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A WEB-BASED ACCIDENT REPORTING AND TRACKING SYSTEM (ARTSYS) USING SENSOR TECHNOLOGY

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ABSTRACT

Nigeria is a country where we experience one of the highest incidences of road accidents in Africa. This is largely due to the deplorable conditions of our road network, incidences of armed robbery attack on the roads as well as lack of proper reporting or alert system for such accidents. The statistics of road accidents, especially those involving loss of lives in Nigeria is alarming. Many lives have been lost as a result of lack of immediate medical attention for accident victims. ARTSYS is a web-based multiplatform accident reporting and tracking system. It was designed to provide avenue for prompt reporting of accidents and avoid possible loss of lives. The system provides an efficient and proper reporting as well as tracking of vehicles involved in an accident immediately after the accident occurrence. It was designed to handle carnage on Nigerian roads where adequate reporting of accidents is almost nonexistent using the GPS technology. The system has two major modules i. e. The tracker and the reporter. The tracking module was devised with the use of a Simulated Sensor Program implemented in Visual Basic and a GPS/GPRS/GSM modem to sense accidents occurrences, track the location of accidents and to send alert and report to concerned agencies. Further reporting could also be done on the website through appropriate documentation interested members of the public.

KEYWORDS: ARTSYS, Simulated Sensor Program, Accident, Federal Agencies, GPS/GPRS/GSM modem.

I. INTRODUCTION

An accident is an unforeseen and unplanned event or circumstance, often with lack of intention or necessity. It usually implies a generally negative outcome which may have been avoided or prevented had circumstances leading up to the accident being recognized earlier, and acted upon, prior to its occurrence. 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 [7]. The worst hit are middle-income countries, a circumstance confirmed by Mrs. Tawia Addo-Ashong, World Bank Global Road Safety Facility Coordinator, she said that 1.2 million die yearly from road traffic accidents especially in low- to middle-income countries [4]. Nigeria still remains one of the worst hit countries. With a human population of about 167 million, a high level of vehicular population estimated at over 7.6 million, a total road length of about 194,000 kilometres (comprising 34,120 km of federal, 30,500 km of state, and 129,580 km of local roads) [12], the country has suffered severe losses to fatal car accidents. Nigeria is ranked second-highest in the rate of road accidents among 193 countries of the world [1]. Oladepo and Brieger in 1986 argued that three-quarters of all accidents on Nigerian roads involve fatalities.[9] The WHO adjudged Nigeria the most dangerous country in Africa with 33.7 deaths per 100,000 population every year [14]. According to their report, one in every four road accident deaths in Africa occurs in Nigeria. The WHO survey and the FRSC report of 5,693 fatal road accidents in 2009[5] leave no doubt about the dangerous situation on Nigerian roads. 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. Many lives were lost due to late report of the accident occurrence.

Accident reporting and tracking system (ARTSYS) is a web-based multiplatform accident reporting system with adequate functionality for tracking the accident location. The system is a multiplatform system that incorporates a Simulated Sensor Program (designed using VB) with a GPS/GSM modem, and a web application. The ARTSYS automate the accident and rescue workflow, which possible to generate a complete record of all car accident encounters – as well as supporting other related activities directly or indirectly.

The remaining part of the paper is organised as follows; section 2 reviews some existing work in the line of the research, section 3 describe the architecture of the system while section 4 entails the design of the system before implementation. Section 5 gives the summary of different module contains in the ARTSYS, simulated test setup is described in section 6 while section 7 discusses the future and conclude the paper. Some references used are listed in section 8.

II. A REVIEW OF RELATED WORK

The research domain is not very popular; there are few of such system in the literature which were thoroughly reviewed to define the scope and requirement of this work. Their special features were also studied.

2.1 Vehicle accident alert and locator (vaal)

Olugbemiga and Emmanuel (2011) did a work on Accident (automobile) emergency alert situation. The authors were able to program a GPS / GSM module incorporating a crash detector to report automatically via the GSM communication platform (using SMS messaging) to the *nearest* agencies, giving the exact position of the point where the crash had occurred. Telit GM862-GPS wireless system is their choice for the automobile GPS/GSM module [10]. The GPS method uses satellite sent positioning signal to handsets equipped with GPS chip, which calculates its own location to approximately 1-10m. The system architecture shows that if a crash occurs in a particular place, the information is been sent to 5 pre-configured numbers. The GPS/GSM module works with an installed crash detector but if their predefined numbers were out of Network coverage areas, no one gets the alert [10].

