Review on Accident Redressal Systems

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Abstract: Advancements in road safety and emergency response are critical to mitigating the effects of vehicular accidents. This paper introduces an integrated Accident Redressal System designed to revolutionize these areas through four key functionalities: automatic accident detection, GSM-based GPS location broadcasting, real-time driver heart rate monitoring, and an Anti-Driver Sleep Detection System. Utilizing a combination of advanced sensors and sophisticated algorithms, this system promises not only to detect accidents swiftly but also to ensure rapid emergency responses, thereby enhancing the safety and security of road users. This study delineates the technological framework of the system, discusses its comparative advantages, and explores its potential to set new standards in intelligent transportation systems.

Keywords: Internet of Things, ESP-32 microcontroller, GSM, GPS, Heart Rate & IR Sensor, Accelerometer.

1. Introduction

In an era where technological advancements are relentlessly transforming the fabric of our daily lives, the domain of road safety and vehicular systems has emerged as a critical frontier for innovation. Despite significant progress in automotive technologies and infrastructure development, vehicular accidents remain a leading cause of fatalities and injuries globally. The complexity of road networks, human error, and unpredictable environmental conditions contribute to a challenging landscape for enhancing vehicular safety. It is within this context that the Internet of Things (IoT) presents a transformative potential, offering new paradigms for monitoring, control, and intervention in the realm of intelligent transportation systems.

The integration of IoT technologies into vehicular safety systems promises a future where vehicles are not merely passive entities within the traffic ecosystem but active participants capable of sensing, decision-making, and communicating to prevent accidents and mitigate their consequences. This paper introduces an innovative Accident Redressal System that stands at the confluence of IoT technologies, advanced sensor networks, and data analytics, designed to revolutionize road safety and emergency response mechanisms.

The urgency for such advancements cannot be overstated. According to the World Health Organization, road traffic injuries are estimated to be the eighth leading cause of death globally, highlighting a pressing need for comprehensive solutions that address the multifaceted challenges of road safety. Traditional approaches to accident detection and response, often characterized by delayed reporting and imprecise location information, underscore the limitations of existing infrastructures in coping with the demands of rapid urbanization and increasing vehicular densities.

Our proposed system addresses these challenges head-on by leveraging the ESP-32 microcontroller, renowned for its low power consumption and robust connectivity options, including Wi-Fi and Bluetooth capabilities. This microcontroller acts as the heart of our Accident Redressal System, enabling real-time data acquisition from a suite of advanced sensors (including accelerometers, gyroscopes, and heart rate monitors) and facilitating instantaneous communication with emergency services through GSM-GPS modules. The system not only detects vehicular accidents with high accuracy but also broadcasts precise location information, monitors the driver's physiological state for signs of distress, and employs machine learning algorithms to predict and alert against driver fatigue.

This paper delineates the technological framework underpinning our system, discusses its comparative advantages over existing solutions, and explores the implications of our findings for the future of intelligent transportation systems. By integrating automatic accident detection, precise location broadcasting, real-time health monitoring, and proactive fatigue detection into a cohesive system, we aim to set new standards in vehicular safety, offering a blueprint for how IoT technologies can be harnessed to create safer, more responsive, and intelligent road networks.

In essence, our work contributes to the burgeoning field of intelligent transportation systems by showcasing how the synergistic application of IoT technologies, advanced sensing, and data analytics can address some of the most pressing challenges in road safety today. As we embark on this exploration, our research is guided by a vision of a future where road accidents are significantly reduced, emergency responses are swift and effective, and the overall safety and security of road users are markedly enhanced.

