# OPERATING COMPUTER CURSOR USING EYE AND FACE MOVEMENTS

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**ABSTRACT**

The advent of modern human computer interfaces has seen a considerable progress in Handsfree Human Computer Interaction (HCI) solutions. This project focuses on developing a methodology to facilitate computer cursor control for people with physical disabilities such as Quadriplegics and amputees. An innovative solution for individuals facing physical challenges in using a traditional mouse by introducing eye gaze control for the mouse cursor. Opening/closing the mouth based on Mouth Aspect Ratio (MAR) indicates activation/deactivation of the cursor control. The nose tip is used for controlling and moving the cursor in all 4 directions by moving the head left, right, up and down. Eye Aspect Ratio (EAR) is used to detect eyes and eye flickering. Left and right eye blinks indicate left and right clicks respectively. Squinted eyes indicate scrolling of pages, which is beneficial while working with PDFs and other such documents. The proposed system requires very basic requirements like webcam and a few Python libraries such as OpenCV, Numpy, imutils, dlib and PyAutoGUI. This alternative method leverages eye movements, catering to those who find touchscreens or traditional mice inaccessible. The system, implemented in Python by using OpenCV library, tracks both iris movement and cursor positioning, providing an efficient and user-friendly virtual mouse controller accessible to anyone, especially those with physical disabilities relying on eye movements.

**Keywords**: Eye Tracking, Virtual Mouse, web-cam based interaction, Human-computer interaction, OpenCV, 68point landmark algorithm, MAR, EAR.

## INTRODUCTION

In today's digital age, computers have become indispensable tools in various aspects of daily life, from communication and work to entertainment and education. The standard method for navigating the computer screen remains the traditional computer mouse, providing users with precise control and interaction. However, for individuals facing physical challenges such as quadriplegia, limb loss, or Locked-in syndrome (LIS), using conventional input devices like the mouse proves impractical or impossible. While existing systems, such as eye movement-based cursor controls, offer a means for individuals with physical disabilities to interact with computers without physical contact, they often suffer from inefficiencies. One of the primary challenges arises from the inability to differentiate deliberate eye movements from unintentional ones, leading to inaccuracies and frustration for users. Recognizing this critical limitation, there arises a pressing need for a hands-free cursor control system that can accurately interpret and respond to the user's intentions. In response to this need, we present a novel approach to cursor control that utilizes eye movements as a precise means of managing the computer cursor. This innovative solution aims to address the shortcomings of existing systems by providing users with a practical, convenient, and empowering method for navigating digital interfaces without the need for physical input devices. The proposed methodology for operating the computer cursor using eye and face movements offers a comprehensive suite of functionalities designed to meet the diverse needs of users with physical challenges. These functionalities include left-clicking, right-clicking, as well as moving the cursor in all directions—up, down, left, and right—enabling seamless navigation across the screen. Additionally, the system facilitates scrolling up and down, further enhancing the user's ability to interact with digital content effortlessly.

## LITERATURE SURVEY

1. **Cursor Control Using Eye Ball Movement by Vandana Khare, S.Gopala Krishna and Sai Kalyan Sanisetty**

   An eyeball based cursor system [1] developed on Raspberry Pi with the pupil as the main point. The cursor moves according to the eyeball movements. The Blinks are translated into clicks based on EAR (Eye Aspect Ratio) value. The system uses an Internet protocol camera to take the image of an eye frame for cursor movement. The cursor will move on the screen depending on how the eye ball is moving, i.e. by mimicking the movement of eye. The user has to move his eyes and focus on where he wants the cursor to move, and it will move accordingly. Clicks are performed by eye winking.

   Summary: From this article, I have considered the EAR(Eye aspect ratio) values and threshold values.
2. **Real-Time Driver Drowsiness Detection Using Eye Aspect Ratio and Eye Closure Ratio by Sukrit Mehta, Sharad Dadhich, Sahil Gumber, Arpita Jadhav Bhatt**

   The Re-Time driver drowsiness system [2] is used to detect the drowsiness level of a driver and send alarm of the same. It makes use of dlib's pre-trained face detector and then captures facial landmarks. These landmarks are used to calculate the EAR value, i.e., Eye Aspect Ratio. If the EAR is lesser than the threshold value, it would indicate a state of fatigue/drowsiness of the driver. ECR value (Eye Closure Ratio) is calculate using the sleep counter (number of times EAR is lesser than the threshold value). If the ECR value exceeds the threshold value, then an alarm is generated to indicate the drowsiness state of the driver.

