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Smart Vehicle Accident Alert System

[1]Dr.M.Nirmala, [2]Arjun K, [3]Sunil Kumar R, [4]Karthikeyan S

[1] Assistant professor-III, EEE, Kumaraguru College of Technology, coimbatore-641042,
[2] Student, EEE, Kumaraguru College of Technology, coimbatore-641042,
[3] Student, EEE, Kumaraguru College of Technology, coimbatore-641042,
[4] Student, EEE, Kumaraguru College of Technology, coimbatore-641042

[1] nirmala.m.eee@kct.ac.in,[2] arjun.18ee@kct.ac.in, [3] sunil.18ee@kct.ac.in, [4] karthikeyan.18ee@kct.ac.in

ABSTRACT
Nowadays Road accident causes serious issues and many people's lives are at risk in their day-to-day life. Due to the rapid growth in science and technology, every problem which arises in today's world can be easily tackled. Road accidents are occurring at a high rate in today's world. India ranks 1st in the number of road accidents death across 199 countries followed by the U.S and China. In 2019 alone India accounts for a total of 4,49,002 road accidents reported by state union territory. Most death cases are mainly due to a lack of medical support. Even if they ended up causing accidents in remote areas, they never get medical support immediately. Due to the delay in reporting the accident, there is always some delay in ambulance arrival at the location of the accident. Thus, to prevent the delay and to get proper medical support, there must be an emergency working model which would send an exact location of the accidental zone to the nearby hospitals and police stations. With the use of modern technology, developing an automatic alert system that sends the location of the accidental zone to the nearby hospitals through GPS/GSM can be achieved and can save precious time and provide a sustainable environment where no lives can be at risk. The camera captures the accident, which can be later analyzed for investigation. The effectiveness of the proposed project is examined using PROTEUS software and simulation results are analysed.

Index Terms— Accelerometer, Global Positioning System (GPS), Global System for Mobiles (GSM), Raspberry pi, PROTEUS, SIM900A GSM.

I. INTRODUCTION

Road accidents are an immense concern in today's world, with over 1.3 million people killed or injured. In today's world, population growth is accelerating, and accidents are occurring at an alarming rate, resulting in a high number of casualties. Over speeding, rushing, carelessness, traffic law violations, Drunk and Drive, and other factors contribute to the accident. Many lives are at risk because of the aforementioned factors. If an accident occurs, minor injuries can be treated using a first aid kit; but, if the injury is severe, the victim should seek medical attention immediately. When individuals are there, they will aid the person and promptly take care of their requirements. But, if they are not present, medical treatment will be required. They can only survive if they receive medical assistance at the precise moment, they require it. They will be put in jeopardy if such support is delayed. Many victims died while on their way to the hospital. Many individuals are dying while being transported to hospitals due to delays in ambulance arrival. Many individuals may suffer because of this. The current technology uses a smartphone app that uses a GPS (Global Positioning System) and accelerometer to identify an accident and alert the ambulance. When an accident happens, the controller activates the sensors, and the corresponding readings are recorded. The readings include the car's speed and position, which are received via GPS. The appropriate readings are delivered to the emergency system or hospitals by establishing an application on the individual's mobile phone. Even if a minor accident occurs, if the individual survives with only minor injuries, they should not require any extra medical assistance, they should be able to manage their wounds on their own or simply contact the emergency services they require. This system should not issue an emergency alert notification to adjacent hospitals in that circumstance. These flaws should be used to characterize the system.

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If any external disturbance is made over the vehicle when a system employs piezo-electric sensors to detect accidents, the piezoelectric sensor determines the disturbance or pressure created on the vehicle and the system should transmit messages depending on the specified values. If the sensed value is higher than the typical value, the system should send out an emergency alert. Some systems employ piezoelectric sensors to detect accidents, while others use GSM (Global System for Mobiles) to send signals.