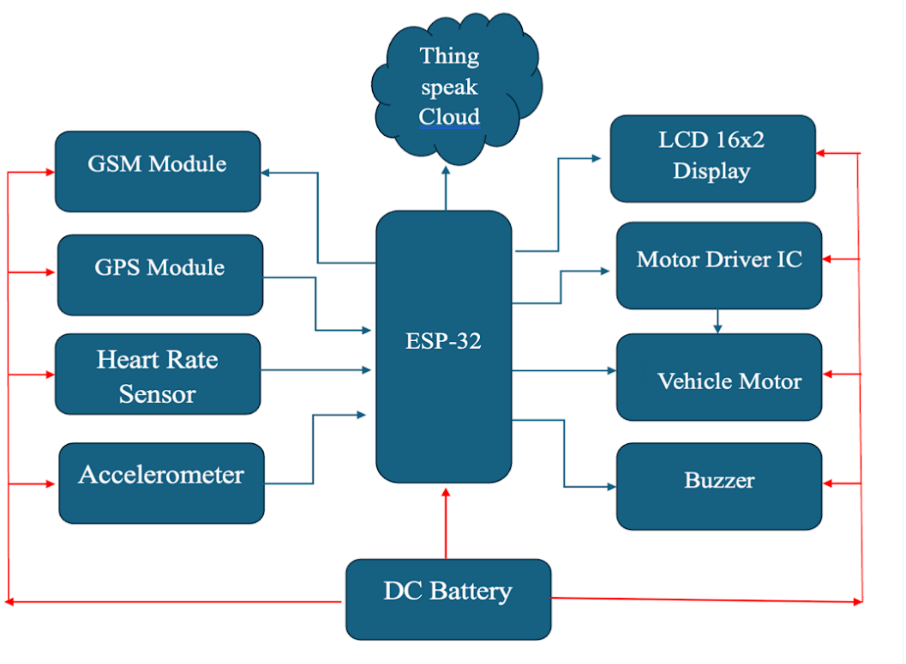

Fig.1: Block Diagram of Accident Redressal system

2. Objectives of project

The primary objective of this project is to implement and evaluate a comprehensive Accident Redressal System that seamlessly integrates advanced functionalities to significantly improve road safety and emergency response mechanisms

In this paper, we introduced the following three objective ideas related to the Accident Redressal system.

A. This system aims to achieve automatic accident detection, precise GSM-based GPS location broadcasting.

B. To develop a feature which is real-time monitoring of the driver's heart rate.

C. Developing Anti-Driver Sleep Detection System with the help of Eye blink sensor signal of vehicle driver and controlling & managing the vehicle speed According to the Eye blink sensor signal of vehicle driver.

3. Related Work

The designed system detects accidents instantly and informs the emergency services or concerned person. ESP 32 micro-controller acts as a heart to the proposed system. It is a low-power on-chip microcontroller which has inbuilt Wi-Fi and Bluetooth modules, it is also battery friendly. There are several sensors interfaced to the ESP 32 to detect the accident when it occurs. The ESP32 micro-controller is the main processing unit of the system. It collects data from the various sensors, including MPU6050, GPS, vibration, and fire sensors. The MPU6050 sensor is used to detect sudden changes in the vehicle's acceleration and orientation. The vibration sensor is used to detect any sudden impacts or shocks caused by an accident, while the fire sensor detects any fire outbreak in the vehicle. Along with these sensors the GPS and GSM modules are incorporated to detect the vehicle location and for sending the notifications to the related people and emergency services respectively. When an accident is detected, the system triggers an alert mechanism that can send an SMS or phone call to the vehicle owner or emergency services. The alert message includes the location of the accident. The system can also be configured to automatically call emergency services or the vehicle owner, providing them with more information about the accident. Rescue services, such as ambulances or police, can respond quickly to the alert and provide necessary assistance [1].

The literature review serves as a basis for the proposed project, emphasizing the need for a comprehensive Accident alert system that goes beyond conventional vehicle solutions. By integrating advanced technologies, such as IoT-enabled sensors, cloud computing, and data analytics, the project seeks to revolutionize Accident management and contribute to the development of more efficient and sustainable transportation systems [12-18].

[1]. Smith William and Anthony Sebastian., ***"Developed a vehicle tracking system by using GPS"***. It is in the form of a device that is installed in the vehicle which will continuously track the position of the vehicle. It helps the owner of the vehicle to track his car and to ensure that his car is not stolen [7].

[2]. Syedul Amin et al.,it is ***"An accident detection system that is fully based on GPS".*** works on the map matching position of vehicle using GPS, it stores speed and position information of vehicle for every 0.1 sec. According to the information, the present speed and position is compared with previous speed and position, if there are any changes in it from when the accident is detected, and the notification is sent to the emergency services [8].

