

Internet-of-things Based Real-time Accident Alert and Reporting System for Nigeria

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ABSTRACT

Accident is an unfortunate and unplanned event or circumstance, which usually occurs without informing the road users or the driver and can lead to serious injuries or even death. The time it occurs and the time of reporting should be very close to avoid death of the victims involved in the road accident. Because of the high rate of accidents involving different road users in Nigeria such as pedestrians, Bike (Okada) riders, Keke (tricycles), trucks, commercial buses and private cars, there is an urgent need to create a system that can alert the family of the victims and Federal Road Safety (FRSC) officers, wherever they are, on time, of the location of the accident in order to take the victims to nearest hospital to save precious human lives. The lack of medical treatment on time is the major cause of high mortality rate or deaths in Nigeria arising from road accidents; many victims bleed to death as result of delay in receiving urgent medical treatment. The proposed accident alert and reporting system will address the delays in giving immediate medical attention to accident victims by providing early detection of accidents and communicating the location information of the accident spot via the GPS and GPRS modules immediately to the emergency responses such as FRSC, hospitals and victims' family on time in order to provide quick assistance for the injured victim(s).

KEYWORDS: GPS, Arduino UNO, accident alert/reporting, Internet of Things, Vibration Sensors, Nigeria

INTRODUCTION

Accident is an unforeseen and unplanned event or circumstance, often with lack of intention or necessity. It usually occurs without informing the road users or the driver. The time it occurs and the time of reporting should be very close to avoid death of the victims involved in the road accident. The International Road Federation, Geneva Programme Center reported that approximately 2.4 million people have died in road accidents across the world, with a yearly record of 1.3 million deaths and daily record of 3,000 deaths [1]. Who reported that an estimated 1.2 million people are killed worldwide in road crashes each year and as many as 50 million are injured [2].

Nigeria still remains one of the worst hit countries and has suffered severe losses to fatal car accidents. In Nigeria, hardly a day goes by without news of a

fatal, ghastly, or minor road traffic crash and data from the National Bureau of Statistics (NBS) reveals that Nigeria recorded a total of 3,345 road traffic crashes in the first quarter of this year 2022, an average of 37 road crashes per day.

While the number of crashes decreased by 1.82% from the 3,407 recorded in Q4 2021, the number of persons killed in road crashes in Q1 of this year increased by 11.02% [3].

The increasing rate of loss of life and property due to road accident warranted the need for a way of getting prompt and immediate report of accident occurrence to the concerned agencies for proper rescue operation and record purposes especially when such accidents occur at locations where necessary rescue operations are inadequate or unavailable.

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Many lives are lost due to late report of the accident occurrence.

Fig. 1 shows the number of deaths arising from road accidents in Nigeria from 2013 to 2020.

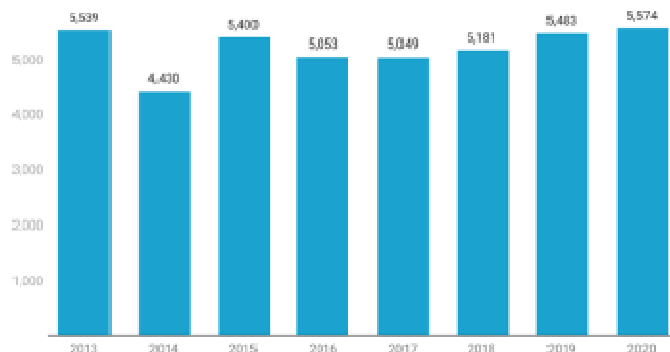


Fig. 1: Number of people killed in road traffic crashes in Nigeria from 2013 to 2020 [4]

Fig.2 shows the wreckage of an accident scene involving a truck and other vehicles in Makera-Mokwa Road in Niger State where 23 victims were killed in December 2020.



Fig. 2: A fatal accident scene involving a truck and other vehicles in Makera-Mokwa, Niger State where 23 victims died on 29th December 2020 [5]

The real-time approach and the application of Internet of Things (IoT) is an arrangement of interrelated computing gadgets, mechanical and digital machines, objects, individuals that are given one kind of an identifier and the capacity to exchange information over a system.

This integration of internet of things with real time methodology will achieve the following result if properly implemented:

1. Reporting accident case to the nearest road safety station
2. Initiating a call to the registered mobile number in the GSM module of the device and as well as sending SMS

3. The GPS in the device will provide the location of the accident while the Wi-Fi will enable the system send email to registered address.
4. The system will provide the accident victim immediate relief to avoid death

IoT is a new concept that has evolved from the convergence of wireless technologies. The definition of the Internet of things has evolved due to convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Cisco Systems estimated that IoT was "born" between 2008 and 2009, with the things/people ratio growing from 0.08 in 2003 to 1.84 in 2010 [6].

