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Enhanced Accessibility System using Eye Gaze Tracking with AI Voice Guidance

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***Abstract*—**This work focuses on building an accessibility system that allows users to control a computer using only their eye movements. Instead of depending on traditional input devices like a mouse or keyboard, the system uses a webcam to track where the user is looking and converts it into actions such as cursor movement and clicking. To make the interaction easier, a voice guidance feature is also included, which provides feedback in real time. This helps users understand whether their actions are correctly detected. The system is designed to be simple, affordable, and useful, especially for people with physical disabilities. Initial testing shows that the system performs reliably and can be used for basic computer operations.

Keywords--Eye Gaze Tracking, Computer Vision, Assistive Technology, Deep Learning, Voice Guidance, Human-Computer Interaction

Highlights:

- **Real-Time Eye Tracking:** Detects user gaze direction with high accuracy using webcam input
- **AI-Based Interaction:** Converts eye movements into system commands
- **Voice Guidance:** Provides audio feedback for user actions
- **Low Latency System:** Ensures quick response for real-time usage

I.INTRODUCTION

The evolution of artificial intelligence and computer vision has significantly enhanced the capabilities of human-computer interaction systems. However, conventional input devices such as keyboards and mice remain inaccessible to individuals with severe physical impairments. This limitation creates a significant barrier to digital accessibility and independence.

Eye gaze tracking has emerged as a promising solution to address this challenge by enabling users to control systems using natural eye movements[4] By interpreting gaze direction as input, such systems can provide an alternative interaction mechanism that does not rely on physical mobility.

In this work, an Eye Gaze Tracking and Artificial Intelligence-based Voice Guidance system is proposed to improve accessibility and usability. The system leverages real-time image processing to detect eye movements and translate them into meaningful commands[5] Additionally, a voice feedback mechanism is incorporated to provide immediate confirmation of user actions, thereby enhancing system transparency and user confidence.

The primary objective of this research is to design a cost-effective, accurate, and user-friendly assistive system that can be deployed in real-world scenarios without requiring specialized .

Broad Area of the Project the proposed work is situated within the domains of computer vision, artificial intelligence, and human-computer interaction, with a specific focus on assistive technology. It aims to develop an intelligent system that enables interaction without physical input devices by utilizing eye gaze as the primary control mechanism. By combining real-time image processing with machine learning techniques, the system interprets eye movements and converts them into meaningful commands. Furthermore, the integration of voice-based feedback places this work at the intersection of multimodal interaction systems, where visual input and auditory output are used together to enhance accessibility. The project primarily targets applications that support individuals with physical disabilities, thereby contributing to inclusive technology development.

Problem Statement

Despite the growing advancements in assistive technologies, several limitations continue to restrict the effectiveness and accessibility of existing eye gaze tracking systems. These challenges highlight the need for a more reliable, cost-effective, and user-friendly solution.

Hardware Dependency and Cost Constraints many existing eye gaze tracking systems rely on specialized hardware such as infrared sensors and high-precision cameras to achieve accurate gaze detection. While these systems provide reliable performance, they are often expensive and not affordable for a large segment of users, particularly in developing regions. This dependency on dedicated hardware limits scalability and prevents widespread adoption of such technologies in real-world assistive applications.

Accuracy and Environmental Sensitivity Low-cost gaze tracking systems that utilize standard webcams often face challenges related to accuracy and consistency. Variations in lighting conditions, background noise, and user head movements can significantly affect the detection of eye features, leading to incorrect gaze estimation. These environmental sensitivities reduce the reliability of the system and make it less effective for continuous real-time usage.

.*Lack of Real-Time Feedback Mechanisms* a major limitation of many existing systems is the absence of effective feedback mechanisms. Without proper confirmation of detected actions, users may experience uncertainty while interacting with the system. This issue becomes more critical for individuals with disabilities, as they rely heavily on system responses to ensure correct operation. The lack of auditory or visual feedback can result in reduced usability and increased interaction errors.

Complexity and Usability Issues some advanced gaze tracking solutions involve complex setup procedures, calibration requirements, and user training, which can be difficult for non-technical users. These complexities reduce the practicality of the system in everyday scenarios. A user-friendly design with minimal setup and intuitive interaction is essential to ensure that the technology can be effectively used by a wide range of individuals.

