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Cursor Interaction System

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ABSTRACT: 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 touchscreens, mouse inaccessible, eye gaze is an alternative method to allow a user to operate their computer, using the movement of their eyes. Eye movement and facial Movements 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.

KEY WORDS: Eye Movements,Eye Gaze,Facial Movements,Head Movements

I. INTRODUCTION

The core problem addressed by this project is the limited accessibility to computers for individuals facing physical challenges, specifically those without the use of both hands. Traditional computer interaction methods often rely on manual input devices like mice, which can be a significant barrier for individuals with physical disabilities. This project aims to alleviate this challenge by providing an alternative, hands-free method for mouse cursor control through facial movements. The project's focus on recognizing actions such as squinting, winking, and head movements enables individuals without the use of both hands to interact with computers effectively. By creating an inclusive Human-Computer Interaction (HCI) solution, the project strives to empower users facing physical limitations and enhance their ability to engage with computing devices.

SCOPE OF THE PROJECT:

The scope of this project encompasses the development and implementation of a hands-free mouse cursor control system using facial movements. The primary focus lies in leveraging Dlib's prebuilt model for facial landmark detection, enabling the interpretation of specific facial actions such as squinting, winking, head movement, and mouth opening as triggers to manipulate the mouse cursor. The system utilizes Python, along with popular libraries such as Numpy, OpenCV, PyAutoGUI, Dlib, and Imutils, ensuring accessibility and ease of integration. The project aims to enhance user-friendliness by allowing configurable facial gestures, enabling users to define their preferred actions for mouse control. The methodology involves predicting 68 2D facial landmarks and utilizing features like Eye-Aspect-Ratio (EAR) and Mouth-Aspect-Ratio (MAR) to detect blinks, winks, and mouth states. The scope extends to providing a detailed execution guide and acknowledging contributions from relevant sources. Future enhancements could include refining facial gestures, improving gesture configurability, and exploring applications for users with specific physical challenges.

II. LITERATURE REVIEW

Computer Cursor Control Using Eye and Face Gestures
Authors: Akshada Dongre; Rodney Pinto; Ameya Patkar; Minal Lopes
Year: 2020

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Description:In this paper, they use the SUNS dataset , which is organized by scene. It isnatural to predict image maps by using image data and prior knowledge to set up an optimization problem, which is solved to recover the desired representation. Scene labels can be provided automatically at high accuracy. Their method performs best when scene information is available from an oracle.

ImageNet classification with deep convolutional neural networks
Authors: A. Krizhevsky, I. Sutskever, and G. E. Hinton**.**
Year: 2017
Description:
The Imagenet contains eight layers with weights; the first five are convolutional and the remaining three are fully connected. It collect larger datasets, learn more powerful models, and use better techniques for preventing overfitting. The network'sperformance degrades even if a single convolutional layer is removed.

Fully convolutional networks for semantic segmentation.
Authors: J. Long, E. Shelhamer, and T.Darell
Year: 2015
Description:
This review paper demonstrates that semantic segmentation using convolutional networks alone, trained end-to-end, pixels-to-pixels, outperforms the prior best practice. Improved accuracy by transferring pretrained classifier weights. Although frequent, patch-wise training falls short of fully convolutional training in terms of effectiveness.

Semantic colorization with Internet image.
Authors: A. Y. S. Chia et al.
Year: 2011
Description:
In order to colorize a grayscale image, the user must frequently put a lot of color scribbles across the image to start a color propagation method, or they must search for certain colors. It minimize user effort an facilitate accurate color transfer. Foreground segmentation using lazzy snipping can be coarse for boundaries withfine scale structure. The color transfer for background regions are less accurate than for foregrounds.

Image colorization with neural network.
Authors: M. Richart, J. Visca, and J. Baliosian.
Year: 2017
Description:
This paper is based on training a simple classifier using back propagation over a training set of color and corresponding gray scale pictures. The classifier predicts thecolor of a pixel based on the gray level of the pixels surrounding it. The project implied color reduction using vector quantization and using a group of neighboring pixels to predict the color of a single pixel. The size of the SOM is an important aspect to improve, as the colors obtained depends on the size of the SOM used.

