DESIGN AND CONSTRUCTION OF GSM AND GPS BASED ADVANCED VEHICLE TRACKING SYSTEM

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY YOLA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING

NOVEMBER, 2018

DECLARATION

I hereby declare that this project was written by me and it is a record of my own research work. It has not been presented before in any previous application for bachelor's degree. References made to published literature have been duly acknowledged.

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CERTIFICATION

This project entitled "**design and construction of GSM and GPS based advanced vehicle tracking system**" by **Ilyasu Abdulazeez (EE/12/0505)** meets the regulation governing the award of the bachelor's degree of the Modibbo Adama University of Technology, Yola and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This project report is dedicated to the Almighty God for giving me the opportunity to carry out this work. Also, to my lovely mother Haj. Zainab Yakubu, and my humble father Late Alh. Ilyasu Shu'aibu Batari Hong, who brought me up, helped me morally and financially in all my academic endeavors.

ACKNOWLEDGEMENTS

My gratitude goes to Almighty Allah whom in his protection and infinite guidance gave me the ability to successfully complete my project.

Also with deep appreciation, I acknowledge the professional support, effort, help, understanding and encouragement given to me during the time of my research by my supervisor, Mr. M. K. Luka and my project coordinator, Engr. A.S. Kadalla who despite their numerous engagements remained with me through their guidance and advice. May Allah reward them abundantly.

My appreciation goes to my H.O.D, Engr. Dr. Iliya Thuku, and to all my lecturers, for the moral support and skills imparted in me.

My special gratitude and appreciation goes to my most loving brothers: Engr. A. J Hamid, Abdulwahab Ilyas, Abdulhamid Ilyas, Usman Ilyas, Hamza Ilyas, Ismail Ilyas, and Suleman Ilyas, and my lovely sisters: Dr. Amina (Ya Asabe), Ya Aisha (Inna AI), Bilkisu (ummi), Khadija (Ya Lami) Ya Maryam, Ya Sadiya, Hauwa (Maman Yara) and most importantly my sweet little niece Amina Sadiq (Momomina), for their love, support and caring towards the successful completion of my studies. I can't find any word sufficient enough to thank you, you mean everything to me, I just pray that may Allah reward you with the best reward of Aljannatil Firdaus.

Finally, I appreciate all my course mates especially Augustine Elemuwa, Skam Chagwa and Ottan Moshood Abdulmumini, also my friends Uzaifa Yahaya Miya, Bala T. Janguza who have in one way or the other contributed immensely to the construction of this project. May God bless you all.

ABSTRACT

The objective of this project is to design and construct a GSM and GPS based advanced vehicle tracking system. In this project, a device was developed that would track and provide complete vehicle location and send the information to a control unit at the user side. This kind of device is able to provide complete location information to user over mobile phone by sending SMS through GSM modem. This SMS contains longitude and latitude of the location of vehicle. Microcontroller is the central processing unit CPU of this project. Microcontroller gets the coordinates from GPS modem and then it sends this information to the user in Text SMS. GSM modem is used to send this information via SMS. The incorporation of GPS and some modules to monitor some parameters of vehicle like overheat or PMS leakage and to stop the vehicle at any point through the SMS, and also help to detect accident with the help of high sensitivity vibration sensors are recommended for future works.

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List		Definitions
1.	GSM	Global System for Mobile Communication
2.	GPS	Global Positioning System
3.	GNSS	Global Navigation Satellite System
4.	SIM	Subscriber Identity Module
5.	LED	Light Emitting Diode
6.	SMS	Short Message Service
7.	IDE	Integrated Development Environment
8.	DC	Direct Current
9.	AVL	Advance Vehicle Locator
10.	I/P	Input/output
11.	PIC	Programmable integrated Circuit
12.	GPRS	General Packet Radio Service
13.	ROM	Read Only Memory
14.	RAM	Random Access Memory
15.	EEPROM	Electrical Erasable Programmable Read Only Memory
16.	AVR	Advanced Virtual RICS or Alf and Vegard RISC
17.	USART	Universal Synchronous and Asynchronous Receiver and Transmitter
18.	GMSK	Gaussian minimum-shift keying
19.	ISP	In-System Self-Programmable Flash program
20.	TXD	Transmitter
21.	CMOS	Complementary Metal Oxide Semiconductor
22.	ADC	Analogue to Digital Converter
23.	RISC	Reduced Instruction-set- Computer
24.	CISC	Complex Instruction Set Computer
25.	CPU	Central Processing Unit
26.	RST	Reset
27.	GND	Ground
28.	RXD	Receiver
29.	VCC	Collector-voltage supply

CHAPTER ONE: INTRODUCTION

Vehicle theft has become a matter of concern these days. In most cases the vehicles which is stolen is not traceable by the owner of the vehicle. So there is a demand for better security systems. This project (GSM and GPS based advanced vehicle tracking system) presents a novel security system which makes use of GPS and GSM technologies. It is designed and develop to accommodate the needs of today's vehicle fleet company to keep track on their fleets. It is a very useful and versatile device, and in fact it is able to be used by anybody with the need to keep track on their valuable goods and not just by the vehicle fleets company. The desired output from the system will be the data such as position and time obtained from the GPS receiver. This chapter will be covering the general background of this project, the problem statement, aim and objectives, its significance and its scope and limitations.

1.1 Background

A vehicle tracking system consists of an electronic device installed on a vehicle so that it could be tracked by the owner or a third-party for its position. Most of today's vehicle tracking system uses Global Positioning System (GPS) to get an accurate reading of the vehicle position. Communication components such as cellular and satellite transmitter will be combined to transmit the vehicle's position to remote user. Vehicle's position can be viewed by using a software on a mobile phone.

Vehicle tracking systems are commonly used by fleet operators for fleet management functions such as routing, dispatch and security. Other applications include driver monitoring, such as an employer of an employee, or a parent with a teen driver. Vehicle tracking systems are also popular in consumer vehicles as a theft prevention and retrieval device. Police can simply follow the signal emitted by the tracking system and locate the stolen vehicle. When used as a security system, a Vehicle Tracking System may serve as either an addition to or replacement for a traditional Car alarm. The existence of vehicle tracking device then can be used to reduce the insurance cost, because the loss-risk of the vehicle drops significantly.

