AUTOMOBILE ACCIDENT ALERT SYSTEM USING INTERNET OF THINGS AND GLOBAL SYSTEM FOR MOBILE COMMUNICATION

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ABSTRACT

In a country like Nigeria that is highly populated and a place where the transport system is predominantly road-driven, accident cannot be completely avoided and as such, prompt rescue measures are of paramount to reduce the number of deaths during accident. Immediate attention to accident victims will go a very long way to ensure their survival. Heavy dependence on the road for transportation, coupled with other factors arising from environment, human beings and machines are responsible for most road accidents, which often result to huge loss of lives and properties. Hence, our paper proposes an automobile accident alert system that uses impact sensors which collaborates with proximity sensors to automatically detect an accident. Such accident is reported to the concerned agency with the help of Internet of things (IoTs) and Global System for Mobile communication (GSM). With IoTs, various objects across the globe can be connected to the internet for effective communication. Through GSM, automobile crash message containing the latitude and longitude location information obtained from Global Position System (GPS) can be sent to emergency services. RF module was also incorporated to the proposed system to report accident to other close vehicles for safety measures to be taken. The proposed system was simulated and implemented. It is capable of timely detection and reporting of accident to rescue agency. Both simulation and experimental methodologies were used in our proposed work. The proposed system will be beneficiary to individuals, governments and any organizations that make use of vehicles.

Keywords: *Automobile, Accident alert system, Sensors, IoTs/GSM and GPS.*

I. INTRODUCTION

The tremendous progress made in technological advancement has to large extent alleviated our suffering and at the same time constitute problem to man and his environment. For instance, the invention of automobiles has made transportation easy and possible for man but when these automobiles are involved in accident, human lives and properties are wasted. Accident is a mishap or an unforeseen event that often results to loss of lives and properties. Accident is categorized as minor, serious and fatal based on the severity of the accident. This accident can occur as a result of human, environmental and mechanical factors. Majority of accidents that occur on our roads are as a result of driver's carelessness, poor road condition, poor condition of vehicles, and weather

condition etc. Accident is said to be fatal, when death is recorded, serious when only serious injuries were sustained and minor when there is no serious injuries.

In Nigeria, the threats of road traffic crashes on the citizen's general health have continued unabated, far above the scourge of HIV/AIDS, malaria, child related ailments and tuberculoses. As proof, more than 4000 people plus an estimate of US$8b got lost because of accident only in 2012 [1]. The result of an analyzed record of 98,494 accident cases that occurred within the period of seven years (between 2000 and 2006), indicates that 28,366 cases were fatal and 47,092 people died [2]. Also, the road traffic accident statistics in Nigeria between the year 1990 and 2012 shows that total of 337,301 accidents occurred, where 96,563 cases were fatal, 150,613 were serious and 90,125 were minor. In these accident cases, 153,853 people died and 454,423 people were heavily injured [3]. Also, Nigeria Watch database shows that between June 2006 and May 2014, a total of 15,090 individuals lost their lives as a result of terrible accidents in 3,075 occurrences [4]. Current statistics indicate that Nigeria is one of the leading countries in the world that records the highest number of road accidents [1]. Road accidents in Nigeria are among the major causes of deaths, trauma and disability [5].

Efforts made in handling accident safety related challenges in Nigeria can be summarized as follows [3]:
1)   In 1913, the first law on transportation known as the Highway Motor Traffic Ordinance was promulgated. The primary objective of this law is to drastically minimize vehicle accident occurrences in the southern protectorate.
2)   In 1916, there was a nation-wide ordinance after the amalgamation of the Northern and Southern regions in 1914.
3)   Consequently, in 1940 and 1945, there was also a revision adaptation of the nation-wide law along the UK Road Traffic Act of 1930.
4)   Law of Carriage, Road Traffic Act and Federal Highway Act were among follow up legislations.
5)   The 2007 amendment of Federal Road Safety Commission Decree of 1988.
6)   Also in the recent time, the institutionalization of Nigeria Road Traffic Strategy whose goal is to reduce road traffic crashes to 35% by 2020[1].

Road accident incidents are still on the rise despite several reviews on the transportation laws,

series of efforts and multiplication of agencies even at state level.

Therefore, because of the socio-economic implication of road traffic crashes to both road users and the nation, concern on the solution to automobile accident on our roads is of very great significant. After a road crash, prompt medical attention, has proven to reduce the morbidity and mortality among the victims [5]. In a case of mishap on the road, immediate assistance to accident victims will ameliorate the effects of such accident on them [5]. According to [6], the research conducted in 2011 shows that out of 500,000 people that died as a result traffic crashes, 150,000 passengers died due to lack of timely assistance. There are two major steps involve in having a significant reduction of assistance time to the victims. The first step is to ensure fast detecting, accurate accident location and reporting it to nearest rescue agency. Secondly, there should be quick and proper ejection of traffic accident casualties.

Nigeria Road Safety Strategy identified lack of standard road accident reporting template and situation where there is no lead agencies for traffic supervision in certain states as gaps in Nigeria road safety management and therefore, recommended development of standard template to capture and report road traffic crashes and other important traffic information as one of those required strategic activities [1].