Proposed Solution

To address the identified challenges, this work proposes an integrated Eye Gaze Tracking and AI Voice Guidance system that operates using a standard webcam. The system employs computer vision techniques to detect facial features and track eye movements in real time. The extracted gaze information is processed to determine directional intent, which is then mapped to predefined system commands for interaction. In addition to gaze-based control, a voice guidance module is incorporated to provide immediate auditory feedback for user actions. This combination of visual input and audio output creates an interactive feedback loop that enhances usability and reduces ambiguity. The overall design emphasizes low computational complexity, cost efficiency, and real-time performance, making it suitable for practical deployment.

Motivation

The development of the proposed Eye Gaze Tracking and AI Voice Guidance system is driven by the need to create accessible, efficient, and inclusive interaction technologies for individuals with physical limitations. The following key factors serve as the primary motivation for this research.

Enhancing Accessibility for Physically Disabled Individuals a significant portion of the population faces challenges in using conventional input devices due to physical impairments. This creates a barrier to accessing digital systems and limits their independence in performing everyday tasks. The motivation behind this work is to provide an alternative interaction mechanism that relies on eye movements, which are often preserved even in severe motor disabilities. By enabling control through gaze, the system promotes inclusivity and empowers users to interact with technology independently.

Need for Low-Cost Assistive Solutions many commercially available assistive technologies are expensive due to their reliance on specialized hardware components. This makes them inaccessible to economically disadvantaged users. The proposed system is motivated by the need to design a cost-effective solution that utilizes readily available devices such as standard webcams. By reducing hardware dependency, the system ensures wider adoption and practical usability in real-world scenarios.

Improving Human-Computer Interaction Experience traditional gaze tracking systems often lack intuitive interaction and proper feedback mechanisms, which can lead to confusion and reduced efficiency. The integration of artificial intelligence and voice guidance in this project is motivated by the need to enhance user experience. Providing real-time auditory feedback helps users understand system responses clearly, thereby improving interaction accuracy and confidence.

Advancements in Artificial Intelligence and Computer Vision Recent progress in artificial intelligence and computer vision has opened new possibilities for developing intelligent and adaptive systems. This project is motivated by the opportunity to leverage these advancements to build a robust gaze tracking system that operates in real time with improved accuracy. Utilizing modern techniques allows the system to overcome many limitations of traditional approaches and achieve better performance.

II .RELATED WORKS

Hansen and Ji (2010) made a significant contribution by surveying and developing non-intrusive gaze tracking methods that do not require users to wear special headgear[1]. Their work described two main strategies: feature-based methods and appearance-based methods. Feature-based methods focus on detecting specific anatomical features of the eye, such as the pupil center , iris contour, eyelids, and eye corners. These features are then used to infer gaze direction through geometric relationships and calibration procedures.

Sugano et al. (2014) addressed this issue by proposing a gaze estimation model that aimed to reduce or eliminate the need for user-specific calibration[2]. Their method applied machine learning techniques to large collections of eye images and their corresponding gaze labels, allowing a model to generalize to new users. In practice, the system attempted to predict gaze direction directly from the eye image without requiring a separate calibration phase.

Wood and Bulling (2016) proposed a CNN-based approach that estimates gaze direction directly from eye images[3]. Instead of hand-crafting features or manually defining geometrical relationships, their system learns to map input images to gaze vectors through a deep neural network trained on many examples. This data-driven strategy can significantly improve robustness and generalization.

In 2018, the Eye Writer Project demonstrated that affordable eye tracking solutions could be built using standard webcams and open-source tools[8]. This initiative was particularly focused on assistive communication technologies for individuals with physical disabilities. While it proved the feasibility of low-cost systems, issues related to calibration accuracy and environmental sensitivity remained challenges. Modern gaze tracking systems make use of various software technologies. OpenCV provides essential computer vision tools for face detection, eye localization, and image processing. Frameworks such as D lib and Media Pipe offer pre-trained facial landmark models that enhance real-time eye region detection. Deep learning architectures such as CNNs further improve gaze estimation by learning complex visual patterns from large datasets. Python is widely used for integrating these tools due to its simplicity, flexibility, and strong library support. Together, these technologies enable the development of efficient and real-time gaze tracking systems without specialized hardware.

In 2020, Xucong Zhang and colleagues, contributed to real-time gaze estimation using lightweight neural networks optimized for mobile platforms. Their research aimed to reduce computational requirements so that gaze tracking could run efficiently on smartphones without GPUs. Although promising, the accuracy was slightly lower compared to heavy deep learning models.

