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EYE GAZE TRACKING TO CONTROL CURSOR MOVEMENT

Prof.Vinutha.N[1], Anusha.N[2], Anusha.P[3], Punyashree.C[4],Vishwas .RP[5]

Faculty, Department of Computer Science and Engineering, Vidya Vikas Institute of Engineering and Technology, Mysore, Karnataka[1]

Students, Department of Computer Science and Engineering, Vidya Vikas Institute of Engineering and Technology, Mysore, Karnataka[2-5]

Abstract: Controlling a mouse can be particularly challenging for individuals with physical disabilities. To address this issue, we propose a system that enables mouse cursor control using eye movements. Eye gaze offers an alternative method for computer access, allowing users to control the mouse by simply moving their eyes. This approach is especially valuable for those who find touchscreens and traditional mice inaccessible. Eye movement serves as a crucial real-time input medium for human-computer interaction, particularly for individuals with physical disabilities. To enhance the reliability, mobility, and usability of eye tracking technology in user-computer interactions, we have developed a novel eye control system that utilizes a standard webcam, eliminating the need for additional hardware.

Our proposed system focuses on providing a simple and convenient interactive mode that relies solely on the user's eye movements. The system's usage flow is designed to align seamlessly with natural human behaviours. The implementation includes tracking both the iris and cursor movement based on the iris position, allowing for precise control of the cursor on the screen. This eye control system is implemented using Python and leverages webcam technology to detect and interpret eye movements. The simplicity and accessibility of this system make it a promising solution for enhancing computer usability for physically challenged individuals.

I. INTROUDCTION

The increasing demand for intuitive and immersive human-computer interaction has spurred the development of novel input methods. Traditional mouse-based interaction may not always be feasible or convenient, especially in virtual reality environments or for individuals with physical impairments. To address these challenges, researchers have explored the use of machine learning techniques to develop human-controlled virtual mouse systems. These systems aim to interpret human gestures and translate them into corresponding mouse commands, enabling users to interact with digital interfaces in a more natural and flexible manner.

Eye-controlled virtual mouse technology offers users the ability to interact with their computers using only their eyes. This technology is particularly beneficial for individuals with physical disabilities or motor impairments that make traditional computer input methods difficult or impossible. The system employs an eye tracker to detect the movements of the user's eyes, which are then translated into mouse movements. This allows the user to move the mouse pointer and click on items on the screen simply by looking at them.

The implementation of this technology can significantly enhance the quality of life for individuals with disabilities, enabling them to interact with computers in ways that were previously inaccessible. Eye-controlled virtual mouse systems not only promote greater accessibility but also pave the way for more inclusive and user-friendly digital environments.

II. LITERATURE SURVEY

1. Eye-Controlled Mouse Cursor for Physically Disabled Individuals

Authors: Mohamed Nasor, Mujeeb Rahman K K, Maryam Mohamed, Haya Ansari, Farida Mohamed (2018)

This paper presents a new algorithm for controlling a computer screen cursor using eye movements. By accurately detecting the position of the iris, the algorithm maps this to a specific position on the screen, enabling physically disabled individuals to control the cursor's movements (left, right, up, down) and perform actions like opening and closing files or applications through a clicking mechanism.

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2. Mouse Cursor Control with Eye Movement Using OpenCV and Machine Learning
Authors: Murali Manoharan, Jaya Krishna Alagappan Pachamuthu, Surya Ganapathy (2024)
For people with physical challenges, using a mouse can be very difficult. Our proposed solution uses eye movements to control the mouse. Eye gaze is a method where users control their computer with their eye movements, especially helpful for those who can't use touchscreens or traditional mice. This system uses a webcam and machine learning to improve the reliability, mobility, and usability of eye tracking for user-computer interaction, allowing users to control the cursor with just their eyes.

3. System Cursor Control Using Human Eyeball Movement
Authors: Dhanasekar J, Guru Aravindh K B, Kiren A S, Faizal Ahamath A (2024)
This paper develops a hands-free system for controlling a computer cursor using eyeball movements. Using image processing and machine learning algorithms in Python, the system translates eyeball movements and blinks into cursor movements and clicks. This system is accurate and user-friendly, improving computer accessibility for individuals with motor impairments. It has potential applications in gaming and virtual reality.

