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Original Article

Quick Response System for Road Accidents with Automatic Accident Detection and Prevention Using IoT

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Abstract *- Demand from the population is rising steadily on this expanding planet. Due to the countless traffic accidents each year, many individuals separate. Due to a lack of coordination between the organizations involved, they result in accidents. They do not adhere to the laws and rules that are in place in society. A few of the main risk factors are reckless driving, drinking and driving, disobeying the law, poor infrastructure, and many others. Due to the fact that two-wheelers do not have as many safety features as four-wheelers, bicycle accidents make up a significant portion of all accidents. The research indicates that this type of detection system uses a variety of technologies, including the Global System for Mobile Communication (GSM) and the Global Positioning System (GPS), among others. In order to identify an accident, we employ gyro and vibration sensors, which pinpoint the accident's location appropriately. We also employ a GPS and GSM module to detect the accident scene and transmit location and alert messages to the police, ambulance, and 1033 toll-free numbers. These detecting systems apply to all of these vehicles, and additional technologies are similarly taken into consideration. By using a technique, the Distance vector routing algorithm discovers the closest site and notifies the user. This article outlines how to develop a system that can successfully prevent any sort of accident. If such circumstances arise, it detects and alerts the relevant authorities and individuals so that the situation or condition can be handled immediately.*

Keywords *- GPS, GSM, Accident detection, Vibration sensors, gyro sensors, Distance vector routing algorithm, Internet of Things.*

1. Introduction

A system that is absolutely capable of coordinating the many steps that must be conducted for the speedy response at the accident site is required. According to the research, this detection system uses a variety of technologies, including conventional neural networks (CNN), object detection and tracking systems, GPS, and GSM mobile phone apps [2]. The major goal is to include or suggest a system that can accurately identify accidents from the cameras' video material. The major goal is to have a fast or rapid reaction time so that the following items may be implemented as soon as feasible.

The demand for vehicles is rising dramatically as a result of the world population's fast expansion, which is also contributing to traffic congestion issues and an increase in accidents. The population of vehicles is rising at a similar rate; thus, it follows that accidents will happen more frequently. Road accidents can be considered a collision involving any on-road vehicles, obstructions, or people. How quickly an ambulance arrives at the scene of the accident and transports the patient to the hospital significantly impacts the victim's chance of survival. In most road accident instances, the injuries are not serious, and the victim's life can be spared; however, because the rescue teams are often late, the injuries become fatal.

For the rescue team to act quickly and save the victim's life, the first objective is to locate the accident scene and quickly communicate the essential information to them. This method assists in quickly identifying accidents and notifying the police, ambulance, and 1033 toll-free number about them, along with the accident's time and location, in a notice. Using the Distance Vector Routing Algorithm, which offers a system by which it determines the closest position and delivers a notification to the involved parties. Our paper's major goal is to suggest a system that may successfully aid in preventing any sort of catastrophe. If such conditions exist, then how it detects and alerts the relevant authorities and individuals so that the problem can be handled right away. In order to design successful systems that can take advantage of the strengths while resolving the issues in the present systems, this article will critically analyze the literature on accident detection and give a wider perspective on the current process.

The primary contributions of this study are (a) creating a new intelligent IOT-based solution that would lower the rate of traffic accidents. (b) Giving the community the right warning to reduce the death rate. (c) Setting up a system of alarm messages to ensure sufficient awareness.

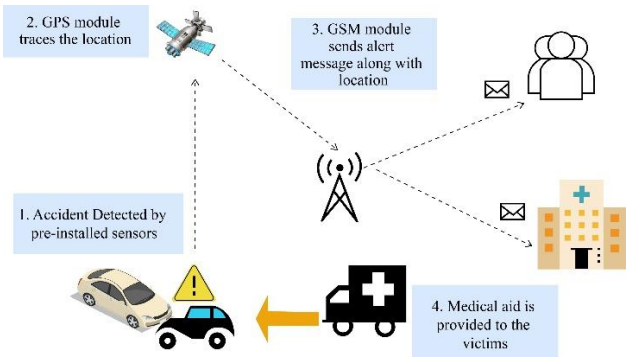


Fig. 1 An accident detection system using GPS and GSM

The remaining sections of the paper are organized as follows: In Part II, the suggested system is distinguished from other comparable approaches, our suggested system's mechanism is described in Part III, and its process and outcomes are examined in Part IV; there is a conclusion in Part V.