II. EXISTING SYSTEM

The existing system has a piezoelectric sensor mounted on all sides of the car. When a collision happens, the piezoelectric sensor generates a higher voltage, and the microcontroller senses the higher voltage and sends a message to the specified Phone number. In some systems, there is also an accelerometer included to detect the rolling of the vehicle after a collision. The location of the accident is detected by the GPS and sent to the specified phone number. There is an application developed for detecting the accident and sending the location of the accidental zone through an SMS. The application is called SOSmart application [1]. This app can access the inbuilt sensor and obtain the location of the accidental area with the help of the GPS in the Mobile phones. After installing the app on the mobile phone, it will request to pre-select the contact of the important or close family circle members. After that, the app stays intact with GPS. If an accident occurs the app trigger an emergency notification to the pre-selected contact members or the emergency unit. This notification contains the location details of the accidental area which is obtained from the GPS in the mobile phones. This application is also tested in real-time application on the National Highway Traffic Safety Administration. The results are characterized based on the normal, mild, and serious accidents.[1] There is also a solution developed by Kaladevi et al. through Android Smartphones. In this system, a Heartbeat sensor is implemented in the Smartphones. The normal Heartbeat rate ranges from 60 to 100 beats per minutes BPM. If there is a variation in the normal heartbeat, then the system checks for the accident or not cases. If it is an accident, then the system will trigger an alert or emergency message. There is also a system that differs from all the existing systems. [2] Sane et al developed a system that is entirely different from other systems. This system uses push button switches. These switches are mounted or integrated on the front and rear ends of the bonnet. In case of any accidents occur, the Collison rate is monitored by the accident detection system and sensors. Then these data are transmitted to the interrupt pins of the micro-controller. There is an access key provided to the drivers, which will be used by the driver alone. If it is a minor accident, then the notification triggered will not send to the emergency units or members. If it is a major accident and the driver does not use the key, then the notification containing the location details is triggered. In addition to this system, there is also another method which will work as same as the mentioned above methods. [3] Anupriya et al also proposed a system Smart Accident Notification and Collision Avoidance System which uses ZIGBEE for the other instruction. [4] Vardhini et all developed a Smart accident alert system that also uses a Vibration sensor alone to detect the accident and a GSM module to send the message of GPS coordinates.[6] Sampoornam et al developed an Intelligent Expeditious Accident Detection and Prevention System which uses an accelerometer sensor to detect the accident and the same GSM module for message communication to the Family members. All these will be useful for developed countries which use automated traffic systems and Radio Frequency systems, which also ultimately decreased the mortality rate.

III. OBJECTIVE

The main objective of the proposed project is as follows:

- To provide proper emergency medical assistance by sending the location of the accidental zone. Through the image captured by the camera, the microcontroller can identify the other accident vehicle, if any crime occurs it should be monitored and helps the police in the investigation.
- The project aims to send the exact location and photos of the accidental zone to the nearby hospitals and police stations.
- By getting inputs from the camera and sensor, the microcontroller will characterize the input and after proper observation, the microcontroller will send the location using GPRS/GSM. If there are small accidents, the microcontroller will not trigger the notification.
- In a smart vehicle accident alert system, it consists of a vibration sensor, which detects vibration, when an accident happens, and it will be finely tuned to cancel false alarms. To detect the force of the collision, an accelerometer is used and a gyro sensor to detect the rotation of the vehicle. In this system there are 4 cameras connected to the microcontroller, when a collision happens, the cameras will capture the surroundings to detect the other vehicle with which the collision happened. The collision location is detected by GPS and the picture of the other vehicle will be sent to the specified number

