

# Vehicle Control Based Drowsiness Response System

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**Abstract-** Driver drowsiness is one of the major causes of road accidents across the world. Fatigue reduces driver alertness, reaction time, and decision-making capability, leading to severe road accidents and fatalities. This paper presents a real-time Vehicle Control Based Drowsiness Response System developed using computer vision and embedded system technologies. The proposed system continuously monitors the driver's facial behavior through a USB camera and detects signs of drowsiness such as prolonged eye closure, reduced blink rate, yawning, and head nodding. The system uses image processing techniques and facial landmark detection to analyze the driver's condition in real time. Once drowsiness is detected, warning alerts such as buzzer sound and LED indication are activated. Additionally, the prototype controls a DC motor to simulate vehicle speed reduction and stopping mechanism. The system integrates both software and hardware components using Python, OpenCV, Arduino, motor driver modules, and alert devices. Experimental results demonstrate that the proposed model can effectively detect fatigue conditions under normal lighting environments with improved reliability and low implementation cost. The proposed work contributes toward intelligent transportation safety systems and can be further enhanced using artificial intelligence and IoT-based monitoring technologies.

**Keywords:** Driver Drowsiness Detection, Computer Vision, OpenCV, Eye Aspect Ratio, Arduino, Vehicle Safety, Fatigue Monitoring.

## I. INTRODUCTION

Road transportation plays an important role in modern society. However, road accidents continue to increase due to driver negligence, fatigue, and reduced concentration. Driver drowsiness is considered one of the major hidden causes of highway accidents, especially during long-distance travel and night driving. Fatigue affects reaction time, steering control, decision-making ability, and lane maintenance.

Traditional vehicle safety systems such as airbags, seat belts, and anti-lock braking systems help reduce accident severity after collisions occur. However, these systems cannot prevent accidents caused by driver sleepiness. Therefore, intelligent monitoring systems capable of identifying fatigue before dangerous situations arise are highly necessary.

Driver drowsiness detection systems are generally classified into three categories:

1. Physiological-based systems
2. Vehicle-based systems
3. Behavioral-based systems

Physiological systems use sensors to monitor heart rate, EEG signals, and pulse rate. Although accurate, these systems are uncomfortable for regular driving applications. Vehicle-based systems monitor steering angle, lane deviation, and braking patterns, but they are affected by road conditions and driver behavior.

Behavioral-based systems using computer vision have become more popular because they are non-intrusive and cost effective. These systems monitor facial expressions, eye blinking, yawning, and head movement using cameras.

The proposed Vehicle Control Based Drowsiness Response System adopts a behavioral-based approach using image processing techniques. The system continuously monitors the driver's face and identifies fatigue conditions in real time. When drowsiness is detected, the system provides warning alerts and controls vehicle motion through a prototype DC motor arrangement.

## II. LITERATURE REVIEW

Several researchers have contributed toward driver drowsiness monitoring systems using different approaches.

Soukupová and Čech proposed a real-time eye blink detection system using facial landmarks and Eye Aspect Ratio (EAR). Their method effectively identified eye closure conditions using image processing techniques.

Vision-based yawning detection systems were developed using facial landmark analysis and mouth opening ratio calculations. These methods successfully detected fatigue symptoms before complete drowsiness occurred.

Head pose estimation techniques were also introduced to monitor head tilting and nodding behavior. These methods analyzed pitch, roll, and yaw angles to identify severe fatigue conditions.

Machine learning and deep learning approaches such as Support Vector Machines (SVM), Random Forest algorithms, and Convolutional Neural Networks (CNN) improved system accuracy under varying environmental conditions.

Although advanced AI-based systems provide better performance, they often require high computational power and expensive hardware. Therefore, there is a need for a low-cost, real-time, and reliable driver monitoring system suitable for practical implementation.

### III. PROPOSED SYSTEM

The proposed system is designed to continuously monitor the driver's facial features and identify signs of fatigue using computer vision techniques.

#### 3.1 System Architecture

The overall system consists of the following modules:

- USB Camera
- Image Processing Unit
- Face Detection Module
- Eye Monitoring Module
- Drowsiness Decision Module
- Alert System
- Vehicle Control Unit

The USB camera captures live video frames of the driver. These frames are processed using OpenCV and facial landmark detection algorithms.

The system identifies eye closure duration, blinking patterns, yawning frequency, and head movement. If the driver shows drowsiness symptoms continuously, the system activates:

- Buzzer alert
- LED warning signal
- DC motor speed reduction

The DC motor is used in the prototype to simulate vehicle movement and automatic speed control.

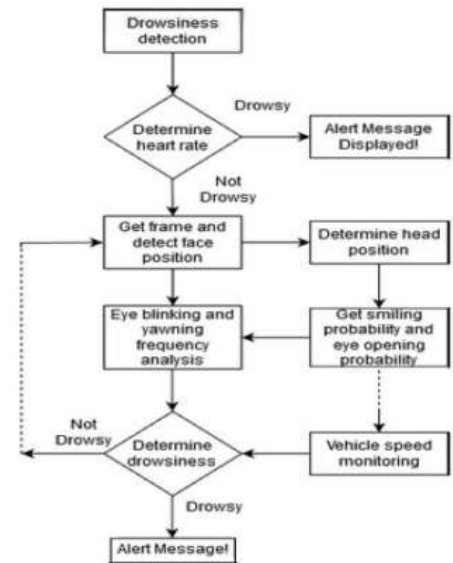


Figure 3 System architecture

#### 3.2 Working Principle

The system continuously performs the following steps:

1. Capture live video from the camera.
2. Detect driver face using Haar Cascade classifier.
3. Extract eye and mouth regions.
4. Calculate Eye Aspect Ratio (EAR).
5. Detect prolonged eye closure and yawning.
6. Generate alerts when thresholds exceed limits.
7. Reduce motor speed or stop motor.

