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Vehicle Tracking and Accident Alert System Using GPS and GSM Modules

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Abstract: *Vehicle tracking systems are popular among people as a retrieval device and theft prevention. In this work, Global Positioning System (GPS) and Global System for Mobile (GSM) technologies have been used to design and construct a vehicle tracking and accident alert system (VTAA). The work integrates GPS receiver, microcontroller GSM module and push button for accident alert activation. The GPS module receives the coordinate of the point at which the system is located. The GSM module acts as a transmitter and receiver of data which is controlled by the user using command interface. The hardware component comprises of the push button, the microcontroller, SIM900, GPS receiver (sensor) and its integration with GSM module. The software component entails programming the microcontroller (ATMEGA328) with the source code, the Google map Application Programming Interfaces (APIs), the GSM message command, and integration with the GSM module. The system is controlled using a centralized interface. Whenever there is an accident, an alert message is sent automatically to the central dispatch server using the automatic alert system. The message is sent through the GSM module and the location of the accident is detected with the help of the GPS module. The result of the work which is user-friendly and reliable shows high sensitivity and accuracy.*

Keywords: *GPS module, GSM module, microcontroller, google map, vehicle tracking, accident alert.*

1. INTRODUCTION

Nowadays, vehicle tracking has become an important application. Vehicle tracking systems have become popular as a retrieval device, theft prevention and accident or emergency intervention. The main benefit of vehicle tracking systems is the security purposes by monitoring the vehicle's location which can be used as a protection approach for vehicles involved in accident or vehicles that are stolen by sending its position coordinates to the police centre or other designated points as an alert. When the centre or the point receives an alert for stolen or accident vehicles, action can be taken to prevent theft or provide rescue operations.

Occurrence of accidents on the highways has increased due to increase in traffic and due to reckless driving. The high demand and supply of vehicles have also increased the traffic hazards and the road accidents. Occurrence of accidents has put people's lives under high risk. This is because of the lack of best emergency facilities available in Nigeria. In many such accidents, the family members of the victims, the ambulance/emergency or the police authority is not informed in time. This results in delay in rescue operations for the accident victims. This work which is a real time Vehicle Tracking and Accident Detection using Global Positioning System (GPS) is designed to address such situations.

This work aims at locating the vehicle by means of sending a message using a system which is placed inside the vehicle. In most cases, accident locations are difficult or near impossible to find because of insufficient information regarding the accident occurrence and location.

When the accident occurs, an alert message is sent automatically to the central emergency dispatch server using the automatic alert system. The message is sent through the GSM module and the location of the accident is detected with the help of the GPS module. The accident can be detected precisely with the help of vibration sensor. An ATMEGA328 microcontroller is used for cost effectiveness and ease of application. Assembly programming has also been used for better accuracy and application of the GPS and GSM modules which helps to trace the vehicle and send messages. The exact location of the vehicle is sent to the remote devices (mobile phones) using the GSM modem.

2. LITERATURE REVIEW

Different types of vehicle tracking devices exist and can be classified as passive and active devices. Passive devices store GPS location, speed, heading and sometimes a trigger event such as key ON or OFF and door open or closed. Once the vehicle returns to a predetermined point, the device is removed, and the data downloaded to a computer for evaluation. Passive systems include auto download type that transfer data via wireless download. Active devices also collect the same

information but usually transmit the data in real-time via cellular or satellite networks to a computer or data center for evaluation.

Passive trackers do not monitor movement in real-time. Further, information that is stored inside a passive tracker must be downloaded to a computer. Once tracking details have been downloaded, it is then possible to view tracking details.

Aside from the fact that a passive tracking device is reliable, it is also less expensive and affordable than active trackers. In contrast to passive devices however, active GPS trackers allow one to view tracking data in real-time. Once installed, one can view location, duration, speed, and other tracking details from the comfort of one's home or office. As such, active GPS trackers are ideal when it comes to monitoring vehicles that need to be tracked at regular time interval.

Although active tracking devices are more expensive than passive devices, they however come with reliable interface (and excellent tracking software) and high efficiency. As opposed to the passive technology, active tracking technology is employed in this work because of its already highlighted merits. Besides, the active real time tracker comes with a convenient GPS locator. Rather than waiting to download data to a computer (as is the case with most passive trackers), a tracker that works in real-time does not require any waiting. Since real-time trackers come with software that allows a user to track an object in real-time, watching any object's progress is simply a matter of sitting at a computer.

