Sustained Approach for Accident Detection and Rescue Alerting System

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Abstract. In the era of rapid modernization and continual advancements in transportation, the escalating frequency of accidents has emerged as a pressing concern. These tragic incidents claim numerous lives, representing a significant and disheartening cause of mortality in contemporary society. The proposed work leverages state-of-the-art sensor technology to not only detect potential accidents but also to promptly alert rescue services. The accident detection mechanism vigilantly monitors the vehicle's dynamics, analyses variations in speed, and even utilizing auditory cues within the vehicle. When an accident scenario is identified, the system initiates an alert that lasts for five seconds. Following this, it promptly dispatches a notification to the nearest rescue team. This innovative integration of cutting-edge sensor technology and intelligent processing represents a significant stride towards mitigating the risks associated with accidents, ultimately aiming to save lives in critical situations. Moreover, the proposed work suggests a sophisticated and comprehensive approach to addressing accidents.

1 Introduction

IoT, which means Internet of Things, is characterized as an arrangement of interrelated gadgets or substances comprising of sensors and knowledge associated by an organization that is liable for the execution of a mechanized software. The term Internet of Things was coined in 1999, by a Computer researcher by the name of Kevin Ashton. While working in Procter and Gamble, he thought of a thought of utilizing Radio Frequency Identification (RFID) chips on items to follow them through the production network. To draw in the consideration of chiefs, he chose to go with the word Internet, which was a famous topic of conversation at the time. His thought of utilizing the popular expression appeared to have worked, since now IoT has become one of the main advancements in the whole world. There

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are a bunch of uses going from home security to the whole agriculture industry being subject to IoT gadgets to set aside time and cash.

1.1 Problem Statement

The world's most dangerous mode of transportation is thought to be the road. As per the yearly report on road accidents by the Ministry of Road Transport and Highways, the states and Union Territories (UTs) documented 461,312 occurrences in 2022, resulting in 443,366 casualties. Compared to 2021, the year had a rise of 11.9% in accidents, 9.4% in fatalities, and 15.3% in injuries. Though Road Transport has become relatively much safer in the past decades, they still remain the cause for the most deaths in the transportation field. Road accidents are very common nowadays .Road safety is still a key problem for development, a public health issue, and the primary cause of fatalities and serious injuries worldwide. The World Health Organization estimates that at least one in ten persons who die in traffic accidents worldwide are from India. Road accidents incur costs that are not only borne by the not only by the victims and their families, but also by the economy at large due to the premature deaths, injuries, disabilities, and lost wages. When a driver collides with a fixed object, such as a tree, a fence, or an anti-collision barrier, they are especially vulnerable. The majority of vehicle accident deaths are not instantaneous deaths but rather the result of delayed emergency assistance and rescue. Advanced Interdisciplinary Accident Response System encompasses the aspects of Physics and Engineering to implement innovative paper that detect accidents and send a rescue alert message.

1.2 Working Principle

The Internet of Things runs on the perfect transmission and receipt of data packets between linked devices, which enables things to communicate with external systems and with each other. This fundamental characteristic forms the basis for features like task automation, remote control, and data collection from numerous sources. A successful IoT ecosystem often consists of a few essential components. These comprise the data-gathering and data-processing sensors and actuators as well as the communication infrastructure required for device-to-device data exchange. IoT frameworks also require cloud-based platforms and services since they offer accessibility, management, storage, and analysis for users and systems. The power of the Internet of Things to automate and control remotely equipped Microprocessor, Iot is made up of networked devices and provides the framework for intelligent systems that increase production, efficiency, and safety. These internet-enabled devices perform tasks and automate judgement calls. The IoT facilitates seamless communication between components, which allows for a paradigm shift in the way systems operate. When real-time data is leveraged to give actionable insights, users and industries are enabled to explore new ideas, optimise operations, and make well-informed decisions. The convergence of technologies creates more flexible and adaptable environments, redefines problem-solving approaches, and increases overall system efficacy and efficiency.

