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Automatic Vehicle Accident Detection and Rescue System Using ESP 32

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ABSTRACT

In this modern world, the increase in number of vehicles has made our lives easier but also risky. The increase in vehicles also increases the traffic, environmental problems and mainly accidents. A large variety of precious lives are lost because of road accidents each and everyday that may occur due to the mistake of driver and delayed response from the place of accident to the emergency services. In our project, the accident occurred is detected by the accelerometer during accident and sends the signal to the ESP32 microcontroller, which act as core of this system. The process of rescue system uses GSM, in the process of sending message to the neighbouring medical Centre or relatives. GPS is used to track the location of the vehicle and used in the calculation of the speed of the vehicle based on the position of (latitude, longitude) and time difference. This system can help to save the lives of people who has met with an accident before it gets lost.

Keywords : MPU 6050, GPS, GSM, Vibration sensor, IOT, Accident detection, Rescue management.

INTRODUCTION

In today's world the number of accidents has been increasing daily and many lives are getting lost. Somehow delay in emergency services or hospitality is also responsibly of the cause of death. To overcome this kind of situation we have designed a system that will immediately alert, when an accident occurs. Even though there is many systems introduced for saving lives caused by the accidents, we have created our system more efficient and less costly. In Chandrasekhar Seregara [1], the system is used to detect the accidents using, the Micro electro mechanical system (MEMS) sensor that senses the signal and provide it to the Arduino, it is used as the core of this system. The location of the place is sent to the emergency services by using GPS with the help of GSM. In Wan-Jung Chang, Liang-Bi Chen [2], the authors proposed uses an in-vehicle infotainment (IVI) telematics platform with collision sensors and front camera. This system is clearly based on a cloud-based server and cloud management platform. The average time required to transmit an emergency-related announcement from a vehicle to the cloud-based management platform is approximately 7s. Syedul Amin, Mohammad Arif Sobhan Bhuiyan [6], it is an accident detection system that is fully based on GPS. It works on the map matching position of vehicle using GPS, it compares speed and position of vehicle for every 0.1 sec. According to the information, the present speed and position is compared with previous speed and position and from that accident is detected, and when it occurs the notification is sent to the emergency services.

The proposed system is an innovative system designed to detect vehicle accidents and alert the rescue services automatically. The system utilizes the ESP32, a low-cost microcontroller with a variety of built-in sensors, to detect an impact and trigger an alarm in case of an accident. The system is designed to help reduce the response time in case of an accident, which can be crucial for the survival of the occupants of the vehicle. The system is also capable of collecting and transmitting data from the accident site to the rescue services, providing critical information such as the location and type of accident. The system uses wireless communication modules such as GSM or Wi-Fi to transmit alerts to the rescue services, which can help them respond to the accident quickly and efficiently. The system can also be integrated with other technologies such as GPS and several other sensors. Overall, the Automatic Vehicle Accident Detection and Rescue System using ESP32 is a highly effective and low-cost solution for enhancing road safety and reducing the response time in case of an accident. It has the potential to save lives and make a significant impact on road safety.

EXISTING METHOD

The road accidents are the major social problems at which serious actions must be taken. In India approximately 1.5 lakhs of people died due to road accidents every year. There are many different solutions have been founded for this problem by different authors.

Smith William and Anthony Sabastin., [5] developed a vehicle tracking system by using GPS. It is in the form of device that is installed in the vehicle which will continuously moves and tracks the position of the vehicle. It helps the owner of the vehicle to tracks his car and to ensure that his car is not been theft.

Syedul Amin et al., [6] it is an accident detection system that is fully based on GPS. It 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 is any changes in it from that the accident is detected, and the notification is sent to the emergency services.

Shripad Desai et al., [8] 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 also it provides an off switch to the driver in case the vehicle had met with a small accident.