Wireless communication is the transfer of information or signal between two or more points that are not connected by an electrical conductor. In IoT devices equipped with Wi-Fi allow the machine-to-machine communication.

Using IoT technique a vehicle tracking system (VTS) can be built. A vehicle tracking system combines the use of automatic vehicle location of individual vehicles with software that collects these fleet data for a comprehensive picture of vehicle locations. Modern vehicle tracking systems commonly use Global Positioning System (GPS) or technology for locating the vehicle, but other types of automatic vehicle location technology can also be used. Vehicle information can be viewed on electronic maps such as Google Maps or OpenStreet maps via internet with specialized software. These systems go beyond simple reporting of each vehicle's location, offering fleet managers a wealth of information about their vehicles and their drivers.

There are some companies that provide Vehicle Tracking Services (VTS) which has some common features like tracking the vehicle using satellite GPS & Global System for Mobile (GSM) communication. But there is no system in Nigeria which can detect accident and also communicate the data stream about the accident in real time to various agencies like police station, Federal Road Safety Corps (FRSC) and hospitals or to the guidance of accident victims.

This research is intended to communicate to the nearest relation or friends of the accident victim and road safety stations so as to provide rapid response to remedy the situation at hand. The vehicle will communicate to the two or three persons registered in the device embedded in the car that there is an accident and the person involved need to be rescued immediately to avoid death. The device having a Wi-Fi and GSM module can be traced using GPS, and the GSM module will initiate a call and at the same time

send an SMS to notify friends and family about the accident, while GPS will enable one know the exact location of the accident,

Nowadays lots of accidents happen on highways due to increase in traffic and also due to reckless driving. And in many situations the family members or the ambulance and police authority are not informed in time. This result in undue delay to reach the people involved in the accident. A serious accident might occur in the night and people may not be aware of it. Many people died on the way due to the delay in waiting for the ambulance.

The problem associated with old way of rescuing accident victims in Nigeria includes:

1. Delay in sending the accident information to the police, road safety officials or hospitals for emergency response;
2. Information sharing is not real time;
3. Life is lost as a result of delay in rescue response; and
4. Lack of comprehensive source of data and information about road accidents in Nigeria.

METHODOLOGY

A. System Methodology and architecture

Fig. 4 shows the methodology employed in developing the proposed accident alert and reporting system. The credentials of the victim are unknown which is tedious during crucial moments for the people at the accident scene/spot. The main motive of the project is to design an IoT based detection and reporting system. The unique feature of the system is to locate the victim and report the accident with the relevant information to Federal Road Safety Corps (FRSC) ambulances and his immediate family members to provide a quick medical aid to the victim(s).

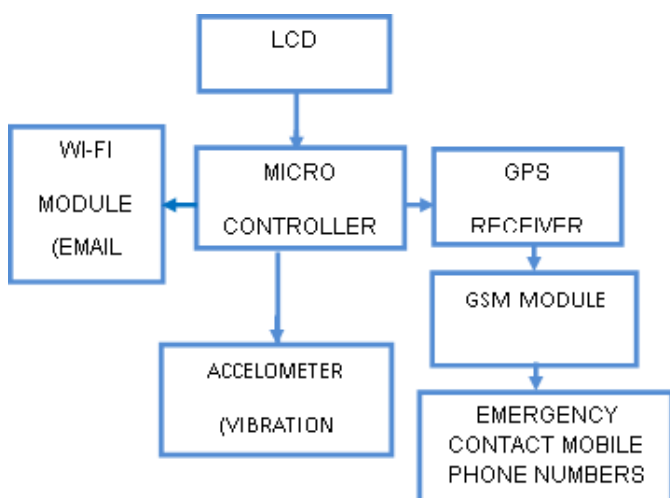


Fig.4: The architecture of the proposed accident reporting system

In this research paper, Arduino Uno was used for controlling whole the process with a GPS Receiver

and GSM module. GPS Receiver is used for detecting coordinates of the vehicle, GSM module is used for sending the emergency alert SMS with the coordinates and the link to Google Map to emergency response such as FRSC or victims family. The Accelerometer sensor used is ADXL335; this was used for detecting accident or sudden change in any axis (x, y or z). And an optional 16x2 LCD display was also used for displaying status messages or coordinates. The UBLOX NEO6MV2 GPS module was used for sending the accident coordinates and SIMCOM SIM900A GSM GPRS module for sending the SMS alert/accident reporting to designated emergency mobile phone numbers.