Vehicle tracking is also useful in many other applications such as Asset Tracking scenarios where companies needing to track valuable assets for insurance or other monitoring purposes can now plot the real-time asset location on a map and closely monitor movement and operating status. Meanwhile, in field sales mobile where the situation of sales professionals can easily access real-time locations. For example, in unfamiliar areas, they can locate themselves as well as customers and prospects and can also get driving directions. Benefits include increased productivity, reduced driving time and increased time spent with customers and prospects.

With this system, the users can be able to get many benefits by auditing employee hours to insure better utilization of vehicles. This system has also proof its ability to reduce mileage hence, reduce the fuel costs through monitoring private use of vehicles.

1.2 Problem Statement

Car theft has become a very big challenge for vehicle owners. Also, fuel, maintenance and insurance costs have become an accepted way of life for owners and managers in the service, delivery and transportation industries. This kind of device has the ability and capability of controlling these factor effectively.

1.3 Aim and Objectives of the Project

The aim of this project is to design and construct a GSM and GPS based advanced vehicle tracking system with the following objectives.

- ✓ To provides security for vehicle.

- ✓ To program a microcontroller and interface it with GPS module and GSM module.
- ✓ To track vehicle's exact location using GPS module.
- ✓ To provide the Vehicle owner with the SMS (Short Message Service) of details of the locations like the latitude and the longitude.
- ✓ To come with my own hardware of GPS and GSM tracking system.

1.4 Significance of the Project

This project is designed to help the owner of vehicle to recover his/her Stolen vehicle, the system is also used for operational functions such as routing and security. It is thus an efficient and effective means of Theft protecting, Route monitoring and Driver monitoring. It also reduces the fuel and maintenance costs through monitoring private use of vehicles. The project will be of particular usefulness to Police. Police can simply follow the signal emitted by the tracking system and locate the stolen vehicle.

1.5 Scope and Limitations

This project is focusing on the study and design of the GPS and GSM Vehicle Tracking system that can give an output of the information of the position of a vehicle from the GPS receiver. The users will also be able to send command to the GPS receiver using the GSM technology. In this project, a Microcontroller ATmega328p, a GPS modem and GSM modem will be used. However, the limitations of this device includes;

- ✓ The device can only work when there is power supply.
- ✓ The GSM modem in the device can only send SMS at a moment when there is a GSM network.

CHAPTER TWO: LITERATURE REVIEW

This chapter deals with the theoretical background of the Fundamental concepts used in this project. A review of Vehicle tracking system is first presented, Comparison between the different components that might be used in this project as well as the review of some previous works undertaken by other researchers is provided. Some concepts required for the better understanding of the work undertaken in this project are broadly explained

2.1 Vehicle Tracking System

Vehicle tracking systems were first implemented for the shipping industry because people wanted to know where each vehicle was at any given time. But in these days, however, with technology growing at a fast pace, automated vehicle tracking system is being used in a variety of ways to track and display vehicle locations in real-time. Vehicle tracking systems use a combination of technologies to keep real-time tabs on the position of a vehicle or to construct a history of where a vehicle has been. These systems are used in a many industries, and they are also a key part of most stolen vehicle recovery strategies. Most vehicles tracking systems use GPS technology, and some also make use of cellular or radio transmitters.

*2.1.1 **Types of Vehicle Tracking***

There are two main types of vehicle tracking, each of which is useful in specific situations.

i. Passive; The simplest vehicle tracking systems are passive in nature. These trackers typically use a GPS device to record the position of a vehicle over time. When the tracker is removed, the data can be transferred to a computer and analyzed. These tracking systems are useful for fleet management, but they also have other applications.

ii. Active; More complex tracking systems also include the ability to transmit the location of a vehicle in real time. For fleet management and dispatch purposes, this data is typically monitored from a central location. This type of system can also be used for stolen vehicle recovery.

Many modern vehicle tracking devices combine both active and passive tracking abilities: when a cellular network is available and a tracking device is connected it transmits data to a server; when a network is not available the device stores data in internal memory and will transmit stored data to the server later when the network becomes available again [1].

Historically, vehicle tracking has been accomplished by installing a box into the vehicle, either self-powered with a battery or wired into the vehicle's power system. For detailed vehicle locating and tracking this is still the predominant method; however, many companies are increasingly interested in the emerging cell phone technologies that provide tracking of multiple entities, such as both a salesperson and their vehicle. These systems also offer tracking of calls, texts, web use and generally provide a wider range of options.

2.2 Review of Related Works

Several attempts were made to design vehicle tracking device using components with limited number of applications. There have been many other projects that use the same concepts applied on this project. But most of the project uses a combined GPS and GSM module, as it is easier to operate. Some of these attempts and their shortcomings are as follows:

In [2] the system has Global Positioning System (GPS) which will receive the coordinates from the satellites among other critical information. Tracking system is very important in modern world. This can be useful in soldier monitoring, tracking of the theft vehicle and various other applications. The system is microcontroller based that consists of a global positioning system (GPS) and global system for mobile communication (GSM). The concept uses only one GPS device and a two-way communication process is achieved using a GSM modem. GSM modem, provided with a SIM card uses the same communication process as we are using in regular phone. The system is not limited to find the location of the target but also calculates the distance travelled between two stations. This system is user friendly, easily installable, easily accessible and can be used for various other purposes. After installation system will locate target by the use of a Web application (HTML based application) in Google map. The system allows to track the target anytime and anywhere in any weather conditions.

In [3] Kai-Tai Song and Chih-Chieh Yang have a designed and built on a real-time visual tracking system for vehicle safety applications. In their paper built a novel feature-based vehicle-tracking algorithm, automatically detect and track several moving objects, like cars and motorcycles, ahead of the tracking vehicle. Joint with the concept of focus of expansion (FOE) and view analysis, the built system can segment features of moving objects from moving background and offer a collision word of warning on real-time. The proposed algorithm using a CMOS image sensor and NMOS embedded processor architecture. The constructed stand-alone visual tracking system validated in real road tests. The results provided information of collision warning in urban artery with speed about 60 km/hour both at night and day times.