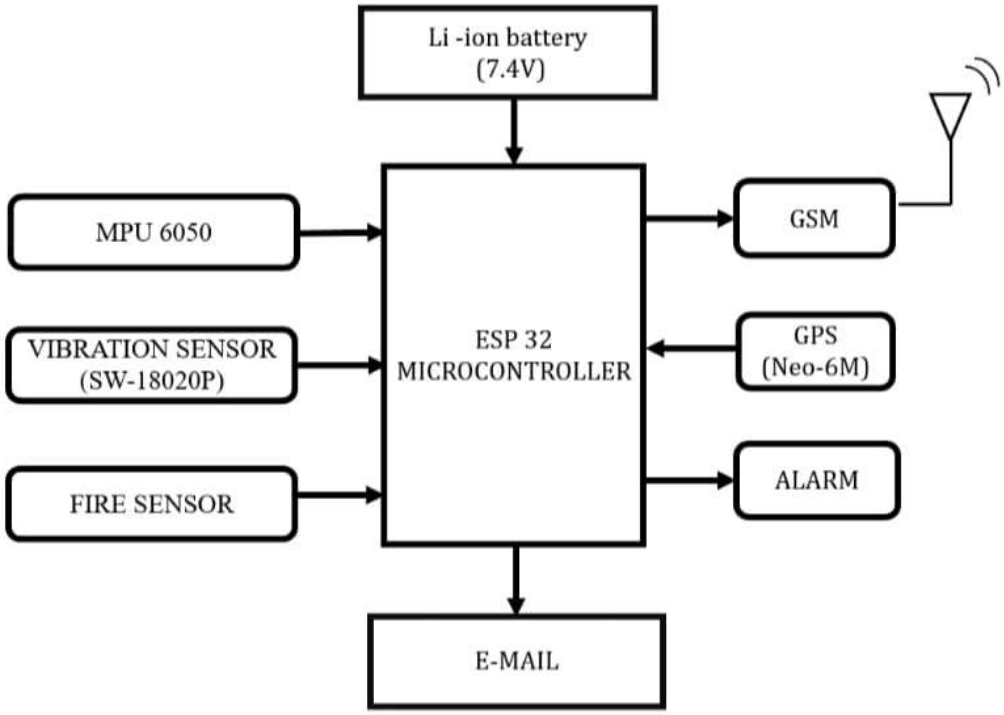
Khamlich Fathallah et al., [12] designed a system that identify accidents in real time and provide medical support to the people. They have developed the system using IOT (Internet Of Things) and it is fully server based control. Raspberry Pi allows the detection of sensors and informs the rescue facilities. It not only informs facilities buts also provides intelligent traffic control for the fast passage of ambulance to the accident zone without any delay.

Srikanth et al., [13] proposed an Automatic Vehicle Service Monitoring by using IOT and Machine learning which also help us to track the system. This system automatically reminds of vehicle service time with help of IOT which allows various devices to collect data like distance travelled, lubricant level, tyre conditions, etc… by using several sensors and the data are stored in cloud storage system. The machine learning is used to predict the vehicles condition based on that it will provide next date for service by verifying the sample data and GPS of the vehicle.

Sandeep and Ravikumar., [15] they provided an idea for detecting accidents that are caused by those who had consumed alcohol while driving. According to the author, different sensors, including alcohol sensors, heartbeat sensors, and touch sensor interfaces with a Raspberry Pi, were used in this system. The system that has been described is only appropriate in the scenario of drunk driving.

PROPOSED METHOD

The designed system detects accidents instantly and informs the emergency services or concerned person. ESP 32 microcontroller act as a heart to the proposed system. It is a low-power on-chip microcontroller which has in built Wi-Fi and Bluetooth module, it is also battery friendly. There are several sensors interfaced to the ESP 32 to detect the accident when it occurs.



The ESP32 microcontroller 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 ambulance or police, can respond quickly to the alert and provide necessary assistance.