2. Literature survey

The number of fatalities brought on by traffic accidents is rising quickly. The numerous approaches emphasized both accident prevention and detection. For accident detection, these methodologies included a variety of sensors, including accelerometer sensors, shock sensors, pressure sensors, etc., as well as a variety of machine learning approaches, including neural networks, support vector machines, representation learning, etc. Numerous accident prevention techniques are also discussed, such as identifying intoxicated and sleepy drivers, controlling vehicle speed, keeping a safe distance from objects, etc. When an accident is discovered, emergency services are informed so that prompt assistance may be given [1][2].

The emergency response assistance system offers a method of avoiding false positives when detecting traffic incidents using a smartphone [3][4]. It discovers a threshold acceleration almost never seen in daily life but is unquestionably observed during traffic accidents. They also go into detail on how the threshold was created to avoid false positives. Road disruptions have grown as a result of increased vehicle use. The technology offers a unique prevention and detection system that gives drivers the ultimate cure-all, ensuring safety and preventing loss of life by taking the proper actions at the appropriate moment [5][6]. This system has an advantage over conventional systems because it mostly consists of RFIDs, sensors, etc.

In regions where fast notification is rarely possible, a novel approach for road accident detection utilizing the DETR algorithm has been developed to help hospitals and the local police [7][8]. With DETR and a random forest classifier, the strategy for identifying traffic incidents presented in this research is new and effective. [9][10] This study focuses on a clever system that warns drivers and automatically reduces vehicle speed if an accident is dangerous. The Naive Bayes Classifier's suggested real-time environmental data is used in its operation. One of its most beneficial characteristics is the Naive Bayes Classifier's ability to function with a Raspberry Pi-sized low-processing unit.

[11][12] A smart system that warns, manages vehicle speed, and alerts people appropriately in the event of an accident is explained. Utilizing a distance sensor, this device continuously keeps track of the separation between oncoming traffic and any impediments. An email alert with the car's information will be sent to the responsible person whenever an accident occurs due to a hazard.

The system is both real-time and completely non-intrusive. They employed the eye closure ratio as an input parameter to determine if the driver was drowsy. A buzzer informs the driver if the eye closure ratio deviates from the desired ratio [13][14]. The photos of the driver's eye are captured for this system using a Pi camera, and the complete system is integrated using a Raspberry Pi.

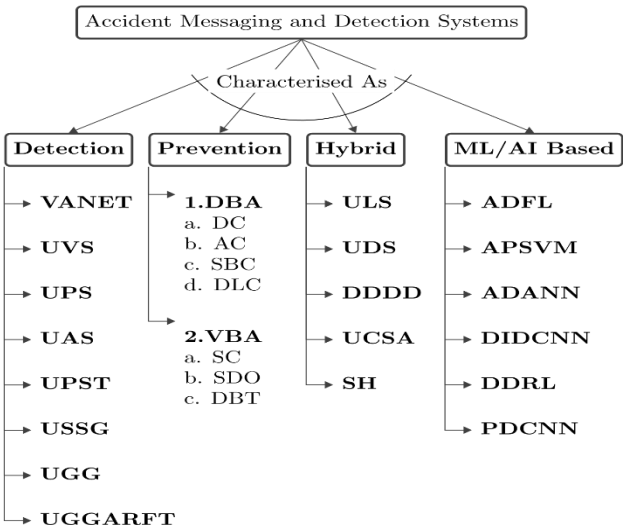


Fig. 2 A taxonomy of accident detection and prevention techniques

3. Proposed system

The suggested method addresses the present system's shortcomings, including the fact that the population is continuing to rise.