2. Existing Methods

The Smart Helmet System represents an innovative solution tailored for drivers seeking enhanced awareness and safety during their journeys [1]. While the concept of social interaction among vehicles is not new, our approach seeks to overcome existing limitations, offering a balance of advantages and disadvantages found in similar papers. Our primary focus is to make smart helmets affordable and user-friendly, ensuring widespread

accessibility. This advanced helmet is designed to gather environmental data, assess rear visibility through object and proximity sensors, and detect nearby vehicles. By interpreting electrical signals from the motorcycle, including lights, speed, and tachometer data, the system wirelessly communicates with both the bike and the helmet module. To maximize efficiency, a helmet-mounted display alerts the rider to potential dangers as other vehicles approach. Careful consideration has been given to hardware selection, factoring in individual components' functionality and costs.

The method in [2] aims to use of intelligent braking systems can stop many accidents and save lives. Installing such intricate systems is frequently required, much like wearing seat belts. This implies that injuries are frequently prevented to some degree. After being integrated into a single car system, our intelligent braking technology provides a glimpse of long-term protection for your car and how these specific devices are further refined to prevent crashes and protect car occupants. The proposed study [3], intends to support parked motorcycles using the side stand. The driver should strike and touch the ground in a non-distracting manner if they fail to fold the side stand beforehand. In a bend, the driver maintains control. To make sure the stand is in a released state, a day sensor is now employed from the centre, the motorbike side stands offset coil springs and metal rods. When parked, some side stands automatically retract. While some are fitted with electric locks, others have raised supports.

The authors of [4], traffic accidents are a major concern for all people. Numerous valuable lives are lost in auto accidents every day. This is the most crucial subject that requires in-depth investigation because of the high death rate associated with road accidents. The two most frequent causes are poor emergency response times and driver error. Efficient traffic collision detection and information exchange systems are necessary for injured rescue operations. For a quick reaction, a gadget that notifies nearby rescue workers about the collision scene is necessary. In the study literature, numerous academics have put forth different automatic collision warning system proposals. These include the Global Positioning System (GPS), the Global System for Mobile Communications (GSM), and incident detection using smartphones. Technology, ad hoc networks in cars, different machine Learning mobile apps and algorithms. Every car needs to have an information communication. Learning mobile apps and algorithms. Every car needs to have an information communication system and automatic crash detection installed.

The authors of [5], there has been a proposal for an intelligent car lights control system. The suggested solution makes use of an Arduino to regulate an automobile's headlights automatically based on the level of ambient light. In addition, it makes use of ultrasonic sensors and light-dependent resistance (LDR) to detect changes in ambient light and approaching cars from the other side of the road. Numerous embedded systems, including those that manage complicated systems like street lighting, home illumination, general parking lights, and car headlight management systems, can be integrated with this technology. Numerous studies have been conducted on networks, light-dependent resistance (LDR) dependent analogue circuits, timers, and wireless GSM / GUI-controlled lighting systems. Passive infrared receivers are used in several of the research papers. This paper aims to use Arduino to construct a sophisticated automotive headlight control system. The system uses light-dependent resistors and ambient illumination-affected ultrasonic sensors to gather information about the presence of cars approaching from the other direction of the road.

The authors of [6], suggested system functions immediately. This study identifies whether the driver is wearing a helmet by means of a magnetic chip that is fastened to the helmet. An analogue signal is output by the magnetic tip. This helmet is identified by the system and displays the following message: Helmets are worn by drivers. Here, the output comes in two flavours: high and low. When the output is received from chip low, it is indicated as high, switches off the engine after indicating that the chip is not connected to the