Investigators have made use of GPS and GSM modules to develop some forms of tracking systems. [1] developed an embedded controller for vehicle in-front obstacle detection and cabin safety alert system. Amidst other things the system monitored, provides alert information in the form of alarm during critical situations and SMS is sent to the authorized person through GSM.

In [2], a vehicle tracking system that works using GPS and GSM technology was designed. The design aimed at a continuous watch over a moving vehicle and reporting of the status of the vehicle on demand.

In [3] and [4], a remote monitoring system based on GSM was implemented. The GSM network is a medium for transmitting remote signal. The result of this demonstration showed that the system can watch and control the remote communication between the monitoring center and the remote monitoring station.

Based on existing detectors, [5] developed a tracking system for detecting vehicles under challenging conditions such as increasing congestion on freeways. The paper describes the issues associated with feature-based tracking, presents the real-time implementation of a prototype system, and the performance of the system on a large data set. However, instead of tracking entire vehicles, only some vehicle features were tracked (to make the system robust to partial occlusion). Their system was secured, reliable and of low cost.

[4] proposed a system-on-chip (SOC) built on a field programmable gate array (FPGA) promising a more cohesive architecture, faster processing time and enhanced system interaction. It was a tracking system based on cloud computing infrastructure which monitors vehicle fuel level and speed. The proposed technology significantly avoids the accident in highways.

In [6] they proposed bus tacking system using Raspberry Pi for the primary feature of tracking the bus on Google map on web app and android app. The tracking system predict the bus arrival time for students. It also uses different sensors to give additional information about the bus for security purposes. The Geolocation Tracking method is used to identify the location of bus.

Shinde & Mane [7] also implemented a system that will increase the security of school buses through automatic tracking and monitoring. The system was designed using the Raspberry Pi, Linux-based, GPS receiver, GSM and GPRS. The site is periodically retrieved and compared with the coordinates of the known name and inventory in the database. The same process is repeated until the bus arrives at school or a wrong path is detected. Once the system suspects anything wrong, it sends GSM message to the owners to alert about the wrong path.

[8] proposed a vehicle tracking system based on GPS. The proposed system consists of hardware equipment such as GPS receiver, microcontroller and GSM modem for sim card. The equipment were embedded into the tracked vehicle as a transmitter part to send the required information to the other end where the tracker is situated. The receiver part consists of a graphic user interface (GUI) designed with Matlab.

A GPS based tracking system was also proposed by [9]. The system consists of three main parts the tracking unit, cloud and android application. The tracking unit resides in the vehicle and sends the required information to the cloud like the temperature and the current possession of the vehicle by identifying latitude and longitude of the vehicle. The location is then represented on the map to provide a real time tracking. This system provides for lower power consumption compared to other similar systems.

Vehicle monitoring and tracking systems were implemented by [10] using Blynk platform acting as a medium for data transfer and visualization. The system was developed to monitor parameters such as eye blinking and alcohol consumption of drivers and vehicle parameters such as engine temperature, the distance between the vehicles and tracking of the live location of the vehicle. When the engine temperature rises, caution is sent. Eye-blink sensor and alcohol sensor were utilized to check the condition of the driver. If the state of the driver is found to be abnormal, a notification is sent.

It is important to highlight some of the salient features and the contributions this research work has made relative to the earlier related works. Firstly, the circuit design has been divided into two sections namely: the accident detecting part and the implementation on a robotic car. The accident detecting part consists of the GPS and GSM modules, the sensors (which detect the accident) and the microcontroller (ATMEGA 328). While the part for implementation on a robotic car consists of

the Bluetooth module, the microcontroller and motor driver. Secondly, ATMEGA 328 microcontroller has been used in this work as against ARM 7 microcontroller used in the past works. The ATMEGA 328 is faster and easier to program.

Furthermore, in some past works, the sensors must be manually triggered for accident notification. This work is implemented on a robotic car which is automated to demonstrate the accident occurrence and the alert systems. Besides, two sensors (the vibration sensor and the tilt sensor) have been used in this work. Some of the past works have used only the vibration sensor. Lastly, SIM 900 has been used for the GSM module in this work as against SIM 800 used in the past works. The SIM 900 is faster and can be used for the GPS module.

The application in this work provides the optimum solution to poor emergency facilities provided to the road accidents in the most feasible way.

3. METHODOLOGY AND MATERIALS

In this section, the materials and methodology used in implementing the project are presented. In Fig. 1, the block diagram of the vehicle tracking, and accident detection system is shown.

