Digital Innovations & Contemporary Research in SCIENCE, ENGINEERING & TECHNOLOGY
Vol. 6. No. 3, September, 2018

Article Citation Format
Ogunrinola O.B., Olalere N.A., Nwosu E.U. & Adebari F.A. (2018): Automobile Accident Reporting and Anti-Theft Stratagem
Journal of Digital Innovations & Contemp Res. In Sc., Eng & Tech. Vol. 6, No. 3. Pp 11-22

Article Progress Time Stamps

Article Type: Research Article
Manuscript Received: 11rd July, 2018
Review Type: Blind
Final Acceptance:: 5th August, 2018
DOI Prefix: 10.22624

Automobile Accident Reporting and Anti-Theft Stratagem

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ABSTRACT

This paper presents a technique through which a vehicle involved in accident can, by itself, send SMS message to designated authority or person for quick assistance. Via the same system, a car-snatch victim can prevent the robber from escaping with the car by sending an SMS message from any mobile phone to disable the car engine. The key components used for realizing these tasks include a GSM/GPS module, a PIC microcontroller, a shock sensor, and electromagnetic relays. The shock sensor gets activated and gives a logic high signal to the microcontroller at the moment a vehicle rigorously collides with a moving/stationary body. The microcontroller prompts the GPS receiver to fetch location of the incident and it also sends AT command to the GSM modem simultaneously. In response, the modem sends an SMS message containing location of the accident to assigned phone number(s). Similarly, at the instant a vehicle is snatched by robbers, the GSM modem receives an SMS message from any mobile phone and sends AT command to the microcontroller. The electromagnetic relays connected to the microcontroller get energized and open the vehicle ignition circuitry, bringing the engine to a halt. In these ways, prompt rescue of accident victims as well as security of property are realized. The developed model was subjected to tests under various conditions and the results were in accord with objectives of the research.

Keywords: Shock Sensor, GSM/GPS Module, Accident, Logic High.

1. INTRODUCTION

According to the Automobile Accident Insurance Act, 2013; an automobile is a motor vehicle propelled by any power other than muscular force and adapted for transportation on highways. Motor vehicle accident is commonly a collision with another vehicle, pedestrian, animal, or other stationary objects like electric poles, trees, and buildings. This often leads to property damage, injury, and death. Although the loss of life usually attracts more concerns, property damage and injury could be more catastrophic considering the possibility of permanent physical/mental impairment, as well as financial costs to both the society and the individuals involved.

The socio-economic implications of automobile accident are too numerous to be listed, yet this modern means for movement of people and goods from one place to another has become an essential part of life. Manufacturers of automobiles have intensely improved vehicle safety in recent decades with advancements such as strategically placed air bags and high-tech collision avoidance systems, still a larger number of people lose their loved ones and properties to road accident every day.

Vehicles are investments and therefore need protection. Securing a vehicle against theft is another area where this paper finds its application. In situations where robbers could not bypass some of the modern security measures put in place by vehicle owners, they resort to snatching the vehicle while its engine is running with all locks deactivated. Vehicle snatching involves trickily/forcefully taking over possession of someone's vehicle. When a car is snatched, more cherished belongings are also lost. A vehicle not being flashy does not mean it is free from being snatched because vehicles are snatched sometimes just to generate a mix-up after being used to commit crimes. Some people face robbery charges day for finding stolen vehicles, which they unknowing purchase, in their custodies. Considering the number of strategies developed by vehicle snatchers, it is understandable that no matter how smart and careful a motorist could be, the chances of falling a victim is still very high. In recognition of the evils associated with vehicle theft, this paper makes it extremely difficult for robbers to escape with snatched vehicles.

1.1 Reporting Automobile Accident

Inadequacies in the manner motor vehicle accidents are being reported bring about a lot of delay in resuscitating or treatment of injured persons. The result of such delay is frequently more number of avertable deaths because a stich in time saves nine. Getting the attention of the appropriate authorities can be a rocket science in rural areas of developing countries. Almost everybody has password on his/her mobile phone, so sympathizers do find it difficult contacting a victim's relatives for financial needs or medical history. In addition, some hospitals insist on getting police report before taking necessary action. One of the objectives of this paper is to minimize lose of life and severity of injury sustained in vehicle crash by getting accident information across to the right quarters at the instant of the incident. This would eliminate delay in commencement of treatment for accident victims.