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IV. BLOCK DIAGRAM

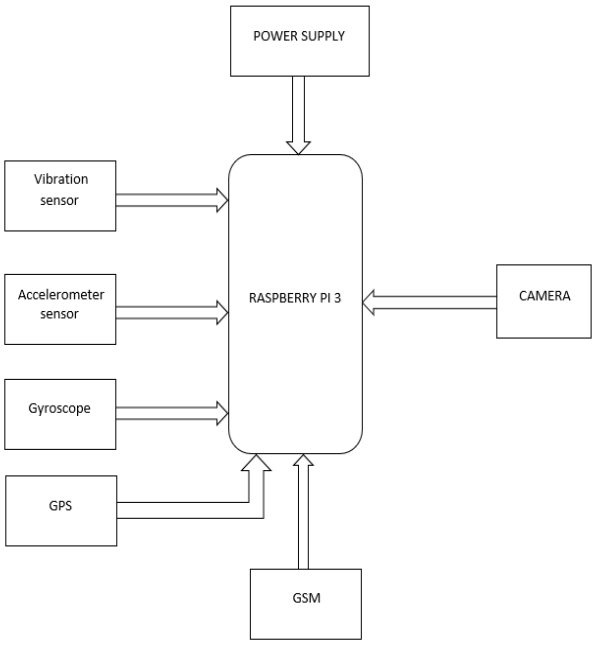

Fig. 1. Block diagram of the proposed smart system

Fig. 1. shows a block diagram of the proposed smart vehicle accident detection system. When a vehicle collides, immediately the vibration sensor calculates the vibration, if the value is greater than 0.5 IPS (Inches Per Second), the microcontroller takes it as an accident. The normal car vibrations are under 0.5 IPS. Accelerometer thresholds are 0-4 g for no accident if it goes beyond that the microcontroller takes it as an accident. 4-8 g indicates a mild accident and 8-12 g indicates a medium accident and 12-16 g indicates a severe accident. The g force created by the accident detected by the accelerometer are sent to the microcontroller.

The gyroscope sensor detects the rotation of the vehicle. If the car rolls and ends facing upside down, the gyroscope sensor will sense the degree (180 or 360 deg) of the vehicle and give the input to the microcontroller. As soon as the collision happens the cameras on four sides with the help of image processing will capture the surroundings of the vehicle and detect the other vehicle with which the collision happened and sent it to the microcontroller. The GPS would detect the longitude and latitude of the location and send it to the microcontroller. The microcontroller could process all the information from various modules and send the data through the GSM module to the specified phone number.

V. SIMULATION MODULE FOR VARIOUS SENSORS

A. VIBRATION SENSOR

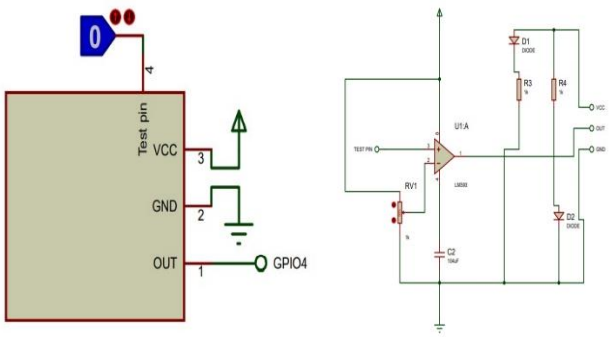

Fig.2. Vibration sensor

Vibration sensor and the in-built circuit of the vibration sensor. Vibration sensor 801S is a digital vibration sensor, which has 3 pins, a VCC, a GND, and a digital output pin. The threshold value can be adjusted using a potentiometer that is

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available on the vibration sensor. It gives a vibration indication to raspberry pi when the accident occurs. It is connected to GPIO 4 pin in the microcontroller.

B. ACCELEROMETER SENSOR:

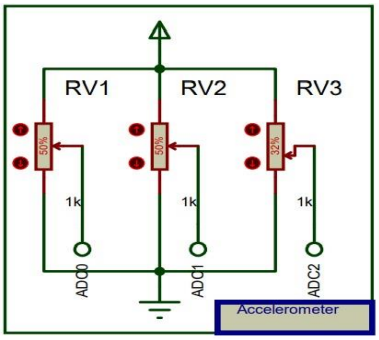

Fig. 3. Accelerometer

Accelerometer sensor inbuild circuit connections. ADXL335 is a 3-axis accelerometer sensor. The bandwidth ranges for the X AND Y-axis range from 0.5Hz to 1600Hz and the Z-axis range from 0.5Hz to 600Hz. There is an x, y, and z-axis in the accelerometer, which are connected to Raspberry pi's input pins. The accelerometer is used to calculate the G-force of the accident and indicate the microcontroller. It is connected to ADC (Analog to Digital Converter) through ADC0, ADC1, and ADC2, and then it is connected to the microcontroller.

