

Accident Prevention Glasses: A Drowsiness Detection System with Automatic Braking and Sound Alert for the Driver

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Abstract—Since the introduction of vehicles, they have been extensively used throughout the world for various purposes. As vehicle use has increased, so too has the incidence of accidents, which continue to pose significant risks today. Many factors contribute to these accidents, with driver drowsiness being a major cause due to reasons such as fatigue, continuous driving, or lack of sleep. Over the past decade, advancements in technology have significantly impacted the automobile industry, leading to the introduction of automatic and even self-driving cars. In response to the growing concern over drowsy driving, there has been a focused effort to develop solutions aimed at preventing such accidents. In this project, we present a solution in the form of accident prevention glasses designed to detect and address drowsiness in drivers. The system utilizes an eye blink sensor to monitor the driver's blink patterns; when drowsiness is detected, it triggers automatic braking through a relay mechanism and activates a vibration motor in the glasses to alert the driver. Our project aims to contribute to road safety by reducing the number of accidents caused by drowsy driving and providing a reliable and automated mechanism to prevent potential disasters on the road. Through this project, we hope to demonstrate the potential of wearable technology in improving driver safety and paving the way for more intelligent and proactive systems in the automobile industry.

Keywords—Driver drowsiness, Accident prevention, Eye blink sensor, Automatic braking, Wearable technology.

I. INTRODUCTION

Vehicles, especially trucks, form the backbone of a country's economy and are essential for its well-functioning. However, accidents caused by vehicles not only harm drivers but also endanger other drivers. A significant proportion of these accidents is attributed to driver drowsiness, which can result from various factors, including fatigue and extended periods of driving[8]. To tackle this issue, several measures have been implemented, including projects that utilize facial recognition, biological sensors, and hybrid systems[1-3]. Facial recognition systems, which can be attached to a vehicle's steering wheel, detect signs of drowsiness through facial cues such as head movements and yawning.

However, these systems may fail to detect drowsiness when facial cues are minimal or when the camera's view is obstructed (e.g., when drivers wear glasses or have facial hair that interferes with detection algorithms)[1] [9]. Additionally, their accuracy can be influenced by external factors such as lighting and camera positioning. Biological sensors present an alternative by measuring brain signals associated with fatigue or drowsiness. However, these devices often need to be continuously worn, raising concerns about comfort and practicality during long drives[2].

Moreover, they may lead to distractions or discomfort, which could compromise safety.

A hybrid approach combines both facial and biological detection methods to improve reliability[3]. By integrating visual cues with physiological signals, these systems strive for a comprehensive assessment of driver alertness.

However, the complexity and cost associated with hybrid systems may limit their widespread adoption, particularly in commercial vehicles like trucks that are vital for economic operations.

There remains a pressing need for a more practical, efficient, and non-intrusive solution to combat accidents caused by drowsiness. This project aims to develop an innovative solution that effectively detects and responds to drowsiness, offering a reliable alternative to existing systems.

The primary goal of this project is to enhance safety measures for truck drivers and others who drive for extended periods. Our solution seeks to address the shortcomings of previous advancements in this field [1-3][9-14]. We have developed a cost-effective yet accurate product designed to maximize driver safety.

Our system utilizes a sensor embedded in glasses or sunglasses that monitors eye activity, detecting when the driver's eyes are closed for a prolonged duration.

When this occurs, the system promptly signals a DC motor to stop the vehicle's wheels, effectively preventing further movement. Simultaneously, a buzzer will be activated to alert the driver.

By incorporating these real-time responses, our project aims to provide a reliable and proactive safety measure for drivers, safeguarding not only their well-being but also that of other road users. The portability of our sensor enhances its accessibility, allowing it to be attached to various types of glasses.

The need for a reliable, cost-effective, and non-intrusive solution to address driver drowsiness is more critical than ever, especially for long-haul truck drivers and those who spend extended hours on the road [5]. While existing technologies have shown success, they are not without their issues[11].

Our solution provides a significant improvement by directly addressing these limitations. The use of glasses equipped with a sensor to monitor eye activity offers a practical and less intrusive option. It requires no complex installation or constant physical contact, ensuring comfort for drivers over long durations. Additionally, it serves as a cost-efficient alternative to more expensive hybrid models, making it accessible for both commercial and personal vehicles.