The diagram shows a portable power supply which power the Arduino board. The Arduino board automatically powers the GSM and GPS modules, the LCD and the sensors. Whenever an accident occurs, the tilt or knock sensor is detected to be high, the sensor generates signal which is then passed to the controller on the Arduino board which, in turn, lights the indicator LED on the board. The Arduino sends signal to the GPS module requesting for the location details. On receiving the location details, the Arduino compiles alert message and then sends it to the GSM module. The GSM module then sends the alert information which includes the location of the accident in form of SMS to the already stored emergency service numbers in the EEPROM.

The programing code was compiled into the micro controller (Arduino). In the occurrence of an accident, the sensors give its output (signal) to the micro controller. The Arduino requests for the location of the accident from the GPS module. The GPS module detects the latitude and longitude position of the vehicle and sends it in form of signal to the micro controller. The micro controller sends the information received from the GPS to the phone number (rescue team) pre-saved in the EEPROM of the GSM modules.

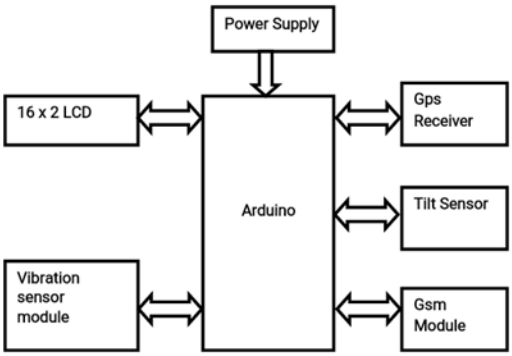

Fig. 1. Block diagram of the vehicle accident detection and tracking system

In Fig. 2, the circuit diagram of the Vehicle Tracking and Accident Alert System is shown. The diagram clearly shows how all the active equipment have been connected.

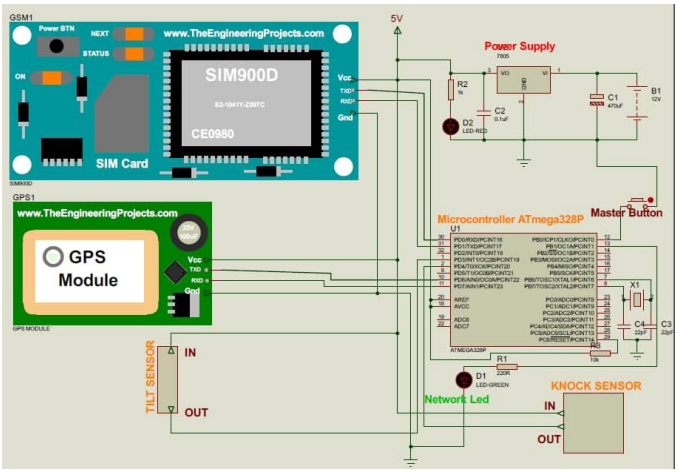

Fig. 2. Circuit Diagram of the Vehicle Tracking and Accident Alert System

The transmitting and receiving pins of the GPS module are connected to the micro controller. The serial communication on pin 10 and pin 11 has been allowed and made the receiver and transmitter respectively. A 5-volt supply is used to power the GPS module.

Pin 20 and pin 21 of the Arduino are used for serial communication by default. The GSM module's transmitting and receiving pins are connected to pin 20 and 21 of the Arduino. The GSM is also powered by the 5-volt supply.

The knock sensor is added to the system. One of the legs is connected to Vcc and the other leg is connected to the pin 2 of the Arduino. The tilt sensor is also added to the system, one leg is connected to the Vcc and the other leg is connected to the pin 1 of the Arduino.

A master button is added to the system such that the driver can press it to negate message to be sent by the device in case of false or minor accident detection. One of the legs is connected to the Vcc and the other leg is connected to a leg of a resistor and pin 13 of the Arduino. The other leg of the resistor is connected to the ground. The resistor is a pull-down resistor in which the residual voltage (that exists in form of noise when the sensor is LOW) will be discharged through it.

The LED represents the engagement of the vehicle engine, the ON state of the LED means the vehicle engine has been engaged and the OFF state of the LED means the engine of the vehicle has been disengaged. One of its legs (negative) is connected to the ground and the other leg (positive) is connected to a leg of a resistor and the other leg of the resistor is connected to pin 8 of the Arduino.