C. GYROSCOPE:

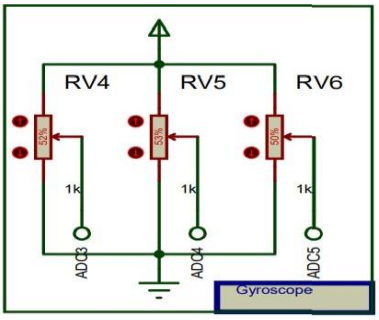

Fig. 4. Gyroscope

Fig 4 shows the Gyroscope's inbuilt circuit connections. GY-521 is a 3-axis gyroscope module, which determines the angle the vehicle is in and sends the information to the microcontroller. It is connected to the ADC through ADC3, ADC4, and ADC5 and it is connected to the microcontroller. It transfers from the highest to 400KHz of I2C or even up to 20MHz of SPI.

VI. CIRCUIT DIAGRAM

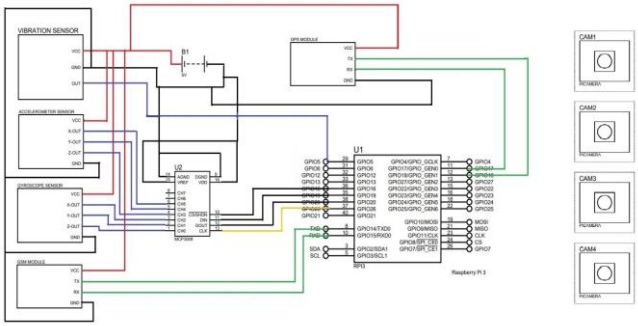

Fig. 5. Circuit diagram of the proposed system

Fig 5 shows the circuit diagram. An accelerometer is used to measure acceleration.[1] A g-force is a measure of acceleration. A g-force of 1 g is equal to the conventional value of gravitational acceleration on Earth, g, of about 9.8 m/s².

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TABLE I
Acceleration for different g forces

0 g – 4 g	No accident
4 g – 8 g	Mild accident
8 g – 12 g	Medium accident
12 g – 16 g	Severe accident

The analog voltage is converted to digital from the acceleration sensor by the formula.

$$Digital\ value = \left(\frac{Analog\ voltage}{Reference\ voltage}\right) \times 1023$$

The Digital value is the axis values x, y, z of the accelerometer.

$$Overall\ acceleration = \sqrt{(x^2 + y^2 + z^2)}$$

$$G\ force = \frac{overall\ acceleration}{9.8}\ m/s^2$$

The acceleration g force can be calculated by above formula. 801S vibration sensor can detect till 1 IPS (Inches Per Second). The potentiometer of the vibration sensor is tuned to half of the value.[16] Whenever a vehicle is driven, its maximum vibration is within 0.5 IPS. Setting the potentiometer at half the value, the vibration sensor is set at 0.5 IPS threshold. Whenever there is a trigger greater than 0.5 IPS then the vibration sensor sent the signal to the microcontroller.