2.2 Wireless accident information system using gsm and gps

Rathinakumar and Manivannan (2012) also worked on a system that has three modules; automatic speed control module, accident detection and information sending module and security enabling module. Automatic speed control module includes RF transmitter placed in specific location and RF receiver in the vehicle. Accident detection module includes GSM and GPS technology. Security enabling module includes sensory units which ensures the condition of seat belt and the driver. In case of any accident, the vibration in vibration sensor increases beyond the limit and information is sent to GSM module. The GSM module then send message to respective authority reporting the accident occurrence [11].

2.3 Automatic Accident Detection Via Embedded Gsm Message Interface With Sensor Technology

Vidya and Balakrishnan in 2012 introduced an automatic alarm device for traffic accidents in this work. The system can automatically detect a traffic accident occurrence, search for the spot and then send the basic information to first aid center within two seconds covering geographical coordinates, the time and circumstances in which a traffic accident takes place. GPS software is fitted in the vehicle will now start communicate with the satellite and get the latitude and longitude values and send the information to the centralized server. Then the server will search the nearest hospital and send the accident information to the hospital. The hospital will then send their ambulance to the accident zone to rescue the injured people as soon as possible [13]. The design is a traffic accident automatic detection and long-distance alarm device. It makes up the control module MC9S08AW60, information detection module includes large range dual-axis accelerometer MMA621010EG and small-scale three-axis accelerometer sensor MMA7260QT, GPS positioning module GS-87, people

machine interaction module, including the keyboard and LED, and message sending module TC35i [13]. When a vehicle collision accident occurred, large number dual-axis accelerometer MMA621010EG detects the level of the collision automatically, vehicle rollover accident occurred, the Z-axis of small range acceleration sensor automatically detects the vehicle roll angle. Accident signal is sent when the angle is greater than the set value given using mobile phone text messages of accident information (accident geographical coordinates, altitude, license plate number, time, date) through the TC35i sent to the owner's family and friends, rescue units and the transport sector [13].

2.4 Vehicle tracking and accident warning system using gps and its implementation in fpga.

Hubert, Karthikeyan and Prabhu (2011) device a system that sense any accident in the vehicle and intimates pre-programmed numbers like the owner of the vehicle, ambulance, police etc. The GSM technology is used to send the position of the vehicle as a SMS to those numbers. And also the position of the vehicle can be obtained by the owner of the vehicle or anyone with proper permission by sending an SMS to a number. The GPS module responds with coordinate's position of the vehicle. This position is sent to the user as a SMS with date, time, latitude and longitude positions. When there is an accident, the accelerometer sensor detects the change in position and sends a signal to the processor. The processor analyses the signal and finds there is an accident. It immediately sends the position of the vehicle and also the information that there is an accident, to pre-programmed numbers such as the owner of the vehicle, police, ambulance etc. So the ambulance arrives in time and the police can arrive in time to clear the traffic. This reduces the time taken by ambulance to arrive and also traffic can be cleared easily [6].

III. SYSTEM ARCHITECTURE

ARTSYS was designed and developed to work in a client-server environment; it is a web-based multiplatform system that is built on the 3W technology. This provides a cost effective way of publishing information, casting and presenting graphics of recent accident occurrences, top accident news and related news, search space and vital information management. Access to the internet is essential and paramount to the success of the system. Information on the website is secured and controlled through a registration process and the use of privileges and password.

Devices that can communicate over the internet without human interference were modelled for the system development. The inter-operability of a GPS/GPRS/GSM modem, a simulated sensor program (programed using Visual Basic), a SIM CARD and a web application make the system as a whole.

