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Smart Eye-Controlled Vehicle Parking System

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ABSTRACT

Road accidents caused by driver fatigue and inattentiveness remain a pressing concern, especially in countries like India. To mitigate such hazards, a robust Driver Drowsiness Detection and Accident Prevention System has been conceptualized. This solution employs Python-based image processing techniques to track the driver's eye aspect ratio in real time, offering continuous vigilance for early signs of drowsiness. The system is supported by an integrated hardware framework comprising two Arduino microcontrollers—one mounted on a robotic vehicle fitted with motors, ultrasonic sensors, and Bluetooth connectivity, while the second acts as a communication bridge between the software and vehicle. This intelligent blend of software analytics and embedded hardware provides an effective safety mechanism that can generate alerts and intervene when required. By proactively identifying driver fatigue and responding accordingly, the system aspires to minimize road mishaps and improve travel safety. The initiative represents a promising advancement toward enhancing road safety through technological innovation.

Keywords: Eye Aspect Ratio (EAR), Arduino Microcontroller, Real-time Monitoring, Ultrasonic Sensors, Accident Prevention System, Road Safety

I. INTRODUCTION

In India, the growing number of road accidents caused by driver fatigue and negligence calls for effective safety interventions. This project presents a smart Driver Drowsiness Detection and Accident Prevention System designed to improve road safety. The system is entirely controlled through hardware-based components, utilizing Arduino microcontrollers along with various sensors and alert mechanisms to monitor the driver's condition and detect signs of drowsiness. By integrating embedded systems and sensor-based technology, the system provides real-time alerts to prevent accidents caused by inattentive driving. This solution not only enhances the safety of drivers and pedestrians but also promotes a more responsible and attentive driving culture through timely warnings and preventive measures.

To enhance the system's functionality, the integration of multiple sensors such as ultrasonic sensors, infrared (IR) sensors, and buzzer modules provides timely alerts and obstacle detection to ensure safer navigation in various environments. The system is designed with a fail-safe mechanism —if the driver remains unresponsive after drowsiness is detected, it can trigger automated control actions such as slowing down or stopping the vehicle.

II.EXISTING METHOD

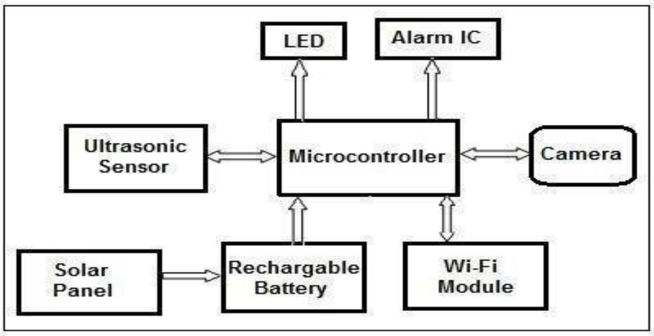

Fig 1: Block diagram of existing method

The Smart Surveillance and Security System is designed to monitor and secure an area using a microcontroller as the central unit. It receives input from an ultrasonic sensor to detect motion and activates a camera to capture images or videos. A Wi- Fi module allows remote access by sending data to connected devices. In case of intrusion, an alarm and LED indicator are triggered to alert users. The system is powered by a rechargeable battery charged through a solar panel, ensuring uninterrupted and eco-operation.

pattern analysis, lane detection, and physiological signal monitoring, most existing solutions function independently and are limited in their integration with vehicle automation. Many focus primarily on drowsiness detection and driver alerts but lack functionalities that support autonomous vehicle control. In contrast, the proposed Autonomous Parking with Eye Motion Detection system introduces an innovative approach by utilizing eye gesture-based control for navigating and parking a robotic vehicle. This system leverages Arduino microcontrollers, obstacle detection sensors, and motor control modules to perform parking maneuvers without manual steering input. The use of eye motion as a directional control mechanism, coupled with sensor-based safety checks, offers a user- friendly and hands-free method of vehicle operation. This approach not only simplifies the parking process but also promotes greater accessibility, especially for individuals with mobility limitations, marking a significant step toward smart and assistive vehicular technologies.

