INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

Driver Drowsiness Detection System

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DOI: https://doi.org/10.51583/IJLTEMAS.2025.140500109

Received: 08 June 2025; Accepted: 11 June 2025; Published: 26 June 2025

Abstract: Driver drowsiness is a serious safety issue that contributes significantly to road accidents. This paper presents a hardware-based system for detecting early signs of fatigue in drivers using a low-cost setup. The system's objective is to issue alerts to drivers showing signs of inattention or drowsiness. It utilizes an infrared eye blink sensor integrated with an Arduino microcontroller, a buzzer, a relay, and a DC motor. The eye blink sensor tracks eyelid movements, and when prolonged eye closure is detected, the system triggers an audible alarm and deactivates the motor to simulate a vehicle stop. The system operates without the use of artificial intelligence or camera-based image processing, relying instead on time-based thresholds. Experimental testing showed consistent activation during simulated drowsy states, though formal metrics such as accuracy and false positive rates were not recorded. While the current model is basic and non-adaptive, it provides a practical foundation for low-resource applications and can be expanded with intelligent features for better real-world usability.

Index Terms – Driver safety, Eye blink sensor, Arduino, Embedded systems, Drowsiness detection.

I. Introduction

Fatigue while driving impairs reaction time, alertness, and decision-making, often leading to critical accidents. The growing number of such incidents highlights the need for affordable and effective drowsiness detection systems. This work introduces a system that uses an IR eye blink sensor to monitor eyelid behaviour and react when prolonged closure is detected. The goal is to warn the driver and prevent accidents by simulating a vehicle stop, thus promoting safer driving practices.

Objectives

The main goals of this Driver Drowsiness Detection System are outlined below:

Detect driver fatigue by monitoring eye blink duration and frequency.

Trigger immediate alerts (buzzer) upon detection of abnormal eye closure.

Simulate engine control by stopping a DC motor via a relay.

Ensure affordability and simplicity using readily available components.

Build a prototype that demonstrates proof-of-concept for vehicle integration.

Support future additions such as GPS, GSM, and smart analytics.

II. Literature Survey

Research on drowsiness detection has evolved over the years, with several studies shaping this field:

Eriksson and Papanikotopoulos (1997): Early work on real-time driver monitoring used computer vision to track eyelid movements, setting the stage for modern blink-based detection methods.

Ji et al. (2002): Developed a non-intrusive system to monitor driver fatigue using eye blink rates and gaze direction, showing the value of simple eye metrics.

Vural et al. (2007): Suggested a combined approach using facial expressions, yawning, and eye activity, proving that even basic blink detection can signal drowsiness.

Zhang et al. (2013): Built a cost-effective system with IR sensors to measure blink frequency, demonstrating reliable detection with microcontrollers.

Sahayadhas et al. (2012): Analyzed various detection methods, noting that sensor-based systems like eye-blink sensors offer a good mix of accuracy and affordability.

Arduino-Based Projects: Numerous academic and hobbyist projects have used Arduino and IR sensors for drowsiness detection, confirming the feasibility of simple hardware solutions.

System Architecture

This technique combines multiple elements to accurately identify drowsiness. A microcontroller called an Arduino UNO controls outputs and processes inputs. While a DC motor serves as the vehicle's engine, an infrared eye blink sensor monitors eye motions.

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A buzzer emits auditory warnings, and a relay module functions as a switch to regulate the motor. All components obtain the required voltage thanks to a power supply.

By using an infrared sensor to monitor the driver's eyes, the system operates. If the eyelids remain closed for an extended period of time, the sensor sends a signal to the Arduino, which mimics a vehicle stop by turning on the buzzer to warn the driver and telling the relay to turn off the DC motor. Once the eyes of the driver are open and blinking normally, normal operation can resume.

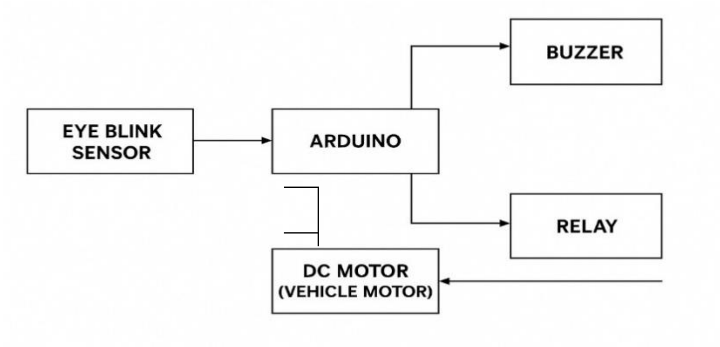

Figure 1: System architecture of the driver drowsiness detection system.

Circuit Diagram

The circuit connects the IR sensor to a digital input pin of the Arduino. The buzzer and relay are connected to output pins. The DC motor is powered through the relay, using an external power source to avoid overloading the Arduino. A timing mechanism in the Arduino code interprets blink durations, and prolonged closure activates the alarm.

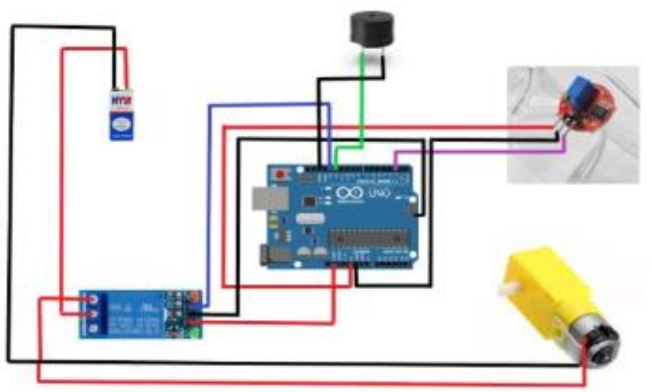

Figure 2: circuit diagram of the driver drowsiness detection system

Working Principle

The IR sensor emits a signal when it detects continuous eye closure. The Arduino uses this signal to distinguish between normal blinks and signs of fatigue. Upon detecting drowsiness, it activates the buzzer and relay to stop the motor. The system resets when normal blinking resumes.

III. Results and Discussion

The prototype was tested in simulated scenarios to validate its functionality. The system successfully detected prolonged eye closure and responded with an audible alarm and motor shutdown. The simplicity of the system ensured low power use and consistent behavior under normal lighting. However, formal evaluation metrics (e.g., detection accuracy, false positives, response time) were not captured. Additionally, the system is not currently tested for real-world complexities such as glasses, head movement, or environmental variations.

Limitations:

No quantitative performance evaluation.

Not adaptive to individual driver behavior.

Lacks testing with glasses or in dynamic vehicle environments.

No gradual stop logic; motor is cut off immediately.

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Applications

Public and private transport vehicles.

Fleet management systems.

Long-distance driving and trucking.

Educational projects in IoT and embedded systems.

Future Scope

Integration with GPS and GSM for real-time alerting.

Use of machine learning to adapt to driver-specific patterns.

Connection with vehicle control systems for safe, gradual stops.

Addition of camera-based detection or EEG monitoring.

Ensuring sensor safety, especially for prolonged eye exposure.

IV. Conclusion

This project demonstrates a basic yet effective method for detecting drowsiness using a blink sensor and microcontroller. The system offers a practical and low-cost prototype that can form the basis of more advanced driver assistance systems. With enhancements such as AI integration and vehicle data analytics, it can evolve into a more robust safety tool for real-world driving condition.

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