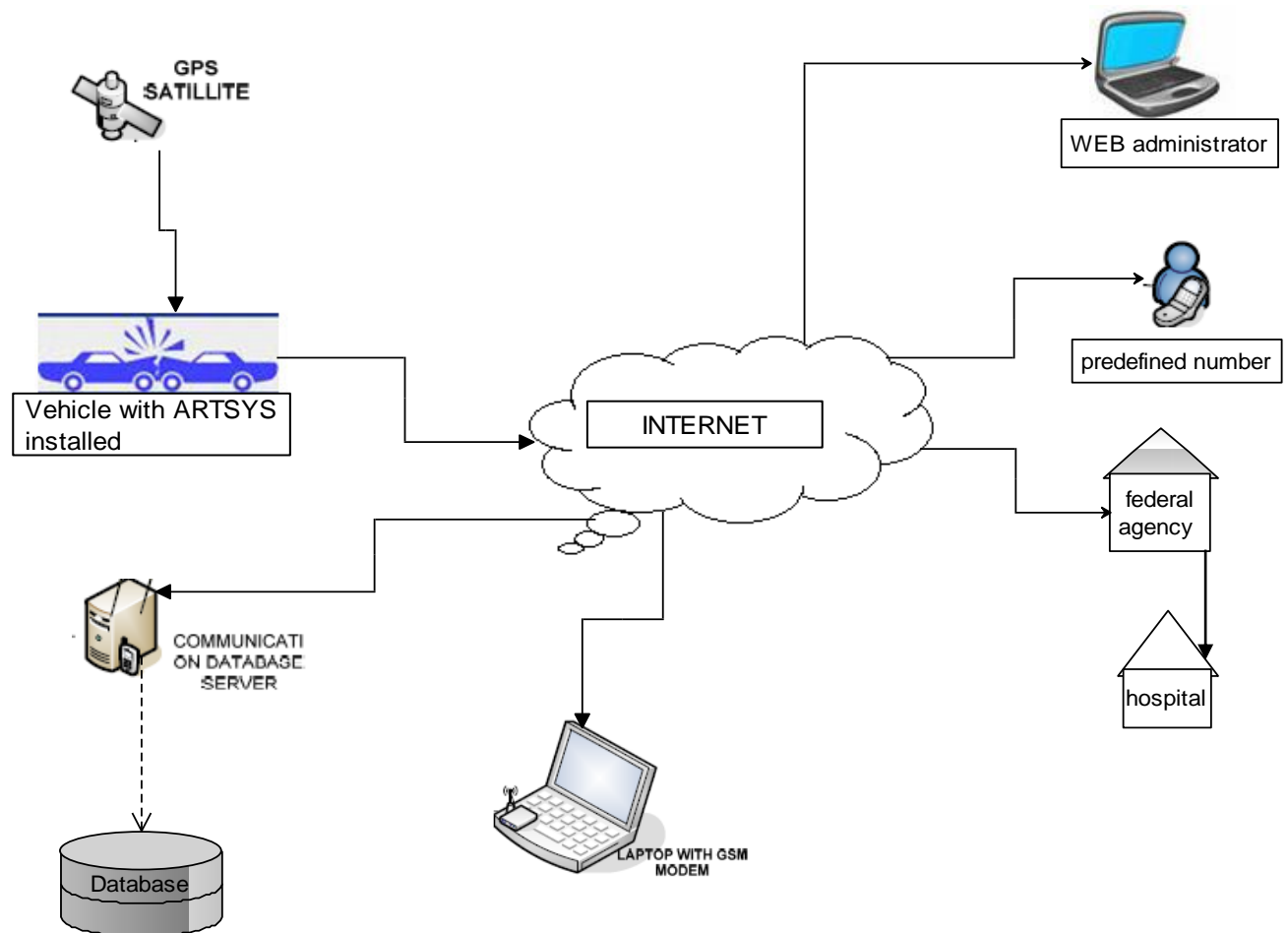


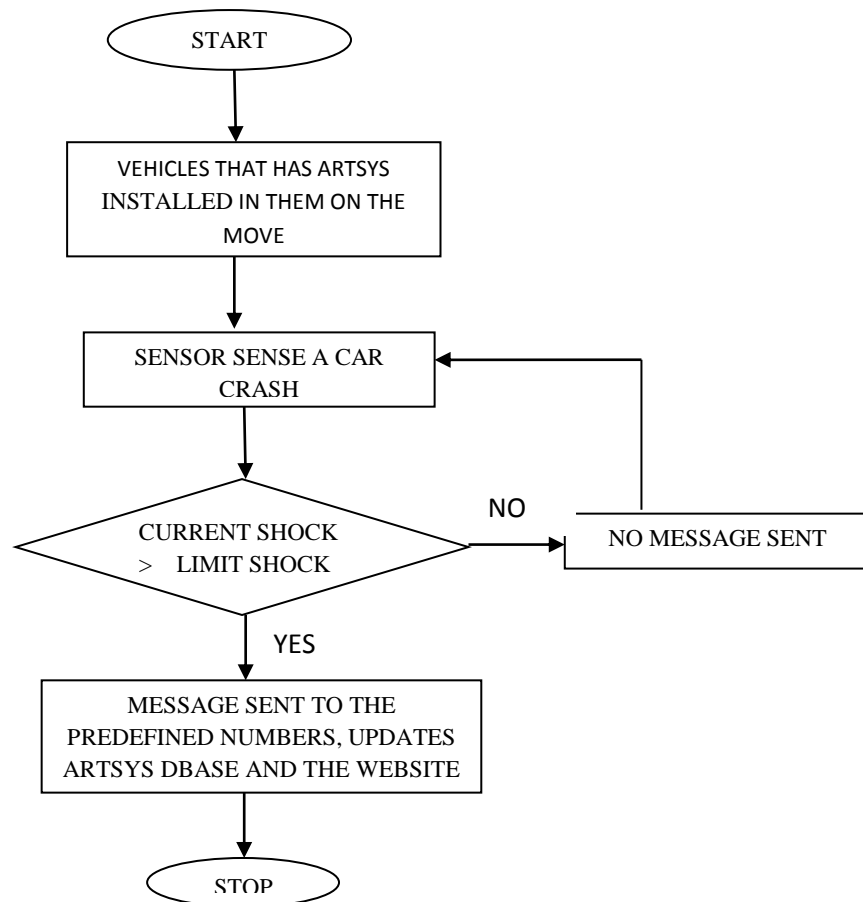
Fig. 1: ARTSYS Architecture

IV. WORKFLOW DESIGN

The workflow of ARTSYS before design the actual implementation and hardware design is shown below.

4.1 System Flowchart

The system flow chart shows the sequenced processes and steps taken to carry out specific action with the application. This employs a number of symbols for representing entities, decisions, conditions, processes and so on

**Fig. 2:** System Flowchart

4.2 Device Modelling

The modeling of the system specifies how the two arms (i.e. the website and the device) of the system interoperate. The modeling gives a clearer vision of how ARTSYS accident detecting and reporting system works.