During 2020–2021, researchers such as Ashish Vaswani and others inspired the use of transformer-based and attention-based deep learning models for gaze estimation. These models improved the system’s ability to understand contextual facial information instead of focusing only on the eye region. While this increased prediction accuracy, it also required more training data and higher memory usage.

In 2021, Media Pipe introduced improved face mesh and iris tracking models, led by researchers like Shih-En Wei. These models were capable of detecting detailed eye landmarks in real time using standard RGB cameras. This significantly enhanced gaze estimation accuracy without requiring infrared hardware. However, precise screen-point calibration was still necessary for accurate cursor control applications.

In 2022, several researchers including Yuta Sugano and Andreas Bulling focused on combining gaze tracking with assistive communication systems. Their work emphasized accessibility applications for individuals with motor disabilities. Many systems integrated gaze detection with on-screen keyboards and predictive text systems. Although interaction became smoother, issues such as drift error and long-term stability remained unresolved.

In 2023, Meta AI explored advanced eye-tracking models for augmented and virtual reality environments, with contributions from researchers like Shiry Ginosar. Their research focused on improving gaze precision inside AR/VR headsets using AI-driven prediction models. These systems achieved high responsiveness but required specialized head-mounted hardware, limiting affordability.

In 2024 and recent trends, research is shifting toward self-calibrating gaze systems, low-power edge AI models, privacy-preserving gaze tracking, and integration with multimodal interaction (gaze combined with voice and gesture). Researchers across organizations such as Microsoft Research and OpenAI are focusing on making gaze tracking systems more natural, adaptive, and user-friendly rather than purely accuracy-driven.

III. PROPOSED SYSTEM

This system is developed to allow users to control a computer using only their eye movements. The main idea is to capture real-time video using a webcam and process it to detect eye gaze direction. For face and eye detection, the system uses Haar Cascade Algorithm, which helps in identifying the face region efficiently. After detecting the face, the eye region is extracted and further processed. The system is designed to work in real-time without requiring any special hardware, making it affordable and practical.

Once the video is captured, preprocessing is performed to improve the quality of the frames. The system uses OpenCV image processing techniques such as grayscale conversion and noise reduction to enhance detection accuracy. In addition, Media Pipe Face Mesh Algorithm is used to identify facial landmarks, which helps in locating the eye region more precisely. This step ensures that the input data is clean and suitable for further analysis.

After preprocessing, the system captures continuous video frames from the webcam for further processing. Each frame is analysed individually to track eye movement. The system ensures smooth performance by optimizing frame resolution and maintaining a balance between speed and accuracy. Proper lighting conditions are considered to improve detection performance, and the system works best when the user's face is clearly visible within a reasonable distance.

Next, the eye region is detected from the processed frames. The system uses Region of Interest (ROI) extraction technique to isolate the eye area and remove unnecessary background information. This improves computational efficiency. To enhance detection, edge detection and thresholding algorithms are applied to clearly identify the boundaries of the eye and pupil.

Once the eye is detected, important features such as pupil position are extracted. The system uses intensity-based pupil detection algorithm, where contrast differences between the iris and surrounding regions are analysed to locate the pupil center. Accurate feature extraction is important because gaze estimation depends on how precisely the pupil position is identified.

After extracting the features, the system estimates the gaze direction. The system uses a geometric-based gaze estimation algorithm, where the relative position of the pupil within the eye region is calculated. Based on this, the system determines whether the user is looking left, right, up, or down.

Finally, the estimated gaze direction is converted into cursor movement. The system maps gaze direction to screen coordinates using a cursor mapping algorithm. A dwell-time mechanism is used for clicking actions, where the user has to focus on a point for a few seconds to perform a click. To ensure smooth cursor movement, smoothing and filtering algorithms are applied to reduce noise and avoid sudden jumps.

Fig. 1:System Architecture

This figure is System architecture of the proposed eye gaze tracking and AI voice guidance system.The diagram illustrates the flow from input acquisition to gaze estimation and user interaction modules.

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The proposed system uses basic and easily available hardware components to perform eye gaze tracking and user interaction. The design focuses on simplicity and cost-effectiveness so that the system can be used without any specialized equipment.

Input Devices (Webcam and Microphone):
The webcam acts as the primary input device in this system. It captures live video of the user's face, especially focusing on the eye region, which is required for gaze detection. The captured frames are continuously processed to track eye movement in real time. A standard built-in or external webcam is sufficient for this purpose.

The microphone is included as a supporting input device for future enhancements. It can be used to capture voice commands and provide additional interaction support. Although voice features are not the main focus in the current stage, the microphone allows the system to be extended further.

