



ACCIDENT MITIGATION SYSTEM WITH DROWSINESS DETECTION

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Abstract: In the era of rapid technological advancement, ensuring road safety remains an ever-persistent challenge. The “Accident Mitigation System with Drowsiness Detection” represents an innovative and holistic approach to enhancing vehicle safety and preventing accidents. This project uses the latest technologies, including IoT and machine learning, which is autonomous, to detect potential risks like inattention and impairment from alcohol. The main goal of this system is to achieve a safer driving environment through the smart utilization of data from the sensors in real-time, which is then done through ML algorithms that process the information on the spot and send warnings before instances of danger happen. The assembly of an IoT system utilizing sensors like alcohol, Vibration Tilt Sensor, and GPS with an Arduino microcontroller as the base is the inception of this innovative design. This project is planned to cover the creation of a static model that will simulate quite a variety of situations, like drowsy driving, drunk driving, and collision scenarios. This model strives to show, by applying them together, the colossal prospect for the system that uses IoT, ML, and live communication, which changes road safety literally.

Keywords— Accident, Drowsiness Detection, Internet of Things (IoT), Machine Learning (ML), Real-time Communication, Sensor Integration, Road Safety

I. INTRODUCTION

In the era of rapid urbanization and smart technologies, transportation systems have witnessed a significant transformation. While this refers to one side of the coin, the other one speaks about a safety loophole. One of the known causes of road carnage is sleepiness, impairment because of alcohol consumption, and interruption of concentration. With the demand for solutions increasing, problem-based approaches have become highly necessary. The Accident Mitigation System with Drowsiness Detection project is a total breakthrough to reach that goal using the latest technologies on the market. In essence, this ground-breaking system combines the Internet of Things (IoT) and Machine Learning (ML) to create a comprehensive and proactive solution that addresses the following crucial aspects:

- **Real-time Drowsiness Detection:** Real-time tracking of the driver's behavior by an IoT device such as camera and ML algorithms, including an eye blink monitoring system, is an effective way of identifying drowsiness
- **Alcohol Impairment Detection:** Accurate recognition of alcohol intake through data exploration by analyzing sensor information in real time.
- **Accident Mitigation:** Use of real time data analysis technology for quick detection of imminent dangers and incidents and taking actions accordingly
- **Buzzer Alerts and Location Notifications:** Instant audio alerts are issued to the driver through the buzzers, thereby making drivers aware of their surroundings, backed by the use of a GPS module on the device.

This project aims to design and develop a static state-space model that can be utilized for analyzing different scenarios: such as detecting drowsiness in drivers, monitoring blood alcohol levels from breath tests and other traffic accidents situations which are almost impossible to see on the spot. The system offers a model required for integrating IoT technology, ML techniques and actual real-time data analysis. In the end, this campaign desires both success in cutting down traffic accidents and an improvement of human life span increase.

The project, as it develops, takes up the mission of bringing state-of-the-art safety to the roads. On the one hand, the development of an accident-mitigation system with drowsiness detection reflects what innovation and technology mean to keep human beings alive on open roads.

II. LITERATURE SURVEY

Road safety is one of the most vital issues worldwide, with a large proportion of incidents associated with drowsy driving, alcohol intoxication, and other types of driver-related distraction. Numerous researchers have explored innovative solutions based on

machine learning algorithms, alert technology, and Internet of Things sensors that help address the problem. This literature review provides an insight into how road safety is enhanced at the moment, focusing on IoT and machine learning utilization for accident and drowsy driving prevention.

P. Sharma and N. Sood [1] have designed an IoT-based driver monitoring system that uses alcohol and air pressure sensors for sobriety checks, including respiration. The integrated machine learning algorithms check for drowsiness, ask for breath samples, and send instant fatigue alerts to drivers for safe driving.

M. S. Razeeth, R. Kariapper, and S. S. Nawaz [2] addressed the issue of road accidents caused by factors such as drowsiness and fatigue. The quickest way to determine drowsiness was proposed through the SVM algorithm that allowed the message to reach the driver almost instantly.

