FLOW CHART



III. RESULT AND ANALYSIS

The eye-controlled mouse system was successfully developed and tested using a standard webcam along with OpenCV, Media Pipe, and PyAutoGUI. The system was able to detect the user's face and track eye movements in real time, which is the core requirement for hands-free interaction.

During testing, the system responded well to eye movements. When the user moved their eyes in different directions, the cursor followed the gaze on the screen. The movement was not abrupt because a smoothing technique was applied in the code. This made the cursor movement more stable and easier to control, reducing random jumps and improving user experience.

A square boundary was added in the system as an active tracking region. The cursor only moves when the user's eye is inside this square area. This feature is very useful because it prevents accidental cursor movement when the user is not intentionally controlling the system. It also helps in improving precision and makes the system feel more controlled and intentional.

Another important feature is the beep sound feedback. When the user's eye enters the active region, a beep sound is played. This gives immediate audio confirmation that the system is ready to track movement. This is especially helpful for users, as it provides both visual and audio feedback, making the system more interactive and user-friendly.

The blinking mechanism works as a substitute for mouse clicks. When the user blinks intentionally, the system detects it and performs a click action. A time delay is added between clicks to avoid multiple unwanted clicks from a single blink. This improves the reliability of the system and prevents accidental inputs.

However, some challenges were observed during testing. The system depends heavily on proper lighting conditions. In poor lighting or when the face is not clearly visible, the detection becomes less accurate. Similarly, if the user moves their head too much, the tracking may lose precision. There is also a small delay in cursor movement because the system continuously processes video frames in real time, which requires some computing power.

In addition, using eye movements for long periods can cause eye fatigue or discomfort for the user. This is an important factor to consider, especially for extended usage.

Despite these limitations, the system performed effectively as a low-cost and practical solution for hands-free computer interaction. It provides a useful alternative for individuals with physical disabilities, allowing them to interact with computers independently. With further improvements such as better calibration, enhanced accuracy, and optimized processing, the system can become even more reliable and widely usable in real-world applications.



Fig1: Detection of Eyes when face is in the frame

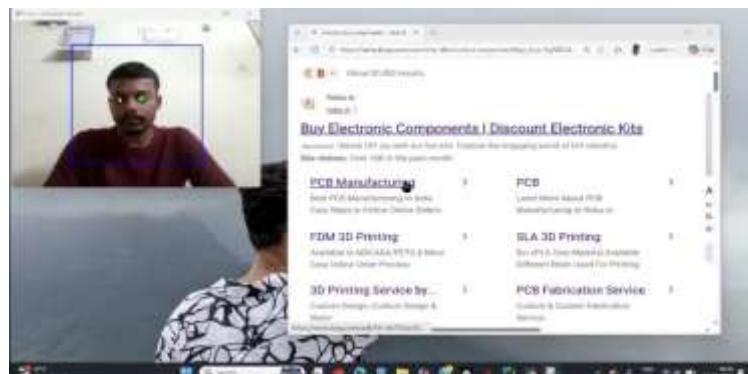


Fig 2: Opening of link

IV. DISCUSSION AND CONCLUSION

This project is about controlling a computer mouse using only your eyes, which makes use of a camera and technologies like OpenCV and Media Pipe to understand where your eyes are looking. The system continuously captures video from your webcam, detects your face, and identifies important points around your eyes. Based on these points, it decides where to move the mouse cursor on the screen. When you move your eyes, the cursor follows the movement, and when you blink, it performs a mouse click. This creates a hands-free way of interacting with the computer.

One important part of the system is making the movement smooth and comfortable. Eye movements are naturally small and sometimes unstable, and the camera can also introduce slight noise. If the program directly followed these movements without any processing, the cursor would feel very shaky and difficult to control. To solve this, the system uses a smoothing technique, where the cursor slowly moves toward the target position instead of jumping instantly. This makes the experience more natural and easier to use, although it can still be improved further for even better accuracy.