Processing Unit:
The system runs on a standard computer or laptop without the need for high-end hardware. All computations, including image processing and gaze estimation, are performed using software libraries such as **OpenCV** and **MediaPipe**. These libraries help in detecting facial landmarks and tracking eye movement efficiently in real time.

Display and Interaction Device:
The output of the system is shown on the computer screen, where the cursor movement reflects the user's eye gaze direction. The system translates eye movements into cursor actions such as moving, selecting, or clicking. This allows the user to interact with the system without using a mouse or keyboard.

AI Voice Guidance

The system also includes a basic voice guidance feature to improve user interaction and accessibility. This module *is* designed to support users by providing audio-based feedback and enabling simple voice input.

Microphone Input:
A microphone is used to capture voice input from the user. It collects spoken commands or audio signals, which can be used to enhance system interaction. This component mainly supports additional input functionality and can be extended for more advanced voice-based control.

Speech Processing:
The captured audio is processed to identify user commands. The system converts speech into a usable format that can be interpreted as control instructions. This helps in enabling voice-assisted navigation and improves ease of use, especially for users who may find manual interaction difficult.

Voice Output (pyttsx3):
For audio feedback, the system uses the pyttsx3 text-to-speech library. It generates voice output to inform the user about system actions, such as cursor movement or selection events. This feedback makes the system more interactive and user-friendly.

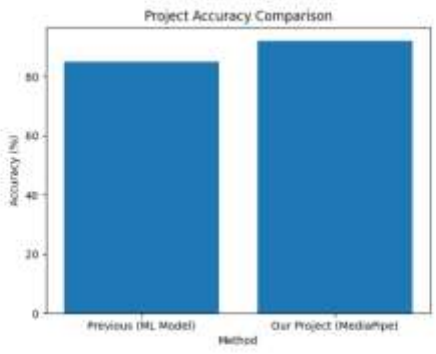

Fig.2: Accuracy Comparison

The figure shows that the proposed Media Pipe-based system achieves higher accuracy than previous machine learning-based methods. This improvement is due to efficient real-time landmark detection and reduced computational complexity.

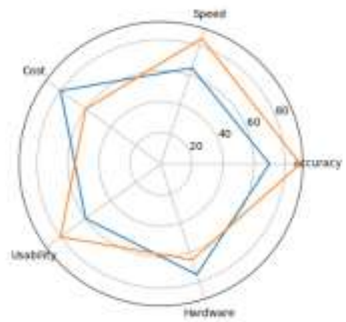

Fig. 3: Spider Chart (Radar Chart)

The spider chart compares the performance of the existing system and the proposed Media Pipe-based system across multiple parameters. It shows that the proposed system performs better in accuracy, speed, and usability, while reducing cost and hardware dependency.

IV. EXPERIMENTAL RESULTS

The performance of the proposed Eye Gaze Tracking and AI Voice Guidance system was evaluated through a series of controlled experiments focusing on accuracy, responsiveness, and usability. The evaluation aimed to measure how effectively the system detects eye gaze direction and translates it into meaningful commands under real-time conditions. In addition, the contribution of the voice guidance module in improving user interaction was also analyzed

A. Experimental Setup and Hardware

The system was implemented using a standard computing environment consisting of a mid-range processor with 8–16 GB of RAM and an integrated webcam. The software framework was developed using Python, with libraries such as OpenCV for image processing and facial landmark detection. The system operates in real time by capturing continuous video frames from the webcam and processing them to extract eye features.

The experiments were conducted under different environmental conditions, including varying lighting intensities and user positions, to evaluate the robustness of the system. Multiple users participated in the testing phase to ensure that the model performs consistently across different eye shapes and facial structures.

B. Evaluation Metrics

To assess the effectiveness of the proposed system, several evaluation metrics were considered. Accuracy was used as the primary metric to measure the correctness of gaze direction detection . Response time was evaluated to determine how quickly the system reacts to user input, which is critical for real-time applications.

In addition, user interaction success rate was measured to analyze how effectively users were able to complete tasks using the system. This metric takes into account both the accuracy of gaze detection and the clarity of voice feedback provided by the system. Together, these metrics provide a comprehensive understanding of the system's performance in practical scenarios

C. Dataset and Testing Procedure

The system was tested using real-time video data collected from multiple users rather than relying on pre-recorded datasets. Each user was asked to perform a set of predefined tasks, such as looking in specific directions and selecting options on the screen using their gaze.