In this paper, the authors proposed a novel method of vehicle tracking and locking system used to track the theft vehicle by using GPS and GSM technology. This system puts into sleeping mode while the vehicle handled by the owner or authorized person otherwise goes to active mode, the mode of operation changed by in person or remotely. If any interruption occurred in any side of the door, then the IR sensor senses the signals and sends SMS to the microcontroller. The controller issues the message about the place of the vehicle to the car owner or authorized person. When SMS was sent to the controller, it issues the control signals to the engine motor. Engine motor speeds are gradually decreases and come to the off place. After that all the doors will be locked. To open the door or restart the engine, authorized person needs to enter the passwords. In this method, tracking of vehicle place is easy and doors locked automatically, thereby thief cannot get away from the car [4].

Anil and S. Rajendra designed and developed an advanced vehicle tracking system in the real time environment. Whenever someone wants to steal vehicle by entering the wrong password then the system which is feed in vehicle sends a SMS to the owner of the vehicle. The other main aim of this project is to send the location of the vehicle if it meets any accident, if so it will immediately send the details of the locations like the latitude and the longitude using GPS module. So the user can get to know the exact location of the vehicle where it has met the accident. The user can use the latitude and the longitude which is obtained in the SMS to find the location of vehicle pointed out on the Google maps. And also if the driver of the vehicle has consumed the alcohol then the vehicle stops moving. The main aim is to get the information of the vehicle time to time. The system can be further improved by upgrading to stop at any point through the SMS. And also send the SMS to the nearest hospital and police station, so that further process can be easier. The project can be extended by adding an android application which can predict the nearest hospital according to the Latitude and Longitude obtained from the GPS device [5].

In [6] The authors designed and developed an advanced vehicle Tracking system in the real time environment. The user can lock the vehicle after it is stolen by sending a text LOCK using mobile phone as soon as the system receives the text it will LOCK the vehicle. The other main aim of this project is to send the location of the vehicle to the user as soon as it receives the text LOCK, the system will immediately send the details of the locations like the latitude and the longitude using SIM908 module. So the user can get to know the exact location of the vehicle where it has taken. The user can use the latitude and the longitude which is obtained in the SMS to find the location of vehicle pointed out on the Google maps. The main aim of this project is to lock the vehicle after it is stolen and find the location of the vehicle and to design and implement a microcontroller based GPS/GSM based advanced security system which will secure the vehicle.

The major components of the system are, AVL (Advance Vehicle Locator) Device, Tracking Server, User Interface. In [7] The AVL (Advance Vehicle Locator) device which is placed in vehicle that accepts data from GPS satellites and stores it temporarily in the device. The device is installed with a SIM card which is useful for the purpose of communication with local network. Now, the data in the device is sent to the tracking server over GSM for further operation. This tracking server contains all data from AVL devices placed in the vehicles. Later on, as per the request of user the data from tracking server is displayed on user interface. That means, the user of the system interacts with the help of user interface provided. Also the registered user can interact with the system using cell phone, just by sending a text message. In this way, the overall system works thus generating reports and also generating alerts. GeoFence can be created on Google Maps which is provided, so whenever the device enters or leaves the geo fence, an alert will be sent to registered mobile number. There are web pages integrated with the Google Map and also for the purpose of viewing the vehicle on the GUI different API‘s are present. In conclusion, With the help of multi tracking system, multiple vehicles can be tracked using the AVL device. As the system is having integration of GSM & GPS it can be used in it various applications. It is having wide scope of applications such as live tracking or personal tracking. You can determine your location, whether you are travelling locally or in a foreign land, having a GPS is truly an advantage and many more similar applications thus, the system can prove to be very helpful in future, providing more security.

The authors, In [8] designed vehicle tracking system along with monitoring of vehicle parameters through GSM technology. The vehicle is tracked by using GPS technology, monitor the parameters using thermistor and sending the status of the vehicle using GSM to the owner thereby providing security to it. In the project the AT89S52 has been used as the main controller. GSM and GPS are connected to microcontroller through serial interface. Thermistor is also connected to microcontroller through digital Input/output lines. GPS parameters like latitude and longitude are transmitted to mobile through GSM modem. LM358P does the conversion from analog input to digital output. The output will be given bit by bit serially. There is also ULN2003, which is the IC used to drive the DC motor. In the paper, a novel method of vehicle tracking and monitoring systems that will provide better security for the vehicles has been discussed, also implemented the monitoring of engine's temperature and even the speed control at the specific locations detected by the GPS along with the voice output.

In [9] The intended application for the authors wireless GPS tracking device is the University of Utah shuttle system. The authors were formulating ideas for project and came to the conclusion that both of them were frustrated with the university shuttle system. The authors had several complaints in common: the shuttles didn't come often enough; they were often late leaving us out in rain, snow, and heat; and worst of all, sometimes they never showed up. In an informal study of the punctuality of the university shuttle system by group members, it was found that on average the shuttle was three and one-half minutes late. Being students with tight time schedules, the unreliability of the shuttle system can greatly affect them. Students have been late to class and almost had their lack of punctuality affect their class grade. The authors and many other university students have thought, “I wish I knew when the shuttle was coming.”

The authors then designed and constructed a hand-held wireless GPS tracking device that can be tracked from the Internet. The project consists of three parts. The first part is a mobile device with an embedded GPS and wireless Internet connection to transmit its current location. The second part is a web server that will receive the data, parse it, and store it for access over the Internet. The third component is the user interface that will allow others to visually see where the hand-held GPS device is and has been. To view its location, one could use any device that can connect to the Internet such as a desktop computer, laptop or cell phone. The data available through a browser includes a scalable map of the surrounding area, latitude, longitude, speed, and altitude of the hand-held device. The system is intended to be a general purpose tracking device; however, the user interface will be tailored to the university shuttle system. The device is engineered to address that question. It will allow anyone with an Internet connection to track the shuttle and know if it is early, on time, or late. With these information students can adapt their schedule to meet the projected shuttle arrival times.