For the power supply, the collector of the transistor and a leg of the resistor are connected to the positive of the battery. The positive leg of the zener diode and the other leg of the resistor are connected to the base of the transistor. The negative leg of the zener diode and the negative of the battery are connected to the ground.

3.1 Components and Equipment

GPS modules: Satellite based navigation uses global positioning system (GPS) to send and receive radio signals that serve the users with the required information.

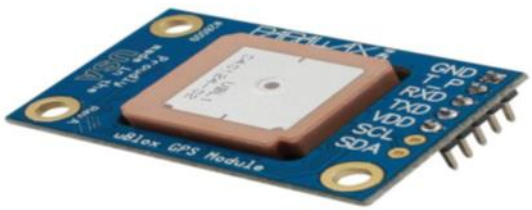

Fig. 3. GPS module

It is used on laptop, phones, airplane etc. The receiver uses the message it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. The receiver is on the surface of each of these spheres when the distances and satellites' locations are correct. The distances and satellites' locations are used to compute the location of the receiver using the navigation equations. The location is then displayed, perhaps with a moving map display or latitude and longitude [2].

Arduino: Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read input light on a sensor, a finger on a button and turn it into an output activating a motor; turning ON a LED. The Arduino takes control and starts collecting coordinates received from the GPS which are later sent to central emergency monitoring station by using the GSM module. The Arduino software runs on window, macintosh OSX and linux operating system [3].

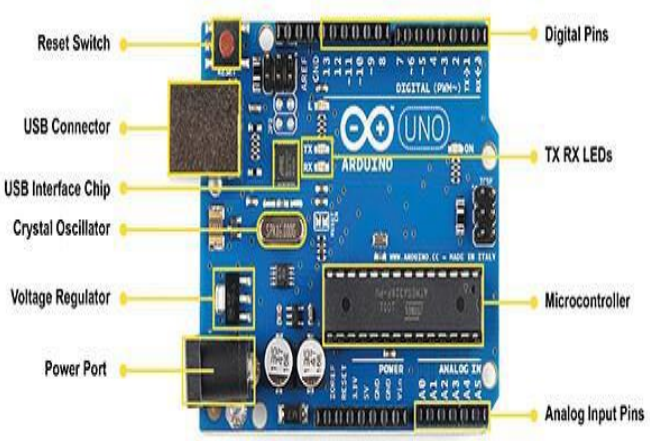

Fig. 4. Arduino board

GSM module: GSM network consist of mobile station, base station subsystem and network subsystem. The mobile station has the mobile phone that consists of the transceiver, the display and the processor. It is controlled by a SIM card operating over the network. The base station subsystem acts as an interface between the mobile station and the network subsystem. It consists of the base transceiver station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the base station controller which controls the base transceiver station and acts as an interface between the mobile station and the mobile switching center. The network subsystem provides the basic network connection to the mobile stations [2]. Other component used are resistors, vibration and knock sensor, lithium battery, zenor diode, TIPI22 transistor.

Fig. 5. GSM module

4. RESULTS AND DISCUSSION

The components highlighted in Section 2 are connected following the circuit diagram. The programming code was uploaded into the Arduino, and power was supplied to the system through a power supply with output of 5-volt taking its source from a battery. Pictures of the coupled design are shown in Fig. 6 and Fig. 7.

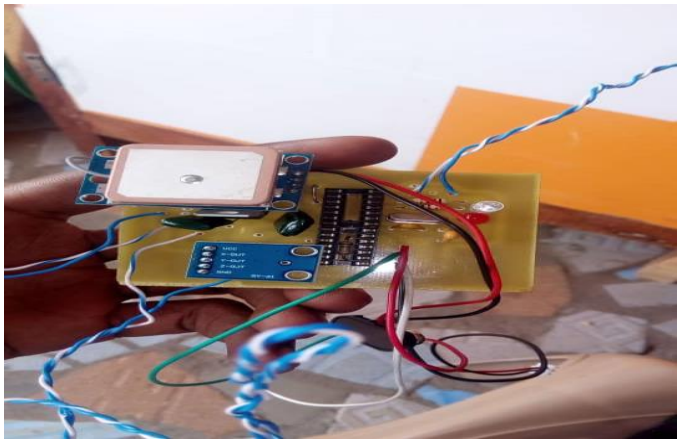

Fig. 6. Accident detecting part of the tracking system arranged on the PCB.

