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SMART CITY VEHICLE ACCIDENT MONITORING AND DETECTION SYSTEM USING IOT

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Abstract

With the rapid increment in the population, roadways have been extremely affected by a lot of accidents, and many people lose their life due to that accident. It is a very concerning topic that needs to be covered for reducing accidents. This article is about the solution to reduce road accidents. In this article, smart city vehicle accident monitoring and detection systems will be discussed. MEMS (Micro electro mechanical system) sensor has been used to detect the accidents and send the information to the server's and GPS have been used in the development of smart city vehicle monitoring and decision systems. The immediate location of the victim is traced by using a GPS modem. The alert message is sent through the Arduino mega controller. The article will focus on detecting gas present inside the vehicles and the heartbeat of the victim measured through the sensor used.

Key Words: MEMS, GPS, GSM, Arduino, and smart city, IoT, Raspberry Pi 4

Introduction

IoT is the future of the upcoming technology that is used for developing smart city vehicle accident monitoring and detection systems. IoT is the network of the physical devices used for exchanging the message without human involvement. Physical devices provided an IP address for data transmission through the embedded system such as the sensor and the Arduino software.

This article is about design an automated system that reduces the time gap between the accident and deployment of the medical response. The combination of the emergency medical services system with the accident can be useful for the designing of the system. In the article, piezoelectric sensors and accelerometers have been used to trigger the microcontroller. GSM and GPS module is for providing database. Microcontroller is used by the solution to detect the accidents, all the operations such as detecting and reporting are controlled through the microcontroller. The system mainly focuses on the accident by minimizing the action time after the accidents occurred. Due to the reliance on a single sensor, there are high probability chances of generating wrong output. A vibration sensor was issued for detecting the accident. In this system, accident location is not shared only an accident alert is provided.

All the relevant information regarding health, emergency contact number as well as hospital details through the initial registration are stored in the android app.

In this article. A non-intrusive and real-time system is designed in this paper. In the existing research, the input used for the system is taken as subjective measurements. In this article, the eye closure ratio has been used as an input parameter to detect the drowsiness of the driver. With the help of the buzzer, the driver is altered in the case when the eye closure ratio deteriorates from the standard ratio.

The rest of the paper is organized as follows. Section 2 discusses background and related works. Section 3 presents the overview of the Accident Detection and Monitoring System. Section 4 discusses tests cases to check the viability and working of the system. Section 5 presents result and discussions. Finally, Section 6 concludes the paper.

Background and Literature review

2.1Background

In the article, piezoelectric sensors and accelerometers have been used to trigger the microcontroller. GSM and GPS module is for providing database.

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In this system, the accident is observed and inform by the rescue team. GSM technology is used to transmit the alert message to the emergency services. The vehicles are continuously tracked by the system through GSM technology. Renesas microcontroller is used in conjunction with the DPS receiver and GSM modem [1]. For communication purposes, the alert message is sent that contains the location that is provided by GPS. The piezoelectric sensor consists of the GPS module. Piezoelectric sensors are the main module of this system. The location of the accidents is tracked by the system. The drawback of the system is the RF module used has limited range. Only one sensor is used in this system that has a single point of failure.

In this system, an android application for the detection of accidents is presented. By the means of the external pressure sensor, the outward force experienced by the vehicles is measured. The data from the sensor is received by Bluetooth on the phone. The speed of the vehicles decreases in the case of an accident [10].

GPS is known as the Global Positional System that is made up of a network of the various satellite. The information from the satellite in the term of coordinate or position such as longitudinal and latitude is received by the GPS. The coordinates can be a plot by using the appropriate software. In today's time, most of the GPS modules are used by vehicles including buses, cars, bikes, and trucks, etc. A-GPS or Assisted GPS technology is used by smartphones that use the base station or towers that provide the tracking capability of the device. In the case of no network, A-GPS will not work. For using the A-GPS the device must be in the area network range. GPS modules provide coordinates or the position of the system. GPS module is connected with the satellite instead of the network area [9]. The GPS location can be retrieved through the GPS module and provide timely information in all the weather conditions. An unobstructed line of sight is provided by the GPS reception. In the case of poor signal conditions, multipath propagation is provided. Tree canopy or inside a structure provide obstructed lines of sight.