[3]. Shripad Desai et al., proposed "**An accident detection system using Arduino** "as its core, where several sensors are used for the detection, sensors like accelerometer (MEMS) and vibration sensor are used in the system and it provides an off switch to the driver in case the vehicle had met with a small accident [10].

[4]. Khamlich Fathallah et al., ***"Designed a system that identifies accidents in real time and provides medical support to the people"*** They have developed the system using IOT (Internet Of Things) and it is fully server based control. Raspberry Pi allows the detection of sensors and informs the rescue facilities. It not only informs facilities but also provides intelligent traffic control for the fast passage of ambulances to the accident zone without any delay [14].

[5]. Srikanth et al., proposed an ***"Automatic Vehicle Service Monitoring by using IOT and Machine learning"*** which also helps us to track the system. This system automatically reminds of vehicle service time with the help of IOT which allows various devices to collect data like distance traveled, lubricant level, type conditions, etc... by using several sensors and the data are stored in cloud storage systems. Machine learning is used to predict the vehicle's condition based on that it will provide the next date for service by verifying the sample data and GPS of the vehicle [15].

Advancements in IoT-Based Vehicular Safety Systems: The integration of IoT technologies has significantly transformed vehicular safety systems, enabling real-time monitoring, advanced analytics, and instant communication capabilities. Studies like "Transforming Car Accident Detection: An IoT and Cloud-Based Approach" and research by Ajay Kumar et al. highlight the use of sophisticated sensors, GSM-GPS modules, and cloud analytics for immediate accident detection and notification.

Automatic Accident Detection: Central to this evolution is the use of microcontrollers like ESP-32, which, due to their low power consumption and inbuilt connectivity options (Wi-Fi and Bluetooth), offer an ideal platform for deploying complex algorithms that distinguish normal vehicular movements from accident scenarios. The integration of accelerometers, gyroscopes (MPU6050), and collision sensors leverages threshold-based algorithms for swift and accurate accident detection.

Location Broadcasting and Emergency Response: The role of GSM and GPS technologies in facilitating precise location broadcasting has been underscored in systems developed by researchers like Syedul Amin et al., enabling efficient emergency response. The GSM module's capability to send SMS alerts or make calls to emergency contacts, including detailed location information, has been a critical feature in enhancing the speed of emergency services' response.

Driver Health Monitoring and Fatigue Detection: Emerging systems also focus on the driver's well-being, incorporating real-time health monitoring and fatigue detection. Utilizing heart rate sensors and employing machine learning algorithms for analyzing driver behavior, these systems, as outlined in works by Fathallah Khamlich and colleagues, aim to preempt accidents caused by driver fatigue or health issues.

4. Major challenges of Internet of Things

There are three major challenges to designing an IoT ecosystem that's capable of supporting these services:

- High reliability
- High scalability
- Desirable trade-off between accuracy and real-time processing

Once the IoT service is up and running, it needs to run continuously – unexpected crashes or downtime may have critical consequences.

5. Problem Statement

The Development of Accident Redressal system using Internet of Things (IoT) System is based on internet connectivity. The better the internet connectivity, the better is data sharing over the cloud. The problem statement is without any internet connectivity this system is not able to share the live status of driver health. Other hand we are using the GSM modem for massage alert which is based on network communication and in Embedded systems most GSM modem works on 2G Network [18-20]. The network status of 2G in India is good but in the embedded application prototype we have to use a ready-made modem. And most importantly we are using a GPS module for location tracking which is completely based on satellite communication and finding the accurate location of the vehicle is also a difficult task .This project has two different software stages, first one programming and the second one is hardware design software.

6. Proposed Approach

Our proposed approach is to design an Accident Redressal system with the help of Eagle Software, Arduino Software IDE. The proposed model connected and tested with the different communication technology Wi-Fi Technology [1-2], Embedded System, Embedded Communication, Cloud and Wireless Communication.

7. Used components

The hardware components used in the " Accident Redressal system " project are listed below [1-7]:

A. **ESP 32 module:** The ESP32 is a powerful micro-controller module that includes built-in Wi-Fi and Bluetooth capabilities. It serves as the central processing unit and communication interface for the electric vehicle system.