In an effort to improve the reporting of accident channeled mostly via informal and unstructured media, road safety has provided a toll-free number (122) for reporting accidents that take place on our roads. When accident occurs, a call is routed to call centre of the Federal Road Safety Commission, overseen by the staff of the commission on a 24/7 basis. When a call is received, effort is made to locate any patrol team nearest to the scene of the accident through automobile tracking suite [1].

The above means of reporting accident in Nigeria today is not yet automated and may lead to delay in reporting or even not reporting the accident, thereby increasing the response time of the rescue agency. Increased response time will perhaps increase the number of deaths. It is in line with this that the researcher proposed an automated means of reporting road traffic crashes using Internet of Things (IoTs) and Global System for Mobile communication (GSM).

In the course of literature review, the authors discovered that other researchers have done reasonable work to bring solution to this problem using different approaches. Such approaches include but not limited to use of accelerometer,

vibration sensor, web-based solution, programmed GPS/GSM module with crash detector etc.

In this research work, an Automobile Accident Alert System is proposed for detection and prompt reporting of accident to the rescue organ of government for adequate and immediate response. The proposed system incorporates sensors for accident detection, GPS for location tracking, Wi-Fi module for transmission of information to the server. GSM is used for effective reporting of the accident information to the designated phone number of the rescue agencies and RF module for informing other vehicles within communication range about the accident. This system is capable of automatic detection of minor, serious and fatal accident based on the predetermined degree of impact (threshold) and thereafter, provides timely reporting of the accident via GSM network area. It equally has the ability of bringing accident notice to other automobile that are within its communication range via the transmitter. When accident occurs, close vehicles are alerted and text message will be sent to a predefined GSM number of an emergency services. The nature of accident will determine the action to be taken by the concerned agency. When the accident is minor, the report of the accident will only be noted and recorded but in the case of serious or fatal, the report will be recorded and the agency will equally mobilize for rescue operation. The faster the accident information gets to the rescue agencies; the more accident victims are recued. With these measures, there will be reduction in number lives and amount property lost as a result of road traffic crashes. There will be Proteus simulation of the system and development of system prototype. The outcome of this research will be of benefit to individuals, government and non-governmental organizations in the country.

2.   REVIEW OF RELATED WORK

Review of related work on accident reporting was done in this section. It was discovered that tangible and meaningful efforts have been made in the past to improve accident reporting system. In this research work, the interest is to develop an automobile accident Alert System using IoTs and GSM.

2.1   Review of Literature on Accident Reporting System

The Authors in [6] proposed an Emergency Services and Accident Detection system that is based on VANET. This system uses RF module to transmit the message which is received by the moving vehicle having this system within the range of RF module. It will continue to send the message to the next moving vehicle until the vehicle in network area receives this message. The message is transmitted through GSM to the service centre as soon as the message gets to a vehicle in network area. This system may not be able to guarantee the delivery of message because VANET does not work well under certain environmental conditions such rain. Another drawback in this system is delay in response time.

In [7], a Vehicle Accident Alert and Locator [VAAL] was proposed. In this paper, a GPS/GSM module was programmed by the author to automatically report accident to the closest agency via GSM Communication platform (using SMS messaging). This system may give false alarm since it uses only one sensor to detect when accident occurred.

Web-based Accident Reporting and Tracking System (ARTSYS) Using Sensor Technology was proposed in [8]. This is a multiplatform system incorporating a simulated sensor program (designed using VB) with a GPS/GSM Modem, and a web application. It has modules such as the tracker and the reporter. The module for tracking was built using simulated sensor to sense accidents occurrence and GPS for tracking the accident location. The reporting module uses GPRS/GSM modem to report accident incidents to the concerned agencies. This system requires internet for it to be successful which is not available in all places.

Authors in [9] proposed a Sensor Based Accident Detection and Prevention Technology. This system employs multiple sensors for accident prevention and detection. In the prevention system, alcohol sensor and ultrasonic sensor are used to sense the alcohol content in the breath of the driver and to detect when a vehicle is much closer to an object or another vehicle respectively. If the driver is drunk, the vehicle is lock automatically so that the driver cannot even start the car. Also, the car automatically slows down the speed of the vehicle using the automatic speed controller fixed to the vehicle engine. In the detection system, the ultrasonic sensor, vibration sensor and glass break sensor are used to detect head displacement of the driver, collision of vehicle and glass breakage respectively. The outputs of the sensors are given as input to the microcontroller which processes the output and initiates the GSM to send emergency message to the rescue team if accident is detected.

In [10], a Wireless based System for Vehicle Accident Detection and Reporting Using Accelerometer and GPS was proposed. Their proposed system uses accelerometer, GPS and GSM for accident detection and reporting. In their system, detection of accident is actualized using accelerometer sensor while GPS gives the real position of vehicle. When accident occurs, an automated message is sent by the system to the preprogrammed number of the emergency service team via GSM.