GPS based vehicle tracking system uses the GPS technology, GSM service and Android mobile. The authors In [10] proposed and developed a system that has three main modules transmitting unit, monitoring unit and server. Transmitting side performs tracking functionality. It tracks the vehicle through GPS and transmits its current location to the server. The main function of monitoring side is to provide login interface to user and to show the google map with vehicle locations. Server woks as a central connector for transmitting unit and monitoring unit. As both transmitting side and monitoring side communicate with each other through Server only. Mobile application communicates with server and access the remote database. Where at transmitting side

Tracker application obtained its current location through GPS technology and update it to server. Monitoring unit, tracking unit and server are the main pillars of GPS based vehicle tracking system. But in this system the authors used GPRS service to perform communication between monitoring and tracking unit to server. Authors used Android platform and Java language for implementation of Monitoring as well as tracking unit. Monitoring side consist of Login page, Signup page and Google Map with the location of required vehicles. As user can easily use this application by sign up and he will get all login rights.

V.Sakthianand and M.Babu Prasad designed and implemented a smart bus tracking system. A smart phone application and server are used to track the location of the bus. The smart bus tracking device is consisting of a microcontroller and GPS/GSM/GPRS module to acquire the bus location information, this information is transmitted to the server by the GSM/GPRS network. The web interface created by PHP connected to the database. The vehicle unique ID is obtained from the database and the information is transmitting to the user by the smart phone application. It is easily access by the self-electronic module [11].

From the review of the related works above made, the method/circuits used for tracking have their various limitations; the circuits are complex, i.e., involves many components, they consume high power etc. The design presented in this project offers many advantages over those mentioned above. The circuitry involved is very simple with few components but high efficiency. Some of the modifications made are

- ✓ The device was built using microcontroller instead of discrete components, which solved the issue of high power consumption and complexity of the circuit.

- ✓ The microcontroller is the control system of the project and it provides ease of measurement and interfacing with other system
- ✓ Compared to the previous works, the cost of construction is significantly reduced

2.3. Review of Fundamental Concepts

2.3.1 Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system that was developed by the U.S. Department of Defense (DoD) in the early 1970s. Primarily, GPS was developed as a military system to fulfill U.S. military needs. However, it was later made available to civilians, and is now a dual-use system that can be accessed by both military and civilian users. GPS provides continuous positioning and timing information, anywhere in the world under any weather conditions. Because it serves an unlimited number of users as well as being used for security reasons, GPS is a one-way-ranging (passive) system. That is, users can only receive the satellite signals [12].

2.3.1.1 GPS Overview

The GPS is made up of three parts: satellites orbiting the Earth; control and monitoring stations on Earth; and the GPS receivers owned by users. GPS satellites broadcast signals from space that are picked up and identified by GPS receivers. Each GPS receiver then provides three dimensional locations (latitude, longitude, and altitude) plus the time. Furthermore, GPS consist of three segments, the space segment, the control segment and the user segment.

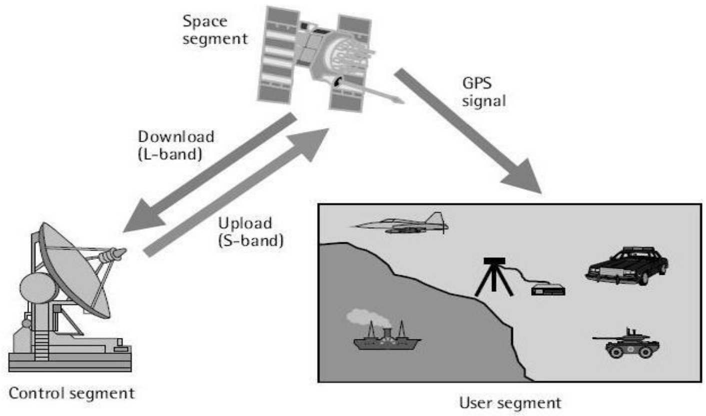


Figure 2.01: GPS segments

- ✓ The space segment consists of a nominal constellation of 24 operating satellites that transmit one-way signals that give the current GPS satellite position and time.
- ✓ The control segment consists of worldwide monitor and control stations that maintain the satellites in their proper orbits through occasional command maneuvers, and adjust the satellite clocks. It tracks the GPS satellites, uploads updated navigational data, and maintains health and status of the satellite constellation.
- ✓ The user segment consists of the GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's three-dimensional position and time.

2.3.1.2 GPS module

A GPS Module is a device that accurately calculates geographical location by receiving information from GPS satellites. GPS module may have capabilities such as: maps, including streets maps, displayed in human readable format via text or in a graphical format; Turn-by-turn navigation directions to a human in charge of a vehicle or vessel via text or speech; Directions fed directly to an autonomous vehicle such as a robotic probe; Traffic congestion maps (depicting either historical or real time data) and suggested alternative directions; Information on nearby amenities such as restaurants, fueling stations, and tourist attractions.

Figure 2.02: GPS module.

2.3.2 Global System for Mobile Communication (GSM)

Global System for Mobile Communications or GSM (originally from Groupe Spécial Mobile), is the world's most popular standard for mobile telephone systems. The GSM Association estimates that 80% of the global mobile market uses the standard. GSM is used by over 1.5 billion people across more than 212countries and territories. This ubiquity means that subscribers can use their phones throughout the world, enabled by international roaming arrangements between mobile network operators. GSM differs from its predecessor technologies in that both signaling and speech channels are digital, and thus GSM is considered a second generation (2G) mobile phone system. The GSM standard has been an advantage to both consumers, who may benefit from the ability to roam and switch carriers without replacing phones, and also to network operators, who can choose equipment from many GSM equipment vendors[2].

2.3.2.1 GSM Overview

There are five different cell sizes in a GSM network—macro, micro, Pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment.

Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average roof top level. Micro cells are cells whose antenna height is under average roof top level; they are typically used in urban areas. Pico cells are small cells whose coverage diameter is a few dozen meters; they are mainly used indoors. Femtocells are cells designed for use in residential or small business environments and connect to the service provider’s network via a broadband internet connection. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells [13].

The modulation used in GSM is Gaussian minimum-shift keying (GMSK), a kind of continuous phase frequency shift keying. In GMSK, the signal to be modulated onto the carrier is first smoothed with a Gaussian low-pass filter prior to being fed to a frequency modulator, which greatly reduces the interference to neighboring channels (adjacent channel interference).

Some of the specifications and characteristics for GSM are;

- ✓ Frequency band—the frequency range specified for GSM is 1,850 to 1,990 MHz (mobile station to base station).
- ✓ Duplex distance—the duplex distance is 80MHz. Duplex distance is the distance between the uplink and downlink frequencies. A channel has two frequencies,80 MHz apart.
- ✓ Channel separation—the separation between adjacent carrier frequencies. In GSM, this is 200kHz.
- ✓ Modulation—Modulation is the process of sending a signal by changing the characteristics of a carrier frequency. This is done in GSM via Gaussian minimum shift keying (GMSK).
- ✓ Transmission rate—GSM is a digital system with an over-the-air bit rate of 270 kbps.

2.3.2.2 GSM module

A GSM module is used for transmitting and receiving the data. it is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. It is a cell phone without display. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

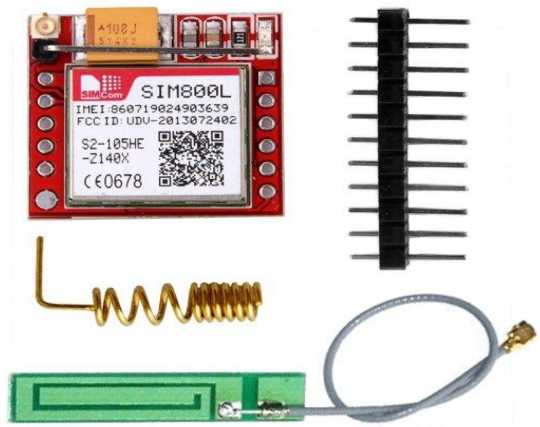


Figure 2.03: GSM module (SIM800L)

2.3.2.3 Subscriber Identity Module (SIM)

One of the key features of GSM is the Subscriber Identity Module (SIM), commonly known as a SIM card. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain his/her information after switching handsets [13]. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them; this practice is known as SIM locking.

2.3.3 Overview of Microcontrollers

A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, Input/output ports, and timers like a standard computer, but because they are designed to execute only a single specific task to control a single system, they are much smaller and simplified so that they can include all the functions required on a single chip.

A microcontroller differs from a microprocessor, which is a general-purpose chip that is used to create a multi-function computer or device and requires multiple chips to handle various tasks. A microcontroller is meant to be more self-contained and independent, and functions as a tiny, dedicated computer.

The great advantage of microcontrollers, as opposed to using larger microprocessors, is that the parts-count and design costs of the item being controlled can be kept to a minimum. They are typically designed using CMOS (complementary metal oxide semiconductor) technology, an efficient fabrication technique that uses less power and is more immune to power spikes than other techniques.

There are also multiple architectures used, but the predominant architecture is CISC (Complex Instruction Set Computer), which allows the microcontroller to contain multiple control instructions that can be executed with a single macro instruction. Some use a RISC (Reduced Instruction Set Computer) architecture, which implements fewer instructions, but delivers greater simplicity and lower power consumption [14].

Early controllers were typically built from logic components and were usually quite large. Later, microprocessors were used, and controllers were able to fit onto a circuit board. Microcontrollers now place all of the needed components onto a single chip. Because they control a single function, some complex devices contain multiple microprocessors.

2.3.3.1 Some Types of Microcontrollers

The use of different types of microcontrollers to handle different operations like processing needs, automobiles, electrical systems, and applications has increased rapidly. Applications of microcontrollers are found in various large equipment to smaller devices such as mainframe computers, air conditioning units, and airplane navigation system, digital watches, PDAs and cell phones.

2.3.3.2 Atmel AVR microcontroller

Atmel AVR (Alf-Egil-Bogen-Vegard-Wollan-RISC) microcontrollers distribute the power, performance and flexibility for automobile applications. This microcontroller consists of the Harvard architecture. So the device runs very fast with a reduced number of machine level instructions. The AVR microcontrollers are classified into three types: Tiny AVR, Mega AVR and Xmega AVR. The main features of AVR microcontrollers compared to other microcontrollers include inbuilt ADC, 6-sleep modes serial data communication and internal oscillator, etc.

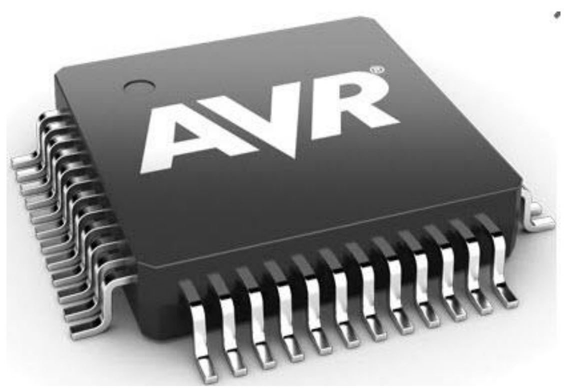


Figure 2.04: AVR microcontroller

2.3.3.3 8051 microcontroller

The 8051 microcontroller is 40 pin microcontroller and is based on Harvard architecture wherein the program memory and data memory is different**.** This microcontroller is used in a large number of machines like automobiles as it can be easily integrated around a machine.

2.3.3.4 PIC microcontroller

The short form of the peripheral interface microcontroller is PIC. It is programmed and controlled in such a way that, it performs multiple tasks and controls a generation line. These microcontrollers are used in numerous applications like smart phones, automobiles, audio accessories and medical devices. The presently available PIC microcontrollers in the market are PIC16F84 to PIC16C84 which are affordable flash microcontrollers. Where, PIC18F458 and PIC18F258 microcontrollers are widely used in automobiles.