B. **MPU 6050 :** The MPU-6050 is a popular sensor module that combines a 3-axis gyroscope and a 3-axis accelerometer in a single package. It is designed to provide accurate motion tracking data for various applications such as robotics, drones, gaming, and virtual reality. The MPU-6050 module is based on the InvenSenseMPU-6050 IC, which features a digital motion processor (DMP) that processes the raw sensor data and outputs the orientation of the sensor in the form of quaternions, Euler angles, or rotation vectors. The MPU-6050 module communicates with a microcontroller or a computer using the I2C interface, and it is compatible with various development platforms such as Arduino, Raspberry Pi, and STM32.

C. **GSM module (SIM 800L) :** The GSM module is an electronic device that enables communication over the Global System for Mobile Communications (GSM) network. The SIM800L is a commonly used GSM module that provides a variety of features for wireless communication and data transmission. The SIM800L GSM module is designed to operate on the 2G GSM network and supports quad-band frequency bands, making it compatible with most GSM networks worldwide. It can be used for voice and data transmission, as well as for sending and receiving SMS messages..

D. **GPS Module (NEO-6M) :** A GPS (Global Positioning System) module is an electronic device that is used to receive and process signals from GPS satellites in order to determine the device's location on the earth's surface. The NEO-6M is a popular GPS module that is commonly used in various projects and applications. It is a small and inexpensive module that can provide accurate positioning data using the GPS satellite system. The NEO-6M GPS module consists of a GPS receiver chip, an onboard antenna, and support circuitry that is mounted on a small PCB. It communicates with a host device, such as a microcontroller or computer, through serial communication using UART protocol.

E. **Li-ion Battery:** Lithium-ion (Li-ion) battery is a type of rechargeable battery that uses lithium ions as the primary component of its electrochemical reaction. Lithium- ion (Li-ion) battery with a capacity of 2000mAh and a voltage rating of 3.7V is a rechargeable battery commonly used in various electronic devices, including smartphones, tablets, cameras, and portable electronic gadgets.

F. **LCD 16×2:** The 16x2 LCD display is used to provide visual feedback and display relevant information to the user, such as vehicle status, sensor readings, and system messages.

G. **BC-547 NPN Transistor:** The BC-547 is a general-purpose NPN bipolar transistor used as a switching and amplifying device in electronic circuits.

H. **Power Supply (AC-DC & DC-AC):** The power supply converts the available electrical power into the required voltage and current levels for different components in the electric vehicle system.

I. **Capacitor 1000 μF-25V:** The capacitor is used to store electrical energy and stabilize the voltage supply in the circuit, reducing voltage fluctuations and noise.

J. **IC-7805:** The IC-7805 is a voltage regulator that ensures a stable 5V supply to power low-power components in the system.

K. **LEDs (5mm, Red, Green, Blue):** LEDs are used as indicators to show the status of various functions, such as power on, system status, and sensor readings.

L. Resistors (1K, 2.2K & 10K): Resistors are used to limit current flow, set voltage levels, and provide necessary resistance in different parts of the circuit.

M. IR Sensor: An IR sensor, or infrared sensor, is a device that detects and measures infrared radiation in its surrounding environment. Infrared radiation is electromagnetic radiation with longer wavelengths than those of visible light, making it invisible to the human eye. IR sensors are commonly used in a variety of applications for detection, communication, and control purposes.

N. Buzzer: The buzzer is an audio output device used to generate audible alerts or warnings for the driver or users.

The combination of these components forms an Accident Redressal system, enhances control and communication capabilities, and improves the overall efficiency and performance of the Accident Redressal system.

8. Software/Tool Explanation

A. Arduino for coding: Arduino is an open-source software and hardware platform widely used for programming and prototyping electronic projects as shown in figure 2. It provides a simple and user-friendly Integrated Development Environment (IDE) that allows developers to write, compile, and upload code to Arduino microcontrollers. The Arduino IDE uses a C/C++ based language to create sketches (programs) that control various electronic components and sensors connected to the Arduino board.