VII. FLOWCHART

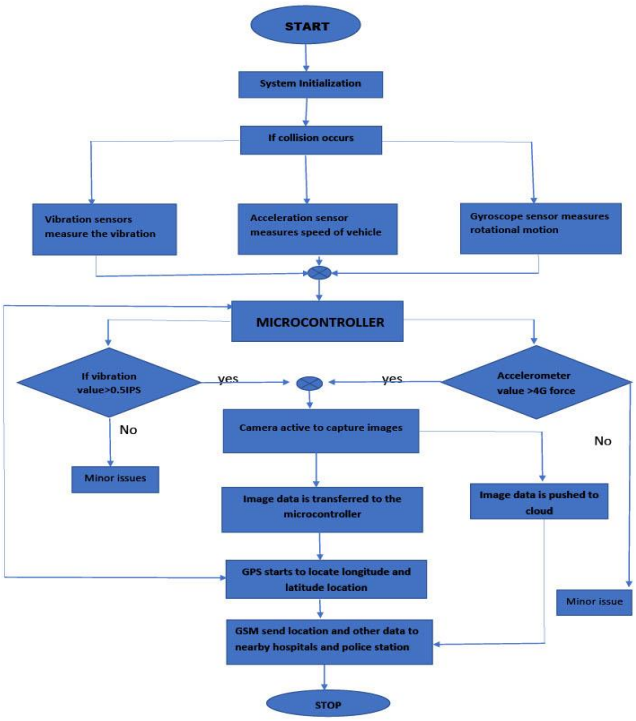

Fig. 6. Flowchart

Fig. 6 shows the flowchart of the working process of the system. At first, there should some parameters be implemented for processing the micro-controller. Then the system should initialize the values of the parameters. If any collision occurs in the vehicle, then the vibration sensor, accelerometer sensor, and gyroscopic sensor should active. Once the sensor is activated then the sensors should start to record the sudden change of values. The obtained values are then transmitted to

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the micro-controller. The micro-controller then processes the obtained value with the specified values of the individual sensors. If the vibration sensor and accelerometer sensor value are greater than the specified value, then these will tend to activate the camera. Once the camera is activated by the vibration and accelerometer sensors value by the micro-controller it starts to capture the images of the accidental zone. These images can be useful for police investigations. These images are also pushed to the cloud storage for further process. By these, the causes of the
accident can be identified. After the time when the camera has activated the location of the accidental zone is obtained with the help of a GPS. Once these parameters are obtained with help of the GSM these parameter values are shared with the nearby hospitals and police stations. After the message is triggered when the system will get back to its initial position.

ALGORITHM:
STEP1: START.
STEP2: Collison happens.
STEP3: The values are generated in all the 3 sensors.
STEP4: Values transmitted to the microcontroller.
STEP5: Compare the values of the three sensors.
STEP6: If the values are lesser than the specified value.
STEP7: Minor accident.
STEP8: If values are greater than the threshold value.
STEP9: Cameras are activated to capture images.
STEP10: Images are pushed to the cloud storage.
STEP11: GPS activates to locate the location.
STEP12: Reads the GPS values and other data.
STEP13: GSM transmits the message to a specified number.
STEP14: STOP.

VIII. SIMULATION RESULT

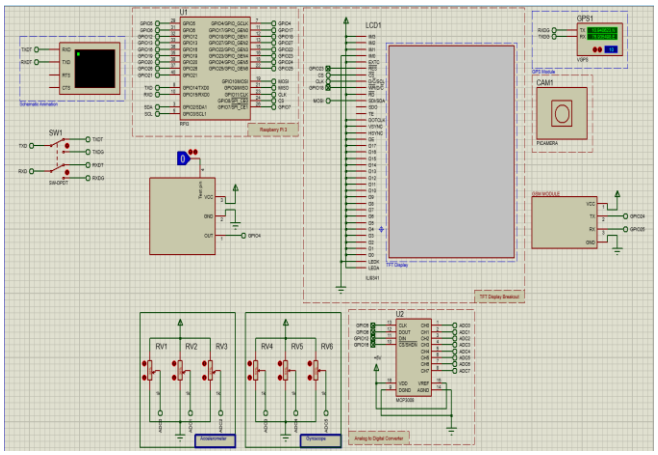

Fig. 7. Overall simulation diagram for the proposed system

The simulation consists of Raspberry Pi 3 as its microcontroller. UART (Universal Asynchronous Receiver-Transmitter) is used for serial communication. A TFT (Thin Film Transistor) display with a resolution of 320*240 is used for displaying sensor values and the image captured by the camera. The accelerometer and gyroscope are designed using 3 potentiometers for 3 axes (x, y, z). The accelerometer and gyroscope are connected to the Raspberry pi 3 using an MCP3008 analog to digital converter. The vibration sensor is designed by keeping a threshold value with a potentiometer. The GSM, GPS, and camera module are connected to the raspberry pi 3.