   Summary: From this article, I have considered ECR value(eye closure ratio).
3. **Facial Expression Based Computer Cursor Control System for Assisting Physically Disabled Person by M. Vasanthan, M. Murugappan, R. Nagarajan, Bukhari Ilias, J. Letchumikanth**

   In this proposed system, a set of five facial expressions are used for controlling cursor movement in left, right, up and down direction and click, respectively [3] . Four luminous stickers are placed on the user's cheeks, forehead, and mouth. Movement of these markers is detected the coordinate changes on the input video and each of the five expressions is represented by five ASCII characters, which are in turn represented by binary numbers.

   Summary: From this article, I have considered libraries and functions that are used in detecting facial expressions, to recognize the actions performed.
4. **Design of Real-time Drowsiness Detection System using Dlib by Shruti Mohanty, Shruti Hegde, Supriya Prasad and J. Manikandan**

   This paper deals with driver drowsiness detection using Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) [4]. The system makes use of Dlib library for face and landmark detection. The calculated aspect ratio values are compared with the eye and mouth threshold values, i.e., if the EAR value drops down , it is considered as a state of drowsiness. IF the MAR value exceeds the threshold value, it is taken as a yawn and the corresponding alarms are fired.

   Summary: From this article, I have considered MAR(Mouth Aspect Ratio and threshold values.

## EXISTING SYSTEM

The Eyeball Movement based Cursor (EMC) is an innovative approach aimed at bridging the gap between individuals with disabilities and computer systems. This system leverages advances in computer vision and hardware technologies to enable cursor control through the movement of the user's eyes. Below is a detailed explanation of the components and functioning of the EMC system:

1. **Image Capture with Internet Protocol Camera:** The process begins with an Internet protocol (IP) camera capturing an image of the user's eye frame.
2. **Pupil Identification using Raspberry Pi**: The captured image is then processed using a Raspberry Pi, a small and affordable single-board computer.
3. **Eye Photo Capture with Eye Aspect Ratio (EAR):** To facilitate accurate pupil identification, the system utilizes the Eye Aspect Ratio (EAR) threshold comparison technique. EAR is a measure derived from facial landmarks and is used to determine the openness of an eye

4. **Cursor Movement Imitating Eye's Movement:** Once the user's eye movement is detected, the cursor on the computer screen moves accordingly, imitating the direction and speed of the eye movement. This ensures that the cursor aligns with the user's gaze and follows their intended actions
5. **Click Actions with Eye Winks:** In addition to cursor movement, the system also enables click actions through eye winks. By detecting a deliberate wink of the eye, the system interprets this as a command to perform a click action, such as selecting an item or activating a function on the computer interface.

**Disadvantages**

1. **Assuming Every Eye Movement is Intentional:** One of the primary limitations of the EMC system is its reliance on detecting every eye movement as intentional. This assumption can lead to decreased efficiency, as not all eye movements are indicative of the user's desire to interact with the computer interface.
2. **Difficulty in Reaching Screen Edges:** Another challenge faced by the EMC system is the difficulty in moving the cursor to the edges of the screen, particularly when navigating to elements located in the corners or edges of the interface. This limitation arises from the finite range of motion associated with eye movements, making it challenging to reach distant areas of the screen efficiently.
3. **Cursor Movement Interruptions during Reading**: A common issue encountered with the EMC system is the unintentional cursor movement that occurs while the user is reading content on the screen.

**PROPOSED SYSTEM**

An innovative way to control the computer cursor using only eye and facial movements. Here's how our system works: it begins by capturing real-time video input using OpenCV. Then, it employs dlib's HOG (Histogram of Oriented Gradients) feature combined with a linear classifier, an image pyramid, and a sliding window detection scheme to detect the user's face in the video. Next, using dlib's 68 point facial landmark detector, it pinpoints specific facial features crucial for action recognition. For instance, a blink or wink is detected through the Eye Aspect Ratio (EAR), while a yawn can activate or deactivate controls using the Mouth Aspect Ratio (MAR). When the MAR value rises, it signals activation, and a click or scroll is triggered when the EAR value falls below a predefined threshold. This groundbreaking approach offers a seamless, hands-free method for users to effortlessly control the computer cursor, revolutionizing the way we interact with technology.