What differentiates our solution is its real-time intervention mechanism. Upon detecting drowsiness, the system immediately halts the vehicle by signalling the DC motor, while also alerting the driver through auditory (buzzer) signal. This prominent response ensures that the vehicle is brought to a stop to prevent accidents while promptly notifying the driver of their condition.

By focusing on affordability, accuracy, portability, and ease of use, our project fills a critical gap in existing drowsiness detection technologies, offering a practical and scalable solution for road safety.

II. PROPOSED SYSTEM

The proposed system involves developing smart glasses equipped with an eye blink sensor and an Arduino Uno to monitor drowsiness levels in real-time.

These glasses will utilize an infrared (IR) eye blink sensor to accurately detect the user's blinking rate, providing critical data that indicates potential drowsiness.

The Arduino Uno will process this sensor data and determine whether the user is drowsy based on predefined thresholds for blink frequency, allowing for timely intervention.

To enhance user safety, an auditory alert system will be integrated, featuring a buzzer that activates whenever drowsiness is detected, prompting the user to take a necessary break.

Additionally, the system will incorporate relays that control the vehicle's braking mechanism automatically, engaging it if the user remains drowsy for a specified duration.

This combination of features aims to provide a proactive approach to accident prevention, ensuring that drivers can maintain alertness while on the road.

By continuously monitoring and responding to the user's drowsiness levels, the smart glasses will contribute significantly to enhancing overall safety in driving scenarios.

III. METHODOLOGY

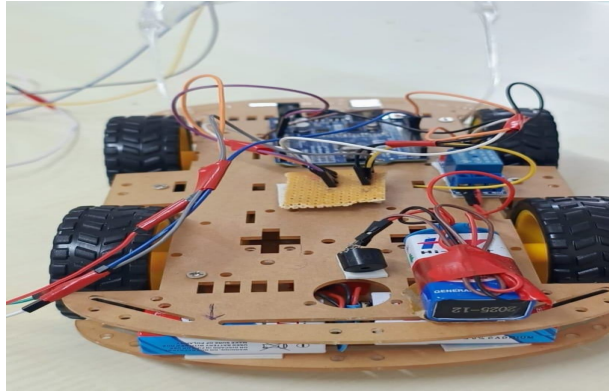


Figure 1: Working Model image 1

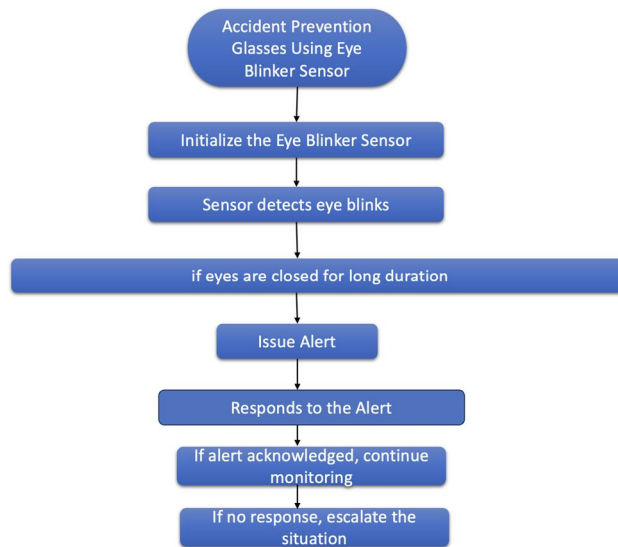


Figure 2: Flowchart of the project

A. Hardware

As shown in Fig. 1 the hardware of this accident prevention system is built around an Arduino Uno microcontroller, which serves as the central processing unit. The key components include an eye blink sensor, two relays, a DC motor, a buzzer, and a vibration motor. Each component plays a crucial role in detecting driver drowsiness and activating necessary alerts. The flowchart in Fig. 2 shows the algorithm of this project.

