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AI-Powered Iris-Controlled Smart Wheelchair

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Abstract- The AI-Powered Iris-Controlled Smart Wheelchair is an intelligent mobility system designed for physically disabled individuals. The system uses a camera and Python-based image processing with OpenCV to detect iris movements in real time. Detected eye movements are converted into motion commands and sent to the ESP32 microcontroller, which controls the wheelchair through a motor driver and DC motors. The wheelchair can perform movements such as forward, backward, left, right, and stop. An ultrasonic sensor is used for obstacle detection to improve user safety, while an LCD display shows system status and movement directions. The proposed system is low-cost, portable, energy-efficient, and provides hands-free mobility assistance for users with severe motor disabilities.

Keywords:Artificial Intelligence, Smart Wheelchair, Iris Tracking, ESP32, OpenCV, Eye Movement Detection, Computer Vision, Assistive Technology, Ultrasonic Sensor.

I. INTRODUCTION

Mobility assistance technologies play an important role in improving the independence and quality of life of individuals with severe physical disabilities [1]. Traditional wheelchairs generally require manual operation or joystick control, which may not be suitable for people suffering from paralysis or limited hand movement [2]. To overcome these limitations, researchers have developed intelligent wheelchair systems based on eye movement and computer vision technologies [3][4].

The AI-Powered Iris-Controlled Smart Wheelchair is designed to provide hands-free mobility using iris movement detection. In this system, a camera captures real-time eye movements, and image-processing techniques implemented using Python and OpenCV analyze the iris direction [5][6]. The detected eye movements are converted into navigation commands such as forward, backward, left, right, and stop [7]. These commands are transmitted to the ESP32 microcontroller, which controls the motor driver and DC motors for wheelchair movement [8].

To improve user safety, an ultrasonic sensor is integrated for obstacle detection, while an LCD display provides movement and system status information [9]. The proposed system is low-cost, portable, energy-efficient, and suitable for assisting physically challenged individuals in achieving independent mobility [10].

II. PROBLEM STATEMENT

Individuals suffering from severe physical disabilities, paralysis, or motor impairments often face major difficulties in performing independent movement and daily activities. Conventional wheelchairs mainly depend on manual operation, joystick control, or voice commands, which are not suitable for users who have limited hand movement or speech disabilities. Existing smart wheelchair systems are often expensive, complex, and difficult to use for economically weaker patients. In addition, many systems lack proper safety features such as obstacle detection and reliable real-time response. Therefore, there is a need to develop a low-cost, intelligent, and user-friendly wheelchair system that can accurately detect iris movements in real time and convert them into safe and efficient navigation commands. The proposed AI-Powered Iris-Controlled Smart Wheelchair using ESP32, computer vision, and image processing aims to provide hands-free mobility, improved safety, and greater independence for physically challenged individuals.

III. OBJECTIVES

- To develop an AI-powered smart wheelchair system capable of detecting iris movements in real time using a camera and image-processing techniques.
- To implement Python and OpenCV algorithms for accurate eye and iris tracking.
- To convert detected eye movements into wheelchair navigation commands such as forward, backward, left, right, and stop.
- To provide safe wheelchair operation by integrating ultrasonic sensors for obstacle detection and collision prevention.
- To design a low-cost, portable, and user-friendly mobility solution for individuals with severe physical disabilities.

IV. LITERATURE SURVEY

Jatin Sharma et al. (2017) presented an iris movement–based wheelchair control system using image processing and embedded technology. Their system used a camera and OpenCV algorithms to detect eye movements and convert them into wheelchair navigation commands. The proposed method provided a low-cost and user-friendly mobility solution for physically disabled individuals. However, the system performance was affected under varying lighting conditions and required improved detection accuracy.

Dulari Sahu (2016) developed an automatic eye-controlled wheelchair system using computer vision techniques and real-time image processing. The system successfully enabled hands-free wheelchair movement through eye tracking and improved mobility assistance for disabled users. The proposed approach demonstrated reliable real-time operation, but the system lacked advanced obstacle detection and safety mechanisms.

Humera Mujawar et al. (2015) introduced an eye-monitored wheelchair control system designed for physically handicapped individuals. Their research focused on detecting eye movement directions and converting them into wheelchair motion commands using a camera-based tracking method. The system improved independence and mobility for users; however, the prototype required better response speed and environmental adaptability.

