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Comprehensive Driver Safety System using Arduino Mega

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ABSTRACT

Enhancing road safety is a major priority right now because there is a lot of increase in accident graphs these days. Most of the accidents are due to over speeding of vehicles, drunken driving, vehicle malfunctions, and delayed emergency responses. This study provides a comprehensive driver safety system using Arduino Mega and IoT technology, which provides solutions to the problems mentioned. The system has several sensors, like an accelerometer for continuous vehicle axis monitoring, a gas sensor for alcohol detection by the driver, and a temperature sensor for engine overheating. Moreover, there is a SOS button that can be used during emergencies. Arduino Mega acts as a medium for all these components to work together. Through the implementation of this system, our research aims to minimize response time during road accidents, promote responsible behaviour and reduce loss of lives. By including the GPS and GSM modules, the system sends the actual location and message to saved contacts. This proposed system presents a detailed analysis of the system architecture, sensor integration, data transmission protocol, and experimental findings, demonstrating the effectiveness and reliability of the proposed driver safety system.

Keywords—Road safety, driver safety system, Arduino Mega, IoT technology, accelerometer sensor, alcohol detection, temperature sensor, emergency response, SOS call, real-time data transmission, responsible driving behaviour, accident detection, sensor integration, experimental analysis.

1. INTRODUCTION

The increasing number of traffic accidents worldwide has become a major concern in recent years, posing serious threats to public safety and wellbeing. This trend is glaringly illustrated by the "Road Accidents in India 2022" report, which was released in November 2023 and shows a consistent increase in fatalities related to traffic accidents. According to the report, there was a concerning increase in the number of deaths from 1,50,785 in 2018 to 1,53,792 in 2021; in 2010, around 1.3 lakh.

The severity of fatalities from traffic accidents is significantly influenced by the delay in receiving emergency medical care. After an accident, victims frequently find themselves unable to get help right away, which exacerbates the severity of their injuries because timely medical attention was not received. The necessity of promptly identifying incidents and initiating emergency response protocols highlights the pressing requirement for inventive approaches to bridge this crucial divide.

Most accidents result from mistakes that are either conscious or unconscious. Conscious errors mostly come from human behaviours that can be avoided, whereas non-conscious errors can arise from circumstances outside of human control. These intentional mistakes, which include drinking and driving, speeding, and car problems, highlight the necessity of taking preventative action to lessen their detrimental effects on traffic safety. Through the implementation of all-encompassing strategies that include infrastructure improvements, technological innovations, and responsible driving practices, societies can work toward reversing the upward trend in road accidents and promoting safer road environments.

The goal of this proposed system is to create a comprehensive driver safety system that aims to prevent accidents and provide rapid response, taking into account the complexity of road safety challenges. The following are the proposed system's main goals:

- Detecting the amount of alcohol consumed by drivers and sending out alerts when set limits are exceeded.
- Engine temperature is being monitored to warn drivers in advance of possible overheating problems.
- Control of vehicle speed by means of alert systems and continuous monitoring.
- GPS-enabled accident location tracking, which makes emergency responses and rescue efforts more efficient.

Current accident detection systems are very helpful in situations where an accident has already occurred, but they are not always effective in proactively preventing accidents. The suggested driver safety system, on the other hand, uses an Arduino Mega and a number of sensors to combine real-time alerting, GPS tracking, and accident detection features in an effort to close this gap. Important elements of the suggested system consist of:

1. Accident detection: Using a MEMS sensor to identify abrupt changes in a vehicle's orientation, position, and movement patterns allows for the identification of possible collisions based on unusual readings.
2. GPS tracking is the integration of a GPS module to continuously track the location of the vehicle in real time, enabling accurate accident location identification and precise positioning.
3. SMS Alerts: By sending registered recipients immediate alerts via a GSM module, important accident information and GPS coordinates are communicated for timely assistance and response.

The suggested driver safety system, which combines quick response times with accident prevention, is essentially a proactive approach to traffic safety. The system aims to reduce the frequency and severity of traffic accidents by utilizing cutting-edge sensor technologies and communication modules, which will ultimately lead to safer roads and increased public safety.

Many researchers have focused their work on an accident monitoring system to control road accidents and save lives. Some of the work has been discussed in this section.

In 2020 “An Arduino Based Automatic Accident Detection and Local Communication System” has been published in IEEE International Conference for Convergence in Engineering

On June 13, 2022, the Indian Ministry of Road Transport and Highways released data on traffic accidents, offering a thorough understanding of the country's traffic patterns.