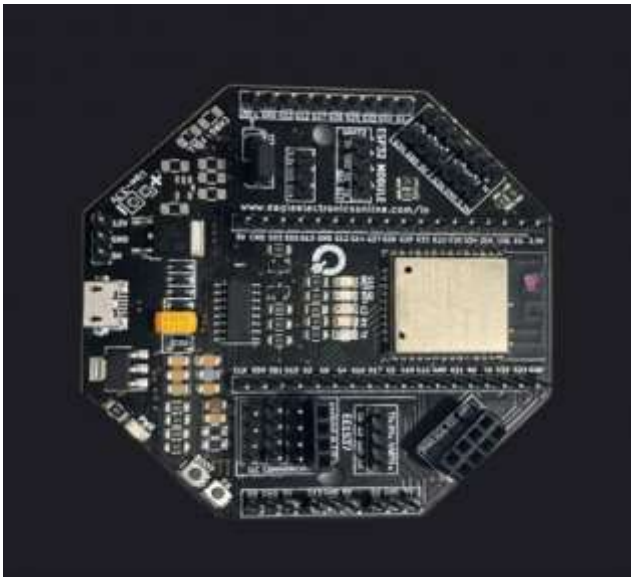
COMPONENTS Used

1) ESP 32
2) MPU 6050
3) Vibration Sensor
4) Fire Sensor
5) GSM Module (SIM 800L)
6) GPS Module (NEO-6M)
7) Li-ion Battery
8) PCB Antenna
9) Alarm Module

1) ESP 32

ESP32 is a popular microcontroller developed by Espressif Systems, which is designed to provide a low-cost, low-power, and high-performance solution for a variety of Internet of Things (IoT) applications. It is an upgrade from the previous version, ESP8266, and comes with a range of new features and capabilities. One of the key features of ESP32 is its built-in Wi-Fi and Bluetooth connectivity, which allows the device to communicate wirelessly with other devices and the internet. It also supports other wireless protocols, such as Zigbee, Z-Wave, and LoRa, making it suitable for a wide range of IoT applications. ESP32 comes with a range of on-board sensors, including temperature, hall effect, and capacitive touch sensors, which can be used for a variety of applications. It also has an ultra-low power consumption mode, which makes it ideal for battery-powered applications. ESP32 can be programmed using various programming languages, including C, C++, and MicroPython. There are also a number of development tools and Integrated Development Environments (IDEs) available, including the popular Arduino IDE, ESP-IDF, and MicroPython IDE.

In summary, ESP32 is a powerful and versatile microcontroller that provides a range of features and capabilities for a variety of IoT applications. With its built-in Wi-Fi and Bluetooth connectivity, low power consumption, and wide range of I/O interfaces, it has become a popular choice for IoT developers and hobbyists around the world.



2) 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.

The key features of the MPU-6050 module include:

- 6 degrees of freedom (DOF) sensing: 3-axis gyroscope and 3-axis accelerometer

- Digital motion processing: DMP provides orientation data in various formats
- Low power consumption: typically consumes 3.9mA in active mode and 5µA in sleep mode
- Wide operating voltage range: 2.375V to 3.46V
- Compact size: 4x4x0.9mm QFN package

Overall, the MPU-6050 is a versatile and cost-effective sensor module that can provide accurate motion tracking data for a wide range of applications.

3) Vibration Sensor

The Vibration Sensor (SW-18015P) from MEC to measure the vibration. It can trigger from any angle, and often used for flex, touch, vibration, and shock measurements. The SW-18015P is a popular vibration sensor module that is widely used in various applications to detect vibrations or impacts. It utilizes piezoelectric technology to convert mechanical vibrations into electrical signals, which can be processed by a microcontroller or other electronic devices for further analysis or triggering actions. The SW-18015P series are spring type, no directional vibration sensor trigger switch, any angle can trigger with vibration detecting functionality. The SW-18015P is known for its high sensitivity, small form factor, and ease of integration, making it a versatile choice for applications such as anti-theft systems, motion detection, earthquake detection, and industrial equipment monitoring. There is an on-board potentiometer to adjust the threshold of vibration. It outputs logic LOW when this module not triggered while logic HIGH when triggered. Proper usage and integration of the SW-18015P in specific applications can help enhance the performance and reliability of vibration sensing systems. Switch is open circuit OFF-state, when it is static, when external force to touch and corresponding vibration, or movement speed achieve adequate (partial) centrifugal force, conductive pick feet will produce instant conductivity is instant ON-state, when external force disappear, switch back to open circuit OFF-state

4. Fire Sensor

The Fire sensor module EE529M is a specific fire sensor module manufactured by E+E Elektronik, a company that specializes in sensors for measuring temperature, humidity, moisture, dew point, CO2, and other parameters. The EE529M is a compact, high-performance fire sensor module designed for detecting the presence of smoke in indoor environments. This Flame Sensor can be used to detect fire source or other light sources of the wave length in the range of 760nm - 1100 nm. The EE529M can provide a fast response time to changes in smoke concentration, allowing for quick detection of smoke and rapid activation of fire alarm systems. It is based on the YG1006 sensor which is a high speed and highly sensitive NPN silicon phototransistor. Due to its black epoxy, the sensor is sensitive to infrared radiation. Sensor can be a great addition in a fire fighting robot, it can be used as a robot eye to find the fire source. When the sensor detects flame the Signal LED will light up and the D0 pin goes LOW. Additionally, consulting with a qualified fire safety professional and following local fire codes and regulations is crucial for proper installation, use, and maintenance of fire sensor modules for effective fire detection and protection.

