VEHICLE TRACKING AND ACCIDENT ALERT SYSTEM USING GPS AND GSM MODULE

G.N. JOLA[1] Y.M. AUDU[2] B.E. ZAKKA[3]

[1, 2]Electrical Electronics Engineering Department, Federal Polytechnic Bauchi, Nigeria. [3]Computer Science Department, Federal Polytechnic Bauchi, Nigeria.

Abstract

The vehicle tracking system is design to monitor and control vehicles that are used by individuals, fleet management function such as fleet tracking, routing, dispatch information and security and urban transportation companies. This system helps to reduce the rate at which cars are stolen and also increased survival chances of accident victim through the impact sensor. The system is designed to track the position of the vehicle and alert the user anytime the vehicle have an accident. It comprises of integration between GPS receiver, microcontroller, GSM module and impact sensor. The GPS module receiver is the coordinate from the satellite at which the system is located, controlled by the user using command interfaces through GSM module as a transmitter and receiver of data. This project consist of two basic parts, the hardware and the software development. The hardware development includes the GPS, impact sensor and the microcontroller wiring connection, and its integration with GSM module. The software development includes the programming of the microcontroller (ATMEGA 328) with the source code and GSM message command.

KEYWORDS:
Tracking, GSM Module, Alert System, Vehicle, GPS.

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

INTRODUCTION

Despite the various technologies that have been developed in recent years to prevent auto theft and to track auto theft, vehicles all around the world are still stolen every year. A variety of safety and monitoring systems has been designed to help businesses administer and manage a significant number of vehicles. A system for fleet management can lower the cost and efforts of employees to complete assignments on the road in a minimum time [Al-Taee *et al*., 2007]. However, there are still some security loopholes where these technologies do not prevent auto theft. Some of these security loopholes do not help to recover vehicles or allow users to know the state of their vehicles. The proposed security system herein is designed to monitor and control vehicles that are used by individual parties for a particular purpose, to lock and unlock the vehicle in the event of theft and to track it online for retrieval. This system is the integration of several modern and integrated communication technologies [Lin, *et al*., 2004]. The use of SMS technology has become popular because it is reliable, cheap, convenient and an affordable way to transfer and receive data. Fig.1 shows the system that introduced consisting of a GPS modem [Tamil *et al*., 2007].

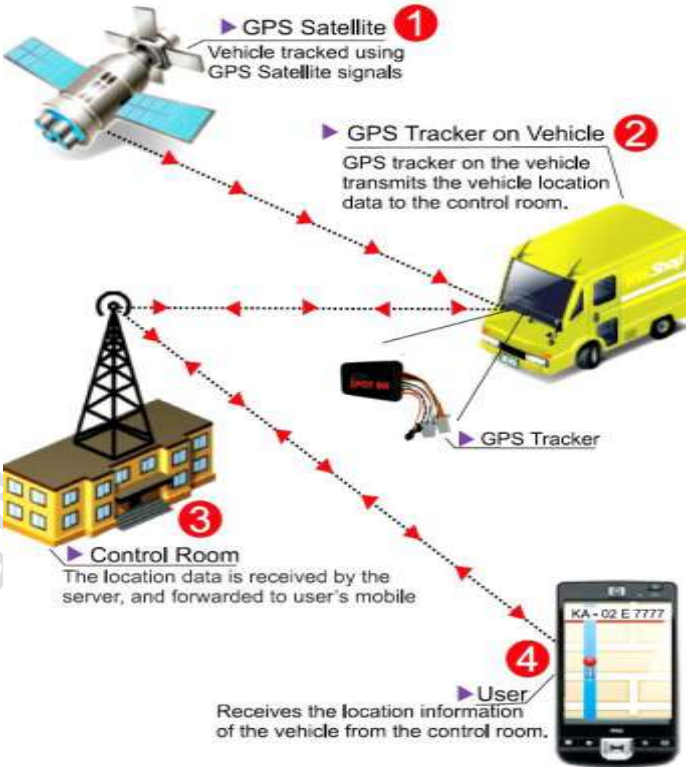

Figure. 1: Vehicle Tracking System Operation Steps
Source: Tamil *et al*., 2007

As shown in Fig. 1, when the car is launched, the client receives a confirmation SMS. When the system receives a message from the owner, the system will do a security check for the number that received the message. When the owner wants to know the vehicle position, an SMS with a

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

special message is sent. Then the vehicle owner will receive an SMS showing the location and position of the vehicle. The owner can communicate with the vehicle via the mobile phone to follow the vehicle. This thesis shows implementation of many modern technologies to accomplish a desirable objective of monitoring and vehicle management.

Problem Statement

Rampant cases of vehicle theft and abuse by drivers who misuse company vehicles for personal activity necessitates the use of vehicle monitoring systems. There is a need of sample electronic solution being addressed by the work. For over a decade, GPS vehicle tracking systems have proven to be effective in determining the precise location of a vehicle or asset. GPS tracking uses a system of satellites orbiting the earth to find an approximate placement of the receiver within a few meters of its actual location.

Aim

The aim of this project is to design and construct a GPS and GSM Vehicle Tracker.