### IV. HARDWARE AND SOFTWARE COMPONENTS

#### 4.1 Hardware Components Arduino

Arduino acts as the main control unit of the project. It controls the buzzer, LED indicators, and motor driver based on fatigue detection results.

#### USB Camera

The USB camera captures real-time facial images of the driver for image analysis.

#### LED Indicator

The LED strip provides visual warning alerts when drowsiness is detected.

#### Buzzer

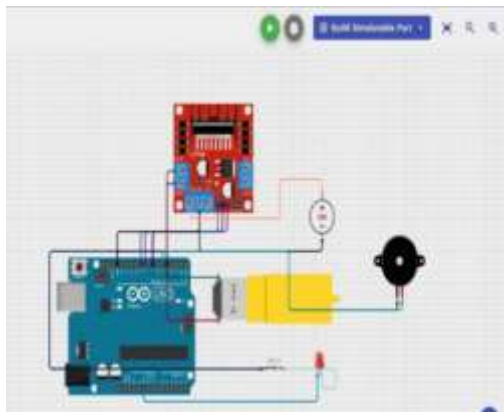
The buzzer generates audible warning signals to regain driver attention.

#### DC Motor

The DC motor simulates vehicle movement and speed control.

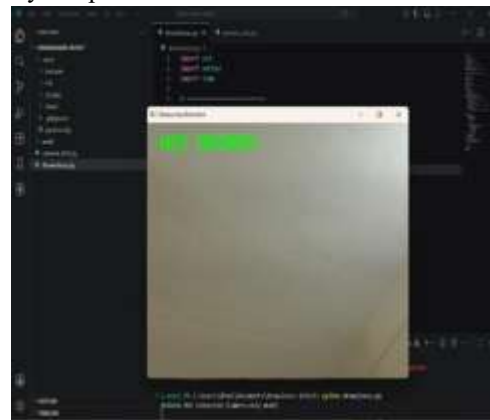
#### Motor Driver Module

The motor driver controls motor speed and direction because the Arduino cannot directly drive the motor.



#### Dlib

Dlib library is used for facial landmark detection and Eye Aspect Ratio calculation.



## V. METHODOLOGY

The methodology of the proposed system combines computer vision techniques and embedded system control.

### 4.2 Software Requirements

#### Python

Python is used as the primary programming language for implementing image processing and control logic.

#### OpenCV

OpenCV is used for:

- Face detection
- Eye tracking
- Video frame processing
- Facial analysis

#### NumPy

NumPy supports matrix operations and image array processing.

### 5.1 Face Detection

The captured video frames are processed using Haar Cascade classifiers to identify the driver's face. Facial landmark points are extracted for detailed analysis.

### 5.2 Eye Monitoring

The Eye Aspect Ratio (EAR) method is used to determine whether the eyes are open or closed.

```
genui {"math_block_widget_always_pre fetch_v2":  
{"content": "EAR = \frac {\|p_2- p_6\| + \|p_3-p_5\|  
{2\|p_1-p_4\|}"}}
```

If the EAR value falls below a predefined threshold for a certain duration, the system identifies drowsiness.

### 5.3 Yawning Detection

Mouth Aspect Ratio (MAR) is calculated to detect yawning behavior. Frequent yawning indicates fatigue.

### 5.4 Head Movement Analysis

Head pose estimation is performed to monitor nodding and abnormal head tilting.

### 5.5 Alert Generation

When fatigue symptoms exceed threshold conditions:

- The buzzer alarm is activated.
- LED indicators start blinking.
- Motor speed decreases gradually.

## VI. RESULTS AND DISCUSSION

The proposed system was tested under different conditions including daytime driving simulation, night conditions, and fatigue scenarios.

### 6.1 Face Detection Performance

The system successfully detected driver faces under normal lighting conditions with high consistency.

### 6.2 Eye Closure Detection

The EAR-based monitoring system effectively differentiated between normal blinking and prolonged eye closure.

### 6.3 Yawning Detection

The system successfully identified repeated yawning behavior and generated warning alerts.

### 6.4 Alert Response

Warning alerts were generated within a few seconds after detecting severe fatigue signs.

### 6.5 Vehicle Control Response

The DC motor speed reduced automatically when drowsiness conditions continued for a longer duration.

The experimental results demonstrate that combining multiple fatigue indicators improves system reliability and reduces false detections.

## VII. ADVANTAGES AND APPLICATIONS

### Advantages

- Real-time monitoring system

- Low-cost implementation
- Non-intrusive monitoring
- Improved road safety
- Fast response mechanism
- Easy hardware integration
- Suitable for intelligent transportation systems

### Applications

The proposed system can be used in:

- Passenger cars
- Commercial trucks
- Public transport buses
- Taxi services
- Ambulances
- Industrial vehicles
- Mining transportation systems

## VIII. CONCLUSION AND FUTURE SCOPE

This paper presented a Vehicle Control Based Drowsiness Response System capable of detecting driver fatigue using computer vision and embedded control technologies. The proposed system continuously monitors eye closure, blinking patterns, yawning behavior, and head movements to identify fatigue conditions in real time.

The system successfully integrates image processing techniques with Arduino-based hardware control to provide immediate warning alerts and simulate automatic vehicle control. The experimental results confirm that the proposed approach is effective, reliable, and suitable for low-cost implementation.

In the future, the system can be enhanced using:

- Artificial Intelligence algorithms
- Deep learning models
- Infrared cameras
- IoT connectivity
- Cloud-based monitoring
- Real vehicle integration
- Personalized driver behavior analysis

The proposed work contributes toward safer transportation systems and intelligent driver assistance technologies.

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