system. The paper also makes use of gas sensors. Using a speed limit sensor that can identify when a motorist is intoxicated, along with a turbine, the turbine may provide information about speed bike limitations. When a driver goes over the speed limit, a buzzer alerts them to their speed limit.
The model in [7] suggested that, it is critical to identify risky driving practices in order to increase bicycle safety. Current bicycle safety solutions require expensive, specialised infrastructure to be installed. In this paper, he presents his BikeMate, a widely used smartphone system for tracking bicycle behaviour. Using the sensors on your smartphone, BikeMate can infer risky driving habits like changing lanes unexpectedly, stepping on the accelerator, and travelling in the wrong direction. In order to streamline the deployment process, BikeMate leverages crowdsourcing to obtain legal riding directions without prior knowledge and transfer learning to minimise the overhead of training models for various users. Using his crowd sourced GPS track, BikeMate achieved 90% detection accuracy in reverse driving and 86.8% overall accuracy in lane weave and stuck pedal identification in a 12-participant experiment. It has been demonstrated to attain accuracy.

3 Software and hardware requirements

3.1 Software requirements

3.1.1 Kodular app

Kodular is a free and user-friendly platform that enables individuals to create mobile applications without the need for extensive programming knowledge. It employs a drag-and-drop interface, allowing users to visually design their app's user interface and functionality by arranging pre-built components and blocks.

.3.1.2 Firebase database

Firebase Database is a cloud-hosted NoSQL database provided by Google as part of the Firebase platform, offering real-time data synchronization and robust backend services for web and mobile applications.

3.1.3 Twilio

Twilio is a cloud communications platform that provides APIs for developers to integrate various communication channels into their applications, including SMS, voice calls, video calls, and more. Twilio's SMS API allows developers to send and receive text messages programmatically, enabling businesses to engage with their customers via SMS at scale. With Twilio, developers can easily incorporate SMS functionality into their applications using a simple REST API or one of Twilio’s many SDKs for popular programming languages like Python, JavaScript, Java, and Ruby.

3.1.4 Arduino IDE

The Arduino Software (IDE) is an open-source integrated development environment designed specifically for writing, compiling, and uploading code to Arduino-compatible microcontroller boards. It provides a user-friendly interface and a simplified programming

language based on Wiring, making it accessible to both beginners and experienced developers.

3.2 Hardware requirements

The Advanced Interdisciplinary Accident Response System, comprising a Gismo board, ESP32 Wi-Fi module, vibration sensor, and MPU6050 accelerometer, necessitates a comprehensive integration of hardware components to ensure seamless functionality. The Gismo board serves as the central processing unit, orchestrating data acquisition and transmission, while the ESP32 Wi-Fi module facilitates wireless communication for real-time alerts. The vibration sensor and MPU6050 accelerometer act as critical sensors, detecting sudden changes in motion and acceleration indicative of accidents or emergencies.

3.2.1 ESP32 Wi-Fi module

The ESP32 WiFi module, shown in Figure 1, developed by Espressif Systems, stands as a cornerstone in the realm of wireless connectivity for embedded systems and Internet of Things (IoT) applications. Leveraging the ESP32 microcontroller chip's powerful dual-core processor and integrated Wi-Fi capabilities, this module offers a versatile solution for connecting devices to local networks and the internet.

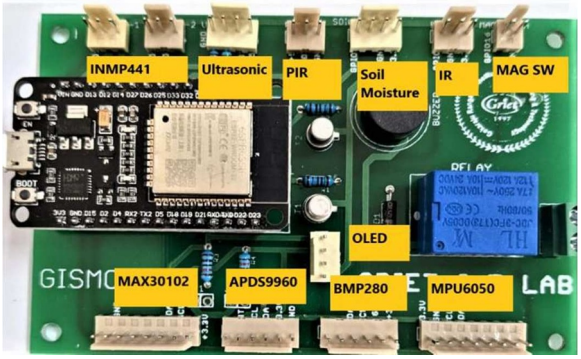

Fig. 1. GISMO IV Board

3.2.2 MPU6050 accelerometer sensor

Accelerometer sensor, shown in Figure 2, is a fundamental component in the field of motion sensing and inertial measurement. Designed to detect changes in acceleration along one or more axes, it provides vital information about the movement, orientation, and vibration of an object or system. Accelerometers operate on various principles, including piezoelectric, capacitive, and Micro Electro Mechanical Systems (MEMS), each offering unique advantages in terms of sensitivity, size, and power consumption.