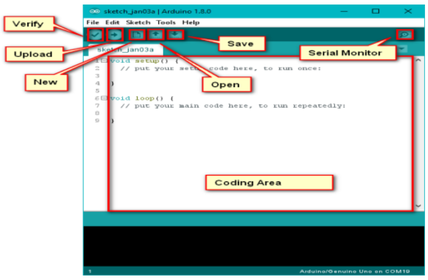

Fig.2: Arduino IDE

B. Eagle-Circuit design: Eagle (short for EAGLE - Easily Applicable Graphical Layout Editor) is popular Electronic Design Automation (EDA) software developed by Autodesk. It is used for designing electronic circuits, printed circuit boards (PCBs), and schematics. With Eagle, users can create and layout complex circuit schematics, design custom PCBs, and generate manufacturing files for PCB fabrication.

C. Thing Speak: Data streams in the cloud: ThingSpeak is an Internet of Things (IoT) platform developed by MathWorks as shown in figure 3. It provides cloud-based storage and analysis of sensor data from IoT devices. With ThingSpeak, users can create channels to store and visualize data sent from various IoT sensors. It offers APIs and integration options to connect IoT devices and applications to the cloud for data monitoring and analysis.

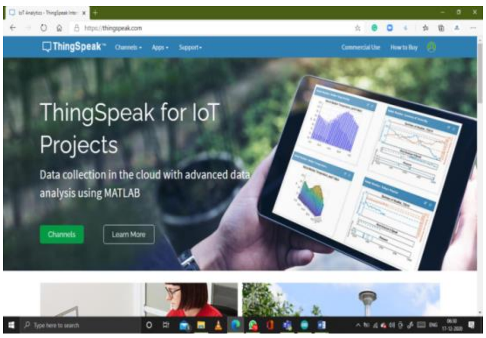

Fig. 3: ThingSpeak Website view For IoT Platform

Each of these software/tools play a crucial role in different stages of the electronic project development process:

- Arduino is used for coding and programming the microcontroller, allowing the project to control and interact with various electronic components.
- Eagle is employed for designing the circuit schematic and PCB layout, enabling the physical realization of the project as shown in figure 4.

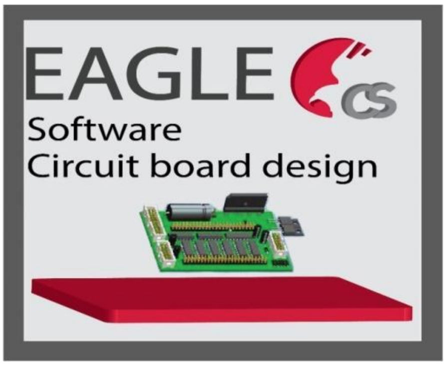

Fig. 4: Eagle Software for PCB Design

- Thing Speak provides a cloud-based solution for storing and analysing sensor data, enabling the project to interact with the cloud and implement IoT functionalities.

9. Proposed study on PCB layouts

The printed circuit board is the main process in electronic hardware implementation. It consists of designing and developing both methods but first we need to design the circuit diagram with the help of software.