M. Ismail, A. Marwanto, J. P. Hapsari, and M. Haddin [4] concentrated on designing an Internet of Things (IoT)-based alcohol detection system to enhance road safety. The system incorporates an MQ3 sensor for detecting alcohol content in a person's breath and employs the WeMos D1 mini ESP8266 Wi-Fi module for IoT connectivity.

A. Kumar and R. Nandal [5] reviewed the methodological tools aimed at the detection of drunken driving and demonstrated the opportunities of machine learning algorithms and the IoT approach for improving the level of accuracy. In this context, the concept of a two-stage model, including the RF classifier, is actively promoted because of its precision in detection.

D. P. Raja, G. Barkavi, S. Aishwarya, K. Keerthana, and V. Vasudevan [7] presented a technical approach aimed at enhancing road safety through a driver monitoring system. The system utilized a combination of sensors and GSM technology for continuous driver monitoring, enabling the detection of suspicious behaviour's such as speeding, intoxication, and fatigue.

E. G. Radhika, S. Bharath, S. Ezhilarasan, and M. Shankar [10] presented a technical approach for real-time driver drowsiness detection. This approach utilizes a convolutional neural network (SVM) model integrated within a container-based system. Leveraging IoT components, Docker, and cloud computing, the system achieves a high level of accuracy in predicting driver drowsiness with minimal loss.

P. Sudarshan, V. Bhardwaj, and Virender [12] proposed a technical approach to address road accidents resulting from driver fatigue. The system utilizes the Haar cascades machine learning algorithm and IoT technology to monitor drivers in real-time. When closed eyes are detected for an extended duration, the system triggers alarms, dispenses water sprays, and notifies concerned individuals through a cloud system. This approach provides both detection and prevention measures to enhance road safety.

The literature review highlights the importance of IoT and machine learning in enhancing road safety by detecting fatigue and preventing accidents. Existing systems have limitations in sensor accuracy, integration with alcohol detection, and preciseness alert mechanisms. This paper proposes a comprehensive system using IoT sensors, machine learning, and existing alert systems to address impairment factors in road safety.

III. PROPOSED METHODOLOGY

The Methodology of the suggested model has been thoroughly covered in this section. A financially impactful real-time driver monitoring solution that detects drowsiness and assists, equipped with a novel approach to accident detection using IOT and ML algorithms, is an efficient device for eliminating road traffic accidents induced by sleeplessness and driver incompetence. This work aims to improve safety on the road by designing a real-time driver monitoring structure that can detect the causes of driver somnolence and prevent the occurrence of accidents. The driver monitoring system utilizes Internet of Things technology, machine learning algorithms, GPS, and GSM to recognize the factors enhancing risks, including driver somnolence and drunkenness.

An Arduino microcontroller, sensors for alcohol consumption and drowsiness such as the MQ-3 sensor and camera, respectively, location identification systems like GPS, communication channels like GSM, and output devices like LCD, buzzer, and others are the main parts of the system. In general, the system needs to be integrated with the vehicle in order to provide an ongoing surveillance system that may promptly alert the driver and prevent uncomfortable and unpleasant traffic incidents.

The Arduino microcontroller serves as the core, analyzing sensor data with machine learning algorithms to assess the driver's condition. An alcohol sensor measures breath alcohol concentration as shown in Fig. 1 and Fig. 2 respectively.



Fig. 2. MQ3



Fig. 1. Arduino
Sensor

The ML model detects tiredness using a webcam's live visual stream. A block diagram (Fig. 3) outlines the system, including drowsiness and abstinence checks. The MQ3 sensor sends abstinence data to the Arduino, which displays results on an

LCD panel and sounds a buzzer for notification. The camera feeds live video to a machine learning algorithm for monitoring drowsiness throughout the drive.