Figure 2.05:PIC microcontroller

2.3.3.5 Comparison of different types of microcontroller features

Table 2.1 microcontrollers features

	PIC18F4550	**PIC16F87XA**	**ATmega3288P**	**AT90USB1286**	**ATtiny5**
Flash memory(KB)	32	14	16	128	0.5
Pin count	40	40	28	64	6
Max. operating frequency(MHz)	48	32	20	16	12
CPU(bit)	12	8	8	8	8
Data EEPROM(Bytes)	256	256	256	4096	0
USB Interface	1	-	-	Device	-
ADC channels	13	8	8	8	4
UART	1	1	1	1	0
Timers	1*8bit 3*16bit	2*8bit 1*16bit	3	4	1
Operating voltage(V)	2-5.5	2-5.5	1.8-5.5	2.7-5.5	1.8-5.5
Temperature Range(^{o}C)	-40-85	-40-125	-40-85	-40-85	-40-125

2.3.4 Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits resistors are used to limit current flow, to adjust signal levels, bias active elements, terminate transmission lines among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity. Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits. The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance will fall within a manufacturing tolerance [15].

Figure 2.06: Axial lead resistor

Resistor is a circuit element having the function of introducing electrical resistance in to the circuit. There are three basic types of resistor.

(a) Fixed resistor

(b) Rheostat

(c) Potentiometer

A fix resistor is a two terminal device which electrical resistance is constant.

A rheostat is a resistor that can be changed in resistance value without opening the circuit to make adjustment.

A potentiometer is an adjustable resistor with three terminals, on at each end of the resistor element and thin movable along its length.

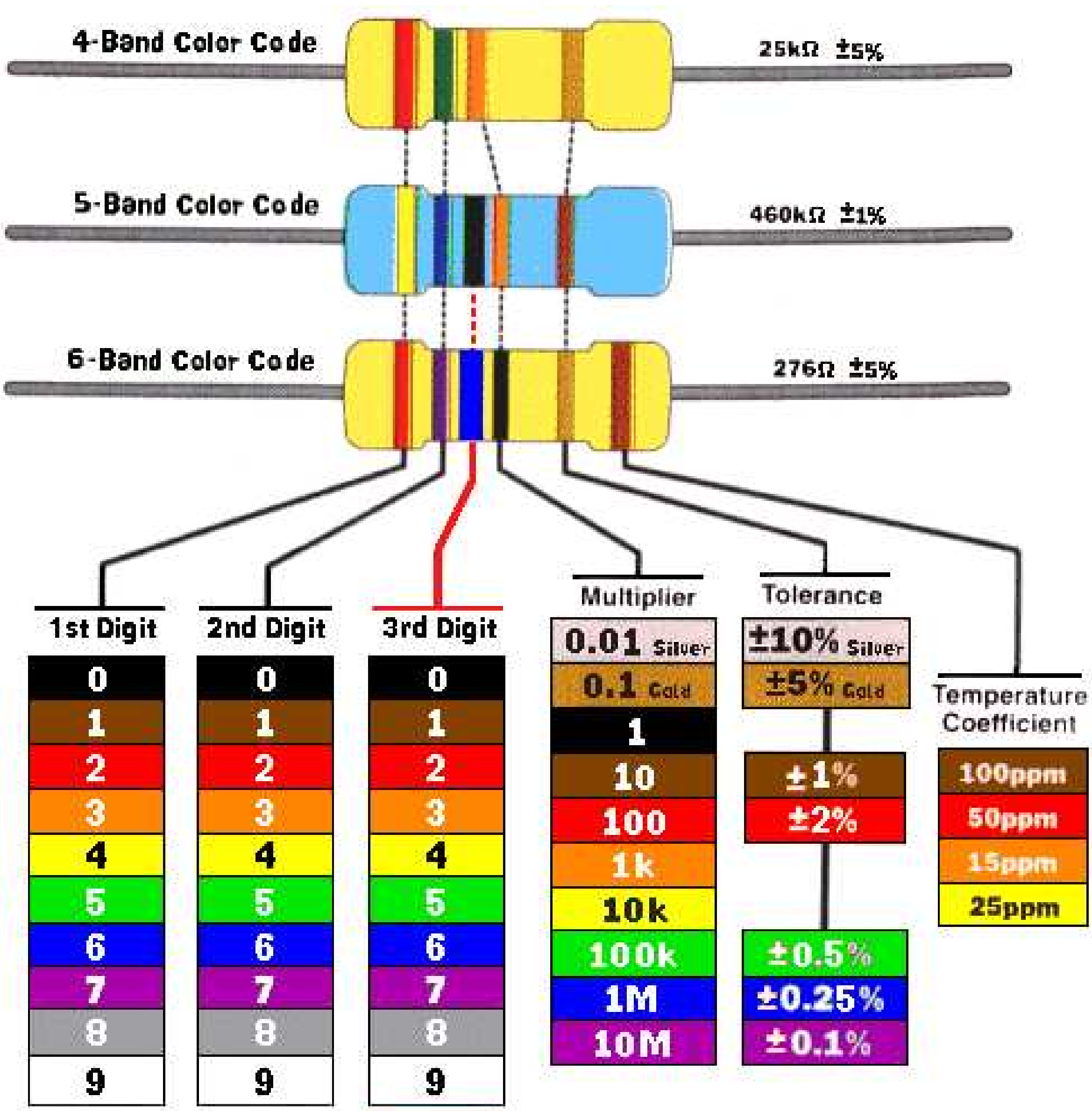


Figure 2.07: Colour Coding in a Resistor

2.3.5 Capacitors

A capacitor (originally known as a condenser) is a passive two-terminal electrical component used to store energy electrostatically in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors (plates) separated by a dielectric (i.e. insulator). The conductors can be thin films, foils or sintered beads of metal or conductive electrolyte, etc. The non-conducting dielectric acts to increase the capacitor's charge capacity. A dielectric can be glass, ceramic, plastic film, air, vacuum, paper, mica, oxide layer etc. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike resistors, an ideal capacitor does not dissipate energy. Instead, a capacitor stores energy in the form of an electrostatic field between its plates.