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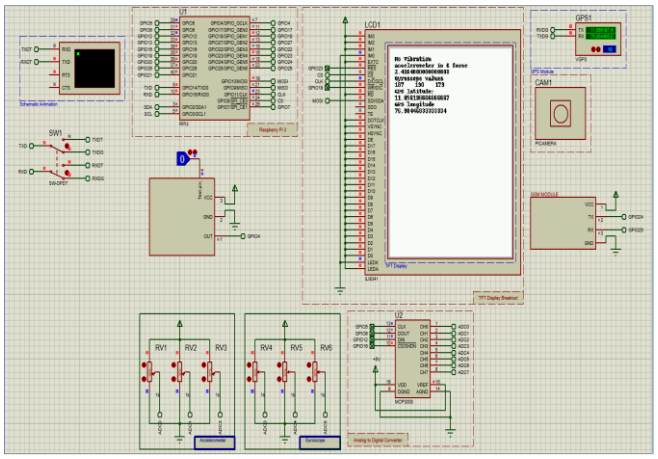

Fig. 8. Simulation circuit under normal condition

Fig 8 shows the Simulation circuit under normal conditions and the output for no impact conditions. Before the accident, all the sensor readings are monitored by Raspberry pi 3 and displayed in the TFT display. The vibration sensor and accelerometer are below their threshold values. The Vibration Sensor is less than 0.5 IPS. An accelerometer is less than 4 g force.

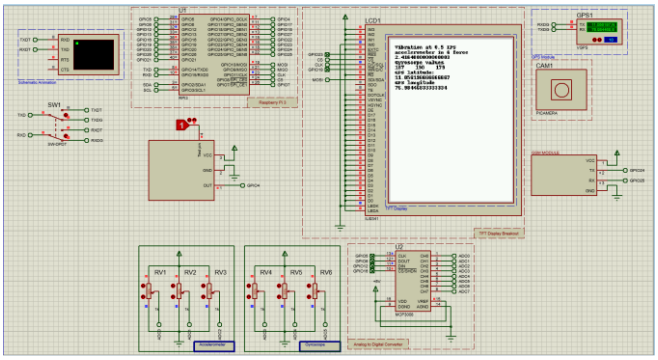

Fig. 9. Simulation circuit under mild accident

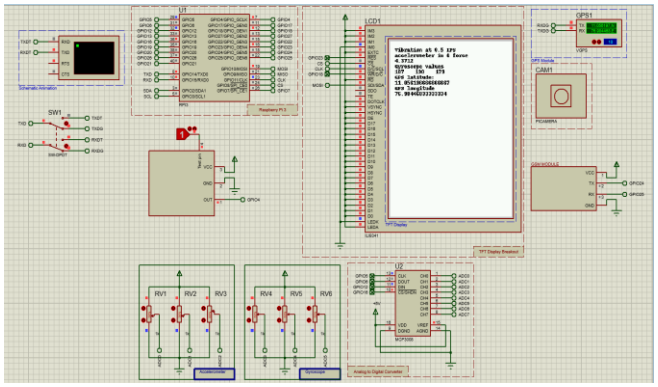

Fig. 10. Simulation circuit under severe accident system

Fig 9 shows the system output for mild accident conditions. The vibration sensor sends a logic high input to the microcontroller when there is a mild impact on the vehicle. The vibration reading is greater than 0.5 IPS displayed in the TFT display. The microcontroller compares the value of the accelerometer, if it is less than 4 g force, then the camera captures the image and uploads it to the cloud, But the message is not sent to the hospital and police station. Fig 10 shows After accident condition, in which both accelerometer and vibration sensor readings are greater than 4 g force and 0.5 IPS.

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The GPS latitude and longitude are read by the microcontroller. The GSM is made to send a message to the hospital and police station with location coordinates.