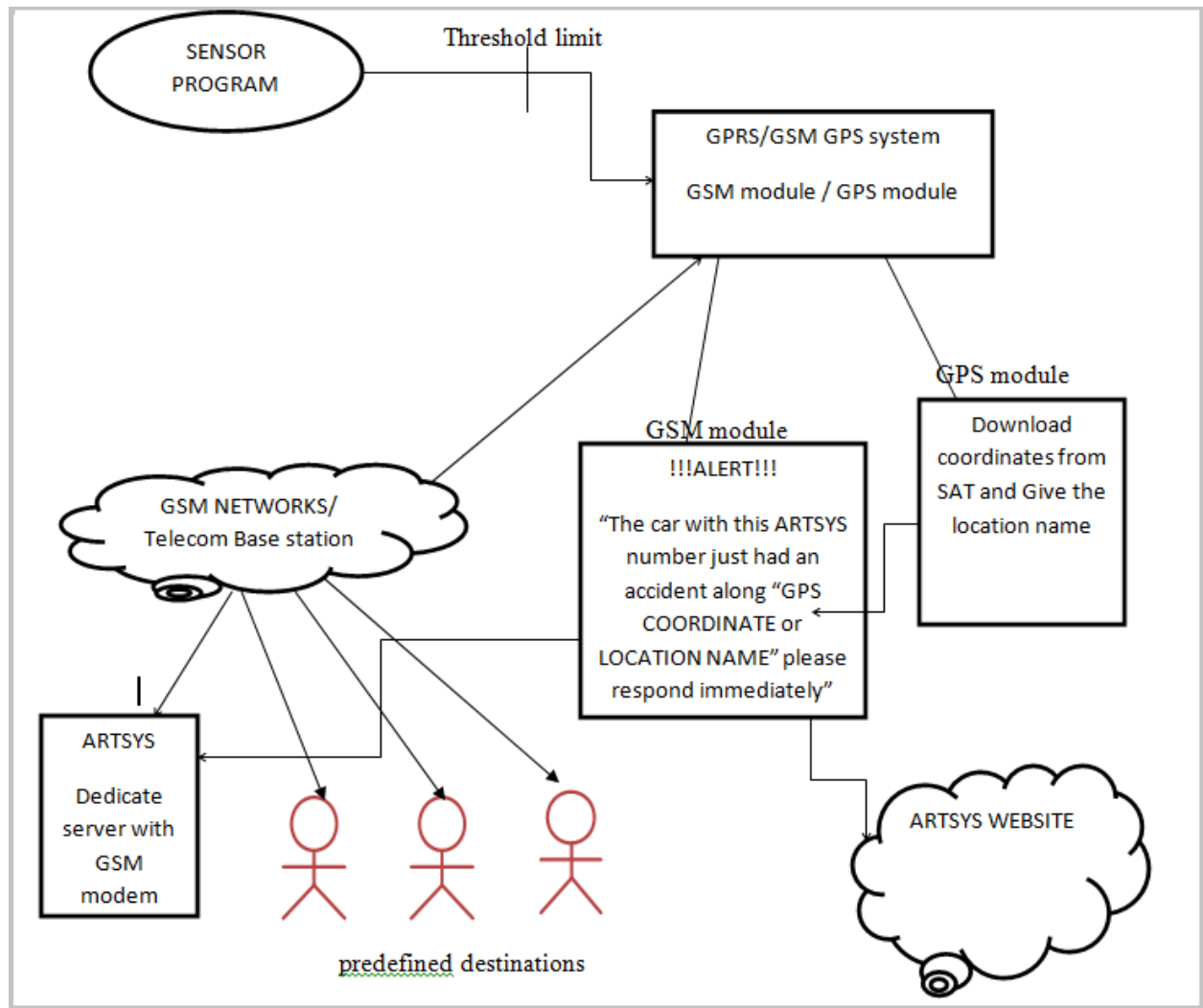


Fig . 3: Device Modeling.