This article explains how to design a system that can successfully aid in preventing any sort of accident and, if such circumstances arise, how it detects and alerts the dispersed authorities and individuals so that the problem can be handled immediately. The technology assists in identifying accidents in a very little amount of time, essentially within a few seconds, and notifies the first aid facility of the accident's time and location.

To become familiar with and comprehend the underlying principles of the sensors and technologies that will be used to carry out this project. To create a technology that would improve the driver's safety. The intelligent accident detection and prevention system aims to save time and human effort. The major objective is to locate the accident's location and quickly convey that information to the rescue crew so that they can act to save the victim's life.

If an accident is discovered, vibration sensors will pick up on an item and gyro sensors will start analyzing the angular moment. A buzzer and an LED lamp will turn on if the moment is unstable. When the light is turned on, GPS Neo 6M will be used to coordinate it. This displays the location and sends SMS messages to the police, ambulance, and the 1033 toll-free number for accident assistance through GSM. The Distance Vector Routing Algorithm offers a system by which it determines the closest place and sends a notification to the interested parties. The patient will then be admitted to the highest level of care after being assessed for their health. The Arduino IDE software is used to visualize the programming. In the Arduino IDE, the output is shown and then performed.

In this process, we also reduce the human effort by sending messages directly to the police and ambulance so that the victim can immediately take the treatment, which helps in reducing the time. To ensure road safety and preserve precious lives, we give a fault-finding study of numerous existing approaches utilized for foretelling and avoiding traffic accidents, highlighting their advantages, drawbacks, and issues that must be resolved.

The majority of the systems emphasized taking precautions to avoid mishaps. The hardware components used in this project are all less expensive and hence can be afforded, and the system is constructed in a way that makes it simple to maintain and highly inexpensive. By integrating network technology into the real world, we are transforming accident detection and prevention into smart accident detection and prevention.