Authors in [11] proposed a system that comprises of Smartphone, heartbeat sensor, accelerometer, Bluetooth and an Android application for detection and reporting of accident. With the aid of attached accelerometer in the vehicle the tilt of the vehicle is detected and a heartbeat sensor placed on the user's body measures the severity of the accident. Bluetooth technology that connects Smartphone to the accelerometer and heartbeat sensor is used to send accident information to the Smartphone. The Android application in the Smartphone will forward alert message to the nearest hospital.

A prototype system the uses control unit (CU) for detecting accident and onboard unit (OBU) for reporting accident location to the rescue agent was proposed in [12]. An Android based application is developed for the prototype and the system depends on the microcontroller for accident sensing. Bluetooth technology removes the need for physical wiring and TCP/IP establishes connection between the server and the Smartphone.

2.2   Author's Contribution

Researchers' findings from the above reviewed literature show that Internet of Things technique has not been fully utilized in this area. Secondly, detection of vehicle's collision with objects or another vehicle is based on one sensor which may often result to false reporting of accident. Thirdly, there was no means of informing nearby vehicles that accident has taken place so that the driver can take another route or slow down to avoid running into the accident point. To address these issues, Wi-Fi module was incorporated into our system to provide internet connectivity and onward transmission of accident information to the server. In addition, two useful sensors for accident detection namely, vibration sensor and proximity sensor were systematically combined in this proposed system to minimize chances of false alarm. Also, RF transmitter and receiver were incorporated into the system to provide the means

of alerting other vehicles that are close to the scene of the accident in order to avoid additional havoc. Furthermore, the present status and efforts made towards accident control and rescue measures as it concerns Nigeria were examined.

3.   METHODOLOGY

In this research, Experimental and Simulation methodologies was used for system implementation and simulation respectively. In the implementation of accident report system via IoTs and GSM, it was first simulated using Proteus software and later, the prototype was experimentally built.

3.1   System Design

The Introduction of a system that has the ability to reduce loss of life due to accidents through timely reporting of accident is a step in the right direction. To improve on the existing system we proposed a system that detects accident automatically and makes a timely report of the accident to the concerned agency through IoTs and GSM.

In this project, our system comprised of GPS module, Wi-Fi module, GSM module, vibration sensors, proximity sensors, microcontroller and power supply unit. In this method, these components or devices mentioned above will be properly interfaced with Ardiuno microcontroller unit programmed for this purpose and serves as the coordinating device. NEO.6M GPS module tracks and monitors the vehicle and pinpoints the location of the vehicle using space satellite. It receives its position data from the satellite, decode the signal and transmit it through it pin outs to the microcontroller that it is connected to. This position information corresponds to the real time position of the vehicle that is housing the proposed system. The system is capable of detecting and reporting three categories of accident namely minor, serious and fatal accident. When the vehicle is involved in an accident, SW18010p vibration sensor detects the degree of vibration that occurred on the automobile and transmitted the signal to the microcontroller. Microcontroller triggers HC-SR04P proximity sensor to ascertain if the vehicle was actually obstructed by an object. Based on the outcome from the proximity sensor, the microcontroller will use threshold of accident impact to determine the type of accident that occurred. Thereafter, it (microcontroller) will get the position information from the GPS and send report to concerned agency via SIM 900 GSM shield specifying accident