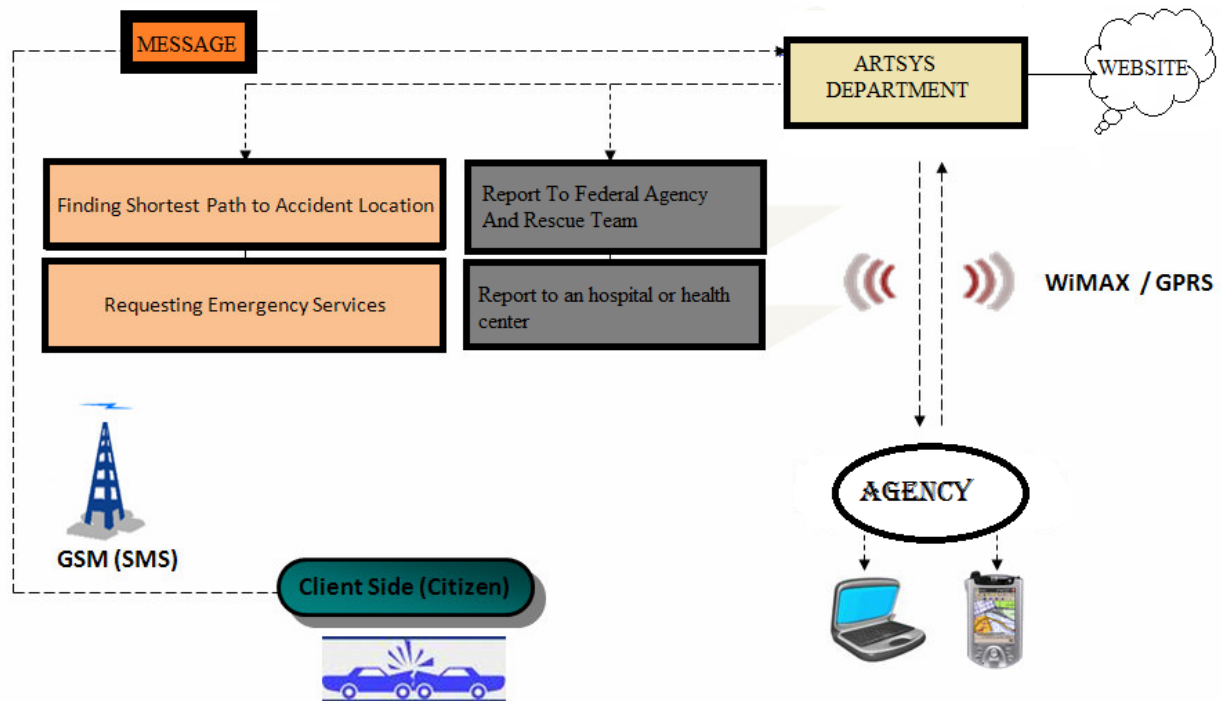


Fig. 4: Device workflow/ Activity Diagram.

V. ARTSYS SYSTEM MODULES

5.1 The Crash Detection Module

This module is modeled using a crash detection simulator program written in Visual Basic. It detects the occurrence of accident by sensing the force of the collision being above the threshold limit of the specified accident force. The module triggers the GPS/GPRS/GSM module to download co-ordinate and also send an alert message to predefine numbers in different locations. This module is an interface-enable application that has an input space for the Limit shock (i.e. the threshold limit for accident occurrence). By entering a value in this space implies that; the value entered is the limit to which a vehicle collision will be considered to be an accident which requires immediate response of rescue operations. The simulated sensor program was packaged and installed on the host machines with which the GPS/GPRS/GSM modem is connected to.

Fig. 5: Simulated Sensor Program (SSP) with values.

Figure 5 depicts the sensor simulation with all the required information supplied to carry out a particular task. The Figure shows that the Threshold shock for all accident was assumed to be 3000 (i.e. Limit shock), the vehicle was assumed to have collided with an object, generating a shock of 3500 (i.e. Current shock), the destination space was filled with the predefined destination numbers (i.e. Police, FRSC, Hospital and Ambulance station) that the alert message will be forwarded to for immediate rescue operation. The shock simulator triggers the GPS/GPRS/GSM modem to forward a message using the GSM module to the predefined numbers, specifying the location of the accident in co-ordinate form (e.g. LATITUDE 3.23434, LONGITUDE 6.677667).

5.2 The GPS/GPRS/GSM Modem

The GPS/GPRS/GSM modem is designed on a chip. It has the GPS facilities to download coordinate from the satellite using the GPS ANTENNA. The modem also has a SIM SLOT where a registered SIM CARD will be placed in order to send the pre-programmed message to the predefined destinations. The modem uses the GSM ANTENNA to search for secured network for the message to be sent. It also has a RS-232 to DB9 connection port which allows the connection of the modem to the simulated sensor application on the host machine.