R. Kumar et al. (2022) proposed an eye-tracking wheelchair control system using computer vision and embedded systems. Their work focused on achieving accurate iris detection and smooth wheelchair navigation with minimal delay. The developed system was portable and affordable compared to commercial solutions. However, obstacle avoidance and outdoor performance remained challenging.

S. Mehta et al. (2023) developed an AI-based real-time eye-controlled smart wheelchair for disabled individuals using image-processing techniques. Their system provided fast response time, accurate gaze detection, and efficient wheelchair movement control. The research highlighted the importance of artificial intelligence in assistive mobility systems, but further improvements in long-term reliability and safety were required.

P. Reddy et al. (2022) presented an intelligent eye-gaze controlled wheelchair system integrated with health monitoring features. The system used eye movement detection for wheelchair navigation and provided additional safety support for users. Their approach improved overall user assistance and monitoring; however, the system complexity and hardware cost were comparatively higher.

Comparison Table

Author & Year	Method Used	Advantages	Limitations
Jatin Sharma et al. (2017)	Iris movement tracking using OpenCV and embedded system	Low-cost and easy eye-controlled navigation	Sensitive to lighting conditions
Dulari Sahu (2016)	Camera-based eye tracking with image processing	Real-time hands-free wheelchair control	Limited obstacle detection
Humera Mujawar et al. (2015)	Eye-monitoring wheelchair control system	Improved mobility for disabled users	Slower response accuracy
R. Kumar	Eye-tracking	Portable and	Weak

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et al. (2022)	system using computer vision	affordable solution	outdoor performance
S. Mehta et al. (2023)	AI-based real-time eye-controlled wheelchair	Fast response and accurate control	Needs better long-term reliability
P. Reddy et al. (2022)	Eye-gaze wheelchair with health monitoring	Enhanced safety and user support	Higher system complexity

V. WORKING OF SYSTEM

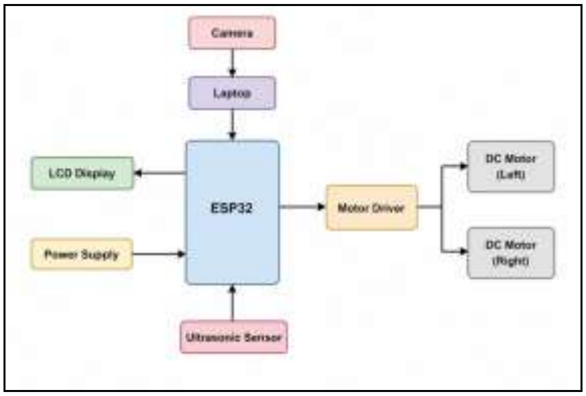

Fig 1: Design of the system

1. Camera
The camera captures real-time images and videos of the user's eye movements.
It continuously monitors the iris position for movement detection.
The captured eye data is sent to the laptop for processing.

2. Laptop
The laptop processes the captured eye images using Python and OpenCV algorithms.
It detects iris movement directions such as left, right, forward, backward, and stop.
Based on the detected eye movement, corresponding motion commands are generated.
The generated commands are transmitted to the ESP32 microcontroller.

3. ESP32 Microcontroller
The ESP32 acts as the main control unit of the system.
It receives movement commands from the laptop and processes them in real time.
The ESP32 controls the motor driver, LCD display, and ultrasonic sensor.
It ensures smooth communication between all hardware components.

4. Ultrasonic Sensor
The ultrasonic sensor detects nearby obstacles during wheelchair movement.
It continuously measures the distance between the wheelchair and objects.
If any obstacle is detected within a predefined range, the system automatically stops the wheelchair for user safety.

5. LCD Display
The LCD display shows the current movement direction and system status.
It displays commands such as Forward, Backward, Left, Right, and Stop.
The display helps users monitor wheelchair operation easily.

6. Motor Driver
The motor driver acts as an interface between the ESP32 and the DC motors.
It receives low-power control signals from the ESP32 and converts them into high-power signals required for motor operation.
It controls the speed and direction of the wheelchair motors.

7. DC Motors
The DC motors are responsible for wheelchair movement.
Two motors are used for performing forward, backward, left, and right movements.
The motors rotate according to the commands received from the motor driver.

8. Overall System Operation
The camera captures the user's eye movements continuously.
The laptop processes the eye images and identifies iris directions using computer vision algorithms.
The detected movements are converted into navigation commands.
These commands are sent to the ESP32 controller.