The innovative system for controlling the computer cursor using eye and facial movements represents a significant advancement in human-computer interaction. Here's a detailed elaboration on how the system works and the actions it enables:

1. **Real-time Video Input with OpenCV:** The system begins by capturing real-time video input using OpenCV (Open Source Computer Vision Library), a widely-used open-source library for computer vision and image processing tasks. This enables the system to continuously analyze the user's facial expressions and movements.
2. **Face Detection with dlib's HOG Feature and Linear Classifier:** Utilizing dlib's HOG feature combined with a linear classifier, an image pyramid, and a sliding window detection scheme, the system detects the user's face in the video stream. The Histogram of Oriented Gradients (HOG) feature descriptor is effective for object detection tasks, such as detecting faces, while the linear classifier helps classify the detected regions as faces.
3. **Facial Landmark Detection with dlib's 68 Point Facial Landmark Detector:** Once the face is detected, dlib's 68 point facial landmark detector is employed to pinpoint specific facial features crucial for action recognition. This detector identifies key landmarks on the face, such as the eyes, nose, mouth, and eyebrows, which are essential for interpreting the user's facial expressions and movements accurately.
4. **Action Recognition using Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR):** The system leverages the detected facial landmarks to recognize various actions performed by the user. For instance, a blink or wink is detected through the Eye Aspect Ratio (EAR), which measures the ratio of the distances between certain landmarks on the eye region. Similarly, a yawn can activate or deactivate

controls using the Mouth Aspect Ratio (MAR), which indicates the openness of the mouth.

Cursor Control Actions Enabled by the Proposed Algorithm:

The system offers a range of hands-free actions for controlling the computer cursor, including:

1. Squinting Eyes for Scroll Mode Activation
2. Winking for Left and Right Clicks
3. Head Movement (Pitch and Yaw) for Cursor Movement
4. Mouth Opening for Cursor Control Activation/Deactivation

## ADVANTAGES

1. Hands-free cursor for people with physical disabilities, making computer use more accessible
2. No need of external sensors.
3. Easy implementation on laptops or desktops, no complicated setup required
4. Users can perform actions like left-clicking, right-clicking, moving the cursor in any direction, and scrolling through pages with ease.