4. Human-Eye Controlled Virtual Mouse
Authors: Mr. Dhanaraju, Dr. Sreenivas Mekala, A. Harsha Vardhan Rao, CH. Pavan Kumar, R. Lokesh (2024)
In the digital era, hands-free computing is essential for individuals with disabilities, like quadriplegics. This paper introduces a Human-Computer Interaction system that uses eye movements (blinking, staring, squinting) to control the mouse cursor. The system is implemented using Python, OpenCV, NumPy, and basic camera technology, making it completely hands-free without requiring additional hardware or sensors.

5. Eyeball Movement-Based Cursor Using Deep Learning
Authors: Shubham Rane, Nihal Salian, Mohit Shetty, Rohan Shinde, Swati Rane (2021)
This paper proposes a hands-free human-machine interaction system for better communication between humans and computers. Long hours of using a mouse can lead to wrist and hand issues. This system, designed for differently-abled people, allows them to control the mouse with their eyes. Using deep learning and machine learning, the system accurately tracks eye movements to control the cursor. The system includes noise reduction filters to ensure smooth and accurate operation.

III. METHODOLOGY

PROPOSED METHODOLOGY

1. System Design
Develop a system to control the mouse cursor using eye movements for physically challenged individuals.
Approach: Utilize a webcam to track eye movements and implement the system using Python without additional hardware.

2. Hardware and Software Requirements
Hardware: Standard webcam
Software: Python, OpenCV for image processing, machine learning libraries for eye movement detection

3. Eye Movement Detection
Webcam Setup: Configure the webcam to capture real-time video of the user's eyes.
Image Processing: Use OpenCV to preprocess the video frames, enhancing the visibility of the iris.
Iris Detection: Implement algorithms to accurately detect the position of the iris within each frame.

4. Mapping Eye Movements to Cursor Movements
Coordinate Mapping: Develop a mapping mechanism to translate iris position to corresponding cursor movements on the screen.

Calibration: Implement a calibration step to align the detected iris position with specific screen coordinates.

5. Cursor Control Mechanism
Movement Control: Allow the cursor to move in response to the detected direction of the user's gaze (left, right, up, down).

Clicking Mechanism: Implement a method to simulate mouse clicks through prolonged eye focus or blinking.