location and type of accident (minor, serious or fatal) that occurred. The Wi-Fi module is equally activated to transmit accident information to the server. Proximity sensors and vibration sensors are used to detect a real accident occurrence to avoid the possibilities of false alerts. There is an in-built 12v battery to take care of the energy requirement of entire system. Through this method, sending of information to the concerned agency on time is made possible so that valuable human lives could be saved. The components of the system were arranged as shown in figure1below and the proteus design is shown in figure 3.
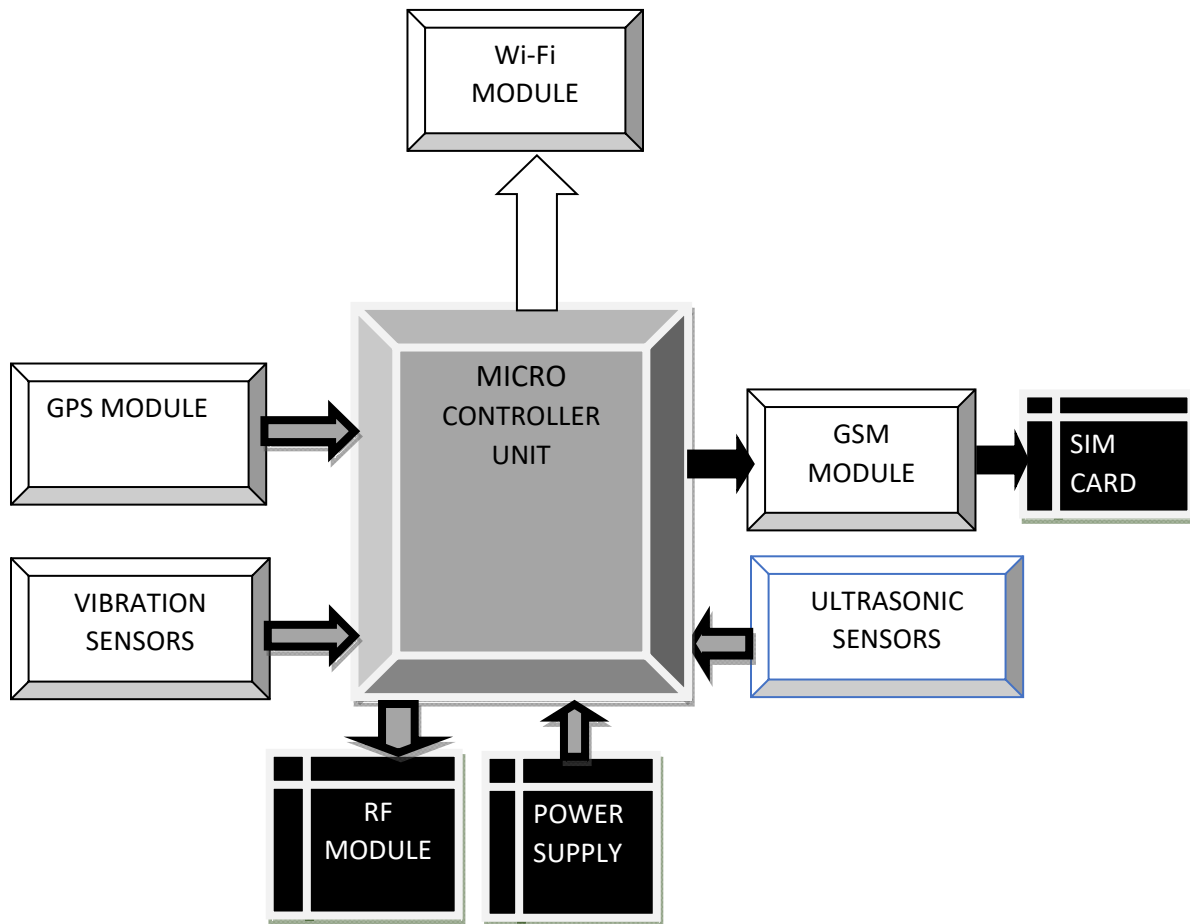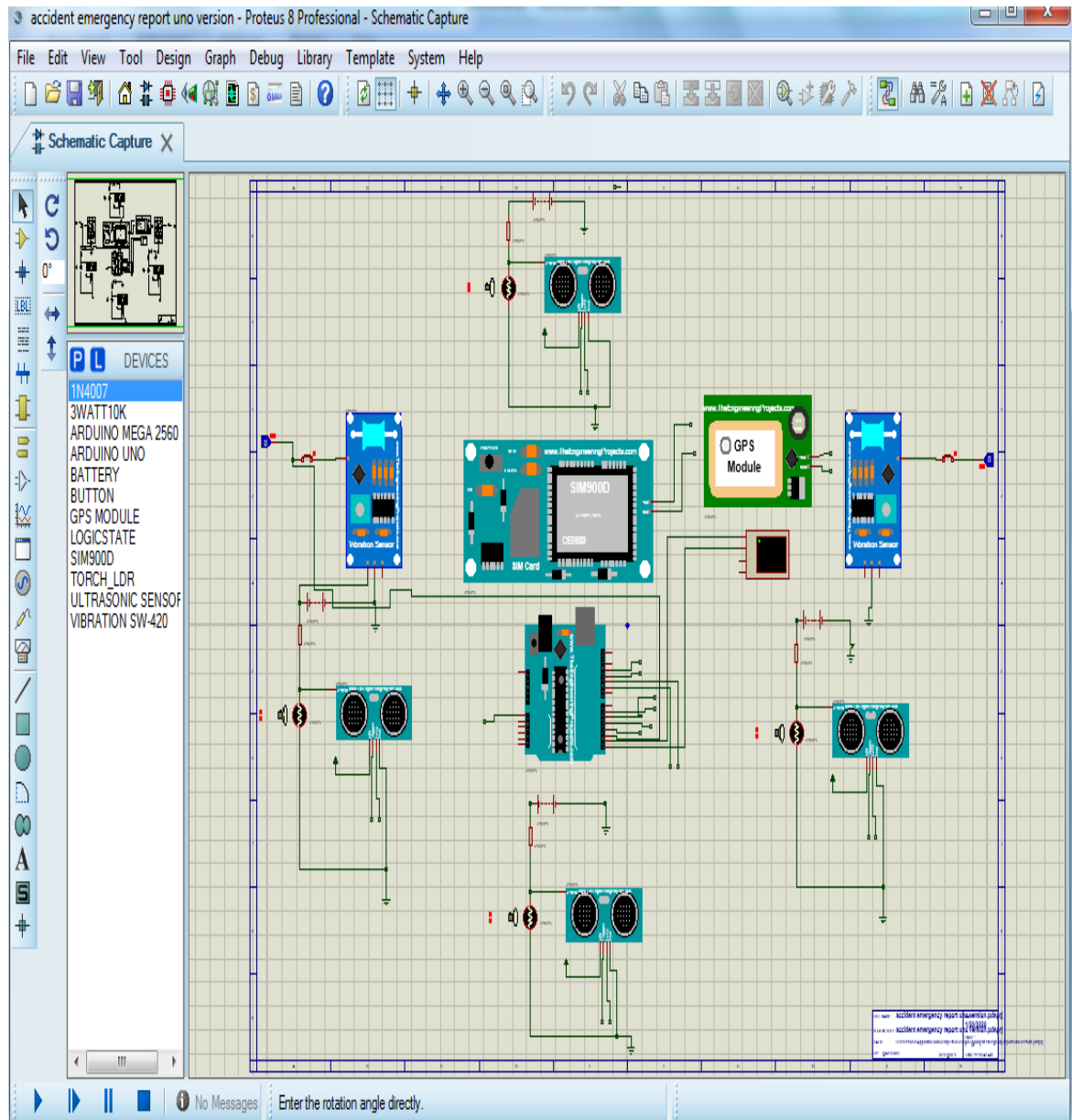
Figure 1: System Block Diagram