III. METHODOLOGY

1. exactly how long to wait and where the next coming bus is. Global
2. Positioning System (GPS) is the main technology implemented
3. behind the system. A GPS receiver is used to track on real time bus
4. coordination by continuously receiving the position data which are
5. latitude and longitude values from GPS satellite, then send the
6. position data back to main server and server process the raw
7. position data into real time information for users. This system is
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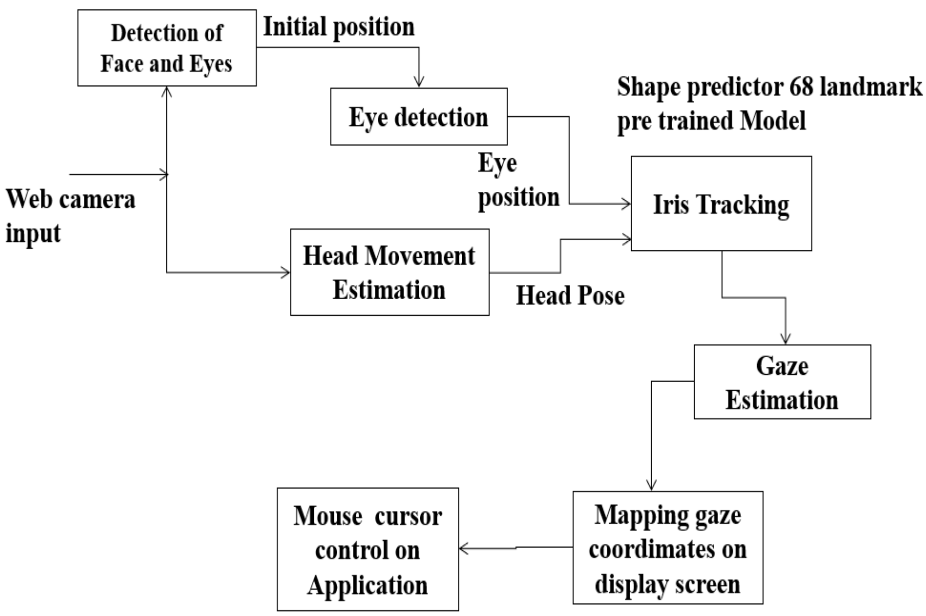
BLOCK DIAGRAM:

This literature survey explores the integration of gaze tracking into standard human-computer interaction (HCI) by employing it as a supplementary tool rather than a standalone pointing mechanism. The study focuses on cursor warping, where the cursor automatically moves to the estimated point of user focus, reducing the manual effort and time required for mouse and keyboard interactions. Results from user studies indicate the potential of cursor warping to enhance efficiency in tasks such as target acquisition, text cursor positioning, text selection, and drag-and-drop operations.



MODULES NAME

- Eye and Mouth Aspect Ratios
- Facial Landmark Detection
- Interaction Triggers
- Eye Movement and Wink Detection
- Mouse Cursor Control
- Input Mode and Scroll Mode
- Implementation Details
- Model Details

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MODULES NAME DESCIPTION:

Eye and Mouth Aspect Ratios:

The system calculates the Eye-Aspect-Ratio (EAR) and Mouth-Aspect-Ratio (MAR) to interpret eye blinks, winks, and mouth states crucial for mouse control.

EAR is computed based on the euclidean distances between vertical and horizontal eye landmarks, determining the eyes' openness.

MAR is derived from distances between sets of mouth landmarks, assessing the mouth's openness.

Facial Landmark Detection:

- Dlib's face detector is employed to locate faces in the webcam feed. Once a face is detected, the facial landmark predictor identifies 68 2D facial landmarks, including eyes, nose, and mouth.
- Interaction Triggers:
  - The system interprets specific facial movements as triggers for mouse actions. These include squinting, winking, head movement, and mouth opening.
  - Different thresholds and consecutive frame counts are set for various actions, ensuring reliable and intentional gestures.