- **Eye Blink Sensor:** The eye blink sensor, attached to the glasses or a headband, monitors the user's eye activity. It sends a digital signal (high or low) to the Arduino Uno when the eye is closed or open, respectively. The sensor operates by measuring infrared light reflected by the eyelids.
- **Arduino Uno:** The microcontroller processes the signals received from the eye blink sensor. The Arduino controls three relays based on the eye blink sensor input. It is programmed to activate specific alerts depending on whether the eyes are detected as open or closed.
- **Relays:** Two 5V relays are used in this project:
 - Relay 1 is connected to a DC motor that drives the vehicle or any similar rotating mechanism. When the eyes are open, this relay remains active, allowing the motor to function. When the eyes are closed (indicating drowsiness), the relay turns off, stopping the motor to simulate a braking system.
 - Relay 2 is connected to a buzzer. When drowsiness is detected (eyes closed), the buzzer is activated to alert the driver.
- **DC Motor:** The DC motor, controlled via Relay 1, simulates the vehicle's wheel movement. The motor operates when the eyes are open, indicating that the vehicle is in motion, and stops when the eyes are closed, triggering an automatic brake response.

- Buzzer: Connected via Relay 2, the buzzer emits an audible alert when the eyes are closed for an extended period, signalling potential drowsiness.
- Power Supply: The Arduino Uno is powered by an external 9V supply(as shown in Fig. 1 and 3), while the DC motors and relays are powered by a separate 9V supply(A separate 9V supply for DC motor , buzzer) to ensure that there is no power shortage when the motor is running.

This configuration ensures that when the eyes are detected as open, the vehicle is in motion, and when the eyes are closed, the vehicle's motor stops, and the buzzer is activated to alert the driver. The real-time response and efficient control of these hardware components make this system suitable for accident prevention applications.

B. Software

The code used in this project to make it a properly working model is written in C language . This code then had been input into Arduino uno board to make this project a success.

Purpose

- The code responds to the eye blink sensor:
 - When the eye is open, the motor is running, and the buzzer and third relay are off.
 - When the eye is closed (indicating drowsiness), the motor stops, and the buzzer and third relay activate, possibly signalling an alert or triggering other actions.

C. Testing and Calibration

In the Testing and Calibration phase, the accident prevention glasses project was tested to validate its functionality. The system successfully achieved its objective, demonstrating that it accurately detects eye closure and responds by stopping the DC motors (which simulates the vehicle's movement) and activating alerts (buzzer). Specifically, when the eyes are open, the DC motors continuously operates, indicating normal driving conditions. However, once the eyes close, signalling drowsiness, the DC motor stops, and the alert is activated, ensuring that the driver is notified immediately. These responses were consistently observed during multiple testing rounds, confirming the effectiveness of the design.

Considerations for Real-Time Vehicle Integration

The project's system operates based on electric signals sent to a DC motor, which is controlled by a relay mechanism simulating an electric braking system. This setup is ideal for electric vehicles (EVs), which inherently use electric braking mechanisms (such as regenerative braking) [7] to control the vehicle's speed and come to a stop [6]. EVs are well-suited for such automated braking systems because they already have the infrastructure to handle electric commands for braking functions. Integrating this system into real-time electric vehicles would require fine-tuning the system's input-output controls to interface with the vehicle's electric motor and braking systems for efficient and smooth operation.

Adaptation for Non-Electric Vehicles

However, if the system were to be integrated into non-electric vehicles, such as those with internal combustion engines (ICEs), significant modifications would be required. Non-electric vehicles primarily rely on mechanical braking systems, which include friction-based components like disc brakes or drum brakes. These systems are activated through hydraulic pressure generated when the driver presses the brake pedal. The current design of the accident prevention glasses, which uses electric relays, would not directly interface with these mechanical braking systems.

To integrate the project's concept into non-electric vehicles, a conversion mechanism would be needed to translate the electrical signals generated by the system (when drowsiness is detected) into a mechanical action that engages the vehicle's brake system.

Calibration Considerations for Both Systems

For both electric and non-electric vehicles, calibration would be essential to ensure that the system responds quickly and appropriately to various levels of eye closure or drowsiness.