Figure 3: System Proteus Design

3.2 System Flowchart

The flowchart of the proposed system is as shown in figure.2. The flowchart shows sequence of actions that the proposed system undergoes during accident detection and reporting.
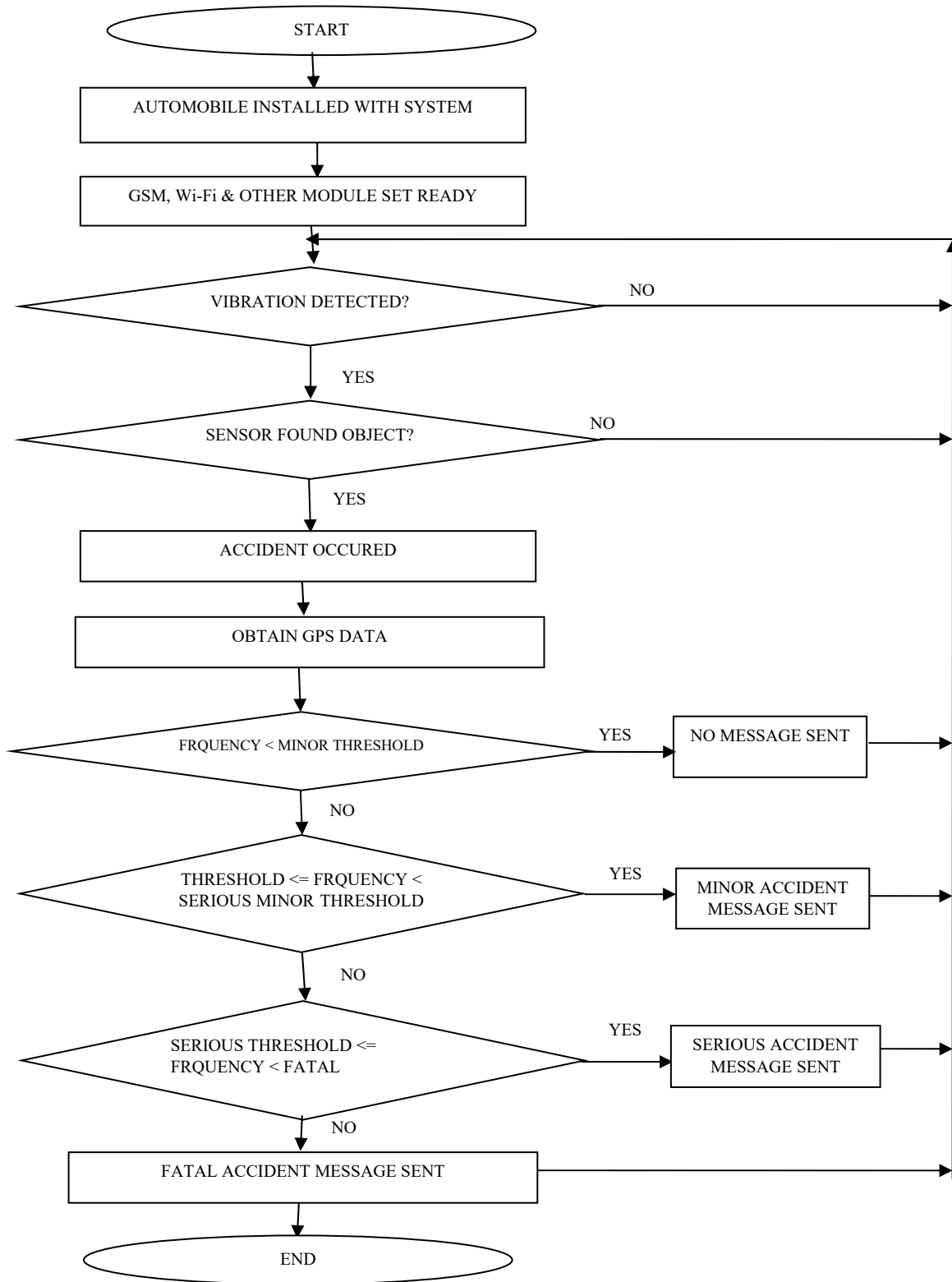
Figure 2: System flowchart

4. SYSTEM IMPLEMENTATION

This section presents the choice of development environment, implementation architecture, software testing and documentation. During implementation, we use the structure of our proposed system, system design and the outcome of system analysis to develop a system that is capable of meeting the specified objectives of the study. In this project, the implementation is will be done in two phases namely, the software implementation and the hardware implementation.