Figure 2.08: Capacitors

2.3.6 IC LM7805 Voltage Regulator

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

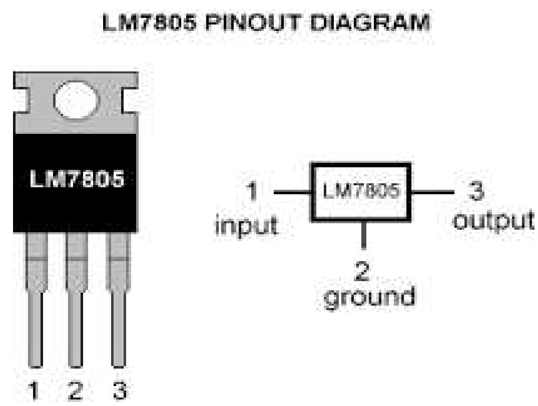


Figure 2.09: LM*7805 pin diagram*

2.3.7 LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a pn-junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

Figure 2.10: LED

CHAPTER THREE: DESINGN AND CONSTRUCTION PROCEDURE

This chapter deals with details and orderly presentation of the design and construction procedures of this system (GSM and GPS based advanced vehicle tracking system). In this project microcontroller is interfaced serially to a GSM Modem and a GPS Modem. A GSM modem is used to send the position (Latitude and Longitude) of the vehicle from a remote place to the monitoring Centre. The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the vehicle. This vehicle tracking system takes input from GPS and send it through the GSM module to desired mobile/laptop using mobile communication, the transmitting side performs tracking functionality. It tracks the vehicle through GPS and transmits its current location, at the monitoring center, various software's are used to plot the Vehicle on a map.

3.1. System Description

The building block diagram of the GSM and GPS based advanced vehicle tracking system is as shown in figure 3.1 below. It consists of the power supply unit, the control unit (which is the microcontroller Atmega328p), the GPS modem with its antenna and the GSM modem with its own antenna.

The power supply unit powers the entire circuit, it has in it an LM 7805 voltage regulator and some capacitors which regulate 12V to 5V, the microcontroller Atmega328p is the control unit, it is a programmable chip and it controls the activities of the entire system, the GPS modem help us calculate accurately the geographical location, the GPS antenna help us receive the information from the GPS satellites, The GSM modem now help us to send the location information through GSM network, the GSM modem has a valid SIM card with a sufficient recharge amount to make outgoing SMS. The circuits are powered by +5v DC

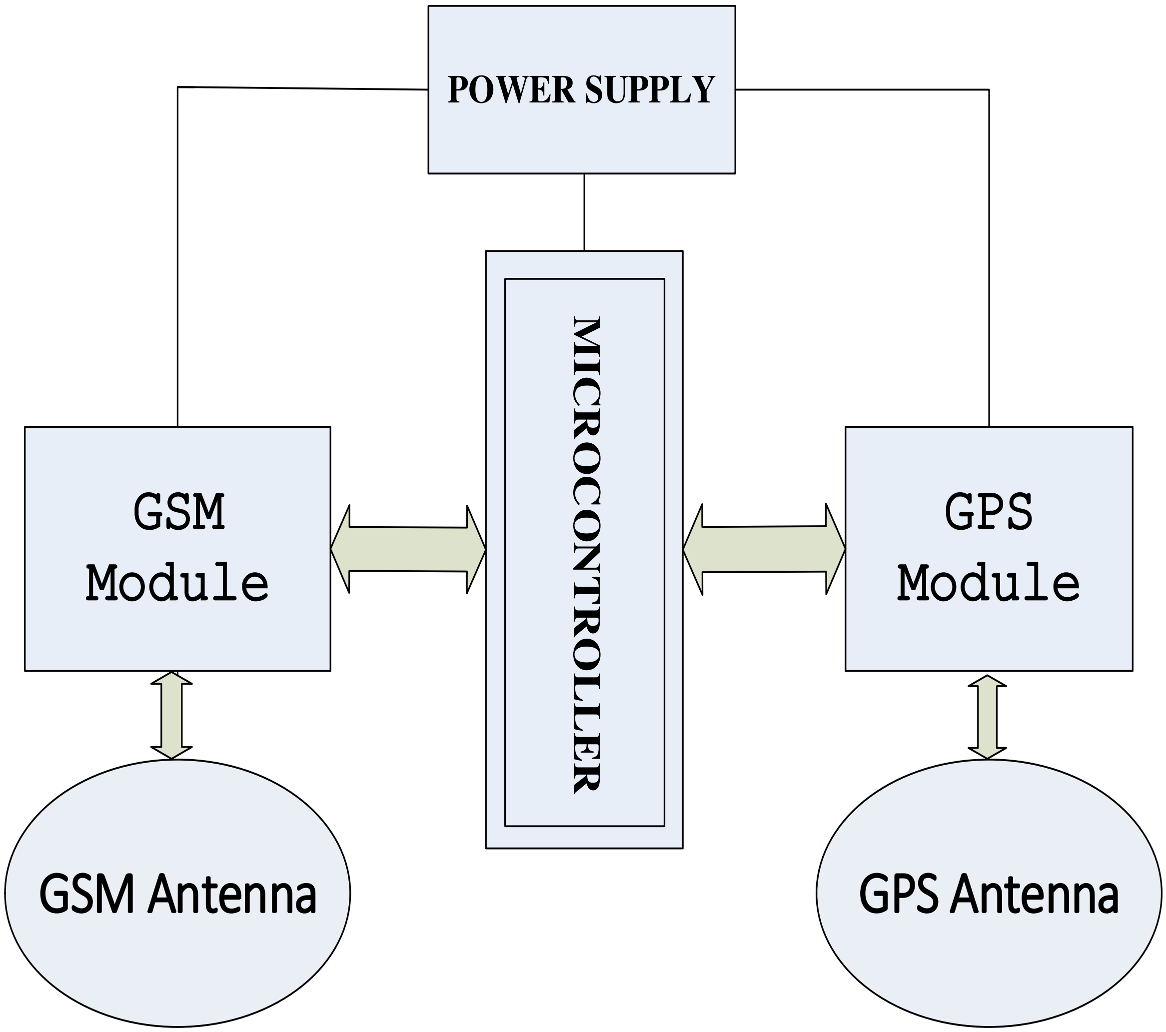


Figure 3.1: Block diagram of the system

3.2 Component Description and Hardware Design

This aspect deals with the detailed design and selection of the hardware components required for each functional block of the system. All components are purchased from different manufacturers. These components are soldered on a soldering board. The following list of hardware are required for this system.