1.2 Retrieval of Stolen Vehicles

Recovering a stolen vehicle, if possible, is actually tedious and time-consuming because a lot of alterations and modifications would have been made on the vehicle. A popular measure for enabling a retrieval is etching of the vehicle's VIN onto its visible and invisible parts. Although knowing that it will require replacement of so many parts could discourage the robber, recovering a vehicle through its etched VIN entails a lot of effort. The GPS/GSM based vehicle tracking system is another means of retrieving stolen vehicles as it provides real time information about the whereabouts of the vehicle. However, the GPS Module will not be able to find a vehicle's location when the automobile is kept within an enclosure like concrete structures. (Ashwini, 2016). If prevention is actually better than a cure, the system that prevents a vehicle from being taken away by the thief, as presented in this paper, should be more desirable.

2. MATERIALS AND METHODS

The accident reporting and anti-theft device presented in this paper is basically made up of a shock sensor module, a switch, an LCD panel, a GSM/GPS module, and electromagnetic relays. The shock sensor reacts to shock magnitudes higher than the predetermined threshold value. This level of shock arises in a vehicle mostly when there is a severe collision between the vehicle and an external object. In such situation, a high input is given to the microcontroller by the sensor.

In accordance with the programming structure, the microcontroller thereby stimulates the GPS module to supply location of the accident and it also sends AT command to the GSM modem concurrently. Hence, the modem sends an SMS message that includes location of the incident to the phone number(s) specified in the codes. This could be the contact of medical rescue team/ *ambulance,* police control room, alert service center, friends or family members of the motorist, etc. The switch is to be operated manually if the accident does not embroil any threat to life. This enables the microcontroller reverse its earlier process and prompt the GSM modem to send annulling SMS before action is being taken on the initial one.