Eye Movement and Wink Detection:

- The system distinguishes between eye movements, detecting if the user is looking left, right, up, or down.
- Wink detection involves comparing the Eye-Aspect-Ratio (EAR) of both eyes and determining if a deliberate wink gesture is performed.

Mouse Cursor Control:

- PyAutoGUI is utilized to control the mouse cursor based on the interpreted facial gestures.
- Actions include left and right clicks triggered by winks, cursor movement with head gestures, and scrolling with specific eye movements.

Input Mode and Scroll Mode:

- The system introduces an "Input Mode" activated by mouth gestures, allowing users to readjust the cursor's anchor point and perform drag-and-drop actions.
- "Scroll Mode" enables scrolling functionality, enhancing the system's versatility for different tasks.

Implementation Details:

- The code utilizes Python with libraries such as OpenCV, Dlib, Imutils, and PyAutoGUI for efficient implementation.
- Detailed instructions for installing the required libraries and executing the code are provided in the project documentation.

Model Details:

- The underlying facial landmark prediction model is based on the work of Kazemi and Sullivan, trained on the shape_predictor_68_face_landmarks dataset.

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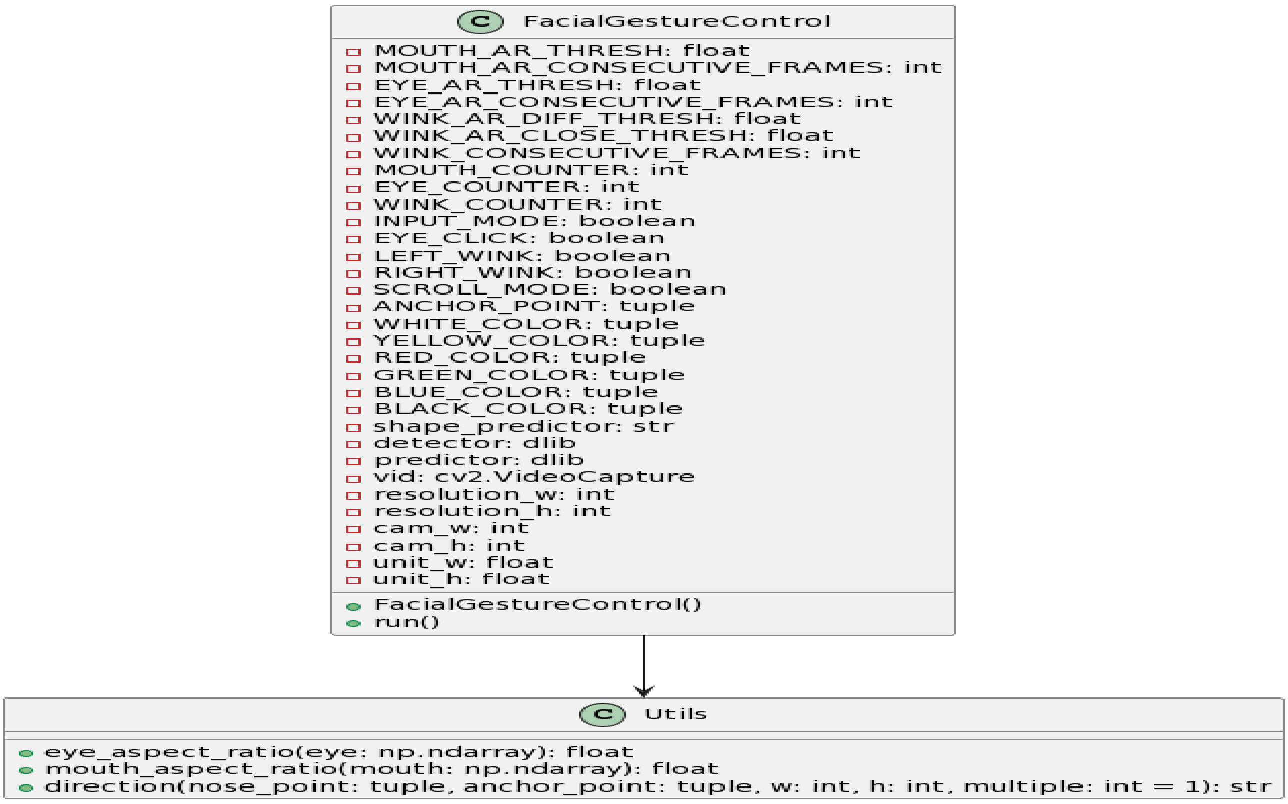
UML DIAGRAM:



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Unit Testing:

- Conduct unit tests for individual functions in your code. This includes functions for eye aspect ratio calculation, mouth aspect ratio calculation, and direction determination
- Verify that each unit of code behaves as expected and handles different scenarios appropriately.

Integration Testing:

• Perform integration tests to ensure that all components of your system work together seamlessly. This includes testing the coordination between facial landmark detection, mouse action triggering, and cursor control.

Functional Testing:

Test the overall functionality of your application by simulating different facial movements and gestures. Check if the mouse cursor responds correctly to actions like blinking, winking, head movement, and mouth opening.

Performance Measurement:

- Measure the real-time performance of your system. Check the frames per second (FPS) rate to ensure that the application responds quickly to facial movements.
- Evaluate the accuracy and consistency of facial landmark detection. Ensure that the mouse cursor follows the user's movements accurately.

User Testing:

- Conduct user testing with individuals who have physical challenges or disabilities to gather feedback on the user experience. Understand their interactions with the system and identify any areas for improvement.

Edge Case Testing:

- Test your application in different lighting conditions, camera angles, and environments to ensure robust performance in real-world scenarios.

Evaluate how well the system adapts to unconventional facial movements and gestures

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Error Handling Testing:

- Intentionally introduce errors or disruptions (e.g., sudden changes in lighting) to assess how well your application handles unexpected situations. Implement appropriate error handling mechanisms.

Usability Testing:

- Assess the overall usability of your hands-free mouse control system. Evaluate if the defined gestures are intuitive and user-friendly.
- Gather feedback on the ease of configuration for users who might want to customize facial gestures.

Performance Metrics:

- Define and measure performance metrics such as response time, accuracy in cursor movement, and false-positive/negative rates for different facial gestures.

Optimization:

Identify areas for optimization to enhance the overall performance of your system. This might include optimizing code, improving the facial landmark detection model, or enhancing the cursor control algorithm

Features

- Hands-free mouse cursor control using facial movements captured by a standard webcam.
- Accurate recognition of facial movements, including squinting, winking, head movement, and mouth opening, as triggers for mouse cursor manipulation.
- Development of a user-friendly interface that encourages easy and natural facial gestures for mouse interaction.
- Utilization of Dlib's prebuilt model for facial landmark detection, ensuring accurate prediction of 68 2D facial landmarks

Specifications:

Hardware Requirements:

System	:	Pentium IV 2.4 GHz.
Hard Disk	:	1TB
Floppy Drive	:	1.44 Mb.
Monitor	:	15 VGA Color.
Mouse	:	Logitech.
Ram	:	8Gb.

Software Requirements:

Operating system	:	Windows 10
Coding Language	:	Python
IDE	:	Anaconda Navigator
Language	:	Python

How eye tracking works

Typically, an eye tracking system comprises one or more cameras, some light sources, and computing capabilities. Algorithms translate the camera feed into data points with the help of machine learning and advanced image processing.