Scope of the Project

The project scope will cover only Bauchi Local Government of Bauchi State, Nigeria. Location of the area will be view via the LCD in the system. The device will be placed at a location and query from a different location. If the system feedback (LCD) tally's with that of a conventional Google map, then the system is said to be perfect and accurate.

Impact of Tracking System in Vehicle

Vehicle tracking systems are commonly used by fleet operators for fleet management functions such as fleet tracking, routing, dispatch, on-board information and security [Al-Taee *et al*., 2007]. Commercial fleet operators as well as urban transport companies use this system for various purposes that include monitoring schedules of buses in service, triggering any change of buses destination and manage per-recorded announcements for

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

passengers. The vehicle tracking system is also used as an anti-theft system. If a vehicle is stolen the owner can easily track the car by knowing the exact location of the car. After the introduction of vehicle tracking system the chances of recovering the car has increased enormously. Vehicle tracking system has made people's life much easier than before. Now, owner of cars can easily track their car from any corner of the world if it is stolen.

LITERATURE REVIEW AND THEORETECAL BACKGROUND

Relevant literature work carry out by various researchers is presented.

Javed (2010) shows that the concept of a car tracking system depends on the mobile phone and network. The software in this system proposes to send an individual request to the cellular network (GSM) to reach and call a private car ID. The car ID, in fact, is a special SIM kept in a secret device inside the car. This device can receive and send messages and receive phone calls automatically. Depending on the data and information which is collected, the software will dissect and analyse the cell information and take the data along with the GPS locations for this cell, and determine the position of the vehicle.

Iman (2011) shows that the GPS is popular and is used for tracking and monitoring vehicles. Many systems have been created to provide these services to make them attractive and more necessary than ever. In this work, a "control system GPS vehicle" is proposed. This system is used to monitor the behaviour of employees; moreover, this system is used to prevent theft. As a recovery device, in addition to working as a safety system, alarms are combined with the car. The main job of this work is to provide two types of end-user applications: a web application and a mobile application.

Atso (2012) shows the development and design of GPS and how GSM depends on car tracking and alarm. This system helps transport companies to reach and track their vehicles at any time and an alarm system is used to provide information about any armed robbery or accidents.

Montaser (2012) a security system that apply efficiency car theft. The main system consists of the GPS and GSM. Customers respond by using this

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

system in their cars to find their position using Google Maps. (Moreover, car owners can determine the coordinates and current location of their cars by using Google Maps using the GPS locator, via the SMS from the GSM network to a GSM modem attached to a laptop or PC.

In view of the above reviewed documentations, this project provide a more cost effective and reliable design using GPS module(NE06), GSM Modem (sim800l), microcontroller (Atmegaa328), Vibration sensor module and display(16*2 LCD).

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as Pulse width modulation outputs), 6 analog inputs, a 16 MHz ceramic resonator, a universe serial bus [USB] connection, a power jack, an in circuit series programming [ICSP] header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform [Alicia 2010]. This is shown in figure 2 beside

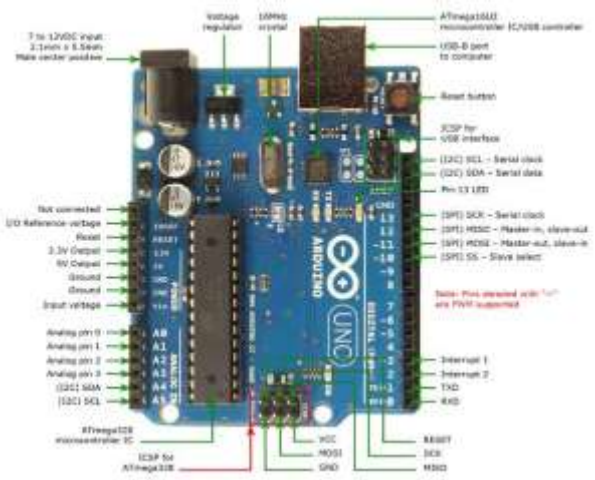

Figure 2: Arduino board

Microcontroller (ATMEGA 328)

This is mainly referred to as the heart or brain of the system as a whole, it is responsible for storing the GPS data on its memory, also feeding the LCD with signal to display the operation been carried out, it also read the data

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

on the subscriber identification module (SIM) card and write a command to the GSM Modem to send SMS to the programmed phone number. In summary, it controls the whole system. The microcontroller is a standalone computer, optimized for control applications, the entire processor, memory and input/output interface are located on a single piece of silicon, so it takes less time to read and write to external device. The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library). It can source up to 5V, 500mA from the supply unit and sink up 20mA.