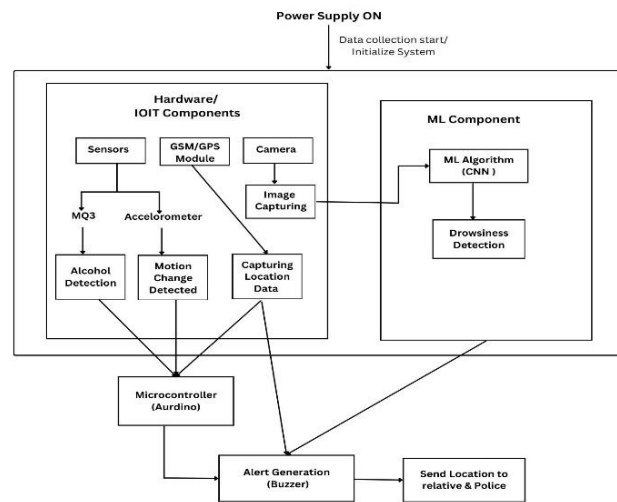


Fig.3. System Architecture

i. Alcohol Detection: The alcohol gas sensor MQ-3, LCD screen, and buzzer make up the abstinence check system's components.

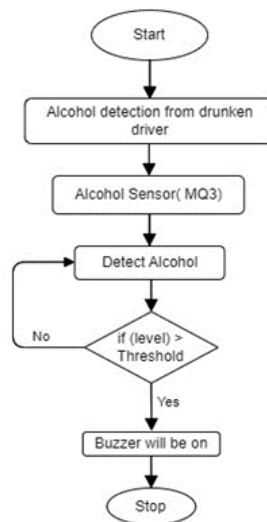


Fig. 4. Flow Diagram for Alcohol Detection

An MQ-3 sensor is an affordable and efficient tool for detecting alcohol fumes. It can pick up alcohol concentrations as low as 0.005 milligrams per 100 millilitre's and as high as 50 milligrams per 100 millilitre's. The sensor operates because it uses tin oxide, a material that conducts electricity more easily when exposed to increased concentrations of alcohol gas. The MQ3 sensor provides voltage data, which is then converted to parts per million. The alcohol detection process begins with sensor calibration to establish a correlation between the sensor's analog output and actual alcohol concentrations. Calibration involves exposing the sensor to known alcohol vapor concentrations and recording its response. The collected data is used to create a calibration table, which maps analog readings to corresponding alcohol concentrations. The data acquisition process involves continuously sampling the analog output of the MQ-3 sensor using the Arduino's analog-to-digital converter (ADC).

Each analog reading is converted to voltage using the formula:

$$\text{Voltage} = (\text{Analog Value} \times 5)/1023 \quad (1)$$

where:

- Analog Value: Analog Value is the raw analog reading from the sensor (between 0 and 1023),
- 5 is the reference voltage of the Arduino's ADC, and
- 1023 is the maximum value that can be read from the ADC, representing the reference voltage.

The alcohol concentration in parts per million (PPM) is calculated using the formula:

$$\text{PPM} = (0.42 \times \text{Voltage} - 0.22) \times 1000 \quad (2)$$

where:

- PPM is the alcohol concentration in parts per million,
- Voltage is the voltage value calculated from the analog reading

This formula is derived from the sensor's datasheet and provides an approximation of the alcohol concentration based on the sensor's response curve.

The system compares the calculated PPM value against a predetermined threshold, typically set at 1000 PPM, to determine the presence of alcohol. If the PPM value exceeds the threshold, indicating alcohol presence, the system triggers an alert using the buzzer and LCD Screen.

ii. Drowsiness Detection: The camera, speaker, and machine learning algorithms are the parts of the tiredness/drowsiness check system that detect the driver's indicators of fatigue. The methodology for the driver drowsiness detection system consists of several key elements. First, this system records a live stream of footage from a webcam that is positioned inside the automobile while constantly monitoring the driving person's facial expressions and motions. The frames from the video are processed using the dlib package to recognize facial landmarks, with an emphasis on the eyes as a focal point. The eye aspect ratio (EAR) is calculated using Euclidean distances among stated facial features to provide a quantitative metric of eye openness.