## SYSTEM ARCHITECTURE

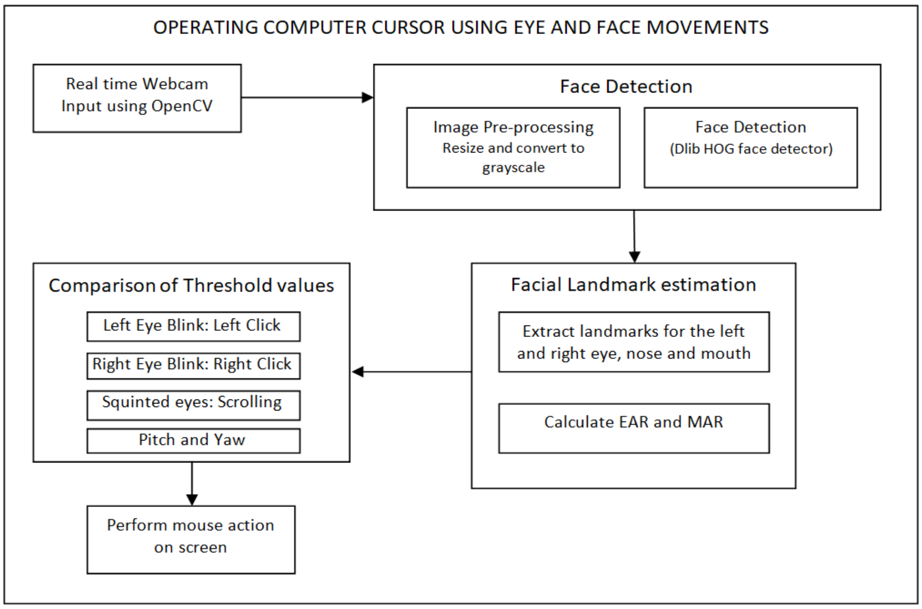


Fig 1: Proposed System Architecture

## OUTPUT SCREENS

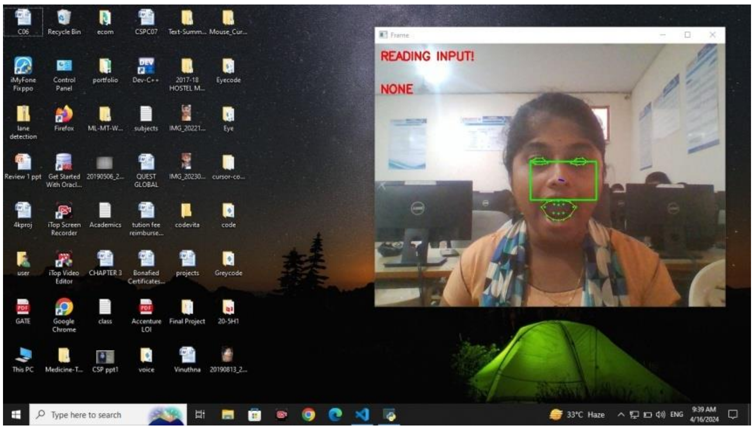


Fig 2: Reading Input

Fig 2 depicts activating the cursor. Open the mouth widely ,then reading input is displayed in the frame. If mouth is opened for the second time, the cursor will be deactivated.

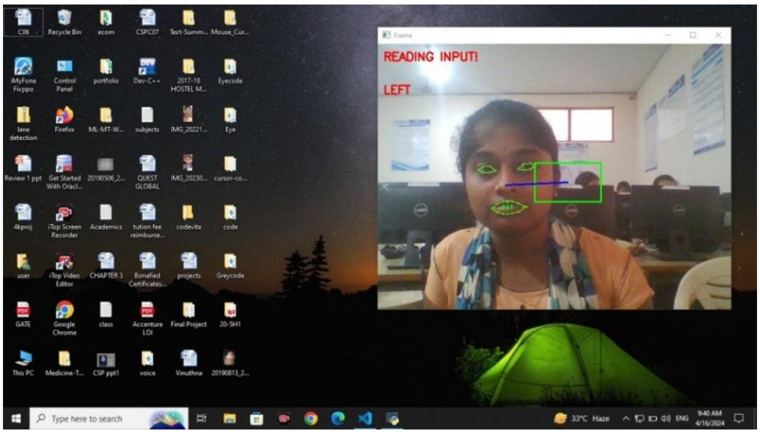


Fig 3: Moving cursor to the left

Fig 3 depicts moving the cursor towards left. If head is slightly moved left, the distance between nose pointer and anchor pointer increases and the cursor starts moving left.

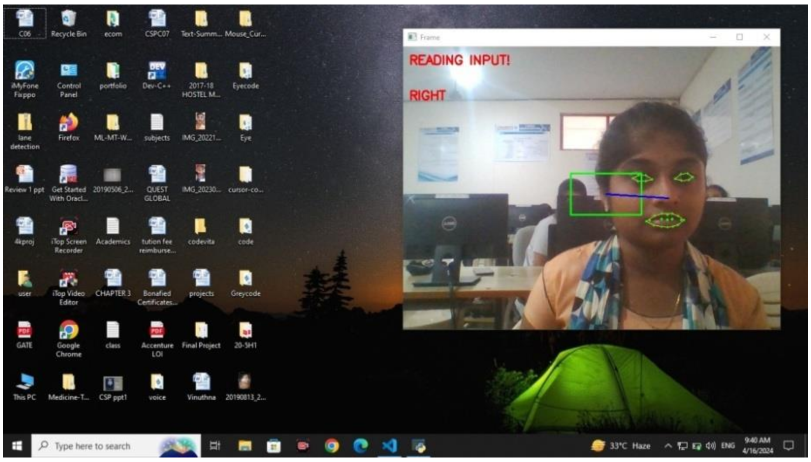


Fig 4: Moving cursor to the right

Fig 4 depicts moving the cursor towards right. If head is slightly moved right, the distance between nose pointer and anchor pointer increases and the cursor starts moving right.