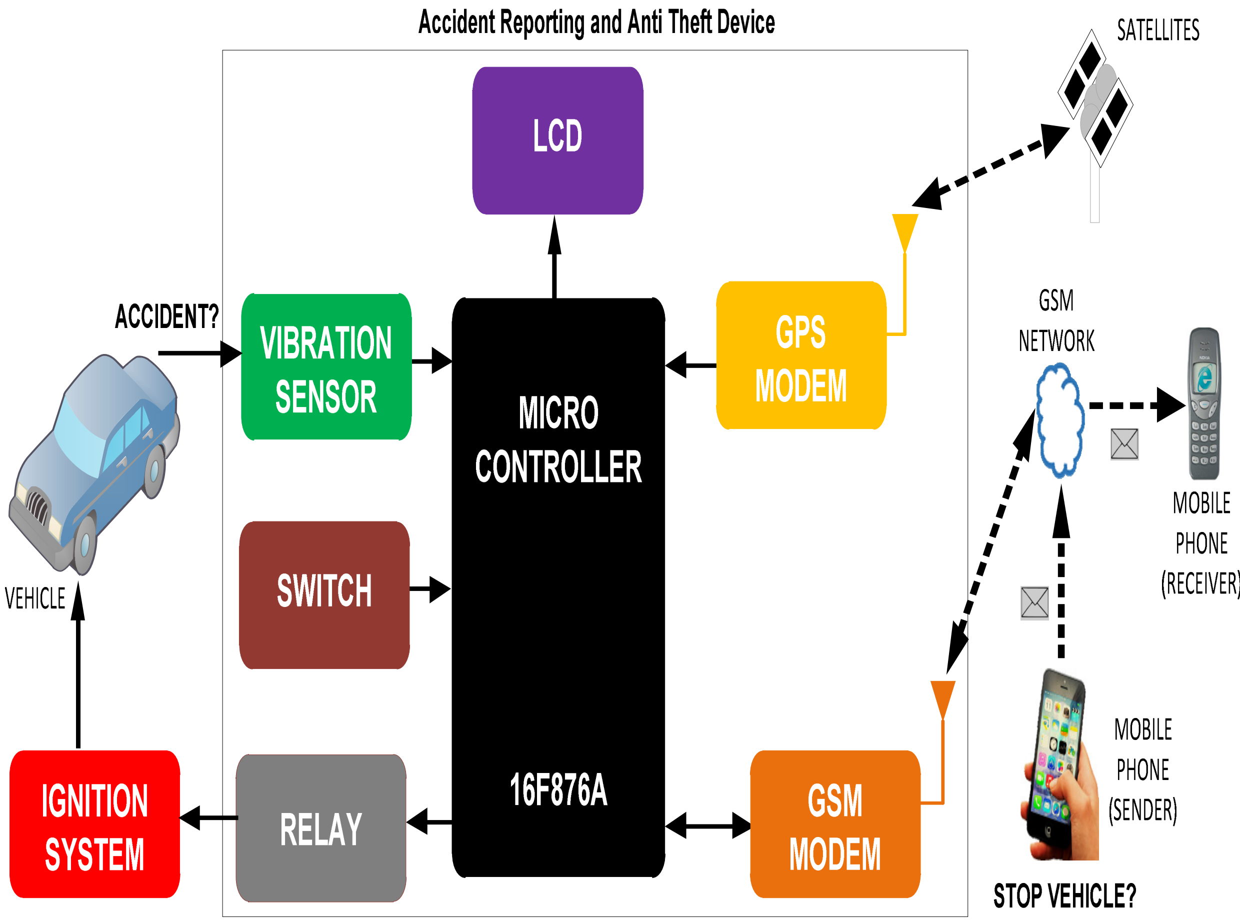


Figure 2.1: System Overview

In the case of vehicle theft, a motorist can immediately send SMS message form any mobile phone to stop the vehicle. This time around, the GSM modem receives an SMS and sends AT command to the microcontroller. Consequently, the electromagnetic relays connected to the microcontroller, through the driver circuit, get energized and open the vehicle ignition circuitry, bringing the engine and of course the vehicle to a halt. Sending and receiving of SMS messages in either case is a function of the GSM network, while the GPS modem requires a clear line of sight to three satellites in order to determine the location of a vehicle.

2.1 System Design

The system design entails software design, hardware design, and fabrication. Proteus software was used for the PBC design and simulation. A preliminary circuit was built on a breadboard for verification purpose before the actual fabrication process was undertaken.

2.2 Software Design

The programs for interfacing each of the components with the microcontroller were written in C language, while Keil µVision5 was used to create hex file (machine language) from the C code and ProgISP was used to load the hex file on to the chip.

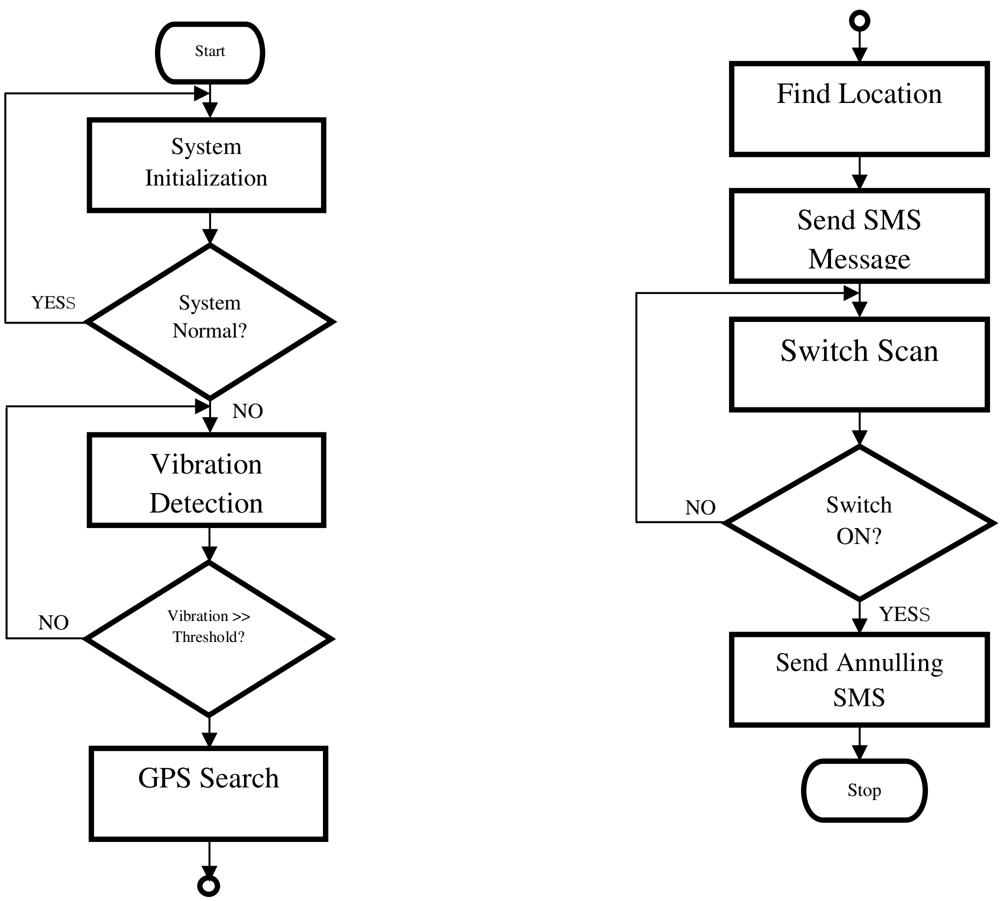


Figure 2.2: System Flow Chart

2.3 Hardware Design

Each of the component was interfaced with the microcontroller to realize the accident reporting and anti-theft features. Nevertheless, simulation of each interface was earlier performed on Proteus before the physical connections.