Road safety information is featured in Association for Safe International Road Travel, which was retrieved on January 30, 2019. The website offers information on the frequency and consequences of traffic accidents across the globe. Asirt.org provides useful information for comprehending the risks related to travel.

Fogue, M., Garrido, P., Martinez, F. J., Cano, J. C., Calafate, C. T., Manzoni, P., & Sanchez, M address the prototype of an automatic notification strategy for traffic accidents on vehicular networks in their 2011 presentation at the IFIP Wireless Days in Niagara Falls, ON, Canada.

Automatic collision detection utilizing a sensor and GSM-based communication was proposed by C. Vidya Lakshmi and J.R. Balakrishnan (2012) and published in the International Journal of Scientific Research Publications.

John and Nishanth (2017) discussed an integrated system designed for collision avoidance, presented at the IEEE International Conference on Electronics, Communications and Aviation Technology. The article proposes a new way to improve road safety by using technology to measure and respond to the causes of accidents, ultimately reducing the risk of traffic accidents.

2. SYSTEM ARCHITECTURE

The proposed driver safety system as shown in in Fig.1.1 is supported by a strong system architecture that seamlessly integrates various components and functionalities. The Arduino Mega microcontroller serves as the central processing unit for data aggregation, analysis, and control. A suite of sensors connected to the Arduino Mega, including but not limited to the MEMS accelerometer, gas sensor, and temperature sensor, are strategically placed throughout the vehicle to monitor critical parameters such as vehicle dynamics, driver behaviour, and engine health.

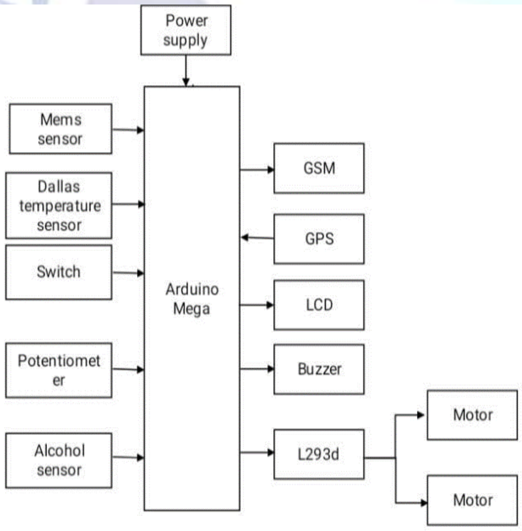

Fig.1.1 Block Diagram

The GPS and GSM modules, among other peripheral modules, and sensors can communicate with each other more easily thanks to the Arduino Mega. The Arduino Mega coordinates the flow of data and commands via hardware interfaces and standardized communication protocols, allowing for real-time monitoring and response capabilities. In order to ensure adaptability to changing road safety requirements, the system architecture's modularity and scalability enable the seamless integration of additional sensors or functionalities in subsequent iterations.

3. SENSOR INTEGRATION

The system architecture includes a range of hardware elements that are essential to the project's operation. The main microcontroller board is the Arduino Mega 2560, which has many digital input/output pins, analog inputs, UARTs, and shield compatibility. In addition, the MQ3 sensor prioritizes safety with anti-explosion measures by detecting alcohol through changes in resistance. In the meantime, the DS18B20 temperature sensor does not require external power and provides accurate temperature readings through a one-wire bus protocol. The L293D motor driver, which can handle two DC motors at once, facilitates motor control. MEMS sensor, which are well-known for their affordability and precision, sense pressure and other external stimuli, which adds to the system's flexibility. While buzzers act as audible signalling devices for alerts and confirmations, LCD modules offer visually appealing displays that are easy for users to navigate. GSM modules improve connectivity and functionality by facilitating communication over mobile networks. Trilateration is a technique used by GPS receivers to determine exact locations from signals received from satellites and ground stations. By providing manual control and triggering capabilities, push button switches and potentiometers enhance user interaction with the system. These hardware elements work together to create a strong system architecture that can accommodate a range of project needs and functionalities. The working flowchart can in be observed in Fig.3.1.