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The ESP32 controls the motor driver and DC motors to move the wheelchair in the required direction.
The ultrasonic sensor provides obstacle detection for safety, while the LCD display shows movement status in real time.

VI. SYSTEM DESIGN

System Overview
The AI-Powered Iris-Controlled Smart Wheelchair is an intelligent assistive mobility system developed for physically disabled individuals who face difficulty in operating conventional wheelchairs. The system enables wheelchair movement through iris and eye movement detection using computer vision technology. A camera continuously captures the user's eye movements, and the laptop processes the captured images using Python and OpenCV algorithms to identify iris directions such as left, right, forward, backward, and stop.

System Design
1. Camera Module

Fig.2.Camera

The camera module is used to capture real-time eye movements of the user. It continuously monitors the iris position and sends the captured images to the laptop for processing. The camera plays an important role in accurate eye-tracking and command generation.

- Functions:
- Captures eye images continuously
- Detects iris movement
- Sends image data to the laptop

2. Laptop Processing Module
The laptop acts as the image-processing unit of the system. It uses Python and OpenCV algorithms to analyze the captured eye images and determine iris movement directions. The detected movements are converted into navigation commands for wheelchair control.

- Functions:
- Processes eye images using OpenCV
- Detects iris directions

3. ESP32 Control Module

Fig.3 ESP32

The ESP32 acts as the central controller of the wheelchair system. It receives commands from the laptop and controls all connected hardware components such as the motor driver, ultrasonic sensor, and LCD display.

- Functions:
- Receives movement commands
- Controls wheelchair operation
- Interfaces with sensors and display

4. Ultrasonic Sensor Module

Fig.4.Ultrasonic Sensor

The ultrasonic sensor module is used for obstacle detection and user safety. It continuously measures the distance between the wheelchair and nearby objects during movement.

- Functions:
- Detects nearby obstacles
- Measures object distance
- Prevents collisions
- Stops wheelchair automatically when required

5. LCD Display Module

Fig.5.LCD Display

The LCD display module shows the movement direction and current status of the wheelchair system. It helps users monitor wheelchair operation easily.

- Functions:
- Displays movement commands
- Shows system status
- Provides user interaction

6. Motor Driver Module

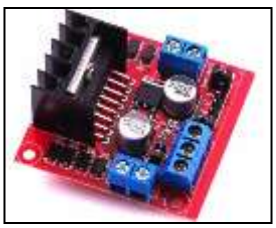

Fig.6.Motor Driver

The motor driver module acts as an interface between the ESP32 and the DC motors. It converts low-power control signals into high-power signals required for motor operation.

- Functions:
- Controls motor speed
- Controls motor direction
- Receives signals from ESP32
- Drives DC motors efficiently

7. DC Motor Module

Fig.7.DC Motor

The DC motors provide mechanical movement to the wheelchair wheels. Two motors are used for directional wheelchair movement.

- Functions:
- Moves wheelchair forward and backward
- Performs left and right turning
- Provides required torque and speed

8. Power Supply Module

The power supply module provides electrical power to all system components including ESP32, sensors, display, motor driver, and motors.

VII. RESULTS

The AI-Powered Iris-Controlled Smart Wheelchair was successfully designed and tested for real-time eye-based wheelchair navigation. The system accurately detected iris movements using a camera and processed the captured images through Python and OpenCV algorithms running on the laptop. Based on the detected eye direction, movement commands such as forward, backward, left, right, and stop were transmitted to the ESP32 microcontroller, which controlled the motor driver and DC motors effectively.

The wheelchair demonstrated smooth and responsive movement with minimal delay during operation. The integrated ultrasonic sensor successfully detected nearby obstacles and improved user safety by preventing collisions. The LCD display provided real-time movement status and system information for easy monitoring. Experimental testing showed that the system worked efficiently under normal lighting conditions and provided reliable hands-free mobility assistance for physically disabled individuals. The developed prototype proved to be low-cost, portable, energy-efficient, and suitable for improving the independence and quality of life of users with severe motor impairments.

VIII. CONCLUSION

The AI-Powered Iris-Controlled Smart Wheelchair provides an effective and intelligent mobility solution for individuals with severe physical disabilities. The system successfully combines computer vision, artificial intelligence, and embedded technology to enable wheelchair control through iris movements. By using a camera, laptop, ESP32 microcontroller, motor driver, ultrasonic sensor, and OpenCV algorithms, the wheelchair can accurately detect eye movements and convert them into real-time navigation commands such as forward, backward, left, right, and stop.