I) The Control Unit

Microcontroller PIC16F876A is a Plastic Dual Inline Package (PDIP) used in this project. It was considered suitable for the task due to some of its features. This 28-pin device has three I/O ports (Ports A, B, C), meaning that each of the pins can be used for both input (read data form devices) and output (send instruction to devices) as they are bi-directional. It has fourteen interrupts and five Analog-to-Digital input channels of 10-bit each. In addition, PIC16F876A has two analog comparators and thirty-five instruction set.

II) Interfacing the Shock Sensor Module with PIC16F876A

The shock sensor module used has three pins labeled: VCC, GND, and DO. The first two are for powering the module, while the last one is the digital output pin which we connected to pin number 6 of port B. (Figure 2.3). To interface the shock sensor module with PIC16F876A microcontroller, port B was configured as input port in our programming. Some major components of the module include a sensing element, an in-built controller, a potentiometer, power and signal indicators, etc.

The sensing element detects shocks in the form of vibrations and sends a signal to the on-board controller to analyze and identify intensity of the disturbance. For high strength vibrations, the controller gives a logic high signal to the PIC16F876A. The sensing element continuously sends signal to the in-built controller as long as the vehicle engine is running or whenever the automobile is on motion, but the controller only reacts to extremely high signals. For this reason, the power indicator is always ON while the signal indicator is a light that comes up occasionally. The potentiometer was used for sensitivity adjustment of the sensor to achieve our desired level of vibration at which action should be taken. The shock sensor covers about six square meter distance from each side of mounting thing.

III) LCD Interfacing with PIC16F876A

LM016L is a 14 pin, 16 x 2 LCD module used in this project. It has an in-built HD44780 controller with which the PIC communicates in order to display character on the screen. This controller must be initialized before sending data to the LCD module. In the HD44780, data can be sent in either 4-bit 2-operation or 8-bit 1-operation. Hence this controller can interface to both 4 and 8 bit MPUs. The 4-bit 2-operation implies that data transfer between the HD44780 & the MPU is done by transferring 4-bit data twice if the interface data is 8 bits long. Data of the higher-order 4 bits (contents of D4-D7) is transferred first before data of the lower-order 4 bits (contents of D0-D3). In this project, data was transferred using only 4 buses (D4-D7) while D0-D3 were not used. The 8 data buses (D0-D7) are preferably used when interface data is 8 bits long. In the program for this interface, pin 4 & 5 of port B were declared as control pins. Therefore the control lines of the LCD (RS and E) were connected to RB4 and RB5 respectively. Similarly, pins 0 to 3 of the same port were declared as the data pins and the data buses of the LCD (D4 - D7) were connected to the corresponding pins of the microcontroller. (Figure 2.3).