The EAR is then used as a feature to determine the driver's drowsiness state. A predefined threshold value is set for the EAR, below which the driver is considered drowsy. A dataset of annotated face landmark features and sleepiness labels is used to train a model using machine learning algorithm.

The model acquires knowledge to identify the driver's condition using the calculated EAR values, predicting whether the driver is alert or drowsy.

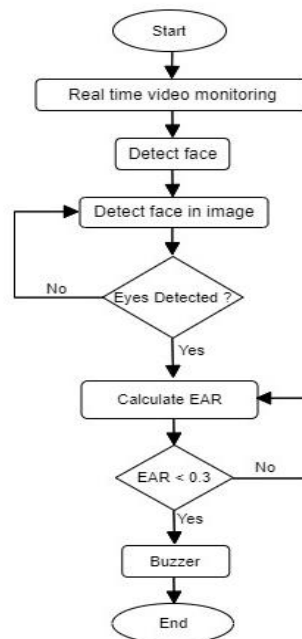


Fig. 5. Flow Diagram of Drowsiness Detection

During runtime, the system continuously calculates the EAR from the live video feed and feeds it into the trained machine-learning model for classification. If the ML model predicts that the driver is fatigued based on EAR values falling below the threshold for a particular number of successive frames, a buzzer is raised to notify the driver. Additionally, the system can be configured to send a notification to a predefined contact, such as a family member or emergency service, to ensure prompt action in case of prolonged drowsiness.

The proposed methodology for the drowsiness detection system involves several key steps to accurately detect and alert drivers of potential drowsiness. This process employs algorithms from computer vision to assess facial landmarks as well as compute an eye-aspect ratio (EAR), a quantitative metric of eye openness. Here is a detailed description of each step:

The system captures live video feed at a standard frame rate of 30 frames per second, ensuring smooth and accurate processing of frames.

1. Data Acquisition and Preprocessing: Each captured frame is resized to a width of 450 pixels to standardize the input size for processing. The frames are then converted to grayscale which simplifies processing by reducing the dimensionality of the data and focusing on relevant features related to drowsiness detection.

2. Facial Landmark Detection: The system uses the dlib package in order to identify facial features in grayscale images. The method uses a pre-trained shape prediction model to identify certain facial markings for each detected face, which include the edges of the eyes. These landmarks serve as important reference points for determining the eye-aspect ratio (EAR).

3. Eye Aspect Ratio (EAR) Calculation: The EAR is calculated for each eye using the formula:

$$EAR = (A + B)/2C \quad (3)$$

where:

- A and B are the Euclidean distances between vertical eye landmarks,
- C is Euclidean distance between the horizontal eye landmarks.

This calculation provides a quantitative indicator of eyes openness, which is an essential sign for somnolence.

- 4. Drowsiness Detection Threshold:** A predefined threshold value for the EAR is set to around 0.3, below which the driver is considered drowsy. This threshold is based on empirical data and determines whether the driver is alert or sleepy.
- 5. Machine Learning Model Integration:** The system integrates a ML model and trained based on a dataset of annotated facial landmark features and drowsiness labels. Based on the computed EAR values, the algorithm learns to categorize the driver's state and forecast whether they are alert or sleepy.
- 6. Real-time Monitoring and Alerting:** During runtime, the system continuously calculates the EAR from the live video feed and compares it to the predefined threshold value. An alarm is set off to notify the driver if the EAR drops below the threshold for a predetermined amount of frames in succession (e.g. 48 frames). This real-time monitoring ensures timely detection and intervention in case of drowsiness.
- 7. Continuous Monitoring and Real-time Operation:** The system constantly analyses the driver's eyes in real-time for indicators of sleepiness. This continuous monitoring and real-time operation enable the system to provide immediate feedback to the driver and enhance driver safety.

By combining these steps, the proposed methodology aims to effectively detect drowsiness in drivers and alert them to prevent potential accidents, thereby improving overall road safety.

IV. RESULT

The intended system is designed to identify drowsiness detection and alcohol detection in an effort to lower the number of accidents brought on by blunders and human error. As a result, the proposed system is tested in real-time environments. The drowsiness detection and alcohol detection systems were tested separately by ML and IOT approaches, respectively.