An Arduino Uno microcontroller module was programmed in unique C code to achieve this functionality. Vibration sensor (Accelerometer) was interfaced with the ATmega328 microcontroller with the Arduino Uno board which senses the vibration frequency of the accident. A maximum stress limit of the vibration threshold is programmed in the module. The GPS module is connected to the microcontroller module in the board to communicate information whenever the car hits an obstacle or enters a dish, while the GPS unit provides the exact location where the accident occurred, the GSM/GPRS module will initiate a call or trigger a call to the emergency response (registered mobile numbers) on the device informing them on recent occurrence and at the same time send an SMS notifying friends and family members. An accelerometer is a device that measures the vibration, or acceleration of motion of a structure. The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" this accelerometer is inter linked with sensor to report a critical situation that needed urgent respond so as to avoid death of the victim involved in the accident. Wi-Fi module will take care of sending the message via internet; in this unit such information could be route through electronic messaging (e-mail).

Arduino Uno board and a micro-controller were used to implement the accident alert/reporting system in Fig.4, a micro controller (ATmega328) will programmed on Arduino UNO board via C prompt integrated development environment. Fig.5 shows the circuit consisting of the different integrated components or modules using breadboard.

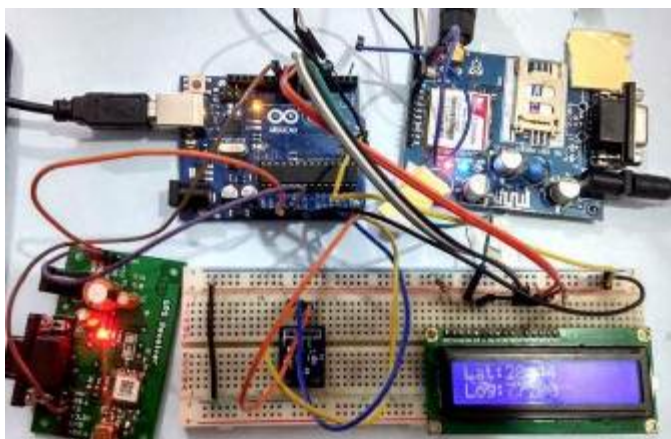


Fig.5: The integration of the proposed accident alert and reporting system modules

Fig. 6 shows the Arduino Uno board with ATmega328 microcontroller used in this experiment.

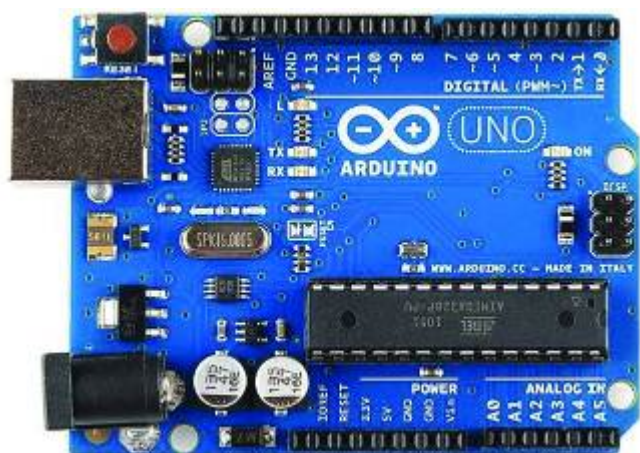


Fig 6. The Arduino UNO board which uses microcontroller ATmega328 onboard.

The GSM Emergency unit was implemented using the SIM900 GSM GPRS shield. This is based on a chip of SIM900 from SIMCOM and is compatible with Arduino and its clones. It is used to make and receive phone calls, send and receive SMS and connect to the internet using the GPRS network via UART using AT commands. It supports quad-band and can communicate through GSM 850 MHz, GSM 900 MHz, DCS 1800 MHz or PCS 1900 MHz networks. It has a power jack along with a toggle switch to use an external power supply.

Fig.7 shows the SIM900 GSM module used in this project to implement GSM emergency call or SMS to emergency FRSC ambulance services and family of accident victims. Fig.7 shows the GPS module used in the project. The GPS module will be helpful in locating the spot or scene of the accident or crash so as to assist the emergency response or family members of the victims to locate him or her for urgent medical attention.

Fig.8 shows the ADXL335 Accelerometer sensor used in this project for detecting accident along the x,

y and z axes. Fig. 9 depicts the GPS receiver module used to detect the coordinates of the accident location. Fig. 10 shows the Wi-Fi module used to send email to emergency contact response in the event of any detection of accident or crash.