Factors like reaction time, braking force, and alert thresholds must be carefully tested and adjusted to suit different vehicle types and driving conditions. In electric vehicles, the system would need to communicate directly with the vehicle's Electronic Control Unit (ECU), while in non-electric vehicles, additional components (e.g., actuators or pumps) would need to be calibrated to apply sufficient braking force when the system detects drowsiness.

In conclusion, while the current project successfully demonstrates the intended functionality in a controlled environment, real-world integration would require customization depending on the type of vehicle.

Electric vehicles present a more straightforward implementation due to their existing infrastructure for electric braking, while non-electric vehicles would require the development of conversion mechanisms to engage mechanical brakes based on the system's electric signals [7].

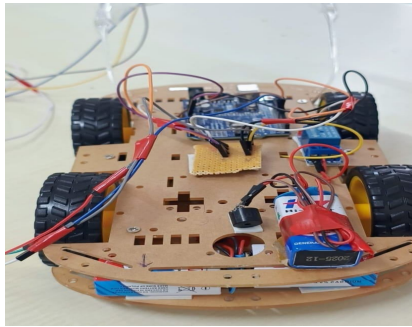


Figure 3: Working model image 2

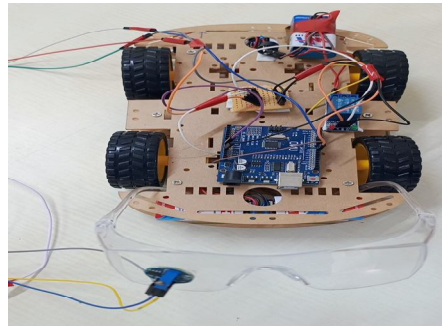


Figure 4: Working model image 3

IV. RESULTS

The accident prevention glasses project yielded promising results during testing. The system effectively detected eye closure and appropriately responded by stopping the motor and activating alerts. The following results were observed during the testing phase:

A. Eye Blink Detection: (as shown in Fig. 5)

- The eye blink sensor accurately identified open and closed eye states.
- When the eyes were open, the sensor continuously sent a signal to keep the DC motor active, simulating normal driving conditions.
- When the eyes were closed, the sensor detected the condition, signalling the Arduino to stop the motors and activate the buzzer

B. Motor Control

- The DC motors (simulating vehicle movement) remained operational while the driver's eyes were open, demonstrating the system's capability to allow regular operation under non-drowsy conditions.
- Upon detecting drowsiness (eye closure), the motors immediately stopped, simulating an automatic braking system to prevent potential accidents.

C. Alert Mechanism

- The buzzer reliably activated when the eyes were closed, providing both auditory alert to the driver, which is crucial for regaining attention.
- The alert turned off when the eyes opened again, preventing unnecessary distractions during normal driving conditions.

D. Response Time

- The system responded within 1-2 seconds after eye closure, which is a critical factor in ensuring timely activation of the braking system and alerts to prevent accidents.
- No significant delay or malfunction was observed in the relay switching for motor and alert control during the testing period.

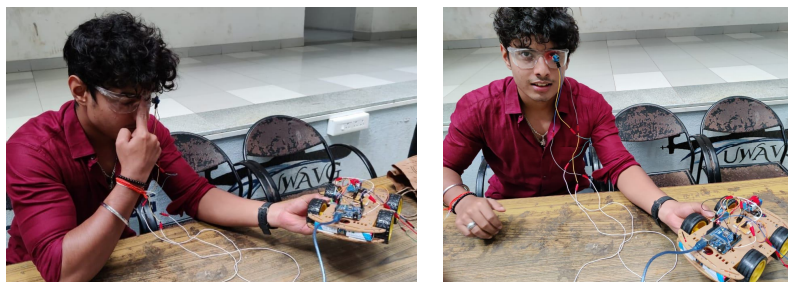


Figure 5: Project Implementation 1 and 2

Limitations

In non-electric vehicle simulations, the system would require adaptations, such as integrating an electro-hydraulic braking system or using servo motors for mechanical braking, which were not part of the current prototype.

V. DISCUSSION

In exploring various microcontroller options for our accident prevention glasses project, we initially considered using the ESP-32 due to its advanced features [4]. The ESP-32 has an inbuilt Wi-Fi module, which provides significant advantages for real-time data transmission and connectivity. This feature would allow the glasses to connect seamlessly to a nearby Wi-Fi network and even act as a Wi-Fi access point, enabling other devices to connect and receive data, such as transmitting drowsiness alerts to a central system or cloud-based service like ThingSpeak.

