# Drowsiness and Crash Detection Mobile Application for Vehicle's Safety

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**Abstract**

Detecting road accidents promptly is crucial for minimizing casualties and property damage worldwide. The proposed system, comprising hardware and a mobile application, automatically identifies and reports accidents to emergency services. It also employs a facial recognition system to detect driver drowsiness, enhancing accident prevention measures. By leveraging sensor technologies, cellular networks, and advanced detection algorithms, the proposed system analyzes data from accelerometers, Global System for Mobile Communication (GSM), and Global Positioning System (GPS) sensors. Originally designed for vehicles, it can be easily adapted for deployment in various settings such as factories and construction sites with minor adjustments. The system continuously monitors the driver's facial expressions and activities using sensors. When drowsiness is detected, it activates a buzzer, and in the event of a crash, it alerts the driver to prevent false alarms while simultaneously notifying the rescue center if a genuine crash has occurred. This integrated approach enhances safety and optimizes emergency response efforts. The Arduino microcontroller, equipped with an accelerometer, identifies sudden changes in motion like acceleration and rotation to assess impacts against predefined thresholds. Furthermore, GPS functionality accurately determines the vehicle's location at the time of the accident, while GSM enables seamless communication with rescue centers through notifications.

**Keywords:** Accelerometer, Arduino, Crash Detection, Drowsiness, GPS, GSM


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## 1. Introduction

The rapid advancement of modern technology has revolutionized our daily lives, offering unprecedented levels of convenience and comfort compared to previous eras. However, as the frequency of road accidents continues to rise, there is an urgent need to prioritize the safety of human lives and property. This necessitates the development and implementation of advanced safety measures aimed at both preventing accidents and facilitating efficient rescue operations in the event of an incident [1],[2]. Central to these efforts are drowsiness detection [3] and crash detection systems[5],[6], which play a crucial role in monitoring drivers for signs of fatigue through continuous facial landmark scanning and analysis, as well as promptly identifying and notifying relevant parties about accidents or collisions[4],[7]. While traditionally deployed in vehicles, these systems are increasingly finding applications across various industries, including factories and construction sites.

The evolution of crash detection systems can be traced back to the early 1970s, initially relying on accelerometers to detect sudden changes in vehicle motion. Over subsequent decades, advancements in sensor technology led to the integration of additional safety features such as airbags and seatbelts in the 1980s, followed by the adoption of computerized systems and software in the 1990s. This progression has significantly enhanced the sophistication of crash detection systems, providing drivers and emergency responders with comprehensive information to effectively manage accidents [8],[9].

Today, crash detection systems have become common place in modern vehicles, often standardized with instantaneous relay capabilities to emergency response centers [10],[11]. The alarming statistics surrounding road accidents, coupled with the potential to mitigate their impact, have spurred extensive research and development efforts in this field. Our motivation for advancing these systems is rooted in our commitment to enhancing safety by monitoring driver’s drowsiness and autonomously notifying both drivers and emergency response centers in the event of a crash.

The primary objectives of this research work are as follows:

1. Implement real-time monitoring of drivers' location and facial expressions to proactively prevent accidents.
2. Develop a robust crash detection system capable of accurately and promptly identifying incidents and alerting relevant parties.

## 2. Related Works

Recent advancements in accident prevention and safety assistance have been fueled by the integration of traditional methodologies and IoT-based approaches. Bhatti et al. [1], presents a noteworthy study introducing an innovative Internet of Things-enabled accident detection and reporting system designed specifically for smart city environments. Utilizing smartphones, this system gathers data on multiple parameters including speed, gravitational force, pressure, sound, and location. This data is then analyzed to detect road incidents and activate suitable responses [12,15]. Through simulations and comparison with real-world accident data, the effectiveness of this approach is demonstrated, showing promising levels of accuracy and efficiency [1].