IoT (Internet of Devices) can be defined as the network of the physical devices, buildings, vehicles that are embedded with software, electronics, actuators, network connectivity, and sensors that allow the object to collect the data and exchange. The Internet of Things enables things to be sensed and controlled remotely using existing network infrastructure, allowing for more direct integration of the physical world into computer systems [14]. When the Internet of Things is enhanced with sensors and actuators, it is classified as a cyber-physical system, which includes smart grids, smart homes, intelligent transportation, and smart cities. Each item has its own unique identity thanks to its embedded computing system, yet it can still communicate with other things on the Internet. According to experts, by 2020, the Internet of Things will have about 50 billion objects. The Internet of Things (IoT) will become a vital aspect of human life, having a significant impact on us. It will also become one of our sustenance requirements such as Internet, telephone, water, electricity.

The impact of the Internet of Things will be comparable to that of the Internet at the time. The Internet, on the other hand, connected individual computers that could be in different locations, whereas the Internet of Things (IoT) will connect everyday devices that will have a significant impact on the physical world [12]. In the Internet of Things, data management is critical. Data management is essential for the Internet of Things. Machine-to-Machine (M2M) computing, one of the underlying technologies for the Internet of Things, represents a long-term opportunity for wireless communications chip makers. This technology can be used in a variety of ways. While there is general agreement that M2M is a promising growth area, analyst estimates on the size of the market differ by a factor of four. According to conservative forecasts, 80 million to 90 million M2M devices will be sold in 2014, while more optimistic projections predict 300 million units will be sold. Based on past adoption trends for similar disruptive technologies like portable MP3 players and antilock braking systems for automobiles, over the next five years, unit sales in M2M are expected to increase by a factor of 10. Within the IoT environment, "data management" is complicated by several technologies and circumstances [11].

Data Collection and Analysis, Big Data, Semantic Sensor Networking, Virtual Sensors, and Complex Event Processing are some of the most important concepts that help us comprehend the problems and prospects of data management.

2.2Conventional accident detection techniques using VANET

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It has been found that vehicle failure is the major reason for traffic congestion. Based on VANET (Vehicular Ad-Hoc Network), the proposed system worked. Every vehicle is considered a node. Using the RF module, alert messages are transmitted and these alert messages are received through the moving vehicles. The message is received by the network area of the vehicle and then transmitted to the base station. Four types of messages are contained in the alert message [4]. Piezoelectric sensors are sued for detecting the signal. MEMS sensor, sensor, sensor flame, and temperature sensor are using in the system. Vehicular mishaps are identified in the system take less time and the rescue team is alert through the system along with the location. In the system, a switch is added that helps the driver to stop sending alert messages in the case of minimum seriousness. From the sensor, input is provided to the controller and sends the accident to the controller. This information regarding the accident is sent to the rescue team.

The location of the vehicle is identified through GPS and WIFI. In the existing research, communication in no network has not been described through the GSM module. In the network and no network, coverage is provided [2]. The switch is provided to stop the sending of the message in the case of no injury. Security and privacy issues are present in the VABET are addressed in the future. The high dynamic topology present in the VANET due to which routing issues arises. For the VANET various survey of different congestion-controlled techniques have been present. Proactive, reactive, and hybrid congestion control strategies are the different approaches used in VANET. Latency and throughput are the two important parameters used for addressing traffic congestion. The six major categories of techniques are categorized that include power-based, rate-based, and hybrid strategies. Proactive techniques are best to solve the congestion problem in VANET [3].

Proposed model

3.1System Architecture

In figure 1, the overview of the Accident Detection and Monitoring System has been shown. The detection and monitoring of the accident become easy through this system. MEMS and vibration sensor has been used for detecting the accident. A signal is sent to the microcontroller by the MEMS in the case when the car has been rolled over. GSM and GPS have been used to send the signal to the server. SMS to the police station or the nearest rescue team is sent by the GSM and GPS involved in the system. It will help to detect the place of the accident as well as the level of oxygen in the car. It will help to detect the present status inside the car. Web Page is used for monitoring the information through the web pages future notifications can be sent. Central severe is used for monitoring and detecting the details of the car [6].

The system design is based on the heartbeat sensor through which the sensor can easily detect the heartbeat that sends the notification to the rescue system. The range of the heartbeat can be measured to the heartbeat system that helps the rescue system. The distance between the vehicles is measured through the ultrasonic sensor. It helps in automatically reducing the speed of the vehicles. Oxygen content inside the car is measured through the gas sensor. In the web pages, the level of oxygen is updated. In the case of small accidents when there is no effect inside the car information regarding the accident is not sent using the switch.