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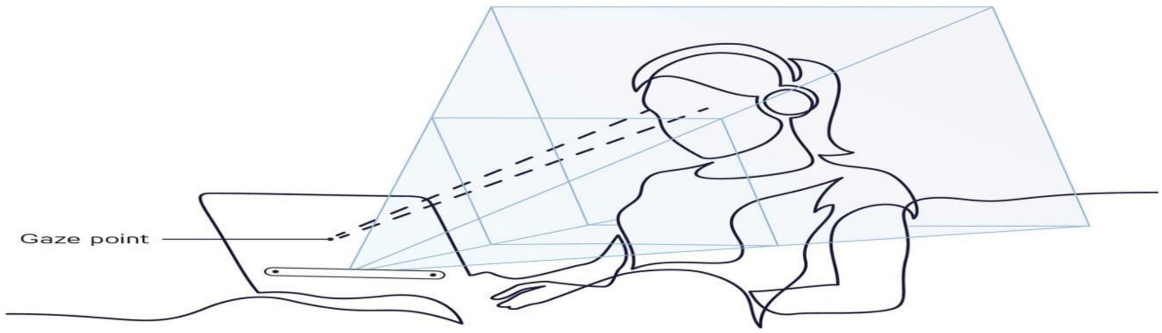
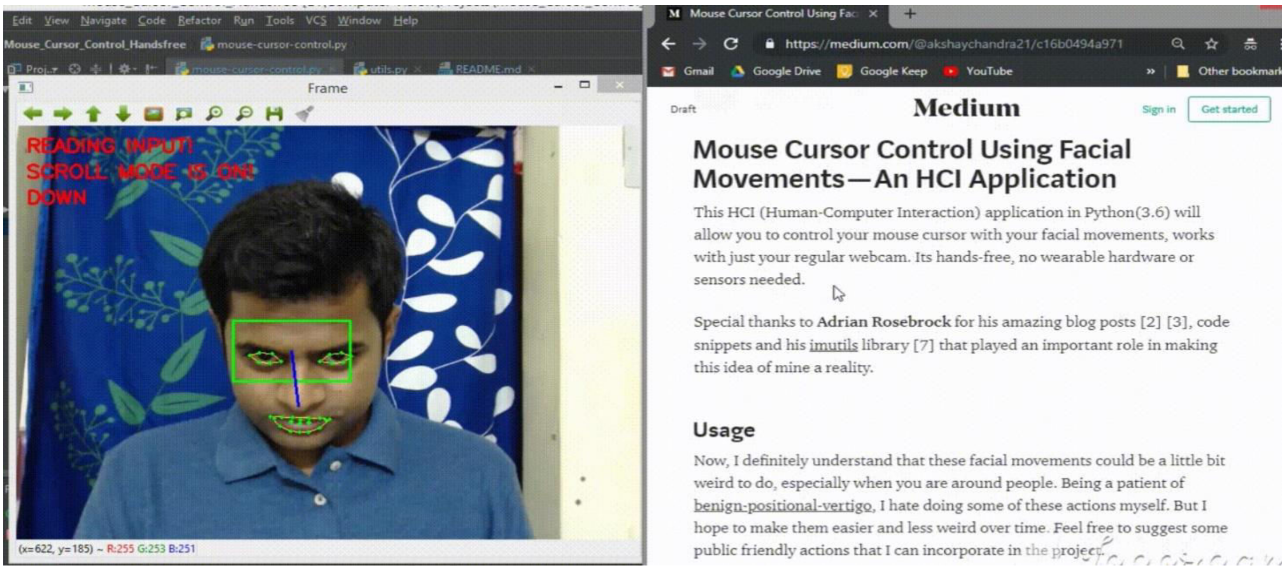


Types of Eye Trackers
Eye trackers use different technologies to measure and analyze eye movements. Here is a brief overview of three common types of eye trackers:

Remote Eye Trackers:
Remote eye trackers are typically mounted on a fixed position, such as a desk or a stand, and are used to track the movement of the eyes in relation to the environment. They typically use a combination of sensors and cameras to measure eye movements and are typically more accurate than head-mounted eye trackers. However, they may be less portable and more difficult to use in certain situations, such as when the user is moving around.

Head-Mounted Eye Trackers :
Head-mounted eye trackers are worn in front of the eyes and are typically used to track the movement of the eyes in relation to the head. Head-mounted eye trackers are typically more portable and easier to use than remote eye trackers, but they may be less accurate due to the movement of the head and the proximity of the sensors to the eyes.

Electrooculography (EOG) Eye Trackers :
EOG eye trackers use electrodes to measure the electric potentials produced by the eye muscles. They are relatively inexpensive and easy to use, but they may not be as accurate as other types of eye tracking. EOG eye trackers are typically used in applications where high accuracy is not a critical requirement.



In this where we can scroll mode is on and we scroll up and down by head movements.