Another important feature is blink detection. The system watches the distance between certain points around the eye to determine if a blink has occurred. If the eyes close quickly, it interprets that as a click. This is a clever idea because blinking is a natural and simple action. However, it is not always perfect. Sometimes the system may detect a blink when there is none, or it may miss a real blink. This can happen due to differences in lighting, face position, camera quality, or even how different people blink.

The system also includes a visible square on the screen, which acts as a control area. The mouse only moves when the eye is inside this square. This helps reduce accidental movements and gives the user better control. Additionally, a beep sound is played when the eye enters the square, which provides feedback and helps the user understand when the system is actively tracking their eye. These small features improve the overall usability of the system.

Despite these useful features, the system still has some limitations. The mouse cursor can sometimes shake slightly, especially if the face is not steady or the lighting is not good. Blink detection is also not fully reliable, and there may be unwanted clicks or missed clicks. Another challenge is performance, as real-time video processing can use a lot of system resources, which may slow down the system on low-end computers. These issues are common in eye-tracking systems and can be improved by adding better filtering, calibration, and optimization techniques.

Overall, this project is a good example of how eye movement can be used as an alternative to traditional input devices like a mouse or keyboard. It shows how technology can help create more accessible systems, especially for people who have difficulty using their hands. Even though it is still a basic version with some limitations, it provides a strong foundation for future improvements. With further development, this type of system could become more accurate, stable, and widely used in real-world applications, making computer interaction easier and more inclusive for everyone.

V. ACKNOWLEDGEMENTS

We express our sincere gratitude to all those who supported us in the completion of this work. Their encouragement, assistance, and valuable contributions at various stages of the project played an important role in its successful completion. We also appreciate the constructive feedback and support received throughout the course of this work, which helped in improving the overall quality of the study.

REFERENCES

- [1] Karthik T., Darsan S., Tamil Nilavan S., Ranjani R., "Gaze Driven Pointer Control System Using OpenCV in Real Time", International Journal on Science and Technology (IJSAT), 2025.
- [2] IEEE paper on "Affordable Eye-Controlled Mouse Using OpenCV and Media Pipe" by A. Syed Haroon, Abhishek Chauhan, K. Ruthureshwaran, Nikhil Yadav (2023).
- [3] N. Vinutha, R. P. Vishwas, "Survey on Eye Gaze Tracking Techniques for Cursor Movement", International Journal of Advanced Research in Science, Communication and Technology, 2024.
- [4] Neil Castellino and Michelle Alva, "An image-based eye controlled assistive system for paralytic patients", IEEE Conference Publications, 2017.
- [5] Florina Ungureanu, Robert Gabriel Lupu and Valentin Siriteanu, "Eye tracking mouse for human-computer interaction", IEEE Conference Publications, 2013.
- [6] PUPIL: constructing the space of visual attention. Diss. Massachusetts Institute of Technology, 2012.) Kassner, Phillip, and Patera (2012).
- [7] IEEE paper on "Differences in the infrared bright pupil response of human eyes" by Karlene Nguyen, Cindy Wagner, David Koons, Myron Flickner (2009).
- [8] "An eye tracking algorithm based on Hough transform" <https://ieeexplore.ieee.org/document/8408915/> (12.5.2018).
- [9] Eye gaze location detection based on iris tracking with web camera: <https://ieeexplore.ieee.org/document/8404214/> (5.7.2018)
- [10] Sunita Barve, Dhaval Dholakia, Shashank Gupta and Dhananjay Dhatrak, "Facial Feature Based Method for Real Time Face Detection and Tracking I-CURSOR", International Journal of Eng Research and App., vol. 2, pp. 1406-1410, Apr 2012.
- [11] W. Tanguksant, C. Aekmunkhongpaisal, P. Cambua, T. Charoen pong, and T. Chanwimalueang, "Directional eye movement detection system for virtual keyboard controller," IEEE Xplore, Dec. 01, 2012. <https://ieeexplore.ieee.org/abstract/document/6465432/> Mar. 09, 2024).

Copyright & License:

© Authors retain the copyright of this article. This work is published under the Creative Commons Attribution 4.0 International License (CC BY 4.0), permitting unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.