Fig. 2. Accelerometer Sensor

3.2.3 Vibration sensor

The vibration sensor, in Figure 3, also known as a vibration detector or accelerometer, is a vital component in various industries and applications, providing critical insights into mechanical systems' health and performance. It detects and measures vibrations or oscillations in machines, structures, and environments, allowing for early detection of abnormalities, faults, or potential failures. Vibration sensors operate based on different principles, including piezoelectric, piezoresistive, capacitive, and MEMS (Microelectromechanical Systems), offering a range of sensitivity, frequency response, and durability. In industrial contexts, vibration sensors are utilized for condition monitoring, predictive maintenance, and asset management, helping to optimize equipment uptime, prevent unexpected downtime, and reduce maintenance costs. In automotive applications, they play a crucial role in vehicle health monitoring, ensuring the safety and reliability of critical systems such as engines, transmissions, and suspension components. Furthermore, vibration sensors find application in consumer electronics for features like image stabilization in cameras, haptic feedback in smartphones, and vibration analysis in gaming controllers. As technology advances, vibration sensors continue to evolve, with advancements in wireless connectivity, miniaturization, and data analytics, enabling smarter, more efficient monitoring and control systems across diverse industries

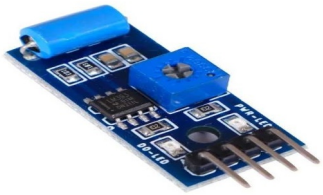

Fig. 3. Vibration Sensor

4 Proposed method

4.1 Problem statement and objectives

The world's most dangerous mode of transportation is thought to be the road. As per the yearly report on road accidents by the Ministry of Road Transport and Highways, the states and Union Territories (UTs) documented 461,312 occurrences in 2022, resulting in 443,366 casualties. Compared to 2021, the year had a rise of 11.9% in accidents, 9.4% in fatalities,

and 15.3% in injuries. Though Road Transport have become relatively much safer in the past decades, they still remain the cause for the most deaths in the transportation field. Road accidents are very common nowadays .Road safety is still a key problem for development, a public health issue, and the primary cause of fatalities and serious injuries worldwide. The World Health Organisation estimates that at least one in ten persons who die in traffic accidents worldwide are from India. Road accidents incur costs that are not only borne by the not only by the victims and their families, but also by the economy at large due to the premature deaths, injuries, disabilities, and lost wages. Thus, the paper's objective is to automatically alert emergency contacts or response services to the impending disaster. In the event of a motorbike crash, this type of application will greatly aid in shortening the time it takes for the emergency services to respond immediately because the driver is typically either unconscious or in a state of shock. This saved time could potentially save one or two lives, as every second matters in deadly accidents. The paper's objectives are to identify a car crash, verify that it is not a false positive, and then notify the designated emergency contacts about the crash's location and timing. This will provide the recipient enough information to contact the appropriate authorities at the crash scene right away and offer the assistance they need. In the unlikely event that a crash occurs.

4.2 Objectives

- To identify an approaching vehicle crash on the road by capturing the event of the car toppling over and the vibration it created.
- To send an update to the Firebase database using the obtained crash data that is linked to the mobile app.
- To provide a false alert service that riders can use if they feel safe or if the accident detection was inaccurate.
- To provide the required location coordinates and crash time to shorten the effective time it takes the emergency services to get at the scene

4.3 Architecture Diagram

Figure 4 depicts the architecture diagram of the proposed work.