4.1 Software Implementation

The Software simulation is very vital in this project in order to visualize the possibility from concept to the actualization of the project. It will equally help us to estimate the working efficiency of the components, identify and make selection of suitable components for our project. For this purpose, an electronic simulation software tool known as Proteus was used. In addition, the coding was done using Arduino software.

4.2 Hardware Implementation

In development of the hardware prototype the following components briefly explained below were interfaced together as shown in figure 1 to actualize the aim of this work.

4.2.1 GSM module

SIM 900 GSM shield is a GSM module that is integrated into a microcontroller to make number of mobile phone functions such as text messages and calls possible. The shield is designed to surround the SIM 900 chip with ability to interface with any microcontroller for automation. With the variety of AT commands, the shield can be opened to send and receive text messages. These features of SIM 900 shield make it a suitable device to accomplish the goal of this project.

Figure. 4: GSM Module

4.2.2 GPS module

The NEO.6M GPS is a well performing module with a complete GPS receiver and an in-built 5x25x4m ceramic antenna. This module is capable of receiving its position data from the satellite, decode the signal and transmit it through it pin outs to the microcontroller that it is interfaced to. With the use of this GPS, we can have track of the real time the location of the vehicle involved in an accident.

Figure 5: GPS Module

4.2.3 Vibration sensor

SW18010p is a vibration sensor with a spring mechanism and a piece metal at the middle of the black component. When an external force is applied, the spring makes contact with the metal and when force is removed the two terminals of the sensor opens contact. The number after "SW18" determines the amount of force required to make contact. The higher the number the larger the force or vibration needed for it to be triggered. Therefore, this sensor will be used in our project to detect when vibration occurred and also the degree of vibration that occurred on the automobile.

Figure 6:Vibration Sensor

4.2.4 Proximity sensor

HC-SR04P Ultrasonic ranging is a low cost proximity sensor that uses sonar to calculate distance to an object. It has ultrasonic transmitter and receiver modules. The transmitter sends a signal (high frequency sound) which is reflected when the signal locates an object. The echo pin of the transmitter receives the reflected signal and the time between the transmission and reception is used to determine it distance to the object since the sounds velocity in the air is known. An on-board

2.54mm pitch pin header allows it to be interfaced to any project during prototyping. With the use of this ultrasonic sensor in our project, it will confirm if there is an obstruction either at the front, back or sides of the car during detection to avoid false alarm and it collaborates with the vibration sensor.

Figure 7: Proximity Sensor

4.2.5   Microcontroller

Arduino is hardware and software packed microcontroller with an open source electronic prototyping platform. Its open source advantage coupled with other benefits such as low cost and availability are among the reasons why it was used for this project. It coordinates the functioning of other components that are connected to it. The signals from these components are processed by Arduino microcontroller and the appropriate device is triggered based on the result of the processing. It is simply the brain of the system.
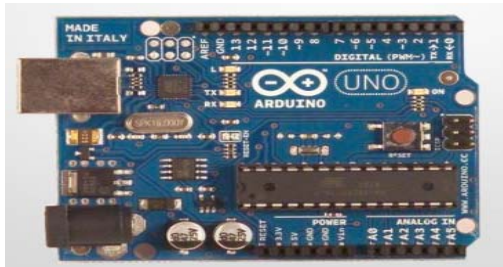

Figure 8: Microcontroller

4.2.6   Power supply

Most of these components and modules work with as low as 5v, and some requiring less except the GSM module that needs about 12v for proper functioning. Therefore, voltage source for this our project would be a battery of 12v which will take care of the GSM module voltage requirement, the prototyping car and the rest of the sensors. With the aid of the voltage regulator, every component will get its adequate voltage for proper performance.

4.2.7   Wi-Fi Module

Wi-Fi is a wireless network technology that allows the system to connect to the internet and also forward stream of sensor information to the server.

5.   RESEARCH RESULT AND DISCUSSION

The proposed system was tested at both simulation and hardware levels. Each of the individual components of the system was tested separately, later they were appropriately connected together and the functionality of the entire system was also tested.