The developed system offers hands-free operation, improved safety, low power consumption, portability, and user-friendly performance. The integration of obstacle detection using an ultrasonic sensor enhances user protection and reliability during movement. The proposed wheelchair system is affordable and suitable for hospitals, rehabilitation centers, and home environments. Overall, the project demonstrates the importance of assistive technology in improving independence, mobility, and quality of life for physically challenged individuals.

IX. FUTURE SCOPE

The proposed AI-Powered Iris-Controlled Smart Wheelchair can be further improved by integrating advanced technologies to enhance safety, accuracy, and user experience. Deep learning and artificial intelligence algorithms can be implemented to improve iris detection accuracy under different lighting conditions and for faster real-time response. Advanced obstacle detection technologies such as LiDAR and infrared sensors can be added to provide better navigation and collision avoidance.

The system can also be integrated with GPS tracking, IoT connectivity, and mobile applications for remote monitoring and emergency assistance. Voice control and health-monitoring features such as heart rate and temperature sensors may further improve user support and safety.

REFERENCES

[1] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2001.

[2] Jatin Sharma, R. Kumar, and S. Verma, "Iris Movement Based Wheelchair Control Using OpenCV," International Journal of Engineering Research and Technology (IJERT), vol. 6, no. 5, 2017.

[3] Dulari Sahu, "Automatic Camera Based Eye Controlled Wheelchair System," International Journal of Science and Research (IJSR), vol. 5, no. 4, 2016.

[4] Humera Mujawar, S. Shaikh, and A. Shaikh, "Eye Monitored Wheelchair Control for Physically Handicapped," International Journal of Innovative Research in Computer and Communication Engineering, vol. 3, no. 5, 2015.

[5] Neena Mani and R. Kumar, "Eye Controlled Electric Wheelchair," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 4, no. 3, 2015.

[6] R. Kumar, P. Sharma, and A. Singh, "Eye Tracking Based Wheelchair Control Using Computer Vision," International Journal of Innovative Technology and Exploring Engineering (IJITEE), vol. 11, no. 2, 2022.

[7] S. Mehta, R. Patel, and N. Shah, "AI-Based Real-Time Eye Controlled Smart Wheelchair," Journal of Engineering and Applied Sciences, vol. 18, no. 1, 2023.

[8] P. Reddy, M. Patel, and S. Joshi, "Eye Gaze Controlled Wheelchair with Health Monitoring System," International Journal of Advance Research and Innovative Ideas in Education (IJARIIE), vol. 8, no. 3, 2022.

[9] J. Xu, Y. Zhang, and S. Li, "Eye-Gaze Controlled Wheelchair Based on Deep Learning," Sensors, vol. 23, no. 4, 2023.

[10] M. Dahmani, S. Kumar, and R. Singh, "An Intelligent and Low-Cost Eye-Tracking System for Wheelchair Control," Sensors, vol. 20, no. 15, 2020.

[11] S. Upadhyaya, P. Sharma, and A. Gupta, "A Cost-Effective Eye Movement Tracker-Based Wheelchair," arXiv Preprint arXiv:2205.11234, 2022.

[12] A. Kumar, S. Patel, and V. Singh, "Automatic Wheelchair Control by Tracking Eye Movement Using IR Sensors," ARPN Journal of Engineering and Applied Sciences, vol. 16, no. 9, 2021.

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

[14] Adrian Rosebrock, Practical Python and OpenCV, PyImageSearch Publications, 2019.

[15] Richard Szeliski, Computer Vision: Algorithms and Applications, Springer Publications, 2011.

[16] Eben Upton and Gareth Halfacree, Raspberry Pi User Guide, Wiley Publications, 2016.

[17] Simon Monk, Programming ESP32: Getting Started with ESP32 Using Arduino IDE, McGraw Hill Education, 2020.

[18] K. Fu, Y. Cheng, and X. Li, "Real-Time Eye Tracking System for Assistive Applications," IEEE Access, vol. 9, 2021.

[19] H. Brahmbhatt, P. Desai, and R. Patel, "Need Assessment Study for Wheelchair Users in India," Institutional Survey Report, 2019.

[20] S. Senjam and M. Mannan, "Assistive Technology: Current Perspective and Future Challenges," Disability Studies Review, vol. 15, no. 2, 2020.