5) 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. The module has a built-in SIM card slot that enables it to connect to the GSM network. It also has a set of pins that can be used to connect it to a microcontroller or other electronic circuitry. These pins can be used to send AT commands to the module, which allows users to control its functions and access its features. The module operates on a voltage range of 3.7V to 4.1V and has a maximum current consumption of 2A. A diode is connected to the module to operate.

6) 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. The NEO-6M GPS module can receive signals from up to 22 GPS satellites simultaneously, which allows it to provide accurate positioning data in a wide range of environments. It supports several positioning modes, including single point positioning, differential positioning, and time-based positioning. The GPS module can output positioning data in several formats, including NMEA and UBX protocols. The NMEA protocol provides standard GPS data, such as latitude, longitude, altitude, and speed, while the UBX protocol provides more detailed and accurate data. The NEO-6M GPS module can be easily integrated into various projects and applications, such as tracking devices, navigation systems, and IoT (Internet of Things) devices. It is compatible with various development boards and platforms, such as Arduino, ESP32 and Raspberry Pi.

7) 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. The Li-ion battery chemistry provides a high energy density, which means that

it can store a large amount of energy in a relatively small size and weight. This makes it an ideal choice for portable electronic devices that require a lightweight and long-lasting power source. The 2000mAh capacity of the battery indicates the amount of charge that the battery can store. In other words, it can deliver a current of 2000 milliampere (mA) for one hour before being depleted. The actual runtime of a device powered by this battery depends on several factors, including the device's power consumption, usage patterns, and operating conditions. The 3.7V voltage rating of the battery is the nominal voltage that it can deliver. However, the actual voltage can vary depending on the charge level and load conditions. Most electronic devices that use this battery have a built-in voltage regulation circuitry to ensure a stable and consistent voltage supply. It is important to note that Li-ion batteries require special care and handling to ensure safe and reliable operation. Overcharging, over-discharging, and exposing the battery to extreme temperatures can lead to performance degradation, reduced capacity, and safety hazards.