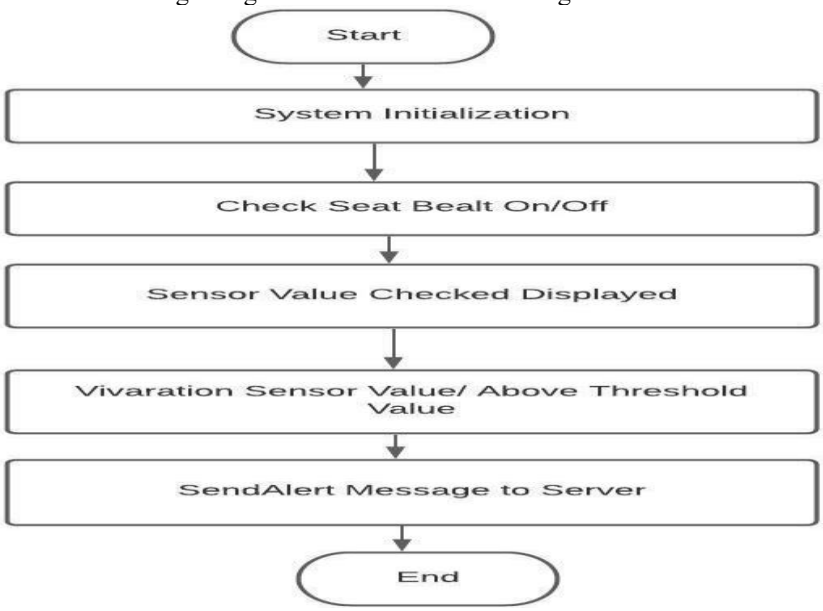

Figure 1: Schematic Flow Chart

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3.2System Components

The architecture diagram and proposed block diagram is shown in Figure 2 and 3 respectively. This system uses the following components:

Arduino Mega: Microcontroller of Arduino mega is based on the ATmega1280 (datasheet) [7]. In the Arduino mega, 54 input-output pins have been used. 15 pins have been used as analog inputs and 14 pins have been used for PWM outputs. Crystal oscillator of 16 MHZ and hardware serial port of 4UART has been used. It acts as a supporter of the microcontroller. By using AC to DC adapter it connects the computer with the USB cable.

GSM Module: GSM module is known as Global System for Mobile Communication. GSM is developed by the European Telecommunication Standards Institute (ETSI). Protocols for the second-generation (2g) digital cellular networks are described by ETSI. Mobile phones used the networks for transmitting the data [6].

Heartbeat sensor: In the heartbeat sensor super bright red LED and the light detector is used. LED used in the heartbeat sensor is super bright so the maximum light can be passed through the finger and the detector can easily detect. The detector can detect when the pulse of blood is pumped through the heart in the blood vessels. There is a variation in the detector signal with each heat pulse. This variation is transferred in the electrical pulse. The amplifier is used as a trigger for amplifying the signal. The output of the pulse is indicated by the blinking of the LED.

GPS module: GPS nodule known as Global Positioning System is made up of 24 satellites. It is a satellite-based navigation system. It works in weather conditions. GPS module requires no subscription fees or setup charges.
Gas sensor: The concentration of gas is measured through the Gas sensor in its vicinity. To measure the concentration of the gas sensor interacts. The breakdown Voltage of each gas is unique. By measuring the voltages gases are identified by the sensors. Measurement of the current discharge can be determined through the concentration of the gas [15].

GSM: GSM stands for Global System for Mobile Communication, which is a digital mobile phone system that is widely used throughout the world. GSM, the most extensively utilized of the three digital technologies TDMA, GSM, and CDMA, is based on a version of TDMA. GSM compresses and converts data before sending it together with two other streams of user data over a channel [13]. The communication is received by GSM, which is active and sends an alert message. It's linked to a Raspberry Pi controller. It allows you to send out TEXT-based messages.

Server: The accident is measured by the server and the lives of the people get saved by the system. Cost is reduced in this system. To the rescue team, the message is sent. The position where the accidents have been taken is shown through the designed system. The graphical view of the webpage is shown through the server.