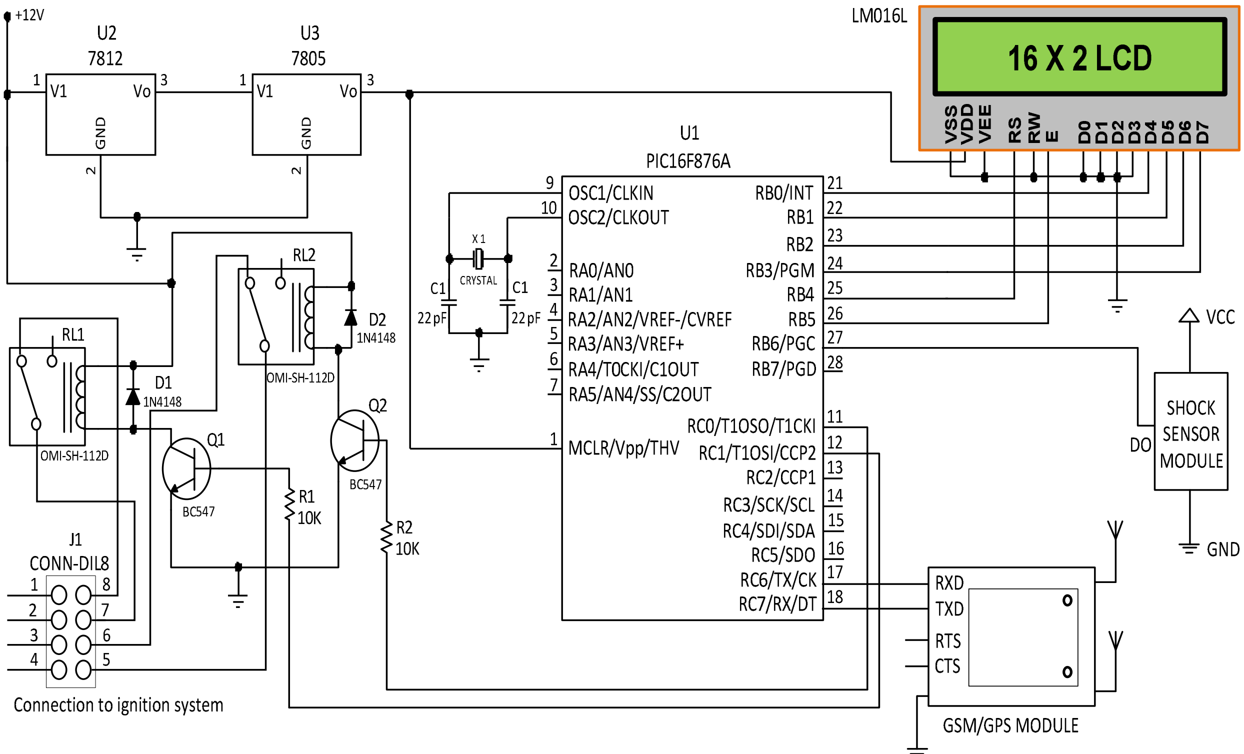


Figure 2.3: Implemented Circuit Diagram

IV) Interfacing the Relays with PIC16F876A

The relays were not connected directly to the microcontroller for two main reasons. Firstly, a negative voltage which may affect the microcontroller is produced in the relay coil due to its back EMF when energized. Secondly, the microcontroller is not capable of supplying the current required for operating the relays. The maximum current a microcontroller can source or sink is 25mA, while a relay needs about 50-100mA current. Therefore, two driving circuits were developed for interfacing each of the relays with the microcontroller. The circuit consists of NPN transistors Q1 and Q2 (BC547) which were connected as switches that carry the current required for operating the relays. It also consists of diodes D1 & D2 (freewheeling diodes) which were used to protect the transistors as well as the microcontroller from back EMF generated in the relays coil. 1N4148 was used because it is a fast switching diode with peak forward current of 450mA. In the program for this interface, pins RC0 and RC1 were declared and outputs from these pins were connected to the base of the transistors (Figure 2.3) because a very small current flowing from **base** to **emitter** causes a large current to flow from **collector** to **emitter.**

V) Interfacing GSM/GPS Module with PIC16F876A

The SIM808 GSM/GPS module that was used can be described as a two in one module. It parses GPS data and sends it through inbuilt GSM module. SIM808 therefore possesses two antenna sockets, one for GSM and other for GPS. These sockets are not interchangeable. The SIM808 module has RXD and TXD pins on board which makes is capable of working at TTL logic and eliminates the use of MAX232 IC to connect serial port to the microcontroller. To interface the GSM/GPS module with PIC16F876A, port C of the microcontroller was configured as output port in our programming. In the program for this interface, we declare the TX and RX pins and initialize asynchronous reception and transmission at 9600 baud rate and 8-bit mode.

The connections were done by linking RXD of the module to TX (pin 17) of the microcontroller and TXD of the modem to RX (pin 18) of the microcontroller. (*Figure 2.3*). A serial communication was thereby established between the GSM/GPS module and the PIC microcontroller such that the RXD and TXD could be used for receiving and transmitting data continuously.

2.4 System Implementation

The entire components were packaged to produce a compact unit tagged: "Automobile Accident Reporting and Anti-Theft Device". For immobilizing a snatched vehicle, the device was connected by interrupting the ignition system of the car. Cables running between the ignition switch & the starter (coil) were broken at a "difficult to reach" point. Thereby creating an open circuit in the ignition wiring. Then, cables emanating from the electromagnetic relays in the gadget were connected at that point to bridge the intentionally created gap (Figure 2.4). The whole idea here was to ensure that current cannot get to the starter except through the anti-theft device. In spite of this interruption in the ignition system which has brought our gadget connected in series with the ignition circuitry, continuity was still maintained in the overall wiring because the normally closed (NC) contacts of the relays were used. Although a mechanical ignition system was tested, other types of ignition systems work on a similar principle. For accident reporting, a suitable threshold for the sensor was determined by experimenting with different categories of potholes and sudden application of brakes at various speeds of a vehicle.