Fig 7. The SIMCOM SIM900 GSM GPRS module for sending CALL/SMS to emergency contact phone numbers



Fig 8. The ADXL335 Accelerometer sensor used in this project for detecting accident along the x, y and z axes



Fig 9. The UBLOX NEO6MV2 GPS module used in this project to send Google Map coordinates of the accident scene

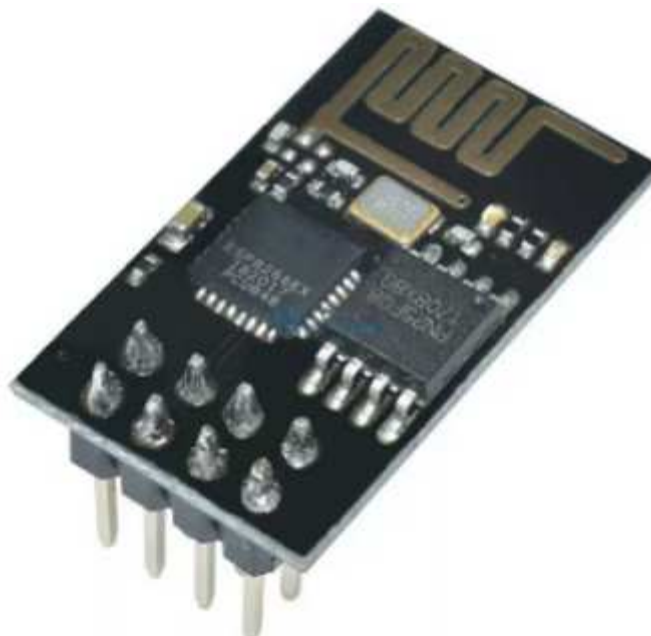


Fig 10. The Arduino-based Arduino ESP8266 ESP-01 Wi-Fi Module used to send email to FRSC ambulance Unit and victim’s family

B. System Flow chart Diagram

The system flowchart for implementing the proposed system is shown in Fig.11.

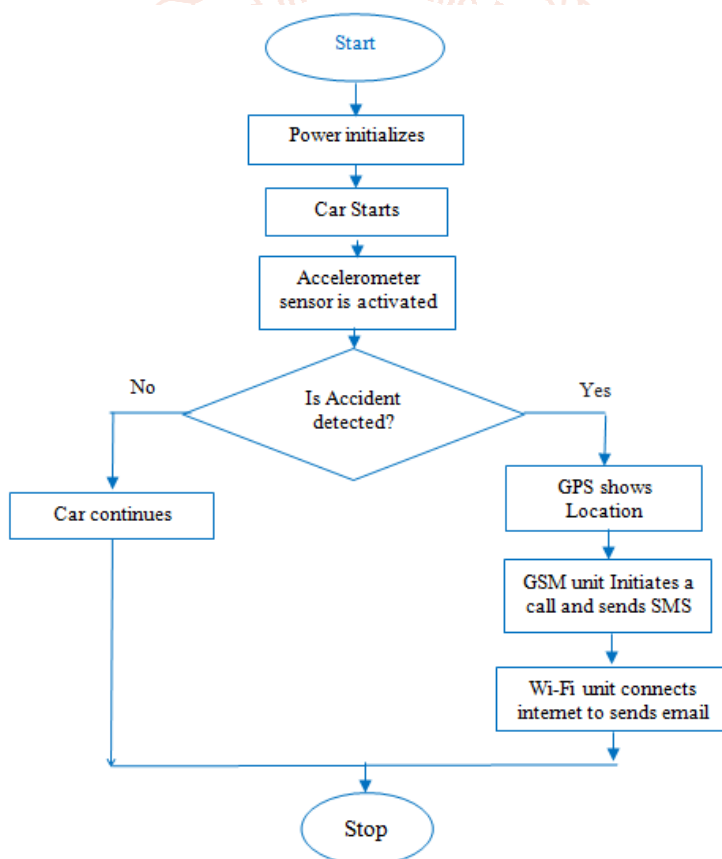


Fig.11: System flow diagram

C. Implementation

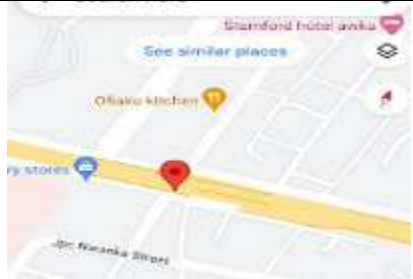


The device was integrated in any moving vehicle both big and small. It only requires 5 – 12 volts of power from the electrical system of the vehicle. Once it is installed, it does not conflict with the car main functional system (brain box). The device comes in the form of a board packaged in a small box connected to match with electrical arrangement with in the car system.