1. Alcohol Detection

An Arduino board, a MQ-3 alcohol sensor, an LCD screen, and a buzzer were used to effectively create the alcohol-detecting system. The alcohol concentration in the air is continuously monitored. Using varying alcohol concentrations, the MQ3 sensor within the system was tested.

The results of the test are shown in the Fig. 6 below.



Fig. 6. Alcohol Detected

The system demonstrated reliable detection of alcohol concentrations, with the LCD screen displaying real-time PPM values. The system's response time to changes in alcohol concentration was fast, allowing for timely alerts to be issued when the concentration exceeded the threshold.

Table 1. Alcohol Detection Test Results

Test Sample	PPM Value	Alcohol Detection Result
Sample 1	1060	Alcohol Detected
Sample 2	755	No
Sample 3	1155	Alcohol Detected
Sample 4	1090	Alcohol Detected

When the alcohol concentration exceeded the threshold, the system activated a buzzer and an LED to alert the user. This alert mechanism provided a clear and immediate indication of the presence of alcohol in the air, enhancing safety measures in environments where alcohol vapours may pose a risk.

2. Drowsiness Detection

A camera module, Python programming, machine learning methods, and other tools were used to develop the drowsiness detection system. A system monitored the driver's blinks and eye motions in real time so as to detect indicators of tiredness and notify the driver accordingly. The drowsiness detection system was extensively tested under various conditions to evaluate its performance in detecting driver drowsiness. The system was tested in three distinct scenarios:

2.1. Driver with Ample Light and Without Spectacles

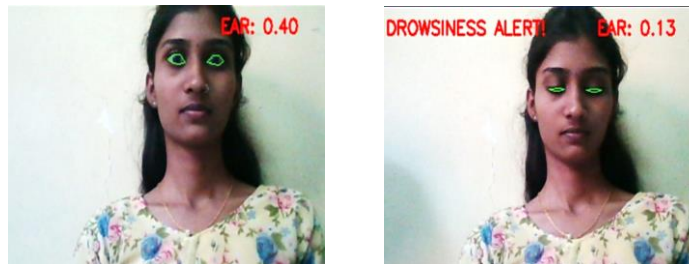


Fig. 7. Conscious Vs Fatigued Driver in Ample Light.

In this scenario, the system accurately detected drowsiness based on the driver's eye driver's blinks and eye motions. The ability of the system to keep track of the eye aspect ratio (EAR) and sound an alarm when sleepiness is detected was consistent and reliable.

2.2. Driver with Ample Light and with Spectacles



Fig.8. Conscious Vs Fatigued driver in Ample Light with Spectacles

Testing with drivers wearing spectacles showed similar results to those without spectacles. The system effectively detected drowsiness regardless of whether the driver wore spectacles, indicating its robustness in detecting eye movements through glasses.

2.3. Driver in Low Light

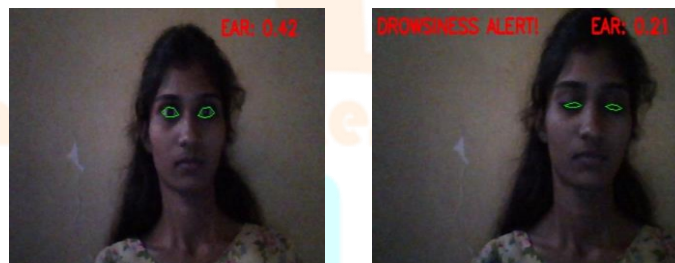


Fig. 9. Conscious Vs Fatigued Driver in Low Light

2.4. Driver in Low Light with Spectacles

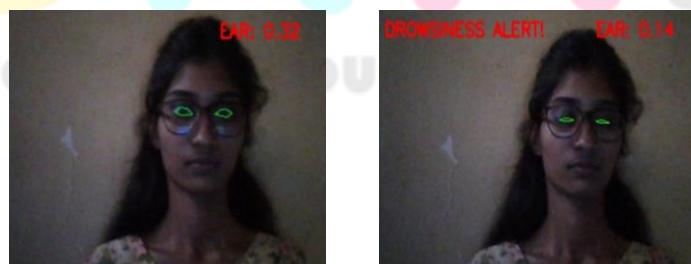


Fig. 10. Conscious Vs Fatigued driver in Low Light with Spectacles

The monitoring system functioned effectively even in low-light circumstances, identifying tiredness depending upon the driver's movements of the eyes. The ability of the system to operate well in low-light environments is critical for maintaining driver safety under varying lighting conditions.