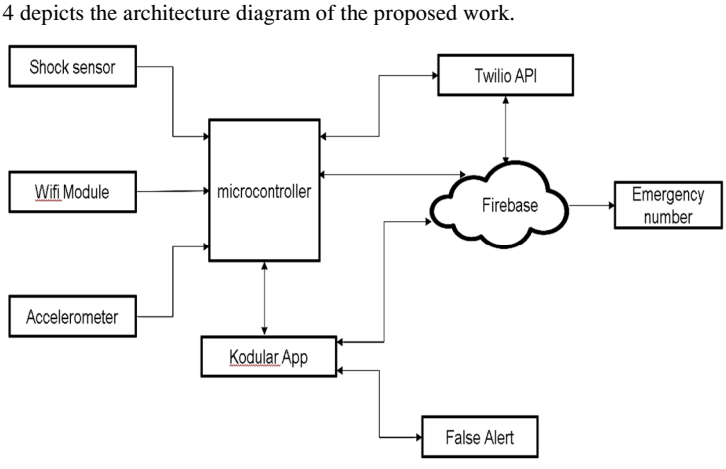

Fig. 4. Architecture diagram.

4.4 Proposed Module

4.4.1 Module 1: Preparing the sensor module:

The Arduino IDE will be used to code the GISMO-VI code in this module. The following features are incorporated into the paper by this module. Read the x, y, and z axis readings of the accelerometer. Show acceleration values in the Serial Monitor's x, y, and z axes.Plot the acceleration values in the serial graph's x, y, and zaxes. For motion thresholds established via a mobile app, see Firebase Threshold Limit Determine the current position by utilising the accelerometer data obtained from the MPU6050 Accelerometer. Send the Firebase database the position status. The electrical potential across the battery cells is measured and recorded using voltage sensors. This information is crucial for evaluating the overall voltage levels and identifying variances that might point to anomalies or possible problems with the batteries. Finally, the presence of current sensors helps to keep an eye on how much electricity is entering and leaving the battery. These sensors monitor patterns of charging and discharging, giving vital information on the energy transfer mechanisms and the battery's state of operation. When combined, these sensors provide an extensive dataset that includes measurements of temperature, voltage, and current—all of which are essential for comprehending the behavior and efficiency of the EV batteries in real time.

4.4.2 Module 2: Data collections

The accelerometer is interfaced with pin 2, while the vibration sensor is connected to pin 16 on the Gismo board, facilitating the real-time monitoring of vehicle dynamics. The microcontroller continuously gathers sensor data, processing information related to acceleration and vibration patterns indicative of vehicle movement and potential incidents. Leveraging the Gismo board's capabilities, the system provides seamless integration and reliable data acquisition, ensuring accurate monitoring of the vehicle's current position and status. This data is then displayed in the serial monitor interface, offering insights into the vehicle's behavior and aiding in the identification of any anomalies or safety concerns. By employing this robust data collection approach, our research endeavours to enhance vehicle safety and performance monitoring through comprehensive sensor integration and real-time data analysis

4.4.3 Module 3: Data transmission

In our data transmission system, we utilize Firebase Realtime Database, Kodular app, and the Twilio API to ensure seamless communication and efficient alerts in case of emergencies. Arduino facilitates the integration by inserting real-time vehicle position data into the Firebase database, leveraging credentials stored securely in the credentials.h file for authentication. This allows the Kodular app to access and interpret the updated vehicle position, enabling timely alerts to designated emergency contacts. The Kodular app, initialized on the driver's mobile device, offers customization options such as specifying emergency contact numbers and motion threshold levels for enhanced accuracy in detecting potential incidents. Additionally, the integration of the Twilio API within the Arduino code ensures an added layer of safety by triggering SMS alerts in the event of non-response from the driver to the initial alerts generated by the Kodular app.