In a similar vein, Uma and Eswari proposed an accident prevention and safety assistance system utilizing IoT and machine learning techniques [2]. This study explores the potential of integrating IoT devices with machine learning algorithms to enhance accident detection and response capabilities. By analyzing sensor data from vehicles and roadside infrastructure, the system can identify potential hazards and alert drivers or emergency services accordingly, thus mitigating the risk of accidents [2],[13],[14].=

Furthermore, efforts have been made to develop hardware-based solutions for accident detection and prevention. For instance, Prabha et al. [4], presents an automatic vehicle accident detection and messaging system that utilizes GSM and GPS modems [15]. This system enables real-time monitoring of vehicle movements and can automatically send distress signals in the event of an accident, facilitating prompt emergency response [3]. Similarly, Mahamud et al. [11] proposed an Arduino-based accident prevention and identification system for vehicles, which integrates various sensors to detect abnormal vehicle behavior indicative of potential accidents.

Additionally, Yee and Lau explored the development of a mobile vehicle crash detection system [7], which aims to promptly identify and report accidents using smartphone technology, thus expediting emergency response and potentially reducing accident-related fatalities and injuries.

These studies highlight the diverse approaches and technologies being employed to enhance road safety and prevent accidents. By harnessing the capabilities of IoT, machine learning, and hardware devices, researchers are striving to develop comprehensive systems that can effectively detect, mitigate, and respond to potential hazards on the road [16],[17].

However, challenges such as scalability, cost-effectiveness, and system accuracy still need to be addressed to realize the full potential of these solutions.

## 3. Proposed Work

### 3.1 System Architecture and Approach

The system comprises sensors like accelerometer MPU6050 to measure the change in speed and GPS NEO 6M to gather the location information of vehicles as shown in Figure 1. It has a GSM module SIM 800L which facilitates the communication between the on-vehicle device and rescue center. Arduino is used as a central controller.

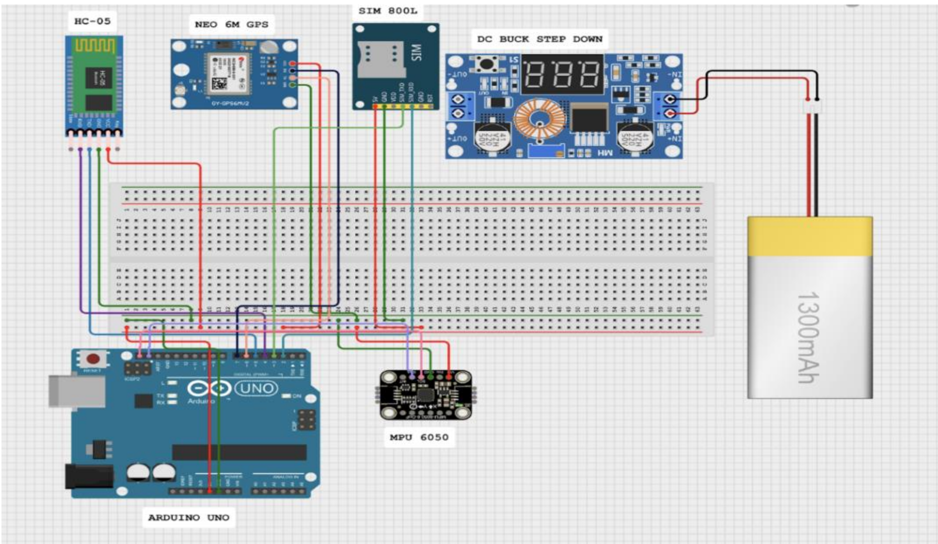



**Figure 1.** System Architecture

### 3.2 Methodology

The system primarily consists of two segments designed to detect crashes and drowsiness for which the activity diagram is shown in Figure 2.

### a. Drowsiness Detection

For detection conditions like yawning, not yawning, eye closed, eye opening, we trained multi-class classification CNN model on Kaggle dataset and tested for similar scenarios. And A mobile application continually scans the driver's face to detect signs of drowsiness. Upon detecting drowsiness, the app alerts the driver with a buzzer sound on their mobile phone.