When the sensors were manually triggered, good result was gotten. The system works perfectly and in accordance with the design by sending an SMS reporting the type of accident that has occurred with the location of where it occurred.

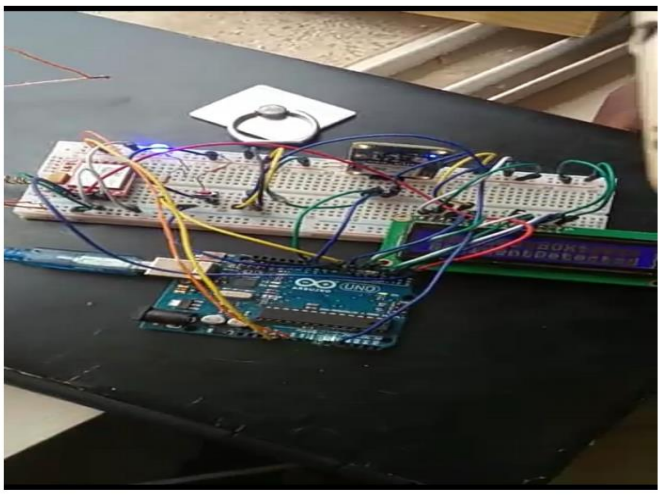

Fig. 7. Connection of the system on the breadboard.

For tracking, a message, "*track#" is sent to the device and the device responded by sending a message back containing the location of where the device is situated. These results are presented in Fig. 8 and Fig. 9.

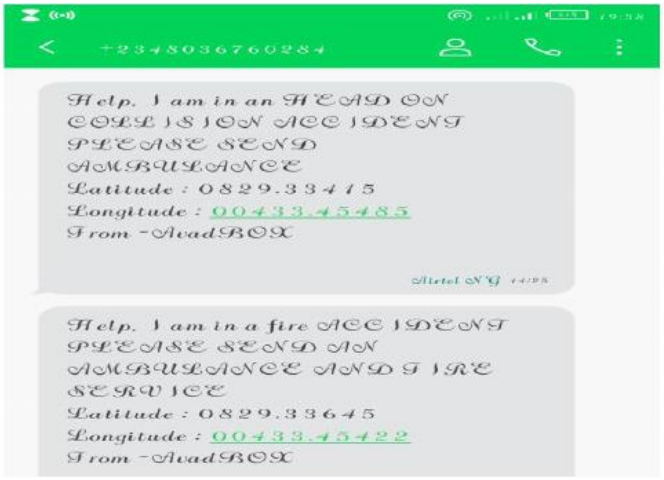

Fig. 8. Messages sent by the device to the user defined mobile number due to accident.

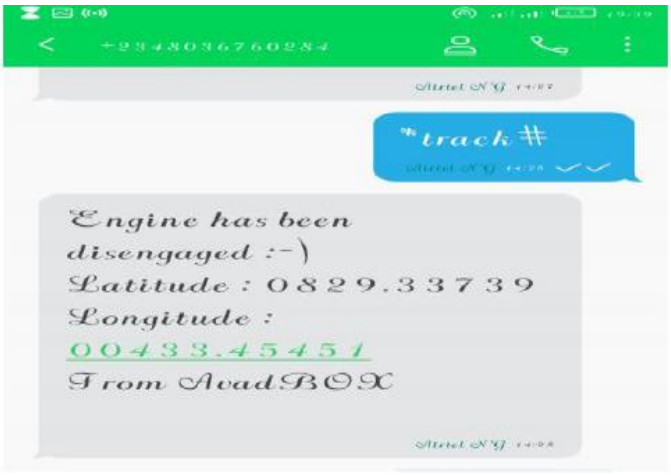

Fig. 9. Messages received after a command (*track#) is sent to the device by the user for tracking purpose.

5. CONCLUSION

In this work, vehicle tracking and accident alert system are implemented using GPS and GSM modules. It presents vehicle accident detection and alert system with SMS to the user defined mobile number and emergency service number. The system is also capable of tracking vehicle in case of theft. 5-volt was used to power the Arduino and other components connected to the Arduino. The GPS module supplies the location of where the accident occurs. The GSM module sends the alert message while the Arduino controls the entire operation.

The system can also track geographical information automatically and send an SMS alert regarding accident. A careful construction work to implement the design was carried out. The result shows high sensitivity and accuracy of the system. From the prototype constructed, the system is user-friendly and reliable. If implemented on an industrial scale, the system can make life easier and highly beneficial for the automotive industry.

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