At the simulation phase, the components of the system available in the Proteus Integrated Development Environment were interfaced as shown in figure 3. The piece of code required to drive these components were programmed and transferred accordingly to the components. The program was run to begin simulation and the result was displayed on the virtual terminal. If the system is properly connected and the GSM is ready to start functioning, it will indicate readiness as shown in figure 9. On activating the vibration sensor and the proximity sensor, the signals from both sensors were received by the Arduino microcontroller. Depending on the extent of vibration produced by the vibration sensor and presence of an object detected by the proximity sensor; the microcontroller decides the type of accident and report the accident accordingly. The accident report through GSM carries the location information of the accident as obtained from the GPS and the Wi-Fi module is also meant to send accident information to the server. Figure 10 is the screenshot showing when there is obstruction only and also when there is minor accident.

At the hardware phase, the system prototype was developed using the required physical components and connected appropriately. It was tested by placing it in a small toy car as shown in figure 11. The software needed for the system to work as expected was programmed in the arduino programming environment and uploaded into the physical arduino microcontroller. The toy car that is housing the prototype was made to collide with an object at varying degree of forces. Depending on the severity of the collision as captured by the vibration sensor, an appropriate accident report is sent to the designated mobile number via GSM cellular network. The latitude and longitude location of the accident scene generated by GPS

forms part of the message sent as shown in figure 12. As the accident message is being sent, alert information is equally being forwarded to nearby receivers through the Wi-Fi and RF modules attached to the system as shown in figure 13. This alert information received through the RF receiver of the nearby vehicle and displayed on the vehicle's screen for the driver to see. With this information, the driver will decide either to follow another route or to slow down so that more havoc will not be caused. Accident is detected by the presence of vibration sensor and proximity sensor in the automobile at the time of the accident. The threshold value of the sensitivity can be set.
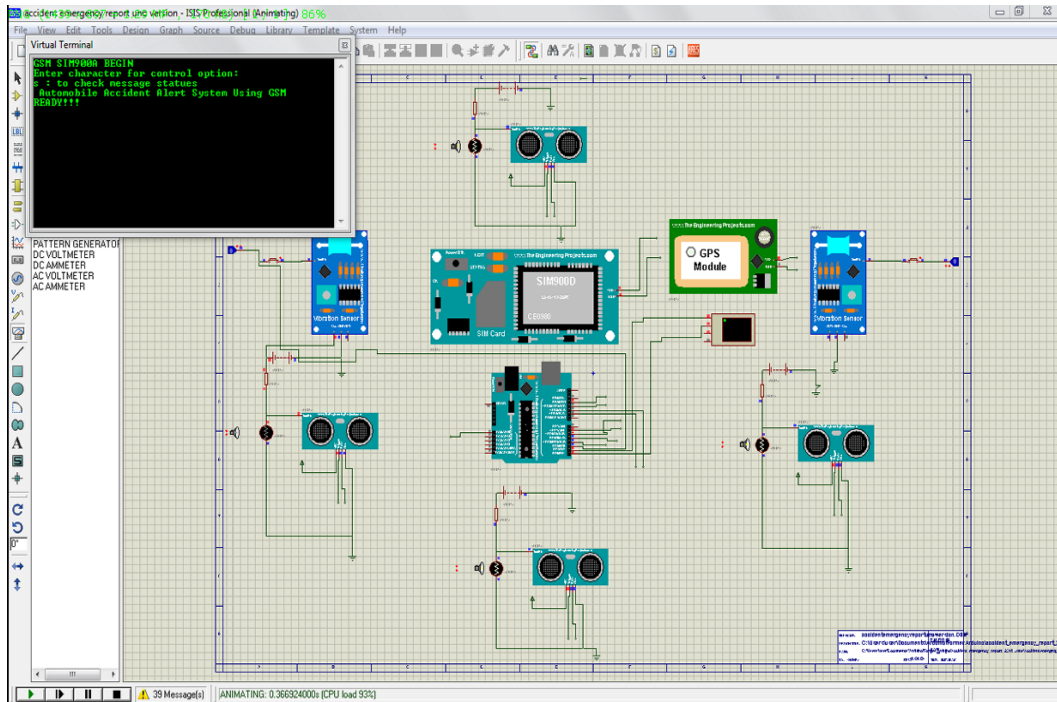