4.4.4 Module 4: Alerting system

The microcontroller continuously updates the vehicle's position in real-time within the Firebase database. The Kodular app is configured to monitor the "position" key in the Firebase database, triggering an alert whenever the value changes to "accident". Upon detection of an accident, the Kodular app initiates a false alert mechanism, activating an alert button for a predefined duration of 10 seconds, followed by a waiting period for the driver's response. If no response is received within this timeframe, indicating a potential emergency situation, the Kodular app updates the vehicle's location in the Firebase database. Subsequently, utilizing the Twilio API, the microcontroller sends an SMS to the emergency contact number stored in the Firebase database, notifying relevant parties of the incident. This multi-tiered approach to alerting and response ensures proactive detection of accidents, allowing for timely intervention and assistance in critical scenarios, ultimately enhancing overall safety and emergency response capabilities.

5 Results and Discussions

The analysis underscores crucial aspects of our system's functionality. Firstly, it highlights that the default motion threshold set for the accelerometer is calibrated at 0.7, showcasing a remarkable accuracy rate of over 95%. This meticulous calibration ensures that even subtle changes in motion are promptly detected, providing a robust foundation for our system's responsiveness. Moreover, the inclusion of a vibration sensor adds another layer of precision to our method. Figure 5 illustrates the experimental setup of the proposed work. By promptly signalling a value of 1 upon detecting high-frequency vibrations, this sensor significantly bolsters the accuracy and reliability of our system. It serves as a valuable complement to the accelerometer, particularly in scenarios where vibration data can offer unique insights into potential hazards or disturbances. On the software side, the seamless integration of the Kodular app with Firebase database functionality is pivotal. Through frequent database checks, the app remains vigilant for any emerging alerts or updates.

Furthermore, the adaptation of Twilio to substitute the SMS feature in advanced Android versions proves to be a game-changer. Twilio’s robust capabilities not only provide an alternative means of communication but also offer impressive accuracy and reliability. This ensures that critical alerts reach designated recipients swiftly and reliably, even in challenging network conditions or environments. Lastly, the user-centric design of the Kodular app deserves mention. By allowing users to effortlessly update emergency contact numbers and motion thresholds directly within the app interface, it enhances usability and empowers users to tailor the system to their specific needs and preferences. This intuitive approach fosters a seamless user experience, contributing to the over

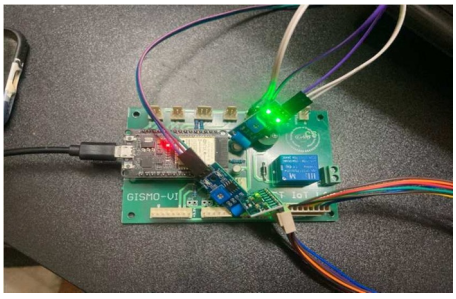

Fig. 5. Experimental Setup.

Fig. 6. SMS by Twilio.

6 Conclusion and future enhancements

This paper contains the following advantages and unique features that make it useful for motorcycle crash detection and alert. This paper uses the smart phone as an agent to send alerts to the concerned contact and to receive GPS location details. Since a smartphone is being used for sending alert information via the Internet without maintaining an external server, this makes the system very responsive and fast. Also, the smartphone's GPS is more accurate than an external GPS module since the smartphone uses WiFi, Bluetooth, Magnetic sensor as well as GPS sensor to provide accurate information on the rider's location. The crash threshold values for the MPU6050 Accelerometer readings are visible in the smartphone, these values are used for real-time comparison by the GISMO-VI module to detect the crash. The rider can update their contact details to their convenience, this makes the app very useful and also lets the rider have it only sent to people nearest to them or ones that can reach out in case they need help.

Further enhancements to the paper could significantly bolster its functionality and safety features. Integrating an airbag sensor would enable the system to detect airbag deployment, providing additional context to accident detection algorithms and helping assess the severity of collisions. Incorporating machine learning models could enhance the system's ability to analyse sensor data and accurately identify patterns associated with accidents, thereby reducing false alerts and improving overall reliability.

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