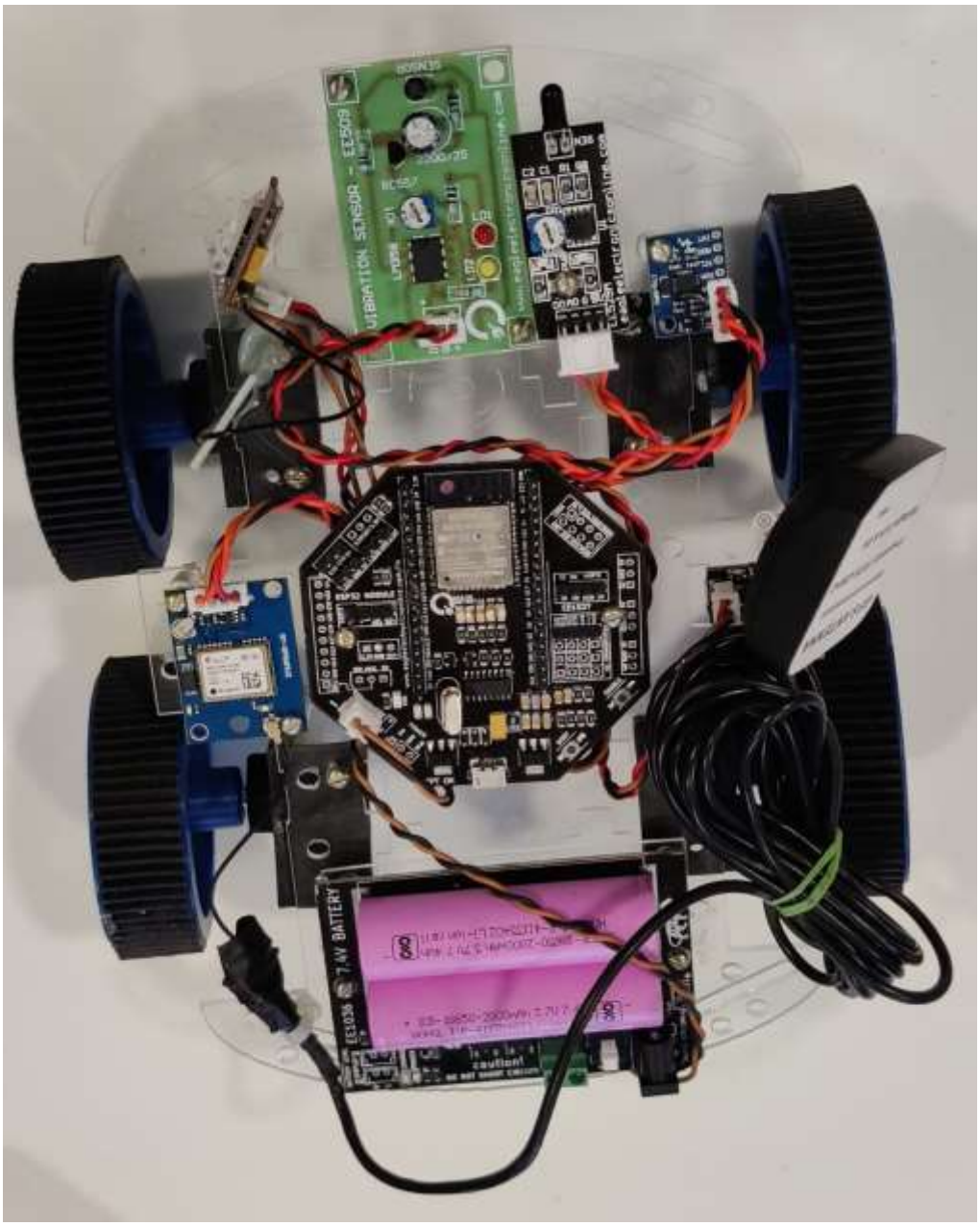
8) PCB Antenna

A 2.5 dB (decibels isotropic) antenna is a type of omnidirectional antenna commonly used in wireless communication applications, including in PCB (Printed Circuit Board) designs. A PCB 2.5 dBi antenna is designed to radiate and receive radio frequency (RF) signals equally in all directions, creating a spherical coverage pattern. This makes it suitable for applications where signals need to be transmitted and received from multiple directions, without requiring precise aiming or alignment. This is quad-band GSM / GPRS, 3G / UMTS & ISM tuned antenna, designed to resonate to a high level at ISM 868MHz and 915MHz; GSM 800, 900, 1800, 1900 and 3G 2100MHz. This PCB antenna manages a peak gain of 2.5dBi at 2100MHz (3G) so is, therefore, a high performance, wide frequency band antenna, suitable for a host of wireless M2M applications that require an embedded solution. Its wide operating frequency band allows for worldwide cellular applications over the quad-band GSM/GPRS networks and high data transfer rates via 3G/UMTS. The antenna can be either vertically polarized or horizontally polarized, depending on the application requirements and the orientation of the other antennas in the system. The polarization of the antenna affects how the RF signals propagate and interact with the environment. The impedance of the antenna is typically matched to the impedance of the RF circuitry on the PCB, usually 50 ohms for most wireless communication applications. Proper impedance matching is important to ensure efficient signal transfer and minimize signal reflections.

9) Alarm Module

The "Active Buzzer Alarm Module - EE2206" is likely a type of electronic module that includes an active buzzer, which is a type of electronic sound generator that produces sound when a voltage is applied to it. It is commonly used in various projects for generating audible alerts or alarms. The module may have additional features such as an onboard driver circuit, adjustable frequency or volume control, and possibly other components for specific functionalities. The exact specifications and usage of the module may vary depending on the manufacturer and model. This is a small buzzer module that operates around the audible 2 kHz frequency range. It is an active buzzer, which means that it produces sound by itself, without needing an external frequency generator. It can easily be used with microcontroller boards, like Arduino, without needing a dedicated PWM channel.