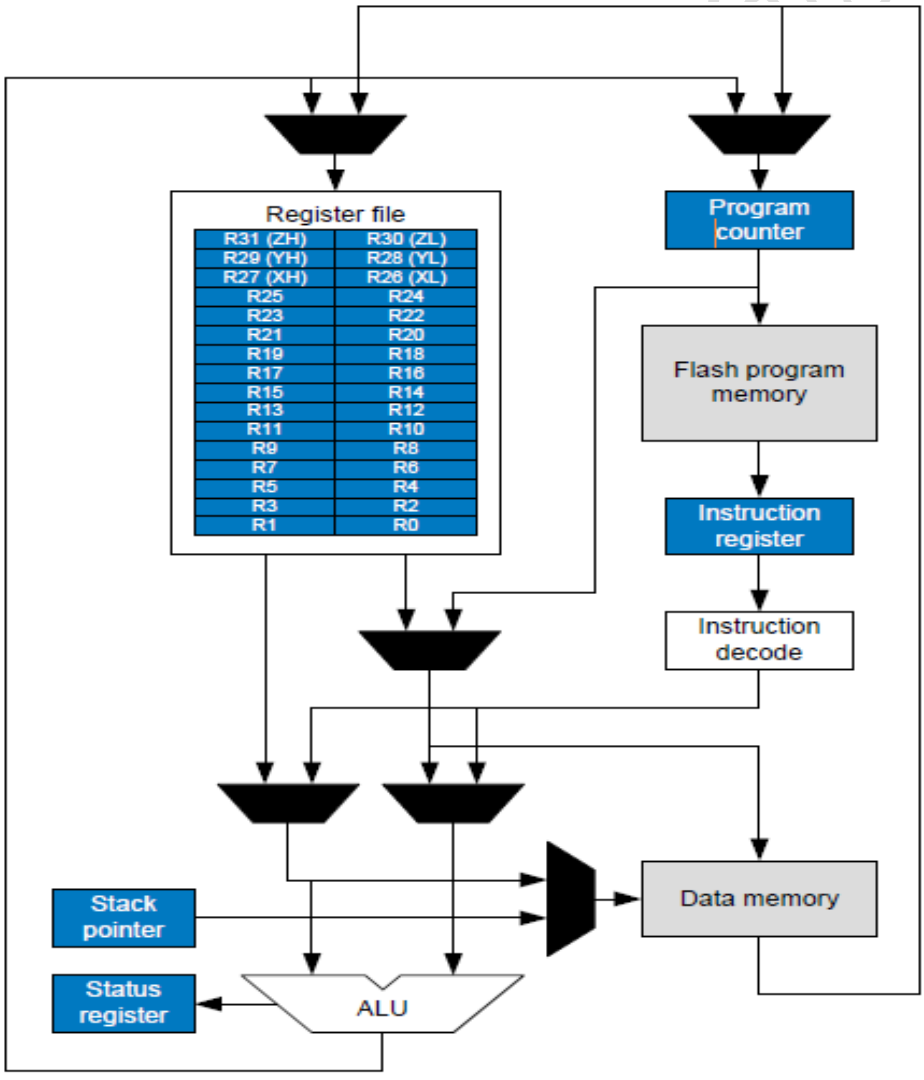

Figure 3: Atmega 328 architecture

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Liquid Crystal Display (LCD)

shown in figure 4 is the Liquid crystal display. It is an electronic display module that finds a wide range of application in circuits. It is preferred over seven segments and other multi LED because it is more programmable and economical. A 16*2 LCD means it can display 16 characters per line and there are 2 such lines.

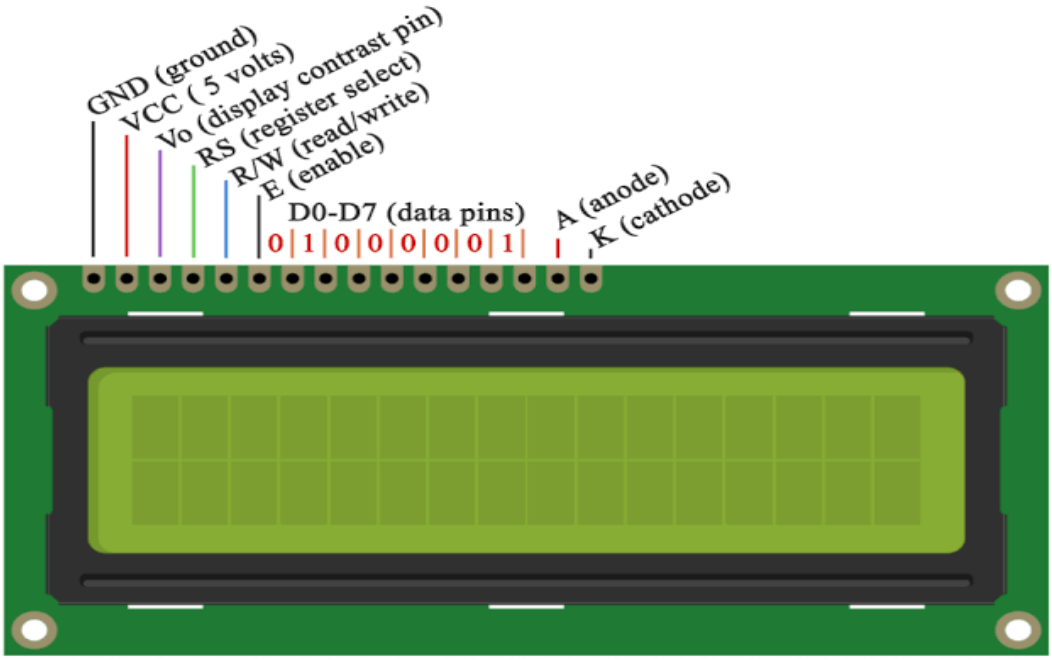

Figure 4: Liquid crystal display (LCD)

GPS Module

The **NEO-6MV2** is a Global Positioning System **(GPS)** module and is used for navigation. The module simply checks its location on earth and provides output data which is longitude and latitude of its position. It is from a family of stand-alone GPS receivers featuring the high performance u-box 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature (16 x 12.2 x 2.4 mm) package. The compact architecture, power and memory options make **NEO-6 modules** ideal for **battery operated mobile devices** with very strict cost and space constraints. Its Innovative design gives **NEO-6MV2** excellent navigation performance even in the most challenging environments.