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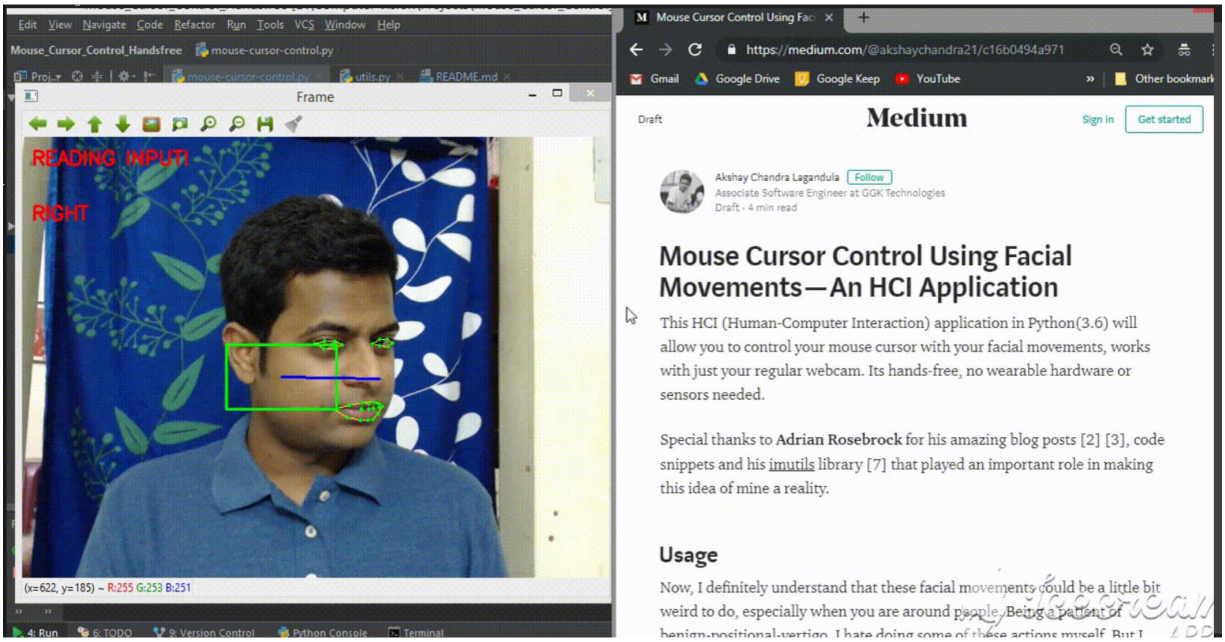
Future works:

- Expansion of configurability options, enabling users to define and personalize a wider range of facial gestures for mouse control.
- Continued improvement of facial gestures to make them more user-friendly, reducing the discomfort associated with unconventional actions.
- Exploration and implementation of advanced feature detection techniques for recognizing additional facial expressions and actions.
- Development of a graphical user interface (GUI) or settings panel for easily customizing and fine-tuning gesture recognition parameters.
- These future works aim to refine and extend the capabilities of the existing system, providing users with a more customizable and versatile hands-free mouse control experience while exploring broader applications and improvements in user comfort.

OUTPUT:



IV. CONCLUSION

In conclusion, this project revolutionizes computer interaction for individuals with physical challenges, offering a groundbreaking solution through facial movements. By harnessing the power of a standard webcam and advanced algorithms, the system enables hands-free control of the mouse cursor, bringing newfound accessibility to those facing limitations in using traditional input devices. The facial feature detection accurately captures movements, while the gesture interpretation module translates these movements into meaningful actions like clicking and scrolling. The user-friendly configuration module ensures adaptability, allowing users to personalize the experience based on their unique preferences. Furthermore, the incorporation of EAR and MAR features enhances the system's reliability in interpreting blinks and mouth states. This project not only addresses a critical need for individuals with physical disabilities but also emphasizes transparency and knowledge sharing by acknowledging and building upon existing works. Ultimately, this hands-free mouse control system stands as a testament to the potential of technology to empower and inclusively serve users of all abilities.

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