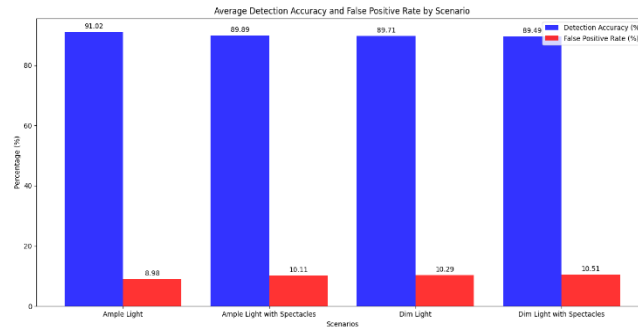


Fig. 11. Drowsiness Detection System Performance by Scenario

The graph below represents the performance of a drowsiness detection system in different scenarios. The accuracy ranges from 89.49% to 91.02% while the FP rate is 8.98% to 10.51%. The below results show how well system is performing in different situations.

Table 2 indicates that compared to other available systems, proposed system is better, more effective, and more adaptable.

Table 2. Existing System Vs. Proposed System Comparison

AUTHOR	EXISTING SYSTEM	PROPOSED SYSTEM
[11]	The device detects eye closing and sleepiness using infrared (IR) technology, which sets off a buzzer. But this technology depends on infrared sensors, it could lack the ability to able to detect minute facial expressions or eye movements, which might lead to decreased accuracy, particularly when there are changes in illumination or when people are wearing glasses.	It uses a camera to capture facial expressions and measure the EAR, which can provide more detailed and accurate information about the user's drowsiness level. Additionally, by incorporating Dlib, the system can learn and improve its detection accuracy over time, potentially leading to better performance compared to the existing method.
[7], [14]	They primarily focus on alcohol detection using sensor-based methods, overlooking drowsiness as a contributing factor to accidents. They rely on a limited set of sensors, potentially missing crucial indicators of impairment.	The system's hybrid approach integrates alcohol and drowsiness detection, offering a comprehensive solution with adaptability and continuous learning through ML algorithms, surpassing static approaches.

The system provided real-time monitoring and alarm mechanisms to alert drivers promptly, enhancing road safety. The user-friendly interface of the system provided clear feedback to the driver, contributing to their overall effectiveness in preventing accidents caused by impaired driving and drowsiness.

In order to improve road safety, we are putting into practice a prototype for accident mitigation with drowsiness detection that incorporates algorithms, IoT sensors, and alarm systems. By solving current system constraints, the system provides exact alarm production and real-time detection of tiredness and alcohol impairment. With advanced sensors that increase precision and dependability, it provides a strong approach to driver safety and accident avoidance.

V. FUTURE WORK AND CONCLUSION

In order to optimize its influence on road safety, the system's future scope will encompass interaction with autonomous cars for increased safety, real-time reporting and notifications to authorities, driver profile customization, and lobbying for worldwide acceptance and legislative backing. Enhanced safety may be achieved by integration with autonomous cars, which facilitates easy cooperation with autonomous driving technology. Driver profile customization might improve each driver's flexibility and efficiency by offering specialized solutions for a range of requirements and driving styles. To optimize the system's impact, promoting its benefits, and encourage implementation while assuring alignment with norms and standards, advocacy for worldwide acceptance and regulatory backing is essential. By examining trends, integrating cutting-edge AI with predictive driver behaviour analysis has the potential to further enhance proactive safety measures and accident avoidance.

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