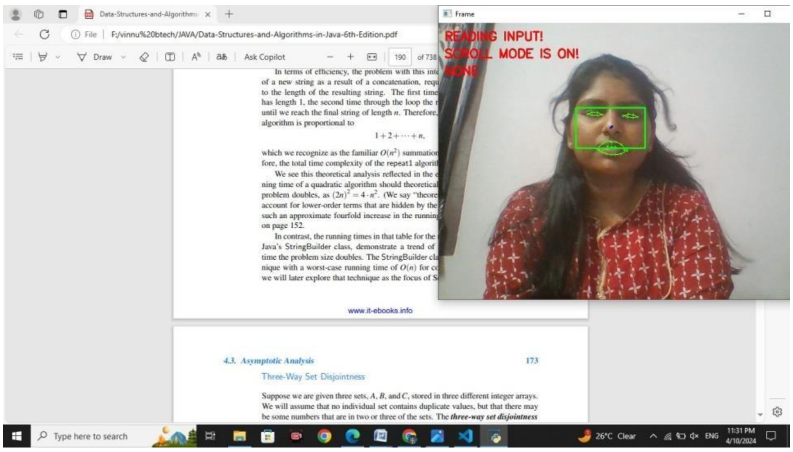


Fig 5: Enabling scrolling effect

Fig 5 depicts the enabling of scrolling effect. If both the eyes are squinted, it enables scrolling mode allowing us to scroll through documents or web pages seamlessly.

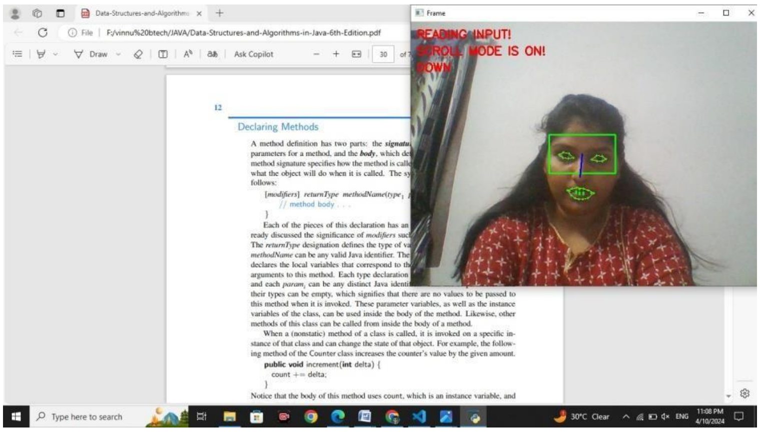


Fig 6: Scrolling Down

Fig 6 depicts scroll action. To start scrolling, start with squinting your eyes (to look with the eyes partly closed eyes) and scroll mode is turned on. Now scroll down by moving your head downwards.

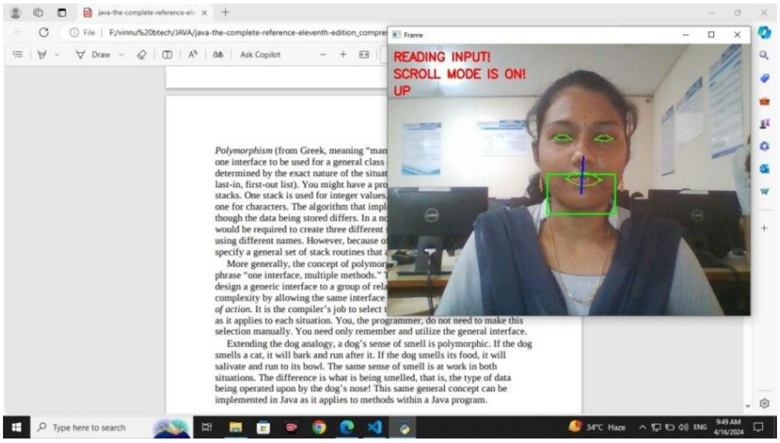


Fig 7: Scrolling up

Fig 7 depicts scroll up action. While scroll mode is on, move your head upwards to scroll up and to deactivate scrolling squint your eyes again.