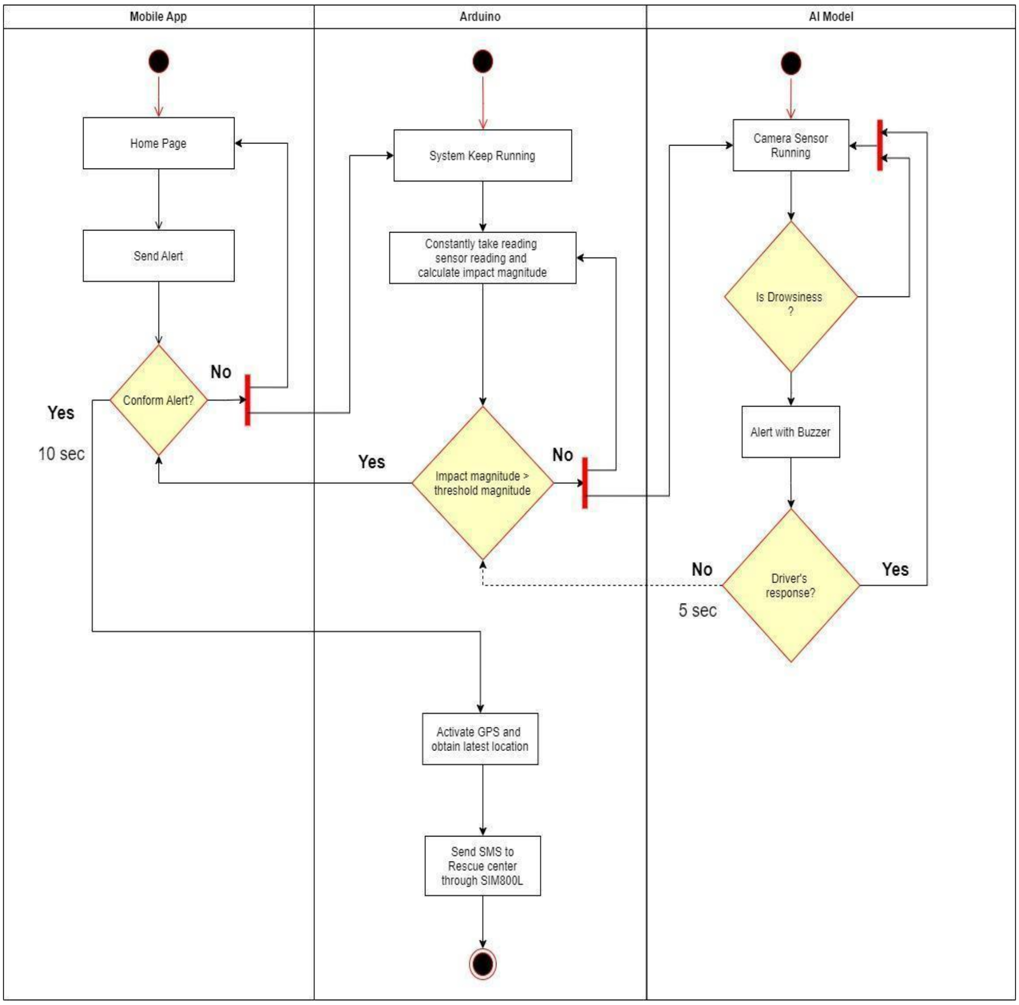



**Figure 2.** Activity Diagram of the Proposed System

## b. Crash Detection

The data acquisition unit captures sensor data encompassing acceleration, angular velocity, and GPS coordinates, which is then analyzed by the crash detection algorithm. Through rigorous testing, threshold values for various crash parameters are established to differentiate between normal driving conditions and crash events. The algorithm compares sensor data against these thresholds to detect crash events accurately. In case of a crash, the communication module is activated to dispatch crash notifications, facilitating prompt emergency response as in Figure 3. Pertinent parties, upon receiving notifications, can initiate requisite emergency protocols, including dispatching emergency services to the crash site.