II. PROPOSED METHOD

The proposed system introduces an autonomous parking solution integrated with eye motion detection, designed to offer hands-free vehicle control and enhanced accessibility. The system utilizes eye- tracking sensors to interpret the driver's eye movements, allowing intuitive directional commands without manual input. Ultrasonic sensors are deployed to detect obstacles during the parking process, ensuring safety and accuracy. The core functionality is managed by microcontrollers, which process sensor inputs and execute control decisions for vehicle movement. Additionally, a display unit and alert mechanism are included to provide real- time feedback on parking status and system errors. This smart integration of sensing technologies and control logic delivers a reliable, user-friendly, and efficient alternative to conventional parking methods. The Autonomous Parking with Eye Motion Detection system not only addresses the challenges of manual parking but also paves the way for next- generation assistive technologies in the automotive sector. By integrating intelligent sensor-based automation and user-friendly control through eye gestures, the system enhances the convenience and precision of vehicle parking. It eliminates the dependency on conventional steering systems, making it especially valuable for differently-abled individuals or elderly users who may face difficulties with physical controls.

The implementation of obstacle detection through ultrasonic sensors ensures safe maneuvering in confined or crowded parking areas, reducing the risk of collisions and human error. Moreover, the use of microcontrollers allows real-time decision-making and efficient coordination between input sensors and motor actuators. This project exemplifies the fusion of automation and accessibility, contributing to the broader vision of intelligent transportation systems and inclusive mobility solutions for all users.

Fig 2: Block diagram of proposed method

Components and Their Functions

1. Power Supply:

The power supply unit provides the necessary electrical energy to all components in the system. It converts the input voltage into a stable DC voltage suitable for the Arduino UNO, sensors, motor driver, and display units. A reliable power source is essential for the smooth functioning of the entire setup.

2. Eye Sensor:

The eye sensor plays a crucial role in detecting the movement and direction of the user's eyes. It sends corresponding signals to the Arduino UNO based on gestures like left, right, up, or down. This sensor acts as the primary input device for controlling the direction of autonomous parking, allowing for a hands- free and user-friendly operation.

3. IR Sensor:

The IR (Infrared) sensor is used for obstacle detection during the parking process. It continuously monitors the surroundings and alerts the system about nearby objects. This helps in preventing collisions and enhances the safety and accuracy of the autonomous parking system.

4. Arduino Uno:

Arduino UNO serves as the brain of the entire system. It receives inputs from the eye sensor and IR sensor, processes the data, and controls the output components accordingly. It executes the logic for direction control, obstacle detection, and alert mechanisms, ensuring efficient coordination between all hardware elements.

5. 16×2 LCD Display:

The 16×2 LCD display is used to provide real-time visual feedback to the user. It displays important information such as system status, parking directions, and alerts, helping the user understand the current operation of the autonomous parking system.

6. Buzzer:

The buzzer serves as an audio alert system. It produces sound notifications to indicate specific events like obstacle detection, system errors, or successful parking. This ensures that the user is instantly aware of any critical situations even without looking at the display.

7. Motor Driver (L293D):

The L293D motor driver acts as an interface between the Arduino UNO and the motor. It receives control signals from the Arduino and directs the motor's movement accordingly. It enables smooth and accurate control of the vehicle's motion based on eye gesture commands.

8. Motor:

The motor is responsible for driving the movement of the vehicle. Based on the signals received from the motor driver, it enables forward, backward, left, or right movement, allowing the vehicle to park autonomously as per the user's eye motion input.

III. RESULTS AND DISCUSSION

The implemented system successfully demonstrated real-time control of a wheelchair using eye blink gestures integrated with obstacle detection for enhanced safety. Upon initialization, the LCD module displayed system status, ensuring clarity for the user. Eye blinks were reliably detected using an analog eye blink sensor, with a threshold-based detection mechanism and a debounce interval of 500 milliseconds to ensure accurate input recognition. Each blink pattern was correctly mapped to directional movements—single blink for forward, double for backward, triple for left turn, and quadruple for right turn—with resets for inputs exceeding four blinks. The system translated these commands into motor actions through pre-defined activation patterns of the motor pins. Real-time feedback was provided on the LCD screen, and a buzzer was triggered upon obstacle detection by the IR sensor, halting the wheelchair to prevent collisions. After each movement or interruption, the system returned to a "Ready" state, allowing continuous and intuitive interaction. The loop function maintained constant monitoring with a minimal delay for performance optimization. Overall, the system functioned reliably, offering an assistive solution for hands-free navigation in dynamic environments.