Fig. 3 Accident Detection and prevention system

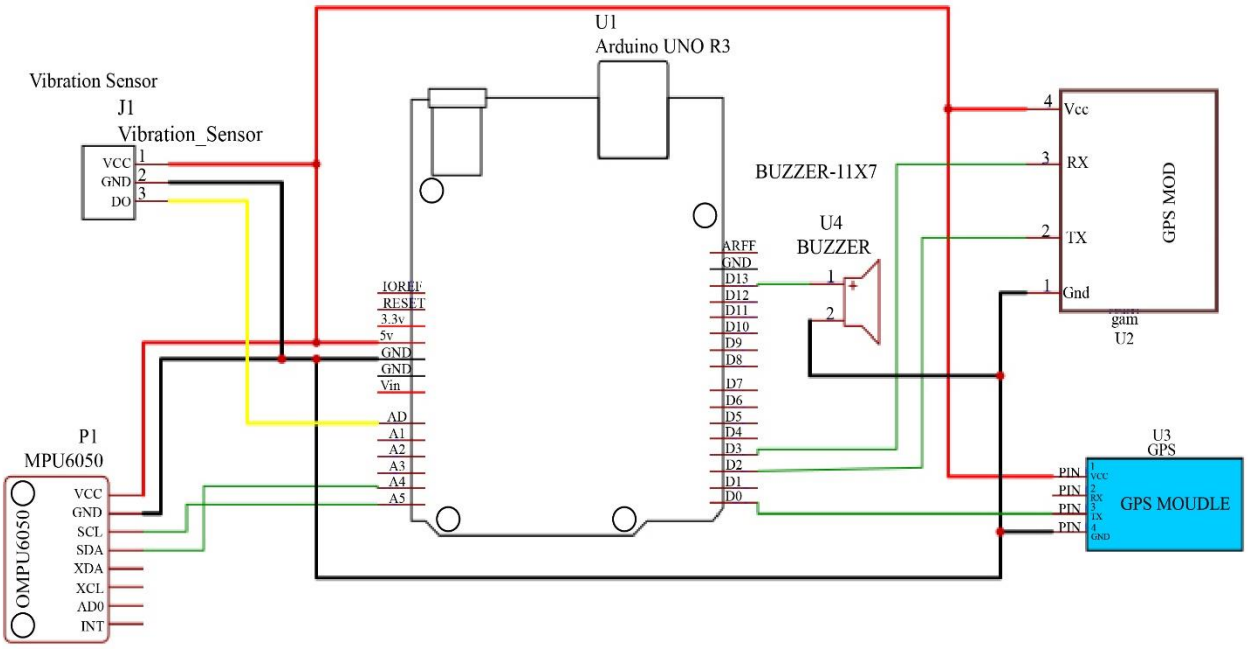


Fig. 4 Working module of IOT-based automatic vehicle accident alert system

4. Hardware Implementation

4.1. Integration of GPS module

In GPS, each module's initial stage is individually tested using an Arduino to ensure the modules function as intended. Later, Arduino UNO is combined with all the modules. Each module has a few ports for serial communication, including input and output. The GPS module's VCC pin is linked to Arduino's pin number 5v, while the Rx pin is left unconnected because it is in hybrid mode, the Tx pin is attached to Arduino's pin number D0, and the GND pin is connected to Arduino's pin GND. We can learn about the specific location monitoring system through these links. Values for longitude and latitude are retrieved.

4.2. Integration of GSM module

The Arduino UNO includes a GSM module. The GSM module's VCC pin is wired to the Arduino's pin number 5, while the Rx and Tx pins are wired to the D3 and D2 pins, respectively. The GND pin is wired to the Arduino's GND pin.

It is used to convey the accident alarm message, as seen in "Fig. 1". A 12 volts power supply powers it using the GSM module's AT (ATTENTION) instructions, which are sent when the circuit sends an accident alarm SMS. The GSM module's operation is fairly straightforward and answers "OK" to each successful AT command.

4.3. Integration of Vibration sensor SW-402

A measurement tool is the vibration sensor. It calculates the system's vibrational frequency and amplitude. The VCC pin of the vibration sensor is linked to Arduino pin number 5v, the GND pin is attached to Arduino pin number GND, and the D0 pin is connected to Arduino pin number A0. These linkages allow us to determine the frequency of an unstable body.

4.4. Integration of Gyro sensor MPU6050

A gadget called a gyro sensor can measure and maintain angular velocity and orientation. The Gyro sensor VCC pin is linked to Arduino pin number 5v; the GND pin is attached to Arduino pin GND, the SCL pin is connected to Arduino pin number A5 and the SDA pin is connected to Arduino pin number A4. These linkages allow us to determine an object's angular velocity.

4.5. Integration of Piezo Buzzer

If an accident is detected, the buzzer will start to produce a beeping sound. The Arduino pin number D13 is linked to the Piezo Buzzer's 1+ pin, while the Arduino pin number GND is connected to the Piezo Buzzer's 2-pin.

4.6. Integration of LED Bulb

A led bulb is used to light if an accident detects.