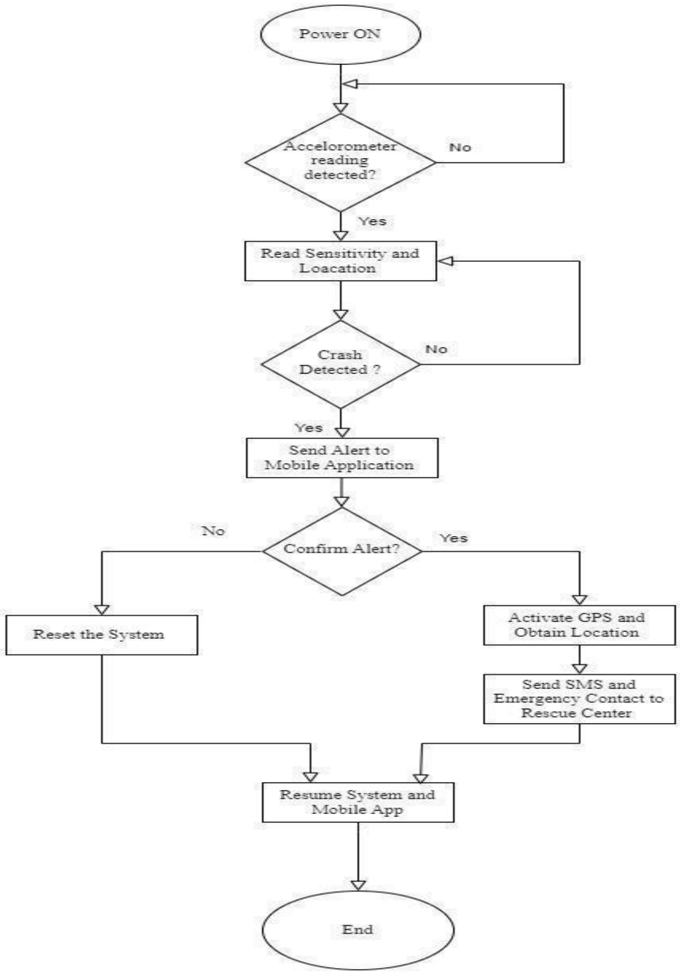



**Figure 3.** Crash Detection Flow Chart

## 3.3 Components Used

### a. Arduino UNO

The Arduino Uno, built around the ATmega328P microcontroller, receives velocity and tilt values from the accelerometer [7]. It verifies if these values meet predefined conditions before proceeding with further operations.

### b. MPU 6050

In this study, a 10 DOF IMU Sensor, capable of measuring 3-axis accelerometer data, is utilized to detect changes in a vehicle's orientation, indicative of potential accidents. To calculate velocity and prevent accidents, the acceleration-time relationship is leveraged, enabling accurate velocity estimation based on acceleration values over time

### c. SIM 800L

This research work utilizes GSM technology through the SIM900A GSM module to send SMS notifications in case of predefined events, such as exceeding velocity limits or detecting vehicle tilt indicating an accident. These notifications include vital information like location and vehicle speed as shown in Figure 4, ensuring prompt response to critical situations.

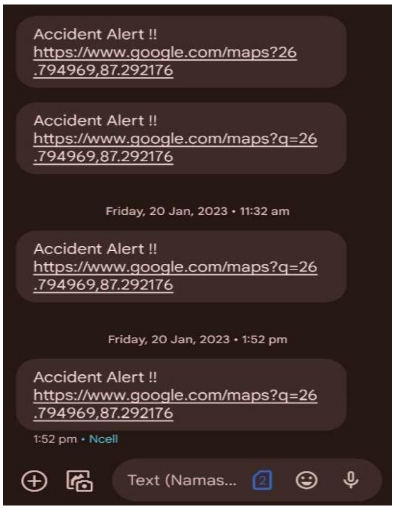



**Figure 4.** Message Screenshot

### d. GPS Module (NEO 6M)

The GPS module in this research work constantly delivers real-time latitude and longitude coordinates (as shown in Figure 5) to the Arduino, which monitors the vehicle's location. By setting a predefined velocity range, the Arduino compares actual velocity with the received coordinates, facilitating real-time tracking and monitoring of the vehicle's speed and location.