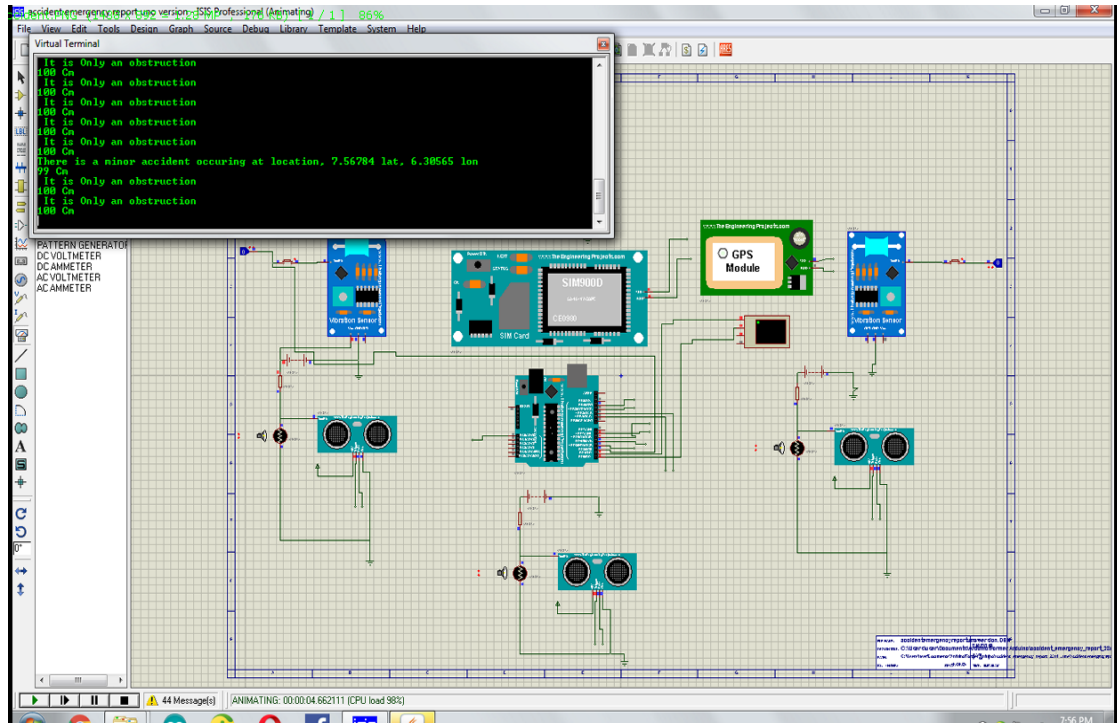*Figure 9: Screenshot showing System's readiness to capture accident*

Figure 10: Screenshot showing obstruction and minor accident

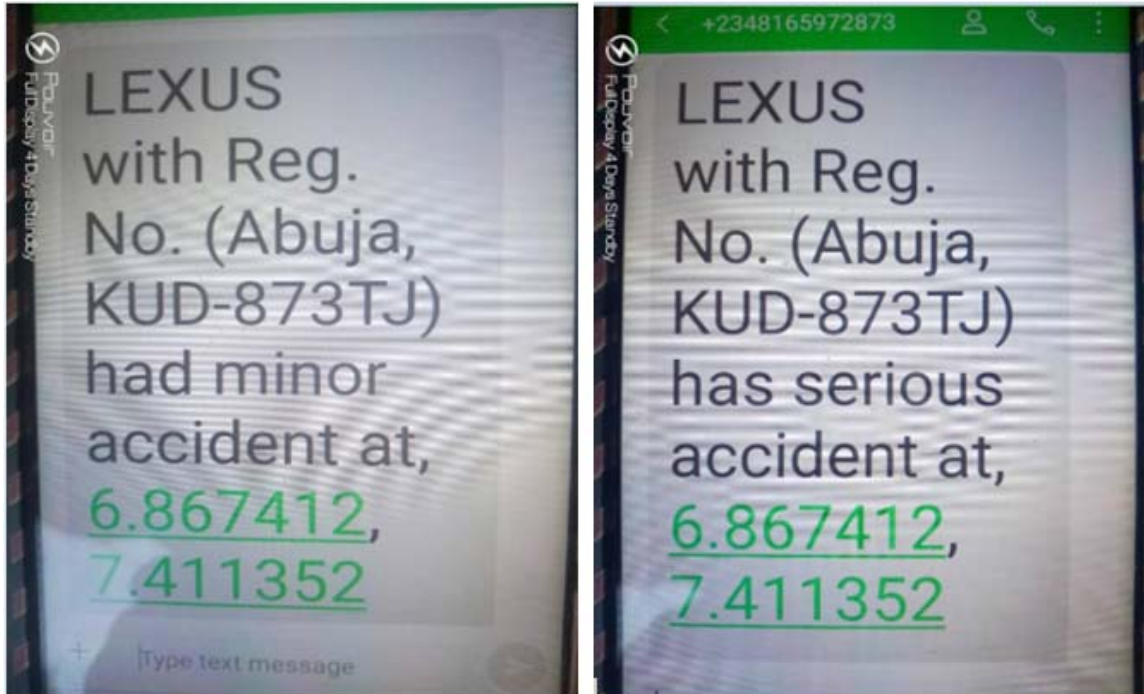*Figure 11: Developed prototype installed in a toy car*

Figure 12: Message for minor and serious accident sent by prototype

Figure 13: Message forwarded to a nearby receiver by the prototype

6.   CONCLUSION

The number of automobiles in our road is on the increase and this development has resulted to an increase on the frequency of road crashes. If these road crashes are not promptly reported and urgent response given to the accident victims, it may result to loss of huge financial resources and quantum number of lives. To reduce the number of deaths and loss of property, this research work offers a solution by developing an automobile accident alert system. The system is capable of timely detection and reporting of accident to the concerned agency to facilitate the rescue of the accident casualties. This timely detection and reporting of accident is made realizable with help of sensors, microcontroller, GPS, GSM, IoTs components of the developed system. With this, many lives will saved and rate of damage will automatically be minimized. The system was designed, simulated, implemented, tested and the results are satisfactory.

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