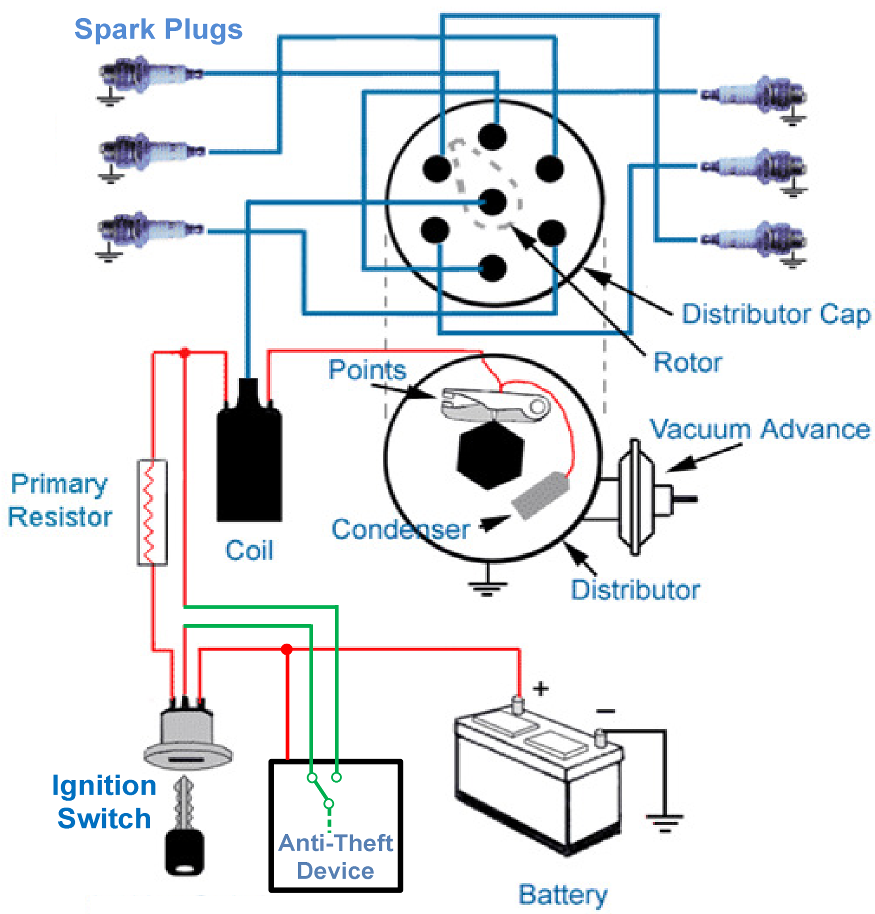


Figure 2.4: Wiring Diagram of A Vehicle Ignition System with the Anti-Theft Device

2.5 Testing

The gadget was installed onto a vehicle in such a manner that it is not visible to anyone inside or outside the car. This was carefully done to enable the device operate as a covert unit. However, the switch for sending annulling SMS was made easily accessible.