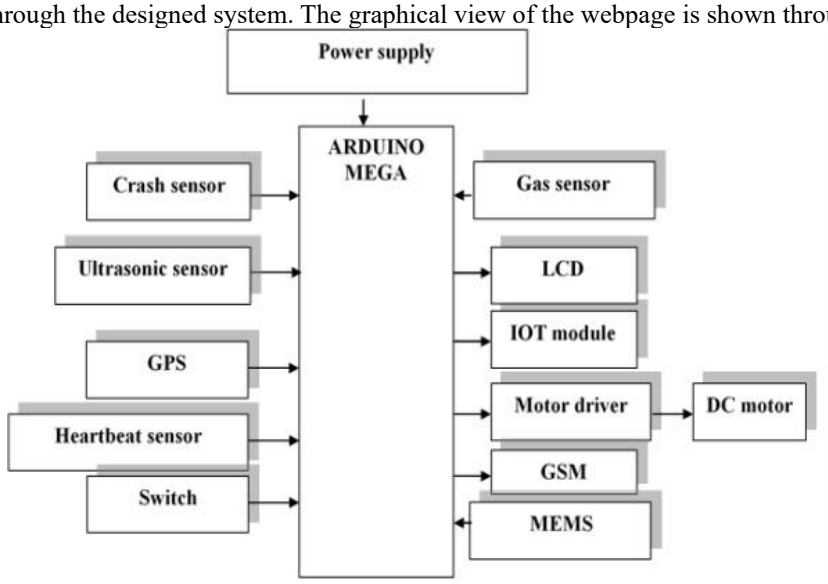

Figure 2: Architecture diagram

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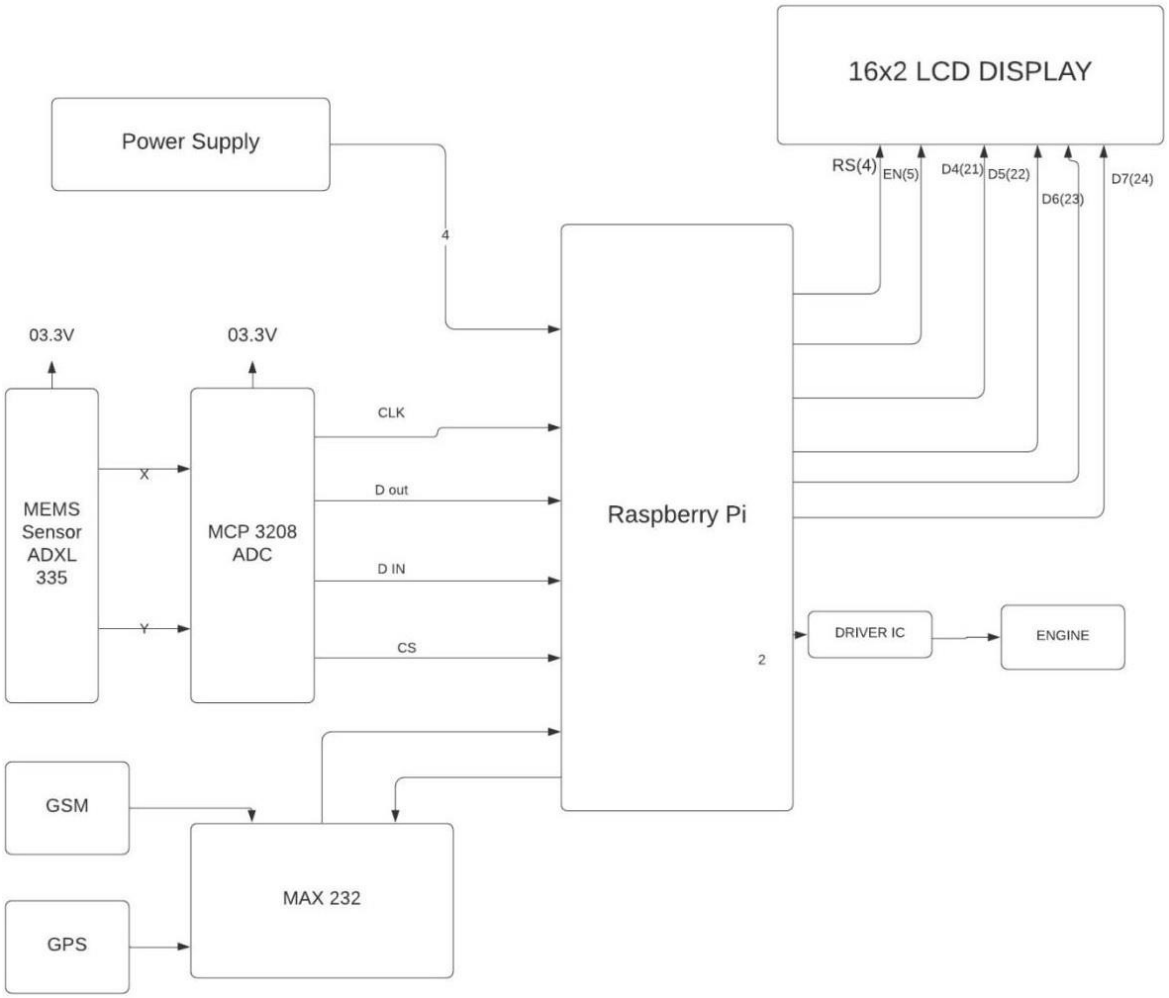