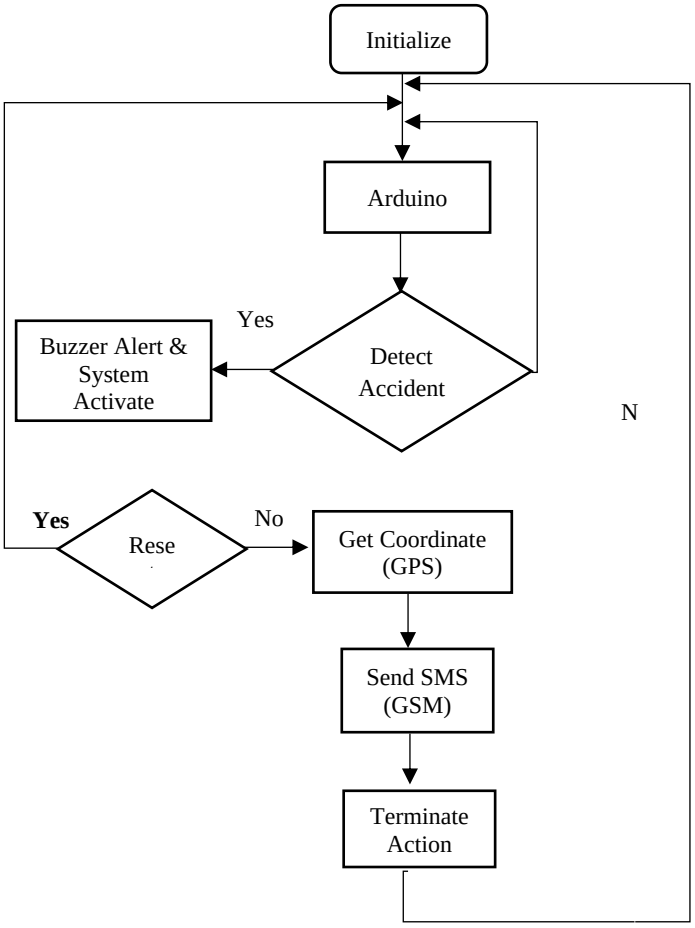


Fig. 5 Flow chart of the accident detection and alert system

5. Working Explanation

An Arduino board controls the entire procedure in this study, as a GPS receiver and a GSM module, as seen in "Fig.5". The GPS receiver aids in locating the vehicle's coordinates. The rescue squad is then notified of the discovered coordinates through SMS using a GSM module. The Distance Vector Routing Algorithm offers a method for pinpointing the position of the closest path and sending a notice. The alert message will display an Arduino Based Smart Accident Detection and Prevention System. By using the longitude and latitude numbers that GPS displays, we can simply pinpoint the precise spot where the accident was discovered.

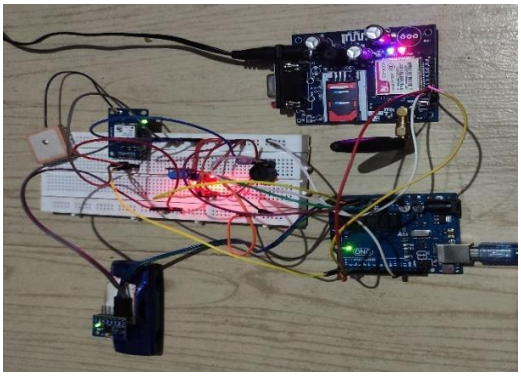


Fig. 6 Connection setup of hardware components

A buzzer will sound, and a led bulb will turn on if an accident is detected. A vibration sensor then measures the system's amplitude and vibration frequency, and a gyro sensor determines the vehicle's angular velocity.

The alarm message will be transmitted via the GSM module to the 1033 toll-free number, the police, and the ambulance to prevent the victim. If we contact the number from where we received the alarm message, we will be put on hold, and it will send one message, known as a RING reply, which sends a precise location for simple tracking.

6. Test Cases and Results

Modules	Test case id	Test case name	I/P	Expected Outputs	Results
GSM	GSM_T1	Checking the circuit while applying power in accordance with the module description's instructions	12v Power Supply	Module should ON and power LED should glow	Pass
	GSM_T2	Checking the GSM modules' functionality after adding the sim making a call to that SIM number	Any active Sim with the incoming enable	Ring the number when someone calls	Pass
	GSM T3	Checking that the module should reply to the Arduino UNO when the GSM is connected with the Arduino UNO module	Establishing a connection through connectivity GSM pins Tx, Rx, VCC, GND, and power supply wires	GSM module should respond to Arduino UNO	Pass
GPS	GPS_T 1	Examining the circuit while applying electricity as directed within the module script's instructions	12v Power Supply	Module should ON and power LED should glow	Pass
	GPS_T 2	Verifying that the GPS module should respond to the Arduino UNO when connected to Arduino UNO	Establishing a connection using the connector wires on Tx, VCC, GND, and power supply pins of a GPS	GSM module must respond to Arduino UNO	Pass
Vibration SW-402	VIB_T1	When the vibration Module is connected to the Arduino UNO, the module should respond to Arduino UNO	Establishing a connection using the connecting wires on the VCC vibration pins, GND, D0, and power source	The vibration module should respond to Arduino UNO	Pass