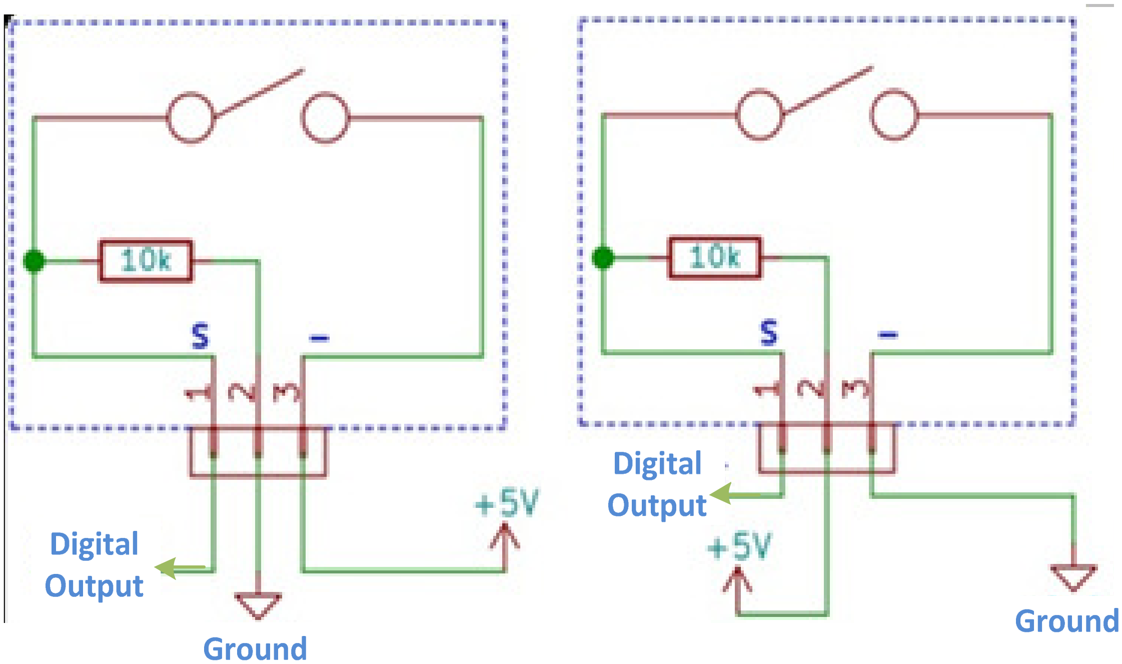
A) Anti-Theft Test

While someone was driving the car in which the rescue device has been installed, an assumed car-snatch victim sent the SMS message "MAOFF" to the car using any mobile phone and the engine suddenly stopped. Efforts to quickly restart the engine failed until when the SMS message "MAON" was sent to the rescue device through another mobile phone. When the text message "MAOFF" was sent to the mobile number of the SIM card inside the GSM modem, the SIM300 module sends corresponding AT-commands to the microcontroller. Consequently, pin RC1 of the PIC microcontroller goes HIGH (1), the transistor Q1 turns ON and current flows through the relay RL1. Similarly, pin RC0 of the PIC microcontroller goes HIGH (1), the transistor Q2 turns ON and current flows through the relay RL2. The relays become energized and the NC contacts become open. As the ignition circuitry of the vehicle is opened, the entire ignition system stopped working and the vehicle was thereby brought to a halt.

By sending the other text message "MAON" to the rescue device, the SIM300 module sends a reverse AT-commands to the microcontroller. Consequently, pin RC1 of the PIC microcontroller goes LOW (0), the transistor Q1 turns OFF and no current flow through the relay RL1. Also, pin RC0 of the PIC microcontroller goes LOW (0), the transistor Q2 turns OFF and no current flow through the relay RL2. The relays become de-energized and assume their original NC contacts allowing continuity in the ignition circuitry.

B) Accident Report Test

The shock sensor was installed in two different configurations to determine which of the connections is suitable for the controller. In the first configuration known as pull down resistor configuration, pin 3 was connected to the +5V supply, pin 2 was connected to ground, and pin 1 was reserved for digital output. Then a 10kΩ resistor was connected in between pin 1 and pin 2. Meanwhile, for the pull up resistor configuration the positive supply voltage and the ground were interchanged as shown in figure 2.5. Sensitivity of the sensor was found to be higher with the pull up resistor configuration.