Figure 3: Proposed Block Diagram

Test Cases

We can run a few test scenarios to see if the system is functioning properly. If the system passes all of the test cases, we may be confident that it meets the criteria.

4.1Working

The following tests can be used to see if various system components are working:
Test case 1: GSM module: The led light on the sensor does not glow when the GSM sensor is in a natural or acceptable position. The led light glows when it has been titled to the position that is unnatural or unacceptable. It helps to check whether the GSM module is working properly or not.

Test case 2: GPS module: The latitude and longitude values to the position of the current status are given by the GPS module. By observing the values of the latitudinal and longitudinal position the working of the system can be observed. The case when the value is displayed as 0.0 for latitude and longitude shows the GPS is not working correctly [20].

Test case 3: Raspberry Pi: It is a mini-computer. The cost of the implementation of the Raspberry Pi is low as compare to its other module. It includes a camera port.

Test case 4: MQTT APP: The detection of the changes in the angle of inclination the notification is sent to the MQTT app. In this case, when the values cannot be viewed shows the MQTT protocol is not working properly. The case when the values are properly displayed shows that the system is properly connected to the server.

4.2System design

In this system GSM, GPS, and Raspberry Pi has been used for detecting the alert. The occurrence of the accident is sensed through the piezoelectric sensor. And then the output is transferred to the microcontroller. The latitude and longitude position of the vehicles is detected by the GPS. GSM is used for transferring the latitude and longitude position of the vehicles. EPROM is used to save the static IP address of central emergency dispatch. Server [16]. The position is detected whenever the accident has occurred and to the pre-saved static message has been sent. Raspberry Pi has been used for better traffic management. Gas sensor, shock sensor, and temperature sensors are the sensors that are used by the raspberry pi controller used by the vehicles. At a predetermined value these sensors are fixed before the accidents. The value of the one sensor gets changed when the accidents occur and through the GSM message is transferred to the predefined number. The location of the message is also sent through the GPS module that interferes through the Raspberry Pi controller [15].

A clear route is provided to the ambulance when receiving the message. ARM controller is found in the ambulance that interferes with the RFID signals that use electromagnetic waves. The electromagnetic waves of the tag are detected by the RFID reader when the ambulance reaches the traffic signal. In the case of a red traffic signal, the driver goes to the database in the fraction and changes the red signal into the green. And RFID technology automatically in that condition turns the opposite signal red. This provides a clear and safe route to the ambulance. Arduino is used for describing the methods for collision detection and remote alarm devices. Through sending the information regarding the longitudinal and latitudinal position, angle for monitoring the stations and provide and provide user mobile that helps to provide basic medical facilities and provide real- time vehicle monitoring system. MEMS and vibration sensors detect the signal in the case of an accident [19].

It allows the users to access the real-time position of the vehicle in real-time. MEMS and vibration sensor sends the signals after detecting the accident to the microcontroller. With the help of GPS, accident location is traced, and by using GSM message is send to the authorized members. By using the GPS, FPGA-based vehicle tracking and accident warning systems are used. The position of the vehicles is tracked by FPGA and an automated message is sent to the pre-programmed number. All the parts of the system are controlled and coordinated through an FPGA. This device allows the information regarding the vehicle owner, ambulance to save people as well as police to clear traffic. The exact position of the vehicle is detected with the help of an accelerometer sensor [18].