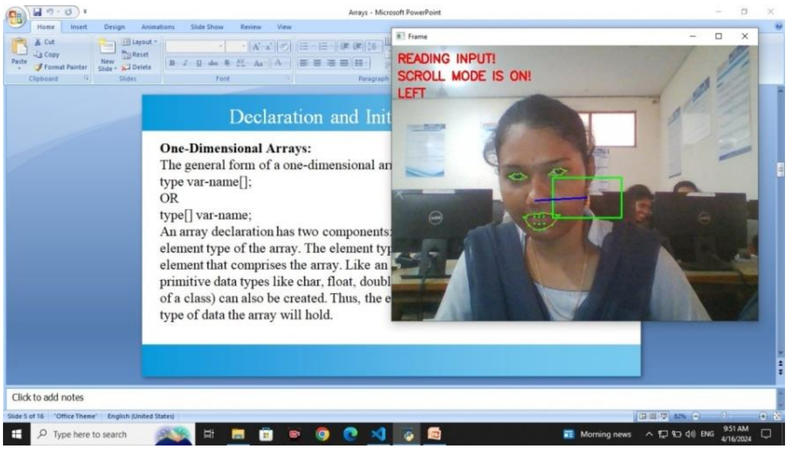


Fig 8: Scrolling left

Fig 8 depicts scrolling left. When scroll mode is on, move your head towards left to scroll the document left. We can similarly move head towards right for scrolling right.

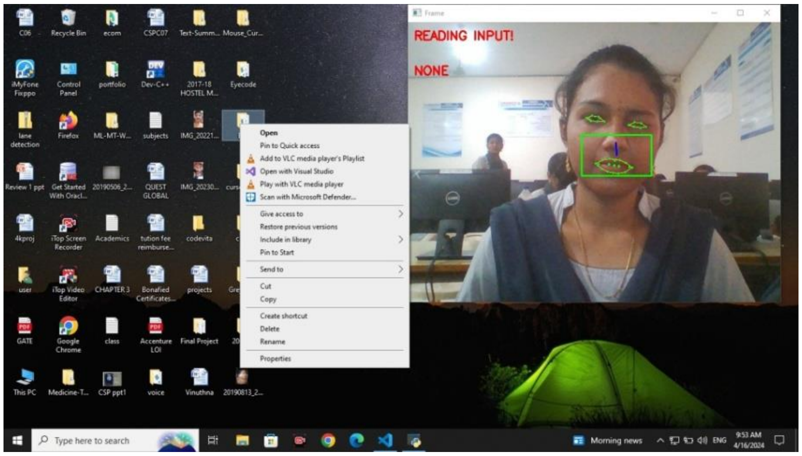


Fig 9: Right Click

To perform click action slightly tilt your head left and wink right eye for right click and left eye for left click as shown in Fig 9

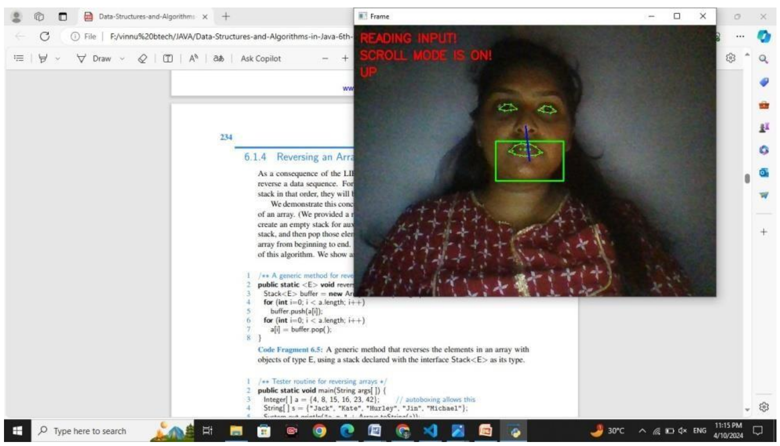


Fig 10: Operating cursor control system in dim light

Fig 10 depicts operating the proposed system in a dim light condition. The system is able to successfullyoperate and perform the required actions.