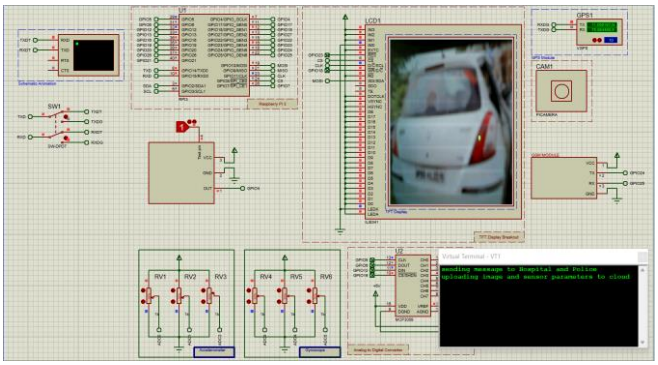

Fig. 11. Image capturing and message sending under a severe accident system

Fig 11 shows the image captured by the camera connected to the microcontroller once the accident happens. The message is sent to the hospital and police station and the vibration sensor, accelerometer, gyroscope, GPS, and image is uploaded to the cloud.

TABLE II

Result for Different Condition

Vibration sensor output	**Accelero meter**	**Camera**	**Message Indicator**	**Cloud Action**
Greater than 0.5IPS	Greater than 4 G-force	Camera captures image	Message sent to specified number	Sensor data uploaded to the cloud
Greater than 0.5IPS	Less than 4 G-force	Camera captures image	Message not sent	Sensor data uploaded to the cloud
Less than 0.5IPS	Greater than 4 G-force	Camera captures image	Message not sent	Sensor data uploaded to the cloud
Less than 0.5IPS	Less than 4 G-force	Does not capture an image	Message not sent	Sensor data not uploaded to the cloud

If the vibration sensor and accelerometer are less than their threshold values, the camera does not capture and the message is not sent and sensor data is not uploaded. If the vibration sensor and accelerometer are less than their threshold values, the camera captures the image, the message is sent, and the sensor data is uploaded. If only one senor is greater than the threshold value, then the only camera captures the image, the message is not sent and sensor data is not uploaded. The entire process of getting the data from sensors and sending messages is completed 500 milliseconds.

CONCLUSION

Before developing a real-time working system, a prototype based on a detection system would be developed and tested for various test cases and operations to examine the proper functioning of the prototype. And we have tested the various test cases by using PROTEUS software. The various results were also updated in the above Simulation Results. By lowering the time, it takes for an ambulance to arrive, this proposed solution can avert numerous accidents and save many lives. It

can also be used in future technologies to ensure that every car is completely safe. Everything that man has created contributes to the universe's stability and environmental friendliness. This proposed technology can guarantee safety at whatever cost, allowing individuals to drive without worry. The use of suitable sensors and integrated circuits and a microcontroller and GPRS/GSM module can ensure human safety and security. This system can function flawlessly, and any future implementation and modification that is required for the next generation can be accomplished with some future study. The proposed system is a low-cost efficient, extreme performance, and highly effective and ensures the system's proper operation

FUTURE SCOPE

This prototype can pinpoint the exact location of an accident and send the information to hospitals and police stations. The use of a camera mounted on the vehicle's exterior layers can capture and record photographs of the accident, allowing the causes of the event to be determined. This system can be further customized to meet future requirements. This system can also be developed without external error by utilizing numerous updated sensors already available on the market. The MAX30100 PULSE SENSOR can be used to detect the victim's pulses, which will aid in the diagnostic process in hospitals. This system can also use breath-detecting sensors like the PIEZORESISTIVE breathing system. The system can also be enhanced by using these sensors. Ambulance navigators can also be included in this system, which will be valuable for ambulance drivers in determining the quickest route. Alcohol sensors MQ135 can be used in this system for patient diagnostic purposes, as they are already used in the car vehicle industry. When a vehicle uses a gas-based fuel system, gas leakage can be detected with MQ-6 gas sensors. As a result, using these sensors to make this system work effectively without any flaws will be beneficial to future generations and society.

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