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Figure 5: GPS NEO Module

GSM Technology

GSM stands for a global system for mobile communication. GSM is an international digital cellular telecommunication **[Gayathri *et al*., 2014]**. The GSM standard was released by ETSI (European Standard Telecommunication Standard) back in 1989. The first commercial services were launched in 1991 and after its early introduction in Europe; the standard went global in 1992. Since then, GSM has become the most widely adopted and fastest-growing digital cellular standard, and it is positioned to become the world's dominant cellular standard.

Today's second-generation GSM networks deliver high quality and secure mobile voice and data services (such as SMS/Text Messaging) with full roaming capabilities across the world.

GSM platform is a hugely successful technology and as unprecedented story of global achievement. In less than ten years since the first GSM network was commercially launched, it become the world's leading and fastest growing mobile standard, spanning over 173 countries.

The Global System for Mobile Communication (GSM) network is a cellular telecommunication network with a versatile architecture complying with the ETSI GSM 900/GSM 1800 standard. Siemen's implementation is the

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

digital cellular mobile communication system D900/1800/1900 that uses the very latest technology to meet every requirement of the standard (Qu, 2016).

GSM Services

GSM services follow integrated service digital network (ISDN) guidelines and classified as either tele services or data services. Tele services may be divided into three major categories:

• Telephone services, include emergency calling and facsimile. GSM also supports Videotex and Teletex, through they are not integral parts of the GSM standard.

• Bearer services or Data services, which are limited to layers 1, 2 and 3 of the OSI reference model. Data may be transmitted using either a transparent mode or non-transparent mode.

• Supplementary ISDN services, are digital in nature, and include call diversion, closed user group, and caller identification. Supplementary services also include the short message service (SMS).

Short Message Service

SMS stands for Short Message Service. It is a technology that enables the sending and receiving of message between mobile phones. SMS first appeared in Europe in 1992. It was included in the GSM (Global System for Mobile Communication) standards right at the beginning. Later it was ported to wireless technologies like code division multiple access (CDMA) and time division multiple access (TDMA). The GSM and SMS standards were originally developed by European Telecommunication Standard Institute (ETSI) which is responsible for the development and maintenance of the GSM and SMS standards.

One SMS message can contain at most 140 bytes (1120 bits) of data, so one SMS message can contain up to:

i. 160 characters if 7-bit character encoding is used. (7-bit character encoding is suitable for encoding Latin characters like English alphabets.)

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

ii. 70 characters if 16-bit Unicode character encoding is used. (SMS text messages containing non-Latin characters like Chinese character should use 16-bit character encoding). Once the message is sent, the message is received by SMSC, which must then get it to the appropriate mobile device. To do this the SMSC sends a SMS request to Home Location Register (HLR) to find the roaming customer. Once HLR receives the request, it responds to the SMSC with the subscriber's status:

- Inactive or active
- Where subscriber is roaming.

If the response is "inactive", then the SMSC will hold onto the message for a period of time. When the subscriber access his device, the HLR sends a SMS notification to the SMSC and the SMSC will attempt delivery.

DESIGN AND CONSTRUCTION

This chapter discusses the design and implementation of the whole system. The system has sub-units: like power supply unit circuit, switching circuit, GPS, GSM and liquid crystal display. These sub-units are also made of some components and all those components have their individual specifications based on datasheets, like current rating ratings, voltage ratings and power ratings. Because of this, proper design calculations and implementation of the designs have to be carried out on each of these sub-units to ensure that the system as a whole functions properly as expected. The methodology implemented was divided into software and hardware method. The software involves simulation of the project using Proteus 8.6 and Arduino IDE while the hardware involved bread-boarding, soldering and casing.

Block Diagram

The Block diagram of Vehicle tracking and theft control using GSM and GPS technology is as shown in the figure 6. It consists of power supply section, GSM, GPS, vibration sensor, microcontroller and the liquid crystal display (LCD) section. The circuit components were powered by +5v DC.

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

The method implemented in this project design was the top-down approach, which was aimed at designing one unit after the other to attain high level of accuracy towards the achievement of desired objectives. The GPS module (NEO6) continuously receives coordinates from the satellite and sends the details to the microcontroller via its serial communication protocol pins. The user can decide to know the location of his vehicle by sending valid commands to the microcontroller. When this command is receives by the microcontroller, it will then send the user with the available coordinate via the GSM module. The user receives the location of the vehicle. The vibration sensor will send a signal to the microcontroller whenever there is a high impact on the vehicle and the microcontroller will then send a message to the user notifying the user of an accident. The microcontroller always send signal to the LCD to display the programmed actions being carried out.