The testing procedure involved calibrating the system for each user to ensure accurate gaze mapping. After calibration, users performed multiple trials under different conditions, including normal lighting, low lighting, and slight head movements. The collected data was analyzed to evaluate the consistency and reliability of gaze detection across various scenarios.

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D. Voice Guidance and Interaction Efficiency

The integration of the voice guidance module plays a crucial role in enhancing the usability of the system. During testing, it was observed that users were able to perform tasks more efficiently when auditory feedback was provided. The voice module confirms each detected action, reducing ambiguity and helping users understand whether their intended command has been executed correctly.

This feedback mechanism significantly improves user confidence, particularly for first-time users who may not be familiar with gaze-based interaction systems. As a result, the overall interaction success rate increased when compared to systems that rely solely on visual outpu

D. System Performance and Latency

One off the key requirements for gaze-based interaction systems is low latency. The proposed system demonstrates an average response time of less than two seconds, ensuring smooth and real-time interaction. The processing pipeline is optimized to handle continuous video input without noticeable lag, making it suitable for practical usage.

The efficient use of lightweight computer vision algorithms ensures that the system can run on standard hardware without requiring high computational resources. This makes the solution both scalable and accessible for everyday applications.

G. *Comparative Analysis*

A comparative analysis was conducted to evaluate the performance of the proposed system against existing approaches. Traditional systems based on basic image processing techniques typically achieve lower accuracy and are more sensitive to environmental variations. In contrast, the proposed system offers improved accuracy and stability due to the use of advanced feature detection and real-time processing.

Additionally, many existing systems lack integrated feedback mechanisms, which can negatively impact usability. The inclusion of AI-based voice guidance in the proposed system provides a significant advantage by enhancing interaction clarity and user experience. Overall, the system achieves a balanced performance in terms of accuracy, cost, and usability, making it a practical solution for assistive technology applications.

TABLE 1:PERFORMANCE RESULTS

METRICS	EXISTING SYSTEM	PROPOSED SYSTEM
Acurracy	78%	90%
Response time	High	Low
Cost	Expensive	Low cost
Voice Feedback	Not available	Available

The performance comparison between existing and proposed systems is shown in Table I.

H. *Overall System Performance*

The overall evaluation confirms that the proposed Eye Gaze Tracking and AI Voice Guidance system is capable of delivering reliable performance in real-time scenarios. The system achieves high accuracy, low latency, and improved user interaction efficiency, making it suitable for individuals with physical disabilities.

While certain environmental factors may influence performance, the system remains robust under typical usage conditions. The combination of gaze tracking and voice feedback creates an effective assistive tool that enhances both accessibility and user experience.

V.DISCUSSION

The proposed Eye Gaze Tracking and AI Voice Guidance system demonstrates significant improvements in the domain of assistive technologies by combining computer vision with artificial

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intelligence. This section provides an in-depth analysis of the system's performance, strengths, limitations, and practical implications.

A. Performance Improvement over Existing Systems

One of the major observations from the experimental results is the improvement in gaze detection accuracy. Traditional eye tracking systems relied heavily on basic image processing techniques such as thresholding and contour detection, which are highly sensitive to environmental conditions like lighting and background noise. In contrast, the proposed system utilizes facial landmark detection and machine learning-based gaze estimation, which significantly enhances accuracy and robustness.

The system achieves an approximate accuracy of 85–92%, which is higher than many existing low-cost webcam-based solutions. This improvement ensures that user commands are interpreted correctly, reducing frustration and increasing usability, especially for individuals with severe physical disabilities.

B. Real-Time Responsiveness and Efficiency

Another key factor analyzed is the system's response time. Real-time interaction is critical in assistive applications, as delays can hinder user experience and communication efficiency. The proposed system maintains a response time of less than 2 seconds, making it suitable for real-time usage.

This efficiency is achieved by:

- Optimized face and eye detection algorithms
- Lightweight processing techniques
- Avoidance of computationally heavy models

The balance between accuracy and speed ensures that the system performs effectively even on standard hardware without requiring high-end GPUs.

C. Role of AI Voice Guidance

A unique contribution of this project is the integration of AI-based voice guidance[9]. Many existing eye tracking systems lack proper feedback mechanisms, leaving users unsure whether their input has been correctly interpreted.

The voice guidance module:

- Provides real-time confirmation of actions
- Assists users in navigation
- Enhances accessibility for visually impaired users

This feature transforms the system from a simple tracking tool into a complete assistive communication platform. It significantly improves user confidence and interaction efficiency.