A. ESP-32 Advantages and Challenges

The decision to try the ESP-32 was motivated by its enhanced capabilities for wireless communication, making it a powerful candidate for integrating IoT functionalities. This would allow the accident prevention system to send data about the driver's drowsiness level or other critical information to a remote server in real time, potentially triggering alerts for fleet management systems or sending data to mobile devices. However, during testing, we encountered a significant limitation regarding the ESP-32's operating voltage. The ESP-32 operates at 3.3V, whereas the relays used in our project require a 5V supply to function efficiently. This voltage mismatch resulted in inconsistent operation of the 5V relays, leading to unreliable control of the motor and alert systems (buzzer and vibration motor). The relays failed to switch properly, compromising the system's effectiveness.

B. Shift to Arduino UNO

To simplify the design and improve reliability, we switched to the Arduino UNO microcontroller. The Arduino UNO operates at 5V, making it a perfect match for our relay-based system. This decision allowed the relays to function smoothly without any need for voltage amplification, significantly simplifying the hardware setup. The Arduino UNO provided a stable and reliable platform for controlling both the motors and the alert system (buzzer). Additionally, its widespread use and compatibility with various components made troubleshooting and development much easier.

C. Real-World Integration with Electric Vehicles

In a real-world scenario, this system could be seamlessly integrated into electric vehicles (EVs), which commonly use regenerative braking systems. Regenerative braking in EVs allows the vehicle's electric motor to function as a generator, converting the vehicle's kinetic energy into electrical energy and storing it in the battery when braking. This aligns perfectly with our project's design, where the motor is stopped based on drowsiness detection.

By integrating our accident prevention system into an EV, the system could automatically trigger regenerative braking when drowsiness is detected, providing both an energy-efficient braking solution and enhancing safety. The Wi-Fi capabilities of microcontrollers like the ESP-32 could further enhance this integration by enabling remote monitoring, data logging, and alerting, allowing fleet operators or individual drivers to track drowsiness-related events and take proactive measures.

Additionally, the integration of IoT features could allow vehicles to communicate with nearby infrastructure [5] or other connected vehicles (V2X communication), improving the overall safety of the driving environment by sharing real-time data about driver drowsiness and potential hazards.

VI. CONCLUSION

To develop accident prevention glasses for driver safety, we explored three main drowsiness detection approaches: facial sensors, biological sensors, and hybrid systems. Facial sensors use machine learning and thermal imaging but can be affected by lighting. Biological sensors like EEG provide high accuracy but lack practicality for long-term use. Hybrid systems offer robust solutions by combining both but are complex.

Our project integrates real-time drowsiness detection with automatic braking, aiming for simplicity and effectiveness. While successful, the eye blink sensor's precision could improve, and future versions will incorporate wireless capabilities and regenerative braking. This project presents a practical approach to enhancing driver safety and sets a foundation for further innovations.

FUTURE SCOPE

The future scope for this project focuses on several critical improvements. First, enhancing the precision of the eye blink sensor output to the Arduino is a priority. Currently, the sensor needs to be positioned precisely for the system to function correctly, which has been a limitation. Future iterations will aim to modify the sensor design or improve the algorithm to provide more accurate and reliable data regardless of the sensor's exact placement, enhancing the usability and flexibility of the system.

Another key area for future development is making the entire system wireless. By eliminating wired connections, the system would not only improve the driver's comfort but also reduce the risk of disconnections or interference with other vehicle components. Wireless functionality would make the installation process easier and more user-friendly, while maintaining the system's reliability and efficiency.

Finally, incorporating regenerative braking technology will extend the project's applicability to all vehicle types, including petrol and hybrid vehicles. Currently, the system is mainly suited for electric vehicles (EVs) that already feature regenerative braking systems. By integrating regenerative braking into non-electric vehicles, the project could offer a more comprehensive solution, significantly expanding its potential for adoption across a broader range of vehicles and enhancing overall energy efficiency.

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