Gyro MPU6050	GYR_T1	When attaching the Gyro module to the Arduino UNO, make sure the module responds to the UNO	Giving connection with the aid of connecting wires on the gyro pins VCC, GND, SDA, SCL, and power supply	The Gyro module should respond to Arduino UNO	Pass
PIEZO_ BUZZE R	PZB_T 1	Verify whether the buzzer sounds when the power is turned on	+5v supply, and GND	The buzzer should sound when electricity is turned on	Pass
Accident Alert circuit	TC_0 1	Examine the circuit to make sure it is powered on after applying a power source to the circuit	Power supply ranging from 9 to 12 volts	Every linked module ought to be powered on	Pass
	TC_0 2	As soon as the GSM module has properly started, respond with the AT command OK		OK, the output should appear on the Arduino console	Pass
	TC_03	After the GSM module has been initialized, confirm that calling is enabled on the SIM	Calling to contact number	The user should be able to dial the number and hear a ring reply message	Pass
	TC_04	Check that the GPS module has been initialized correctly and provide the location's current coordinates		The message "GPS module initialized successfully" should appear	Pass
	TC_05	Make that the vibration module is properly initialized and measuring amplitude and frequency		Vibration module initialized Successfully and gives measures a device	Pass
	TC_06	Check to see if the Gyro module started properly and measured the angular moment		The Gyro module initialized successfully and output x, y, and z angular velocities	Pass
	TC_07	Make sure the Piezo buzzer starts on vibration and gyro and that it emits a beeping sound as a signal		Beep sound should blow when the accident detects	Pass
	TC_08	Check to see whether the circuit should be reset, and no notification should occur if the buzzer is not operational		Resetting the circuit should stop any notifications from starting	Pass

	TC_09	Check that the GPS and GSM modules should be started by the vibration and gyro		GPS unit ought to obtain the current coordinates	Pass
	TC_10	Check that the GPS and GSM modules can provide the current position		Send a message to the specified cellphone numbers	Pass
	TC_11	Check to see if the SMS circuit is reset to the beginning stage after sending		System Ready message should display after the circuit reset	Pass