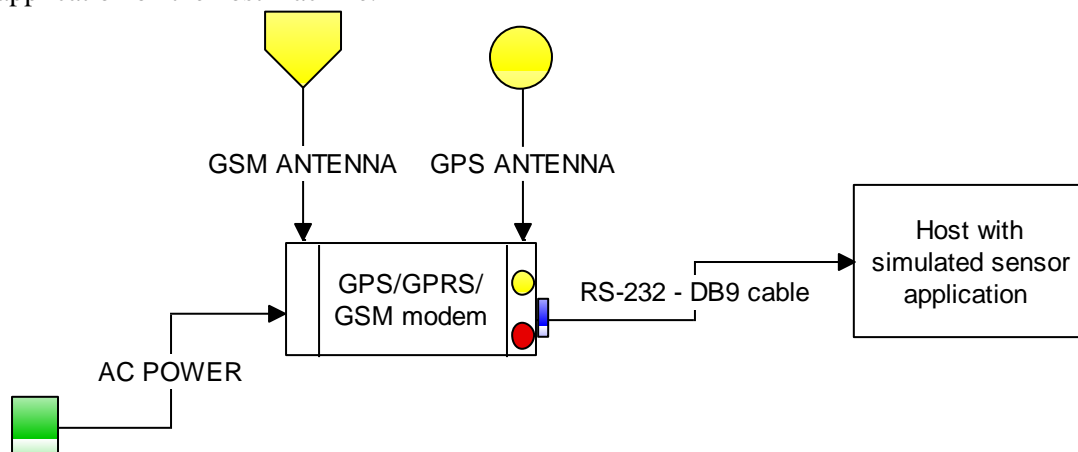


Fig. 6: Prototypic design of the device connection.

VI. ARTSYS EXPERIMENTAL SETUP AND TEST

ARTSYS was tested by setting up the devices, and connecting it to a system (i.e. host) that has the simulated sensor program (SSP) installed on it. A WiMAX modem was also used for easy internet connection. The test session comprises of a laptop that has a simulated sensor program (SSP) installed on it, the GPS/GPRS/GSM modem, RS-232 to DB9 cable, the GSM and GPS antenna, a SIM card place in the GPS/GPRS/GSM modem, a WiMAX modem for fast internet access, and the web application. The laptop was incorporated with the WiMAX modem running an SMS messaging service. Number of Agencies such as police, FRSC, hospital and ambulance services located in different geographical area of Osun State and the neighbouring states in Nigeria were predefined. An example of the message received at each location of the predefined destination is as follows.

“ALARM!!! Probable accident at location Longitude: 6.5961600666667N,

Latitude:3.27069101666667E.”

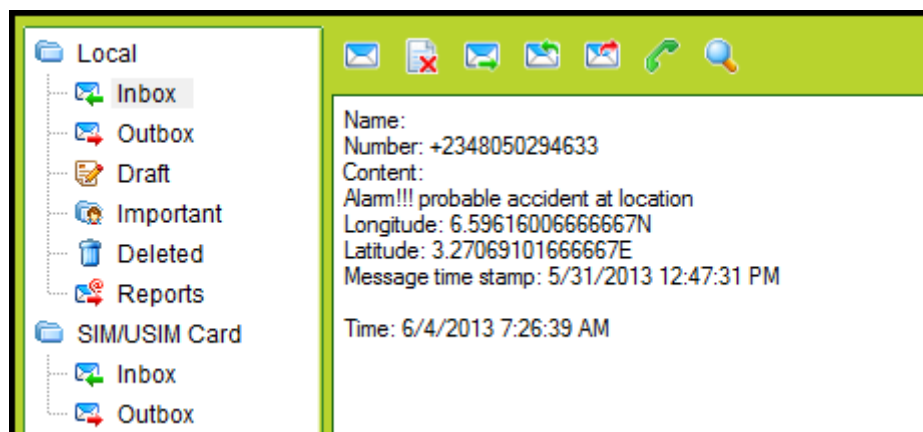


Fig. 7: Alert Message.

By receiving this Alert, the web administrator logs into the web application, using the admin credentials, to search for the specific location of the coordinates forwarded by the GPS/GPRS/GSM modem. On the web application, there is a module GPS locator that does GPS locations confirmation and translate map coordinates into the actual location. This was achieved by entering Google Map's API (application program interface). The web application also has various modules that helps facilitate the ARTSYS operations and adds more credibility to the system as a whole.