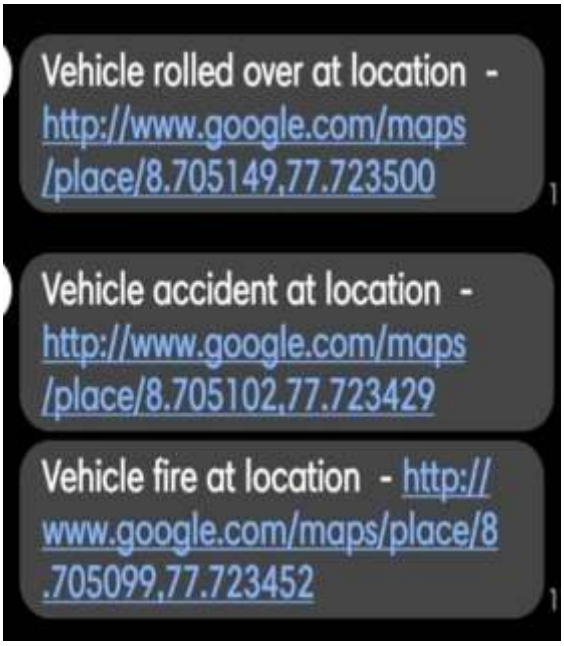
HARDWARE MODEL

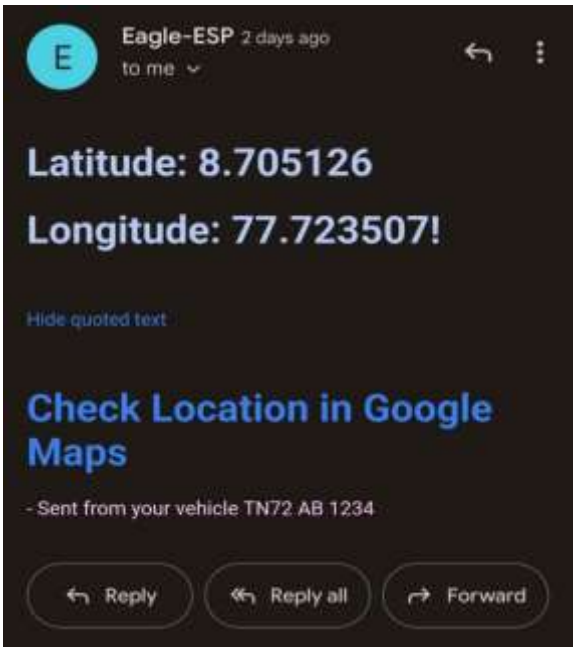


RESULT AND DISCUSSION

The prototype model was successfully implemented and tested. The ESP32 microcontroller was programmed to read sensor data and detect an accident. The system was also able to send an alert to emergency services with the location of the accident using Wi-Fi and GPS modules. The system's sensors was triggered when an accident was detected, and GPS co-ordinates are sent to the emergency services or related person. The system was able to operate autonomously and did not require any intervention from the vehicle's occupants. The system's response time was evaluated, and it was found to be significantly faster than traditional methods of reporting accidents. This is due to the system's ability to automatically detect accidents and send alerts to emergency services immediately.

In terms of the discussion, the Automatic Vehicle Accident Detection and Rescue System using ESP32 has several advantages over traditional methods of reporting accidents. Firstly, the system can operate autonomously, which means that it can detect and report accidents without requiring any intervention from the vehicle's occupants. This is especially useful in situations where the occupants are unable to call for help themselves. Secondly, the system's response time is significantly faster than traditional methods of reporting accidents. This is because the system can detect accidents immediately and send alerts to emergency services with the location of the accident.





CONCLUSION

The proposed system is developed to provide information about the accident occurs and the location of the accident. It helps to easily provide the assistant and help to the victim of the accident. This system uses the GPS module to locate the vehicle. MPU 6050, vibration and Fire sensors are used to determine whether an accident had occurred, if an accident occurs the GPS and GSM modules installed in the system sends the information to the related person or emergency services. The systems we developed here is a kind of both hardware and software-based technology. A rescue measures in time with sufficient preparation at the correct place can save many lives. Thus, the proposed system can serve the humanity by a great deal as human life is valuable.

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