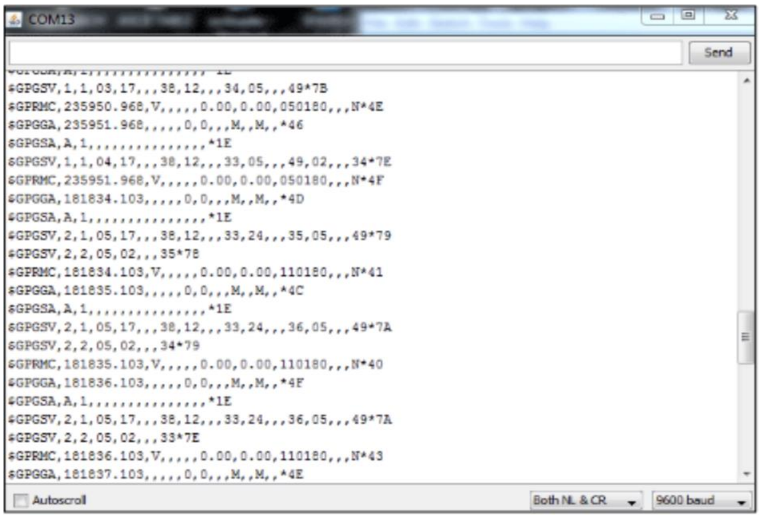


**Figure 5.** Sample GPS Data

### e. LM2596 DC-DC Buck Converter Step-Down Power

The LM2596 DC-DC Buck Converter is utilized in crash detection systems to regulate and step down the voltage from a power source, ensuring stable and appropriate voltage levels for the electronic components involved in the system. It helps maintain the reliability and efficiency of the crash detection system.

## 4. Result and Discussion

The crash detection system was implemented and subjected to testing, employing a combination of hardware and software as shown in Figure 6 and Figure 7. The primary aim was to accurately identify various crash events and promptly notify for emergency response. In this section, we outline the results of the system's performance evaluation and discuss their implications.

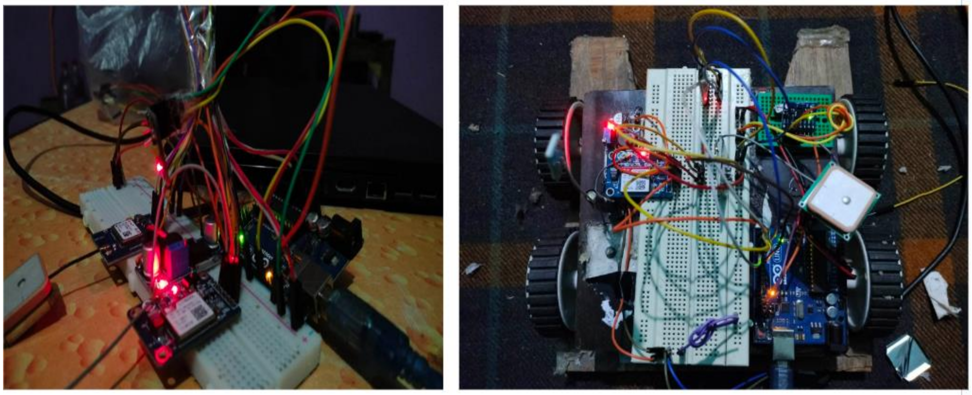
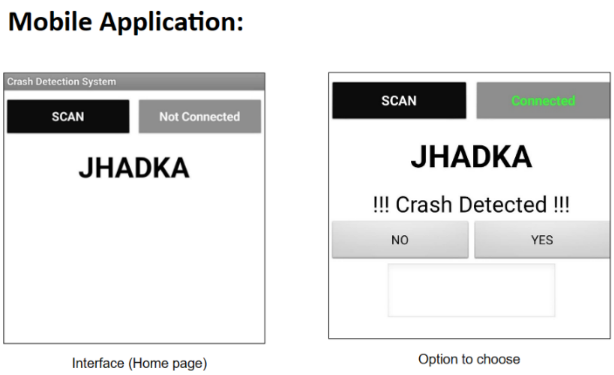