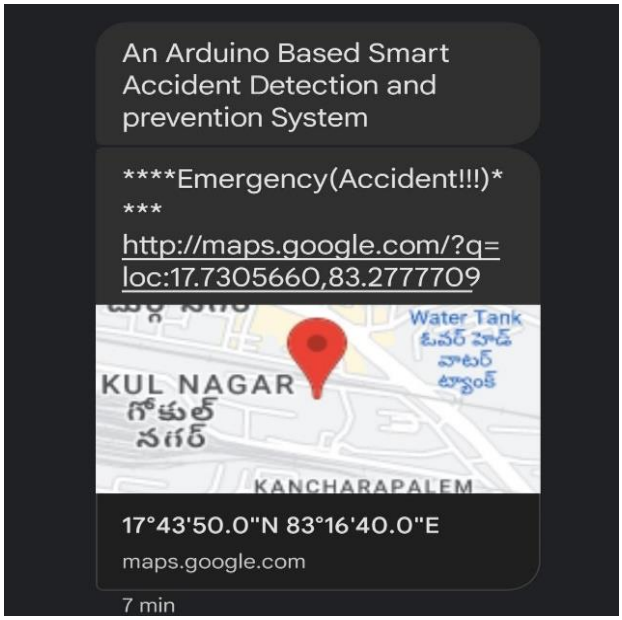


Fig. 7 Alert message GPS tracking location

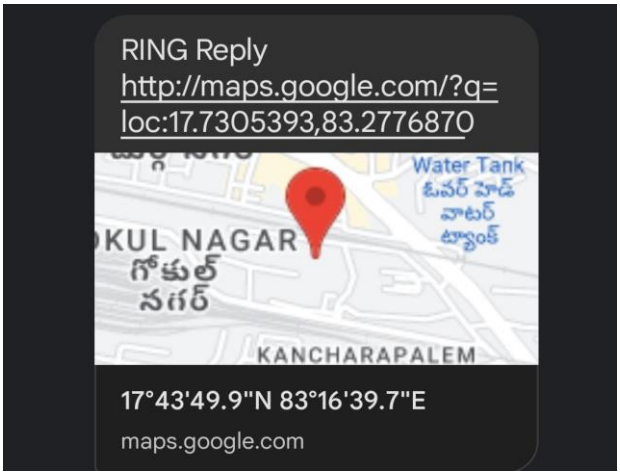
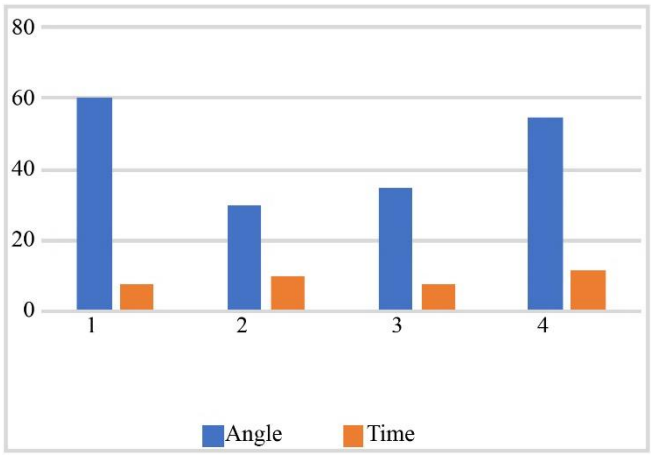


Fig. 8 If a person calls, then GPS will track the exact location of the RING reply

Table 1. Test cases for Gyro angles (Gyration)

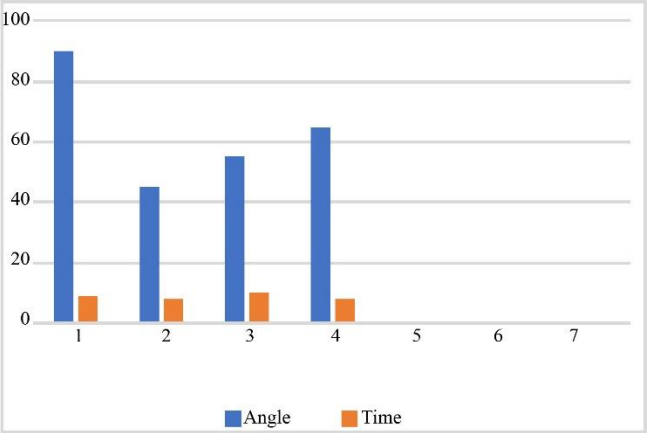
Angle	Time
60	8
30	10
35	8
55	12



Graph 1. Graphical representation of Gyro angles (Gyration)

Table 2. Test cases for Gyro angles (Throw and Fro)

Angle	Time
90	9
45	8
55	10
65	8



Graph 2. Graphical representation of Gyro angles (Throw and Fro)

7. Conclusion

The major objective is to locate the accident's location and quickly convey that information to the rescue crew so that they can act to save the victim's life. If an accident is discovered, vibration sensors will pick up on an item and gyro sensors will start analyzing the angular moment. A buzzer and an LED lamp will turn on if the moment is unstable. When the light is turned on, GPS Neo 6M will be used to coordinate it. This displays the location and sends SMS messages to the police, ambulance, and the 1033 toll-free number for accident assistance through GSM. The Distance Vector Routing Algorithm offers a system by which it determines the closest place and sends a notification to the interested parties. The patient will then be admitted to the highest level of care after being assessed for their health. The Arduino IDE software is used to visualize the programming. In the Arduino IDE, the output is shown and then performed. Therefore, it helps to reduce communication delays and allows for prompt treatment of the accident victim. It is crucial to locate the sites of accidents at midnight.

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