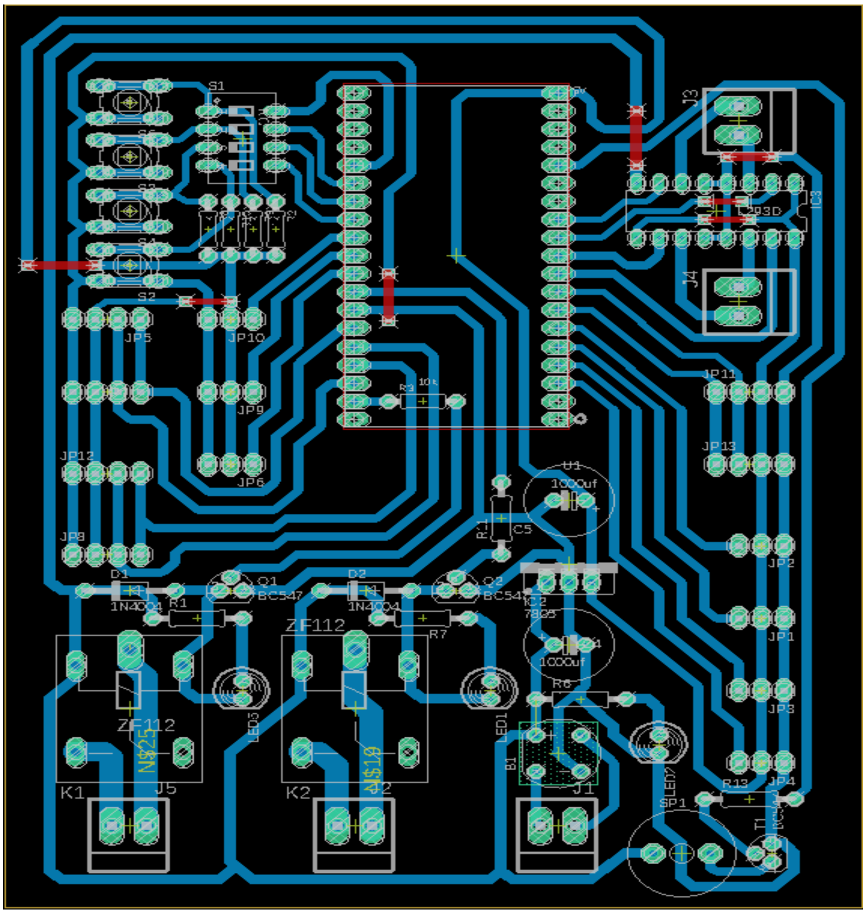

Fig. 5: Accident Redressal system Board Layout

For designing the circuit, there is lots of software available. To develop this system we have used eagle software. We have proposed an Accident Redressal system Board layout as shown in figure 6.

Innovative Aspects and Comparative Advantages:

- The system's integration of ESP-32 microcontroller not only offers low power consumption and enhanced connectivity but also supports the complex data processing required for real-time monitoring and alerting functionalities.
- The use of cloud analytics for processing driver health data and predicting fatigue sets our system apart from existing solutions, offering a more nuanced understanding of the driver's condition and potential risk factors.
- The architecture is designed for scalability and flexibility, allowing for the integration of additional sensors and modules to address emerging safety challenges and technologies.

10. Conclusion

The development and preliminary evaluation of our IoT-based Accident Redressal System mark a significant stride towards revolutionizing vehicular safety and emergency response mechanisms. By leveraging the power of IoT technologies, we have introduced a comprehensive system that not only detects vehicular accidents in real-time but also provides critical functionalities such as precise GPS location broadcasting, real-time driver health monitoring, and an innovative Anti-Driver Sleep Detection System. This integrated approach ensures rapid emergency responses, enhancing the safety and security of road users significantly.

Our findings demonstrate the system's potential to bridge critical gaps in current road safety measures. The automatic accident detection feature, underpinned by sophisticated algorithms and advanced sensors, offers a leap forward in accurately identifying accidents, minimizing response times, and potentially saving lives. Furthermore, the system's ability to monitor the driver's health in real-time and detect fatigue preemptively introduces a proactive layer to accident prevention, addressing a common cause of road accidents that has been challenging to mitigate.

The proposed system also underscores the importance of integrating emerging technologies with existing emergency response infrastructures. By establishing seamless communication channels with emergency services, the system facilitates a coordinated and efficient response, ensuring that help arrives when and where it is most needed. This integration highlights the system's role not only as a technological innovation but also as a catalyst for enhancing the operational capabilities of emergency response teams.

Looking forward, the deployment of the Accident Redressal System opens several avenues for future research. Key among these is the real-world application and evaluation of the system across a broader spectrum of vehicular types and driving conditions. This will not only validate the system's effectiveness in diverse scenarios but also uncover insights into optimizing its functionalities for maximum impact. Additionally, further refining the algorithms for accident detection and fatigue prediction to enhance accuracy and reduce false positives will be critical in ensuring the system's reliability and user trust.

Expanding the system to include additional sensors for environmental monitoring, such as weather conditions and road surface analysis, could offer deeper insights into accident causation and prevention. Lastly, exploring the integration of this system within the broader ecosystem of smart cities could unveil synergies with other safety and emergency response technologies, amplifying its impact and setting new benchmarks for intelligent transportation systems.

In conclusion, our research contributes to the ongoing efforts to enhance road safety through technological innovation. The IoT-based Accident Redressal System represents a significant advancement in intelligent transportation, offering a multifaceted approach to accident detection, driver safety, and emergency response. As we continue to push the boundaries of what is possible with IoT in vehicular safety, we remain committed to the vision of safer roads and communities, underpinned by the power of technology and interdisciplinary collaboration.

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