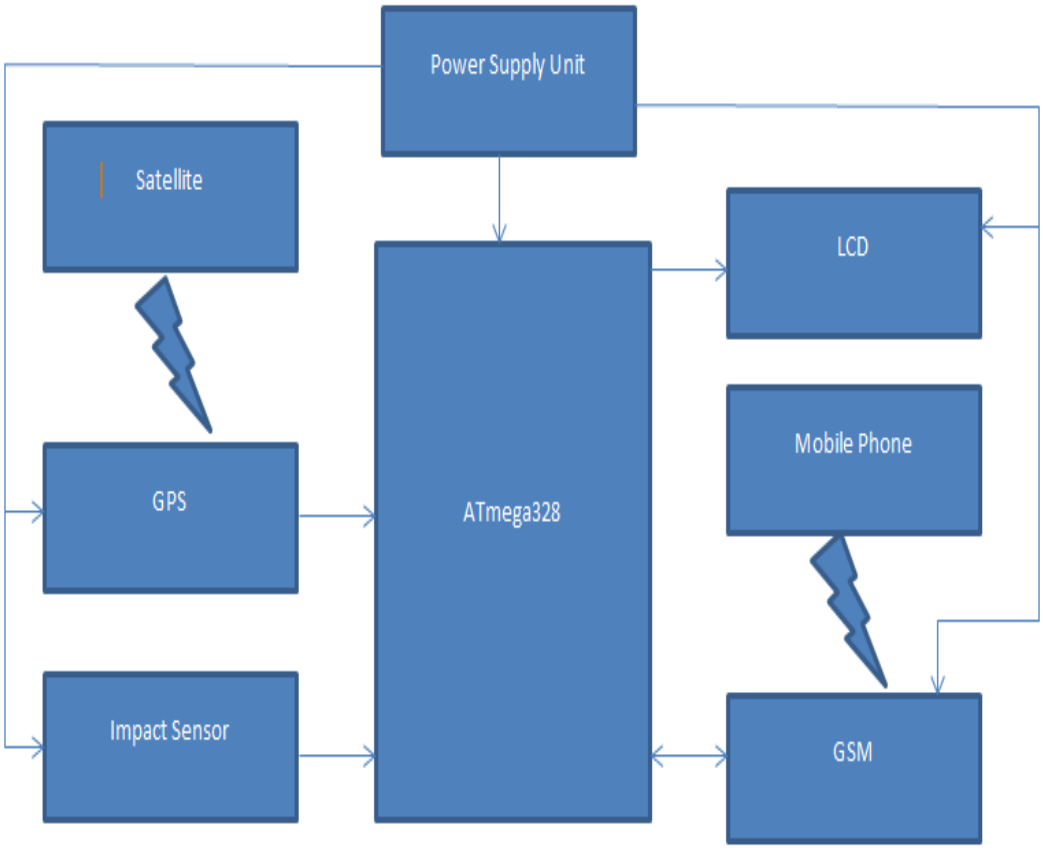

***Figure 6*:** Block Diagram

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Design

This unit explains the details design of each unit as presented in figure 6 above.

Power Supply: Lithium Iron Battery

The lithium iron phosphate battery (LiFePO battery) or LFP battery (lithium ferrophosphate), is a type of rechargeable battery, specifically a lithium-ion battery using LiFePO as the cathode material, and a graphitic carbon electrode with a metallic backing as the anode. The specific capacity of LiFePO is higher than that of the related lithium cobalt oxide (LiCoO) chemistry, but its energy density is less due to its lower operating voltage. The main drawback of LiFePO is its low electrical conductivity. Therefore, all the LiFePO cathodes under consideration are actually LiFePO. Because of low cost, low toxicity, well-defined performance, long-term stability, etc. LiFePO is finding a number of roles in vehicle use, utility scale stationary applications, and backup power. The battery has a working voltage of 3.7 V and four pieces of the batteries are connected in series to get a total of 14.8V which is enough to power the whole system.

Voltage Regulators

A block diagram of a voltage regulator is shown in figure 7, while Figure 8 shows the circuit diagram of the system. A voltage regulator is designed to automatically 'regulate' voltage level. It steps down the input voltage to the desired level and keeps it at that same level during the supply. This is to ensure that even when a load is applied the voltage doesn't drop.

Thus, a voltage regulator is used for two reasons: -

1. To regulate or vary the output voltage of the circuit.
2. To keep the output voltage constant at the desired value in-spite of variations in the supply voltage or in the load current.