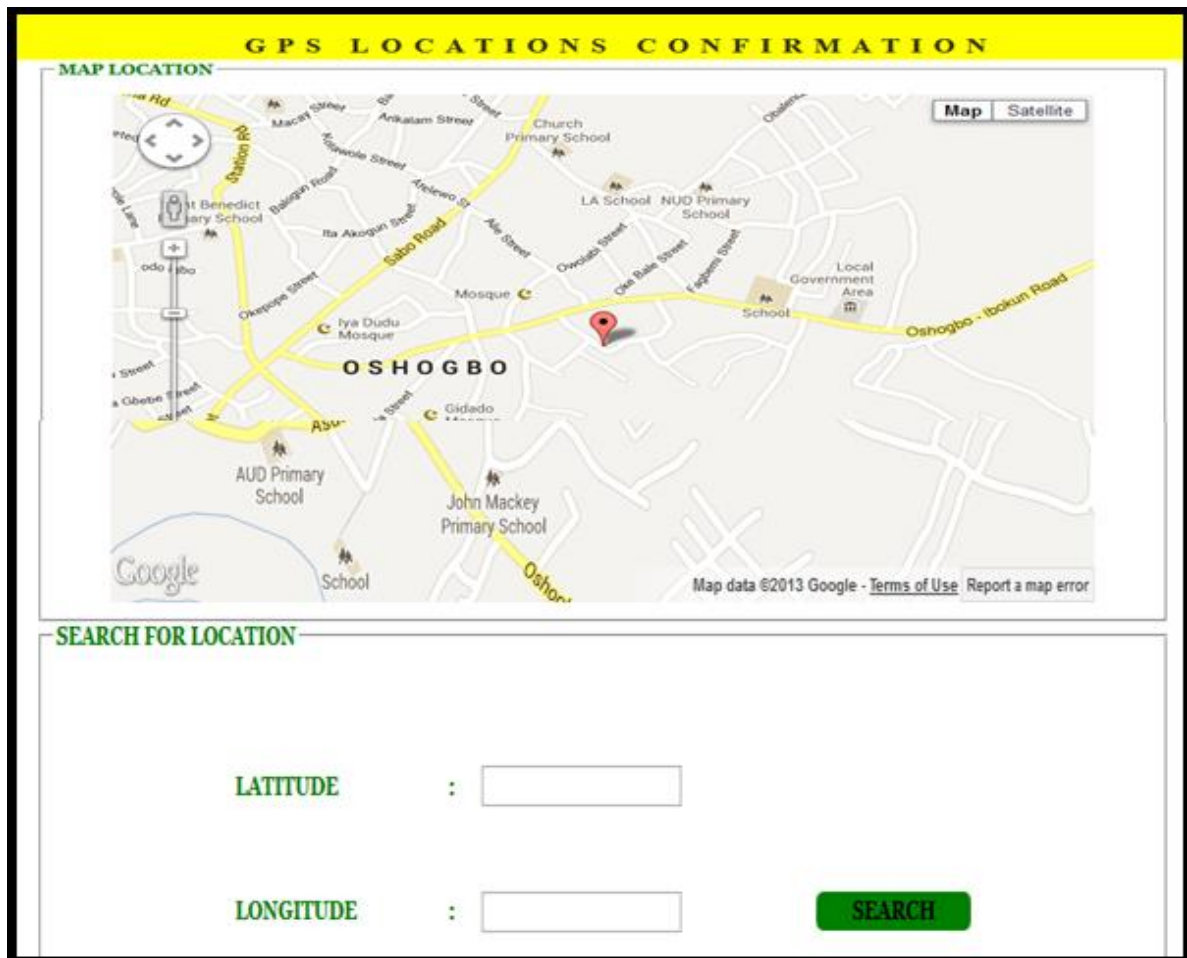


Fig. 8: GPS locator.

VII. CONCLUSION

Realizing the automation of accident detection and information transmission, this study solves the issue of automatic accident detection, tracking and reporting. Our conclusion is that if ARTSYS is properly implemented, this system will reduce the accidents and save the human lives. It will reduce cost effectively, the rate of accidents occurrence in our motor ways and save an appreciable amount of human lives. The result from the experiment shows that the system can be implemented in real life scenario. Work is ongoing in other to improve ARTSYS through the development of a Geographical Information System (GIS) that will extensively map all locations surrounding the system. Extension of GPRS service connectivity throughout nooks and cranny of Nigeria by the service provider is highly needed in order to increase the coverage area of the system.

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