**Figure 6.** Final Prototype of Crash Detection System



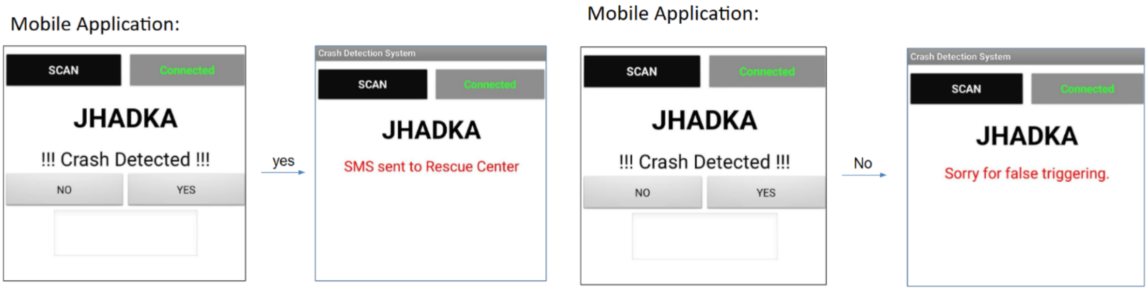



**Figure 7.** Mobile Application Snapshots

The system's performance was assessed through a series of controlled experiments, specifically focusing on frontal collision scenarios. These evaluations gauged the system's response time and reliability as shown in Figure 8 and Figure 9.

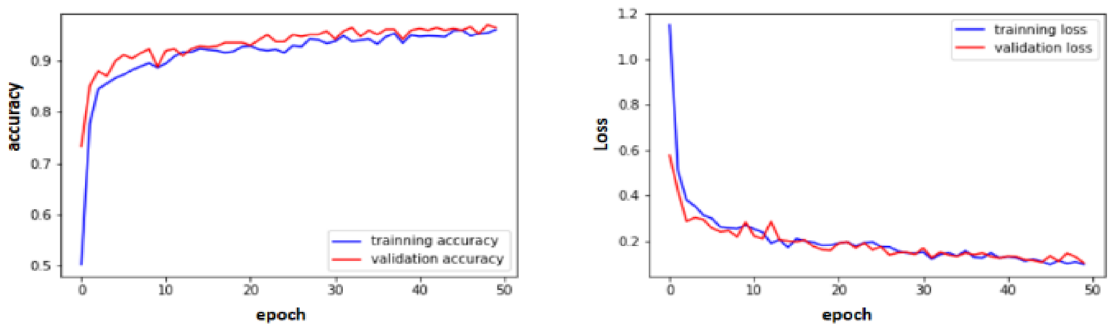



**Figure 8.** Accuracy and Loss Curves

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| yawn | 0.96 | 0.81 | 0.88 | 63 |
| no_yawn | 0.84 | 0.97 | 0.90 | 74 |
| Closed | 0.95 | 0.96 | 0.96 | 215 |
| Open | 0.97 | 0.95 | 0.96 | 226 |
| accuracy | | | 0.94 | 578 |
| macro avg | 0.93 | 0.92 | 0.92 | 578 |
| weighted avg | 0.95 | 0.94 | 0.94 | 578 |

**Figure 9.** System Performance Report

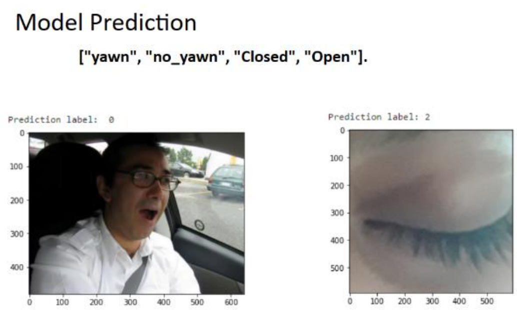



**Figure 10 .** Facial Drowsiness Detection

The facial detection system accurately identifies yawning and eye conditions as in Figure 10, and the crash false notification triggering mechanism responds as depicted in Figure 7.

## 5. Conclusion

The results obtained from the drowsiness and crash detection system demonstrate its effectiveness in improving road safety. By detecting driver drowsiness and accurately identifying crash events while promptly notifying relevant parties, the system facilitates swift emergency response and aids in preventing potential accidents by monitoring the driver's facial condition. Moreover, it promotes seamless coordination between vehicles and rescue center. The system's accuracy rate and response time underscore its potential to enhance the efficiency of emergency services and potentially reduce the severity of injuries in crash incidents.

Nevertheless, it is important to acknowledge certain challenges and limitations. Environmental factors, such as adverse weather conditions or heavy traffic congestion, may introduce additional complexities in crash detection. Further research efforts, such as integrating both crash detection and drowsiness detection into a single device, are necessary to enhance the system's performance in such challenging scenarios.

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## Author’s biography

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