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

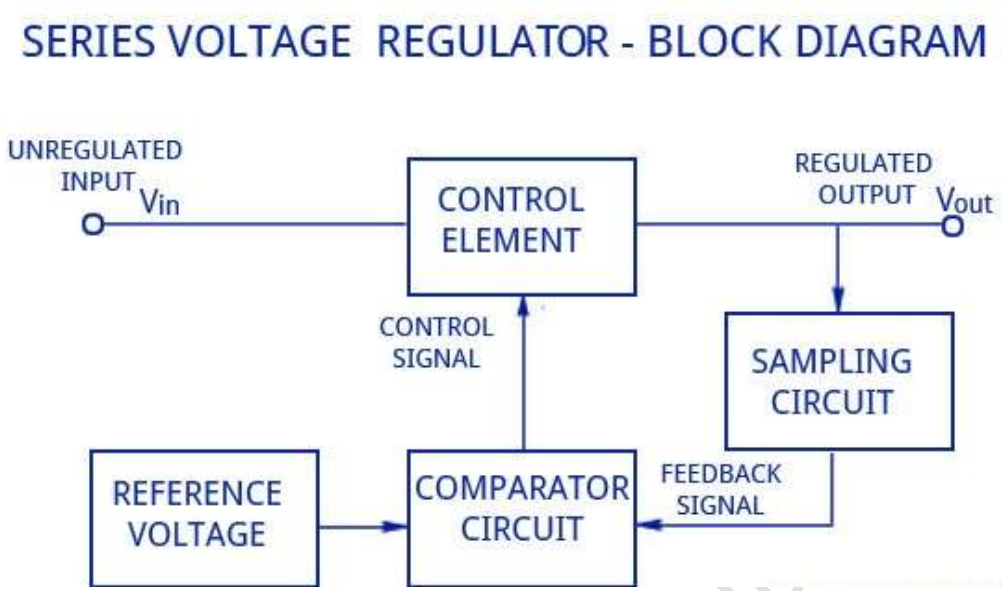

Figure 7: Voltage Regulator Block Diagram

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications.

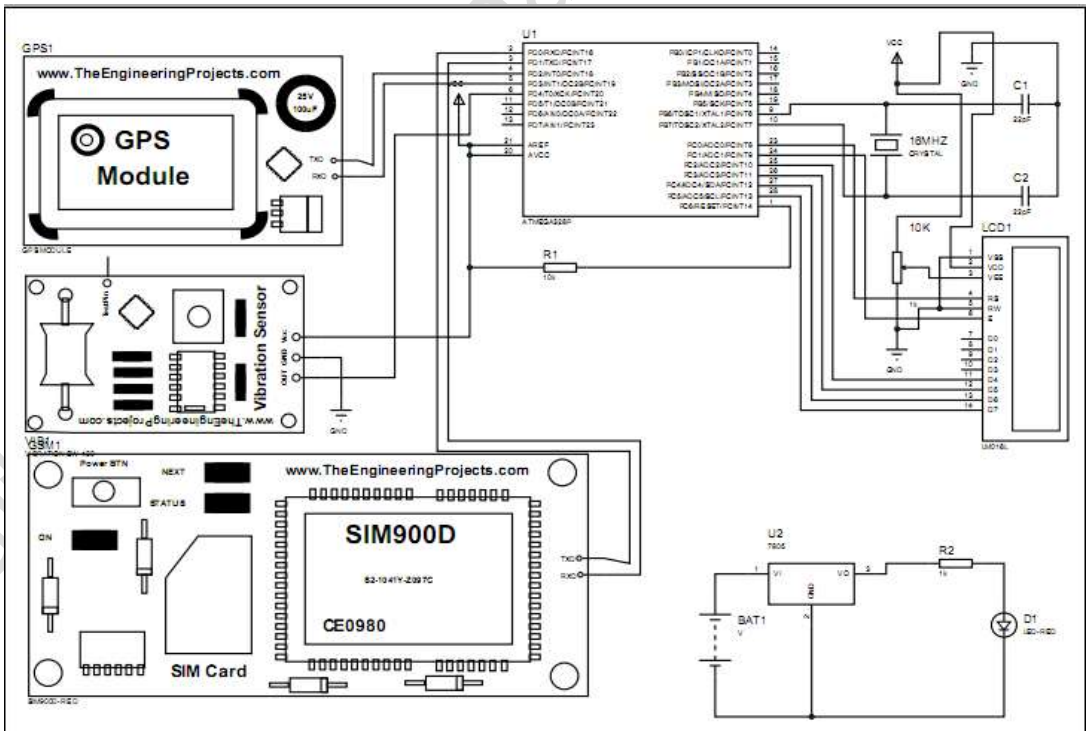

Figure 8: Circuit Diagram of the system

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Program Development

For this project, C programming language was used to write the program for the vehicle tracking system. The preparation symbol which is the "START" begins the programming process. The system was then initialized, connecting the various units of the circuit. After this, the status of the GPS and GSM module was checked to know the state of the device. Then a decision was made to track the GPS and wait for request from the user to either send the vehicle location. If the request received by the system is tracking, then longitude and latitude of the system location together with the http link is sent to the authorized user. And if the impact sensor sends a HIGH signal to the microcontroller, a short message will be send to the programmed phone number with the programmed contents. The program flow chart is shown in figure 9.