RESULT AND DISCUSSION

The accident later and reporting system was tested at various locations within Awka Metropolis of Anambra State, Nigeria after implementation. Table 1 shows the detected locations. The system reports the information to

the emergency responses including the results of the accident locations with latitude and longitude values, which helps to find the accurate accident’s location using Google maps. Fig.12 shows the received SMS alert showing the GPS coordinates of the accident or crash location of the victim.

Table 4.1: Detected Locations

COORDINATES	TEST LOCATION	GOOGLE MAP
LATITUDE: 6.228570 LONGITUDE: 7.081277	Arroma Roundabout Awka	
LATITUDE: 6.204553 LONGITUDE: 7.052015	Ngene, Amawbia, Awka	
LATITUDE: 6.259570 LONGITUDE: 7.110286	Garuba Square, Nnamdi Azikiwe University Awka	

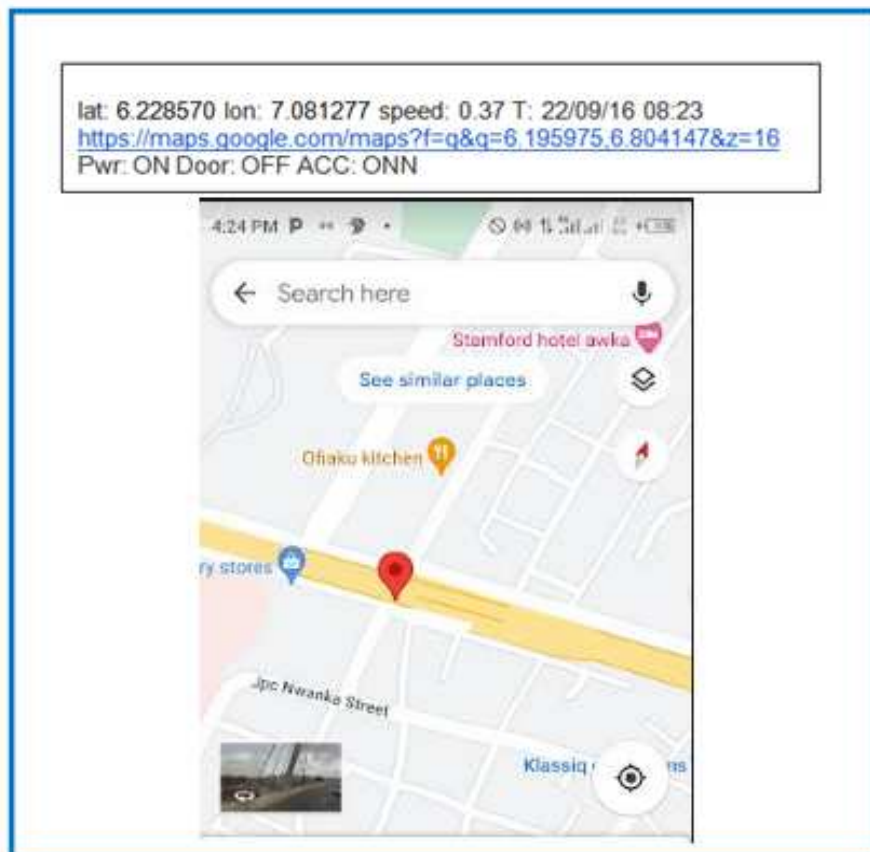


Fig. 12: The received SMS alert message and GPs coordinate

SYMMARY AND CONCLUSION

The negative impacts of frequent road accidents in Nigeria cannot be overemphasized; thousands of lives have been lost prematurely and several victims maimed for lives because of the impacts of road crashed. This can be mitigated if there is a way to interface with emergency rescue officials such as the Federal Road Safety Corps (FRSC), hospitals and family members of the victims on time whenever road accident occurs, This is necessary to as to save precious human lives by giving the victims emergency medical attention. This paper introduced a road accident alert/reporting system to contact emergency rescue teams on time from the scene of the accident. This system is a unique one because whenever accident occurs it will trigger a call bearing the name tag “accident victim” to friends and family on a real time approach and also sends an email to registered address in the device. This will enable emergency road safety officials or the family members of the victims in order to take the victims to urgent medical treatment.. This is very critical for Nigerian road users to forestall incidences of unfortunate deaths arising from various road accidents.

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