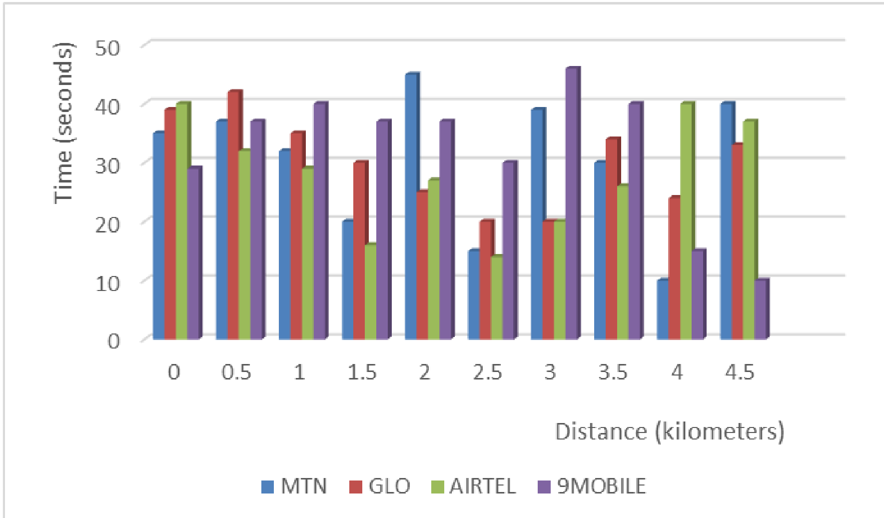


(a) Pull-down Resistor (b) Pull-up Resistor

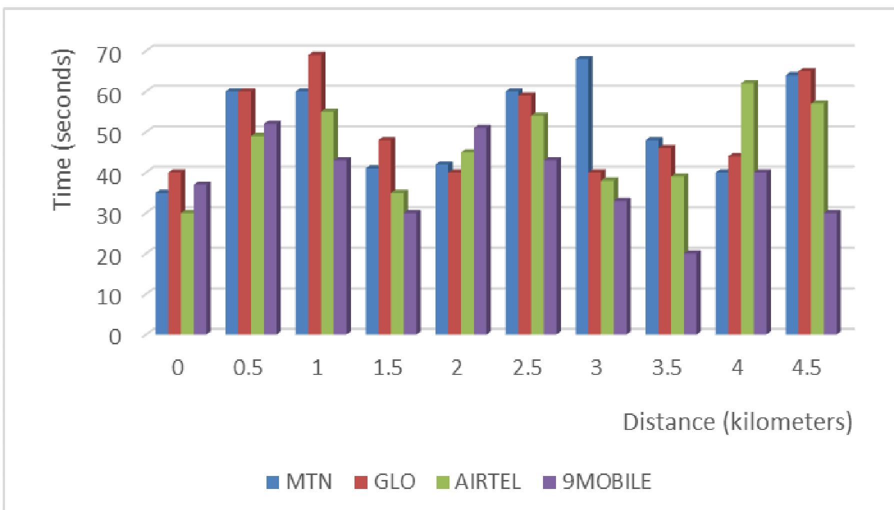
Figure 2.5: Shock Sensor Configurations

3. RESULT AND DISCUSSION

The system was tested several times at different times of the day with a vehicle at various locations, an assumed car-snatch victim at varying distances, and expected medical rescue team at different distances away. The four major GSM networks available in the country were utilized one after the other. Communication between the sending and receiving ends of the system was established using the same and different networks such as MTN to MTN, or MTN to AIRTEL. Time taken for the SMS to be delivered were plotted against the distances. The system was tested in both urban and rural areas of the country.



(a) Urban Area



(b) Rural Area

Figure 3.1: System Reliability Test

It was observed that a linear relationship does not exist between the distance and time taken to deliver an SMS message. It was also noticed that the text messages were delivered faster with the hours of 5:00 a.m. and 7:00 a.m., but slightly delayed in the afternoon period. Using the same or different service providers for the sending and receiving ends did not make any significant impact. However, one of the most noticeable outcome is that the efficiency of the system is a bit lower in the rural areas. SMS charge of ₦4 was deducted by the network operator for each of the messages.

4. CONCLUSION

Two major problems are hereby solved simply by establishing communication between a vehicle and someone at any distance away. The statement: "accidents are not made, they are caused" may be an acceptable one, but some of the causes of automobile accidents cannot be eradicated due to human nature. The National Bureau of Statistics (NBS) recently released figures which show that not less than 2,673 people lost their lives in road accidents at the first half of last year (Leadership Newspaper, August, 12 2017). This is approximate fifteen people daily. Delays in giving appropriate support to the accident victims must be responsible for most of these deaths. In addition, not all accident cases on our roads are being reported and this leads to shortfall of data.

When the engine of a snatched vehicle suddenly stops, the criminals would panic. Even if they can somehow locate and bypass the rescue device, the extra time it would take will discourage them from making such attempt. The vehicle would be abandoned as they run away with the thought that certain individuals could be tracking their movements. Therefore, with the implementation of this system, it is not going to be business as usual for vehicle snatchers as it will go a long way in reducing the incidences of car snatching on our roads. Any victim of car-snatch can be rest assured of recovering the vehicle within the shortest time period, without much stress and at minimum cost. Also, there will be reduced rates on both life and vehicle insurance. Besides, the resources expended in search of missing vehicles would be channeled towards the social-economic growth of our nation.

The mobile number of the SIM inside the device remains the "rescue number" of the vehicle if snatched and should therefore be confidential and memorized. One of the areas that calls for improvement in this research is the inclusion of software that would allow the accident location to be sent in the form of geographical map rather the merely stating the longitude and latitude.

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