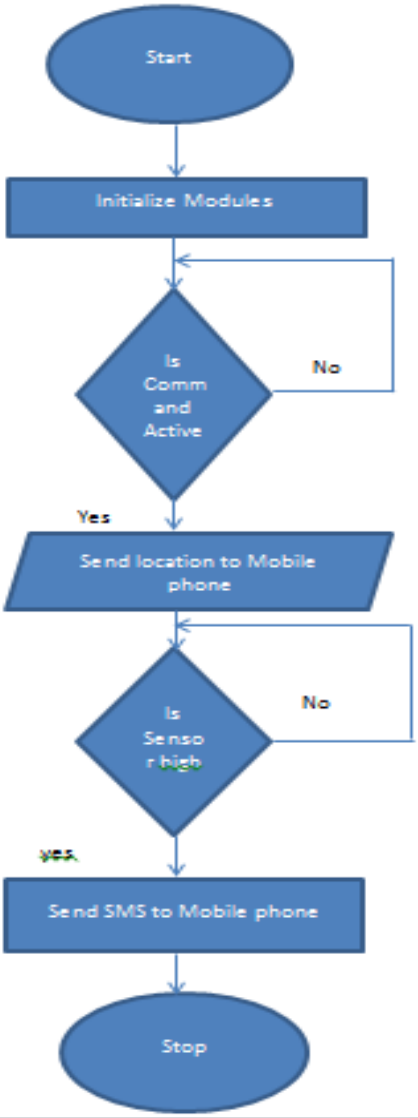

Figure 9: Program Flow Chart

TEST, RESULTS AND ANALYSIS

Test

The components used for the implementation of this project were tested on breadboard for better performance, and were later transferred to the Vero board and soldered. The heat applied during soldering was just moderate to avoid damage of the Vero and the components since most of the components have low heat resistance. The test equipment includes;

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

i. Breadboard-To assemble and test individual components
ii. Digital multi meter to measure voltage, current, resistance and check for continuity
iii. Light emitting diodes
iv. Arduino sketch

GSM Module Test

Six (6) separate tests were conducted on the GSM module (sim800L) and the results are shown in the Table 1 TRACK

Table 1: GSM module test results

SMS	TRACK
1	Delivered
2	Delivered
3	Not Delivered
4	Not Delivered
5	Delivered
6	Delivered

GPS Module Test

Five (5) separate tests were conducted on the GPS module at Federal Polytechnic Bauchi and the results obtained are shown in the Table 2

Table 2: GPS module test results

S/N	LONGTITUDE	LATITUDE	LOCATION
1	9°46'08.24"E	10°15'42.51"N	FPTB
2	9°46'08.24"E	10°15'42.51"N	FPTB
3	00000.00000	0000.00000	FPTB
4	9°46'08.24"E	10°15'42.51"N	FPTB
5	9°46'08.24"E	10°15'42.51"N	FPTB

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Impact Sensor Test

The following test were conducted on the Vibration sensor to show how the accident detection works, the output pin of the vibration sensor is HIGH whenever a heavy impact is detected and the microcontroller was programmed to send a short message via the GSM module to the user active mobile number indicating the occurrence of an accident. The results obtained from this test are shown in the Table 3.

Table 3*:* Impact sensor test results

SMS	SENSOR OUTPUT STATE	LCD DISPLAY	SMS STATUS
1	HIGH	Accident detected	Received
2	HIGH	Accident detected	Received
3	HIGH	Accident detected	Received
4	LOW		Not Received
5	HIGH	Accident detected	Received

Results

Plate 1: below shows the system on test after soldering with the Arial view together with the System showing location on Google Plate 1: Tracking

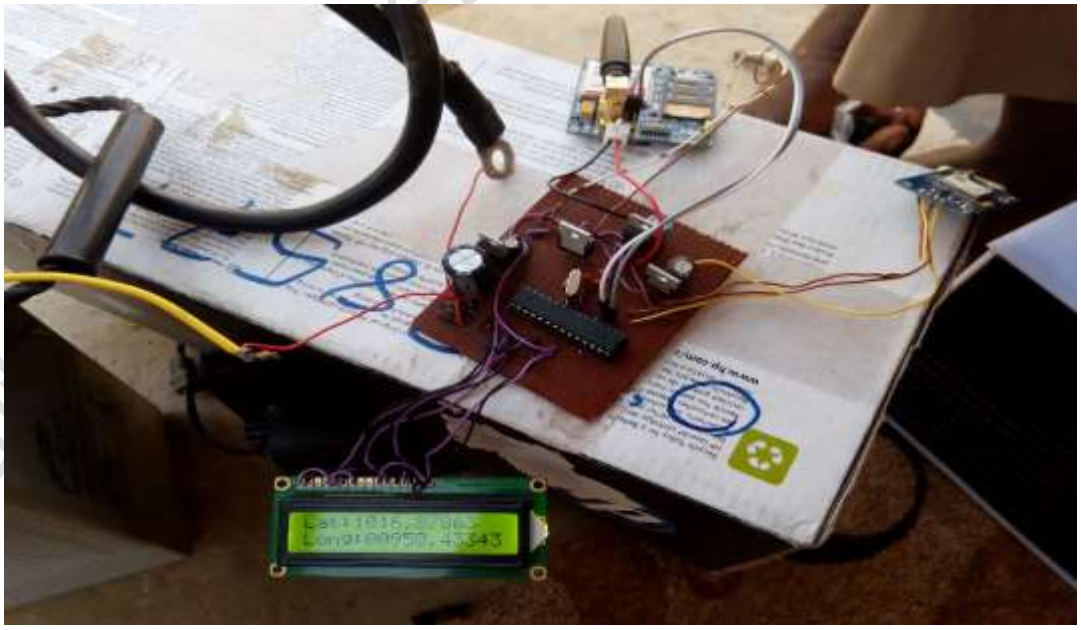

Plate 1: Pictorial diagram of the system

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Plate 2: Aerial view of location of the device on Google map