The positioning of the vehicle either it is normal side or upside down is predicted through this system. The system requires a single sensor that lowers the cost of installation as well as reduces the initial investment cost. These systems are easy to maintain. The parts used in the system are easy to maintain as well as can be easily replaceable. The proposed system uses MIM S sensors to send the signals to the IoT devices that include the Wi-Fi module. The location of the vehicle is tracked by the GPS module. It also provides latitude and longitudinal data about the location of the accident. By using the MQTT protocol the data is sent to the cloud. By the control groups or the hospitals, MQTT protocol can be accessed that helps the people to respond to the situation in the minimum time that reduces the number of accidents and damages [16].

Result and Discussion

The development environment is simply a collection of python functions that can be used to generate code. The figure is a flowchart for the system. We must first establish the system, which includes the Raspberry Pi module, GSM module, and GPS module, with the default defaults of no alcohol detection and no seat belt use. There is no speed. When the system is turned on, GPS receives the signal from the satellite and sends the latitude and longitude values to the receiver.

The communication is received by GSM, which then begins the process of sending the message to emergency server numbers [25]. If an accident occurs while traveling, the vibration sensor detects it and alerts the system, which then sends an alarm message to the local ambulance, police station, and insurance office numbers provided in the software. If the value exceeds the threshold, an alarm message is sent. As a result, the GPS sends information about the automobile, such as its location, time, and whether or not the passengers are wearing seat belts, to the users or the server using GSM [27].

After completing the test cases and making sure all the system components are fully functioning, we can start using the system. The following observations are made after the system is implemented: The led light on the tilt sensor begins to glow when the system is in an abnormal position, indicating that the tilt sensor is in the position when an accident occurs. The GSMsensor measures changes in the object's g-forces. The status of the object's collision or crash is indicated by a change in g-forces [26]. Accelerometers are utilized in a variety of systems, including advanced braking, passive restraint, and electronically controlled suspension systems, to measure

vehicle body movement. The body of the car is measured using accelerometers. In an automobile application, the tilt sensor has higher sensitivity and stability. For a vehicle accident detection system, the tilt sensor module is critical. It functions as an automatic ECS (Emergency Calling System), sensing changes in the system's g-forces. Table 1 shows the actual g-force thresholds used to detect accidents [24].

Table 1: Thresholds g-forces for accident detection

Accident harshness	Actual Maximum G Range representation
No Accident	0-4 g
Mild accident	4-20 g
Medium accident	20-40g
Severe Accident	More than 40g

Changes in the vehicle's attitude will result in normal accelerations due to the impact of the earth's gravitational forces [23]. The GSM sensor's sensitivity is evaluated in g-forces, which are measured at the time of a crash. The existence of vibration in the vehicle at the time of the impact can be used to detect the accident, and the sensitivity threshold value can be determined. Table 2 shows the g-forces experienced by cars during an accident.

Table 2: Vehicle G-forces during a crash

S.no	G- forces	Severity ofAccident	GSM sensor	Message Activated
1.	4g	No accident	Sensor off	No
2.	10g	Mild accident	Sensor off	No
.3.	14g	Mild accident	Sensor off	No
4.	40g	Major accident	Sensor Glow	App MessageActivated Location is given
5.	60g	Major accident	Sensor Glow	App messageActivated location is given
6.	70g	Major accident	Sensor Glow	App messageactivated, location is given
7.	73g	Major accident	Sensor Glow	App messageactivated, location is given

The location of the accident is communicated, and Google Map integration is an added benefit in the proposed system that does not exist in the prior systems presented are demonstrates two variables in the MQTT Application, one of which displays a notification of whether or not an accident has occurred. When the tilt sensor is tilted beyond the defined threshold, the message "ACCIDENT OCCURRED" appears on the screen [22]. When the tilt sensor is in its natural position, as shown in Figure, the message “NO ACCIDENT” appears on the screen.

Conclusion

It has been concluded that design has been providing through the system that provides more advantages in low cost, small size, and portability ease. An accelerometer sensor is used in this system. The number of accidents is reduced through the GSM and GPS. A lot of problems can be solved through the automated system for the detection and the accident location. Time for searching the location and providing immediate treatment to the people. The main purpose of the articles was to solve the issues of the accident and save the lives of the people. The article tries to solve the chances of casualties in the accidents. The devices designed help to detect the place especially the accidents that occur at night time. The designed system will help in reducing the number of accidents in their daily lives. Accidents can easily be detected by the buzzer. In the case of accidents, neighboring places are alerts through the buzzer. Any hard impact on it is detected through a buzzer. On the side

of the vehicle, sensors are fixed to detect the impact on it. By using the application, it can be implemented in the future [21].

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