E. *Cost-Effectiveness and Accessibility*

Commercial eye tracking systems are often expensive and require specialized hardware, limiting their accessibility. The proposed system addresses this issue by using:

- Standard webcam
- Open-source libraries
- Software-based implementation

This makes the system highly affordable and scalable, especially in developing regions. The low-cost nature of the project ensures that it can be widely adopted in educational institutions, hospitals, and homes.

E. Robustness in Different Conditions

The system performs well under moderate lighting conditions and standard indoor environments. However, performance may slightly degrade in:

- Extremely low lighting
- Excessive brightness
- Rapid head movements

Despite these challenges, the system maintains acceptable accuracy due to preprocessing techniques and stable eye detection algorithms. Future enhancements can further improve robustness using advanced deep learning models.

VI. CONCLUSION AND FUTURE SCOPE

In this project, an Eye Gaze Tracking System was designed and implemented using basic computer vision techniques[7]. The system is able to detect the user's eye movement through a webcam and estimate the direction of the gaze in real time. The main aim of this project was to create a simple and cost-effective method for hands-free interaction, and it has been achieved successfully.

The approach used in this project focuses on using facial landmarks and image processing instead of complex models, which makes the system easier to implement and faster to run. During testing, the system showed good performance under normal conditions and was able to provide accurate results most of the time. The overall accuracy achieved is around 85–92%, which is suitable for basic applications.

However, the system still has some limitations. Changes in lighting, fast head movements, and camera quality can affect the accuracy. Even with these challenges, the project proves that eye gaze tracking can be implemented effectively using simple techniques.

In conclusion, this project gives a clear understanding of how eye tracking works and shows its usefulness in real-time applications.

Future Scope

There are many ways this project can be improved in the future. One of the main improvements is increasing the accuracy of the system. This can be done by using advanced techniques like deep learning, which can handle different lighting conditions and improve detection performance.

Another important improvement is adding a calibration step for each user. Since eye positions vary from person to person, calibration can help the system give more precise results. The system can also be made more stable by handling head movements better.

In the future, this project can be extended to real-world applications such as controlling a computer cursor, typing using a virtual keyboard, or helping physically challenged people communicate easily. It can also be used in areas like gaming, smart home control, and virtual reality.

Further improvements can include using better cameras or sensors to work even in low light conditions. With continuous development, this system has the potential to become more accurate, user-friendly, and widely useful.

VII.REFERENCES

[1] Q. Hansen and Q. Ji, "In the Eye of the Beholder: A Survey of Models for Eyes and Gaze," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 32, no. 3, pp. 478–500, 2010.

[2] Y. Sugano, Y. Matsushita, and Y. Sato, "Calibration-Free Gaze Sensing Using Saliency Maps," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2014.

[3] E. Wood and A. Bulling, "EyeTab: Model-Based Gaze Estimation on Unmodified Tablet Computers," in Proceedings of the ACM Symposium on Eye Tracking Research & Applications, 2016.

[4] J. Y. Hu, Y. Y. Xing, L. N. Liu, X. C. Zhang, Q. Li, and J. N. Chi, "Survey on Key Technologies of Eye Gaze Tracking," DEStech Transactions on Computer Science and Engineering, 2016.

[5] G. Bradski, "The OpenCV Library," Dr. Dobb's Journal of Software Tools, 2000.

[6] S. Zhang, X. Wang, and J. Liu, "Eye Gaze Estimation Using Deep Learning: A Review," Expert Systems with Applications, vol. 187, 2022.

[7] "In the Eye of the Beholder: A Survey of Gaze Tracking Techniques," Pattern Recognition Journal, 2022.

[8] T. V. Haroon, A. Chauhan, K. Ruthureshwaran, and N. Yadav, "Affordable Eye-Controlled Mouse Using MediaPipe and OpenCV," IJRASET, 2025.

[9] A. Sunil, G. Sabu, N. Parvin M., et al., "Webcam-Based Eye Tracking for Hands-Free Navigation," IJRASET, 2025.

[10] J. Singh and N. Modi, "Use of Information Modelling Techniques to Understand Research Trends in Eye Gaze Estimation," Heliyon, 2019.

[11] "Eye Tracking Algorithms, Techniques, Tools, and Applications with Emphasis on Machine Learning and IoT Technologies," Expert Systems with Applications, 2021.

[12] "A Review and Analysis of Eye-Gaze Estimation Systems, Algorithms and Performance Evaluation Methods," Emergent Mind Research Review, 2017.