Analysis

This section gives the tests carried out on the components and the modules that make up the whole system and test results are presented in tabular forms for perfect understanding. The tests carried out on power supply unit (PSU) were based on theoretical and measured values of the voltages across the regulator being used. It was found that there is a small variation between the theoretical voltage value and the measured voltage value. The test carried out on GSM module, GPS module and DC motor also showed the effectiveness of the system. The Arduino Microcontroller is the heart of this system; all other modems connect to this Microcontroller. The system uses the Arduino UNO as a microcontroller. The GSM modem is used to connect to the GSM network. This system uses the SIM800L to send and receive instructions and alerts. The GPS modem is used to connect to the GPS satellite system. This system uses the GPS modem to acquire vehicle position and to send these data to the vehicle owner's mobile phone.

Conclusion

The vehicle security and tracking system uses the SIM 800 (GSM modem) for communication between the mobile station and microcontroller to send and receive instructions. The system attains the results for a car system

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

providing security to the car as well as alerting the user whenever the vehicle had an accident.

The purpose of this project is to create a vehicle system to tract vehicle location remotely as well as to alert the user of his vehicle status should in case of an accident. Furthermore, the prevention of vehicle theft was also an important factor. All objectives have been achieved successfully with a system yielding results as expected. Users can determine the position of their vehicles via GPS, by using a smart phone in conjunction with the Google Maps application to show vehicle coordinates.

Limitations

Following are the limitations of this system:

i. The working of the system is highly dependent on the coordinates provided by GPS module, many other important systems are working on the grounds of the coordinates of the GPS.
ii. The working of the system also depends on the availability of the internet in order to view the location of the vehicle on Google maps.
iii. It also depends on the network service of the installed SIM in order to send/receive messages efficiently.

Recommendation

We recommend that the project can be extended to use active tracking technology to track vehicle on Google maps at stipulated time intervals and can add other sensors to know the speed, distance covered and estimated time of arrival to a particular destination. The concept and information used in this system design could be used for development of smart vehicle tracking and security system.

REFERENCES:

Alicia M. G., (2010), "*New Media Art Design and the Arduino Microcontroller*", PhD Thesis, School of Art and Design, Pratt Institute, United States America, pp. 23.

Al-Taee M. A., Khader O. B., Al-Saber N. A., (2007), "*Remote Monitoring of Vehicle Diagnostics and Location Using a Smart Box with Global Positioning System and General Packet Radio Service*", Electrical and Computer Engineering, IEEE International Conference, vol. 53, pp. 385–388.

Fan X., Xu W., Chen H., Liu L., (2006), "*A Composite Communication Scheme for Mobile Object Management System*", In Advanced Information Networking and Applications, IEEE International Conference, vol. 2, pp. 235-239.

Hapsari A. T., Syamsudin E. Y., Pramana I., (2004), "*Design of Vehicle Position Tracking System Using Short Message Services*", in Proc. Conference on Asia South Pacific Design Automation, vol. 41, pp. 285-288.

Hsiao W. M., Chang S. J., (2006), "*Optimal Location Update Strategy of Cellular Network Based Traffic Information System*", Intelligent Transportation Systems Conference, IEEE International Conference, pp. 248-253.

http://arduino.cc/en/Main/ArduinoGSMShield. (Data Download Date: 15 November 2017).

Kishore T. K., Vardhan T. S., Narayana N. L., (2010), "*Vehicle Tracking Using a Reliable Embedded Data Acquisition System with GPS and GSM*", Int. Journal of Computer Science and Network Security, vol. 10, no. 2, pp. 286-291.

Lin C. E., Hsu C. W., Lee Y. S., Li C. C., (2004), "*Verification of Unmanned Air Vehicle Flight Control and Surveillance Using Mobile Communication*", Journal of Aerospace Computing, vol. 1, no. 4, pp.189–197.

Muhammad R. A. F., Micheal D., (2013), "*Remote Vehicle Tracking System using GSM Modem and Google Map*", Utilization and Development in Engineering and Technology, IEEE International Conference, pp. 15- 19.

Parvez M. Z., Ahmed K. Z., Mahfuz Q. R., Rahman M. S., (2010), "*A Theoretical Model of GSM Network Based Vehicle Tracking System*", Electrical and Computer Engineering, IEEE International Conference, vol. 47, pp. 594-597.

INTERNATIONAL JOURNAL – ERT
VOL. 11 NO.5 JUN-2020 ISSN: 1074-4741

Paul E. C., (2003), "*History of Modern Computing*", MIT press Publishing, England, pp.179.

Rindt C. R., Mcnally M. G., Doherty S., (2000), "*A GPS Enhanced in-Vehicle Extensible Data Collection Unit*", Univ. California, Irvine, vol. 28, pp. 1-23.

Tamil E. M., Saleh D. B., Idris M. Y. I., (2007), "*A Mobile Vehicle Tracking System with GPS/GSM Technology*", in Proc. 5th Student Conference on Research and Development, pp. 39 402.