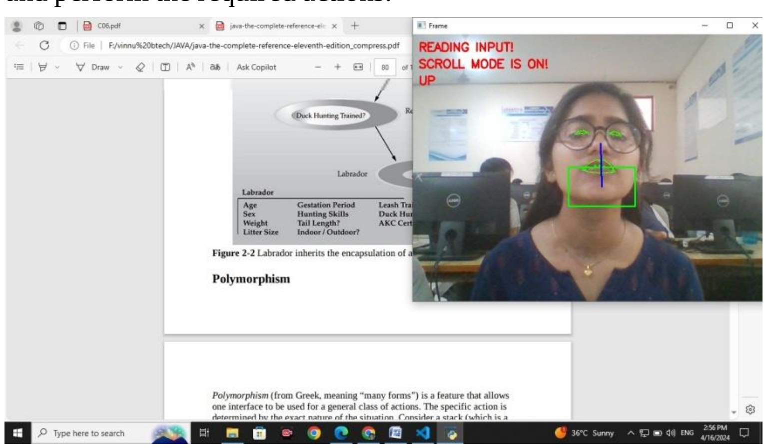

Fig 11: Operating cursor control system by a user wearing glasses

Fig 11 demonstrates operating the proposed system when the user is wearing glasses. The system is able to precisely locate the landmarks and perform the required action.

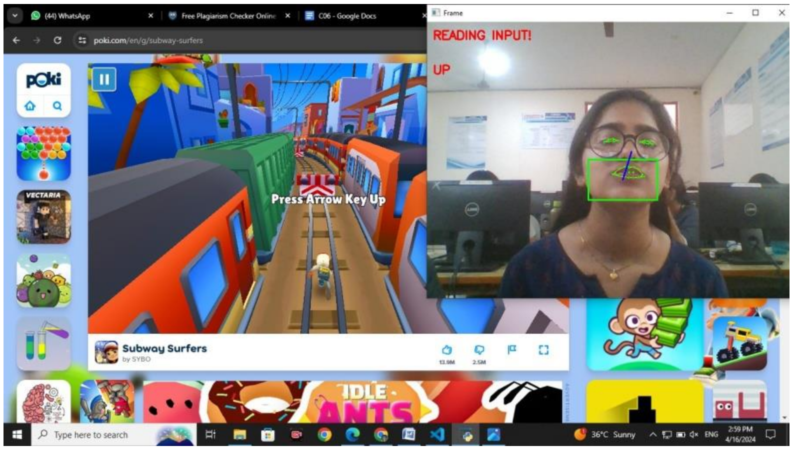


Fig 12: Playing a simple online game with the help of eye cursor system.

Fig 12 depicts operating the proposed system in a simple online video game. The system was able to perform all the required actions successfully.

## CONCLUSION

In conclusion, the development of a system for operating a computer cursor using eye and face movements represents a significant advancement in human-computer interaction technology. The proposed "Operating Computer Cursor using Eye and Face Movements" method is a reliable and practical solution for physically impaired users to manage their computer cursors. To summarize, we have created an efficient, practical, and accurate cursor system that overcomes the limitations of existing systems. This project aims to replace the traditional computer cursor device for the benefit of impaired people, promoting operational freedom. Future work could include improving the system to allow for easier control of home equipment such as lights, fans, and television sets. . By harnessing natural eye and facial gestures, this system offers a novel and intuitive method for users to interact with their computers, potentially enhancing accessibility, productivity, and user experience. Throughout the project, careful consideration must be given to factors such as accuracy, responsiveness, user comfort, and privacy to ensure the system's effectiveness and acceptance. Integration testing plays a crucial role in validating the interactions between various components, verifying the reliability and functionality of the system, and identifying any issues that need to be addressed. The project outcome is a sophisticated software application or system that seamlessly integrates eye and face tracking algorithms with cursor control mechanisms, providing users with a seamless and intuitive means of navigating their computer interfaces. Through thorough testing, documentation, and support, the system aims to deliver a user-friendly and ethically sound solution that empowers users to interact with their computers in a natural and efficient manner. In summary, the development of a system for operating a computer cursor using eye and face movements represents a promising frontier in human-computer interaction, with the potential to revolutionize the way we interact with technology and enhance accessibility for users of all abilities.

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