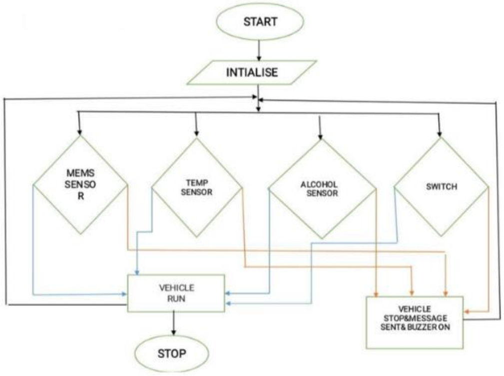

Fig.3.1 Components Working Flow Chart

4. SYSTEM IMPLEMENTATION

The project's implementation entails sensor calibration and microcontroller programming after parts and modules are assembled inside the vehicle. To facilitate smooth communication and feedback mechanisms, the microcontroller is interfaced with other modules like GSM, GPS, and LCD displays after it has been programmed. Thorough system testing is carried out following integration to confirm functionality and dependability. The final system is as shown Fig.4.1

Fig.4.1 Final System

After passing testing, the separate parts and modules are combined to form a coherent system that can track, evaluate, and react to different vehicle parameters instantly. To assess performance in real-world settings, the integrated system is put through field testing in real-world vehicle environments.

In order to verify system accuracy, responsiveness, and dependability, field testing involves keeping an eye on the system while it operates in typical driving conditions. Furthermore, user training is carried out to acquaint car owners with the functionality and operation of the system.

5. RESULTS & DISCUSSIONS

The system effectively accomplishes its goals in terms of identifying accidents, tracking engine temperature, detecting alcohol consumption, monitoring vehicle speed, and sending emergency help via the push button feature. When the power supply is given to the system it starts monitoring and display sensor values as in Fig.5.1

Fig.5.1 Monitoring of Different Sensors

Alcohol Detection is accomplished through the MQ3 sensor, which accurately detects alcohol vapor levels and triggers appropriate responses when the threshold limit is exceeded. In order to ensure prompt intervention and prevent potential accidents caused by drunk driving, the system efficiently notifies the user and provides location notifications to selected contacts as shown in Fig.5.2

Fig.5.2 Alcohol Detection Results

Speed Detection functionality ensures that the vehicle operates within safe speed limits. The system monitors vehicle speed using appropriate sensors and provides alerts when speed exceeds predefined thresholds as shown in Fig 5.3. This feature enhances road safety by promoting adherence to speed limits and preventing accidents caused by over speeding.

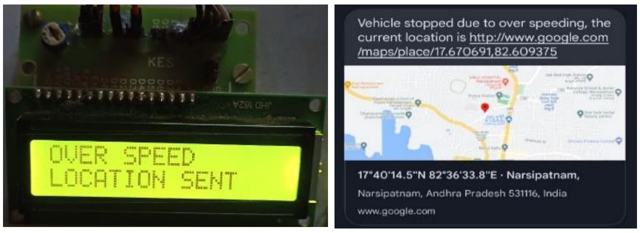

Fig.5.3 Speed Detection Results

Overheating Detection is achieved through the DS18B20 temperature sensor, which continuously monitors engine temperature. When the temperature exceeds safe levels, the system triggers alerts as in Fig.5.4 and initiates necessary actions to prevent engine damage and ensure vehicle safety.

Fig.5.4 Overheating Results

Accident Detection capability relies on the MEMS sensor, which detects sudden changes in vehicle orientation indicative of an accident. Upon detection, the system promptly notifies emergency services and designated contacts, providing accurate location information for swift response and assistance as in Fig.5.5.

Fig.5.5 Accident Detection Results

Push Button feature serves as a critical emergency response mechanism, allowing vehicle occupants to request immediate assistance in threatening situations such as kidnappings or thefts. Activation of the push button triggers alarms and sends distress signals to authorities and predefined contacts as shown in Fig.5.6 facilitating rapid intervention and ensuring the safety of occupants.

Fig.5.6 Push Button Results

Overall, the results show that the developed system is effective and reliable at improving vehicle safety, preventing accidents, and providing timely assistance in emergency situations. Through extensive testing and validation, the system demonstrates its ability to reduce risks and protect vehicle occupants while encouraging responsible driving behaviour.

6. CONCLUSION & FUTURE SCOPE

In this project, an IoT-based framework for smoothly integrating GPS, GSM modules, smart sensors, and microcontrollers inside cars is introduced. Real-time accident detection and prompt incident details communication to registered contacts and neighbouring ambulances are made possible by this synergy. Cloud connectivity enables centralized data management and remote updates, thereby increasing scalability and flexibility. Collaborative vehicle-to-vehicle communication improves situational awareness and traffic flow. The integration of autonomous driving features aims to reduce human error while increasing

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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