Table1: Comparisons between existing and proposed system

Features	Existing system	Proposed system
Parking Control	Done manually or with remote	Controlled using eye movement
User Input	Uses buttons or mobile apps	Uses eye gesture recognition
Hardware Used	Basic sensors and motors	Arduino, IR sensors, motor driver, LCD, etc.
Obstacle Detection	Basic detection	IR sensors detect obstacles and parking spot
Alerts and Display	Not available or very basic	LCD display and buzzer alerts

The existing parking systems generally rely on manual control or remote operations, which can be inconvenient and less accessible for people with disabilities. User input is usually through physical buttons or mobile apps, whereas the proposed system introduces a more advanced and accessible method using eye gesture recognition. Traditional systems often use only basic hardware and lack wireless communication. In contrast, our proposed solution uses Arduino UNO, IR sensors, LCD, buzzers, and a Wi-Fi module (ESP8266) for smart control and monitoring. Obstacle detection in existing setups is often limited, but our system uses IR sensors for accurate detection of both parking space and obstacles. Additionally, while current systems may lack real-time alerts, our model provides an LCD display and buzzer alerts for enhanced user safety and awareness.Our proposed solution revolutionizes the traditional parking experience by incorporating advanced hardware and wireless communication capabilities. Unlike existing systems that rely on basic hardware and limited functionality, our system utilizes the

Arduino UNO microcontroller, IR sensors, LCD display, buzzers, and a Wi-Fi module (ESP8266) to provide a comprehensive and intelligent parking solution.he IR sensors play a crucial role in accurate obstacle detection, identifying both parking space availability and potential hazards, thereby ensuring a safe and efficient parking experience. Furthermore, our system addresses the limitations of current setups by providing real-time alerts and notifications through the LCD display and buzzer, keeping users informed and aware of their surroundings.

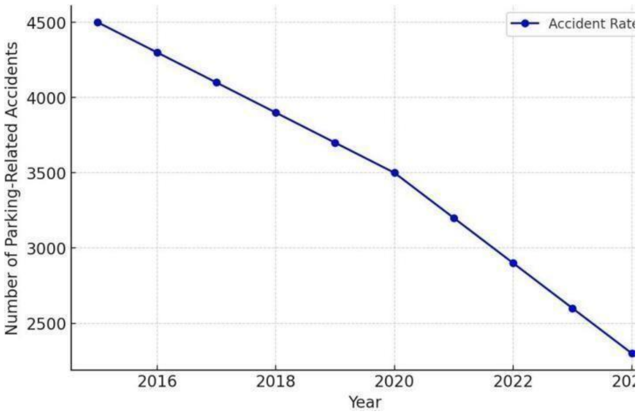

Fig 3: Decline in Parking-Related Accidents Over the Years

The number of parking-related accidents has shown a consistent decline from 2015 to 2024. In earlier years, accident rates were significantly higher, with around 4,500 incidents recorded. However, advancements in vehicle automation, improved driver assistance systems, and the implementation of smart parking solutions have contributed to a steady decrease. By 2024, the number of accidents has dropped to nearly 2,500, indicating a significant improvement in parking safety. The introduction of autonomous parking technologies, better obstacle detection systems, and increased awareness among drivers have played a crucial role in reducing these incidents. This trend highlights the positive impact of modern innovations in enhancing road and parking safety.

IV. CONCLUSION

The Autonomous Parking with Eye Motion Detection system provides a hands-free parking solution by integrating eye-tracking technology and IR sensors for efficient and safe vehicle maneuvering. It enables users, especially those with mobility impairments, to control parking using eye movements, reducing human effort and reliance on manual steering. The system ensures safety with IR sensors detecting obstacles, while the L293D motor driver and motors facilitate smooth vehicle movement. Real-time alerts via buzzers and an LCD display enhance user awareness and system reliability. This innovative approach improves parking precision, minimizes accidents, and contributes to the advancement of intelligent transportation systems. Future enhancements in response time and environmental adaptability can further optimize its real-world application.

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