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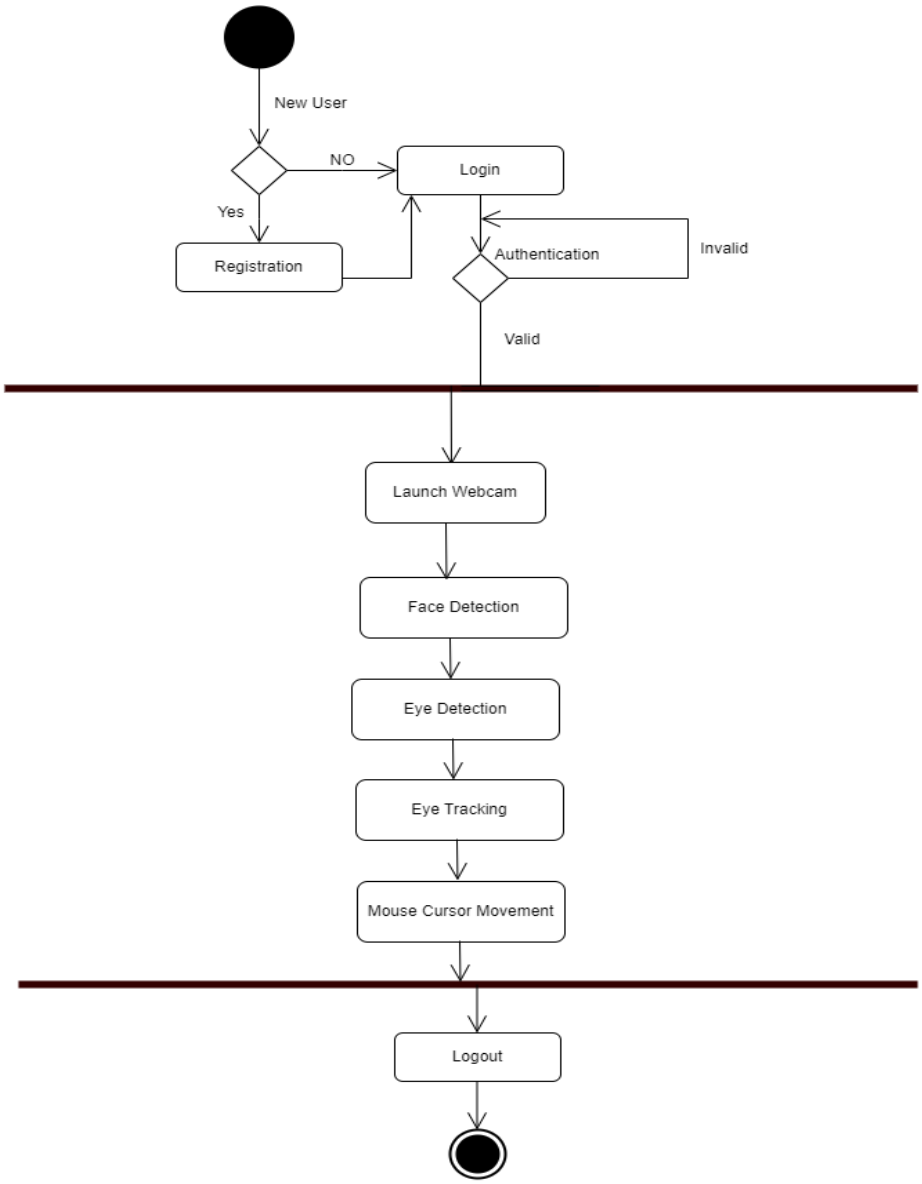
6. User Interface Design

Interactive Mode: Design the system to follow natural human habits, ensuring intuitive and seamless interaction.

7. Implementation

Programming: Develop the system using Python, integrating OpenCV for image processing and machine learning techniques for accurate eye tracking.



IV. RESULTS & DISCUSSION

➢ **Effectiveness for Physically Challenged Users**

The eye-controlled mouse cursor system significantly improved accessibility for users with physical disabilities, allowing them to interact with computers without using their hands.

The system's reliance on eye movements provided a reliable alternative to traditional input devices, enhancing the autonomy and independence of users.

➢ **Challenges and Limitations**

While the system performed well under controlled conditions, varying ambient light and background conditions affected the accuracy of iris detection.

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Some users with severe eye movement restrictions or conditions such as nystagmus experienced difficulty in achieving consistent cursor control.

Prolonged use of the system could lead to eye strain, indicating a need for further optimization in terms of user comfort and ergonomics.

➢ **Comparison with Existing Technologies**

Compared to other assistive technologies like head-tracking or voice-controlled systems, the eye-controlled cursor system offered a more direct and natural method of interaction.

The system's reliance on a standard webcam without additional hardware reduced costs and complexity, making it more accessible and easier to deploy.

➢ **Future Improvements**

Enhancing the robustness of the system to cope with varying environmental conditions would improve overall reliability. Integrating machine learning models that adapt to individual user patterns could further increase the accuracy and usability of the system.

Exploring additional features such as multi-click options, scroll functions, and customizable gestures would expand the system's functionality.

➢ **Implications for Broader Applications**

Beyond assisting physically challenged individuals, the eye-controlled mouse cursor system has potential applications in fields such as virtual reality, gaming, and hands-free control environments.

Its ability to provide an alternative interaction method could lead to innovations in how users interact with digital interfaces, promoting more inclusive and versatile technology use.

V. CONCLUSION

The development of an eye-controlled mouse cursor system represents a significant advancement in assistive technology, providing a viable solution for individuals with physical disabilities who find traditional input methods challenging. This project successfully demonstrates that eye movements can be harnessed to control computer cursors, offering an intuitive and accessible alternative to the conventional mouse.

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