Major components are;

- Microcontroller ATMEGA328P
- GSM module
- GPS module
- Voltage regulator

Auxiliaries are;

- Crystal Oscillator
- Diode
- Resistors
- Capacitors
- LED

3.2.1. Power Supply Unit

The circuit requires +5v DC supply. A 12v battery was used and regulated to the required voltage using LM7805 regulator. The features of LM 7805 regulator as seen from the datasheet [19] are as follows:

Maximum output current of regulator = 1.0A

Maximum output voltage of regulator = 5.2V

A 1.0A output current is sufficient for this project as the current requirement for the components are summarized in the table below.

Table 3.1 current requirement for components

COMPONENTS	TYPICAL CURRENT	MAXIMUM CURRENT
Atmega328p	250mA	-
GPS Module	200mA	250mA
GSM Module	250mA	500mA
LED	5mA	10mA

***<u>3.2.1.1 IC LM7805</u>*:**

7805 is a **voltage regulator** integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The **voltage regulator IC** maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

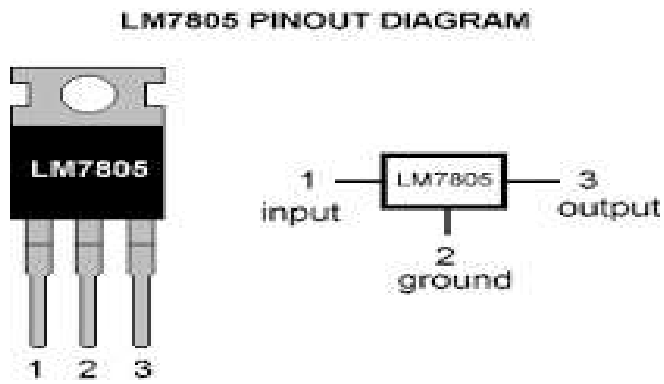


Figure 3.2a: LM7805 Pin Diagram

The circuit diagram of a regulator is shown in figure 3.2 below

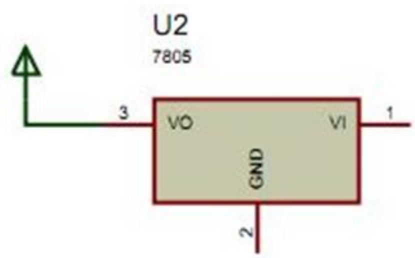


Figure 3.2b: Voltage Regulator Circuit

The circuit diagram of the power supply unit is shown below;

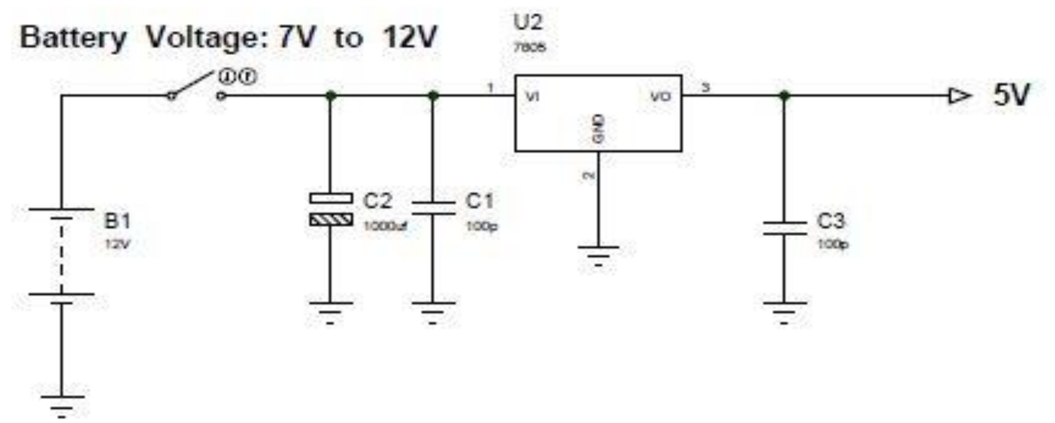


Figure 3.2c power supply unit circuit

3.2.2 Control Unit (microcontroller ATmega328p)

The microcontroller is the heart of the project; it controls all the activities of the entire system.

The criteria for choosing the microcontroller are: -

- Meet the computation needs of task at hand efficiently and cost effectively.
- Availability of software development tools such as compiler, assemblers and debuggers and widely availability and reliable source of the microcontroller.

For these reason the microcontroller ATmega328p is chosen.

The control unit is made up of a microcontroller of Atmel or AVR microcontrollers called ATmega328p. The ATmega328p is a high performance, low-power CMOS 8-bit microcontroller based on the AVR enhanced reduced- instruction- set computer (RISC) architecture. It combines 32KBytes of ISP (In-System Self-Programmable Flash program) Memory with read-while-write capabilities, 1KBytes EEPROM, 2KBytes Internal SRAM, 23 general purpose I/O lines, 32 x 8 General Purpose Working Registers, three flexible timers/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, 6-

channel 10-bit A/D converter, programmable watchdog timer, and five software selectable power saving modes. It operates between 1.8-5.5 volts and a temperature range of -40°C to 105°C. It achieves throughputs approaching 1 MIPS. The chip is a programmable device [20]. It controls the activity of the entire system. The microcontroller circuit is as shown below.

Figure 3.3a Microcontroller circuit

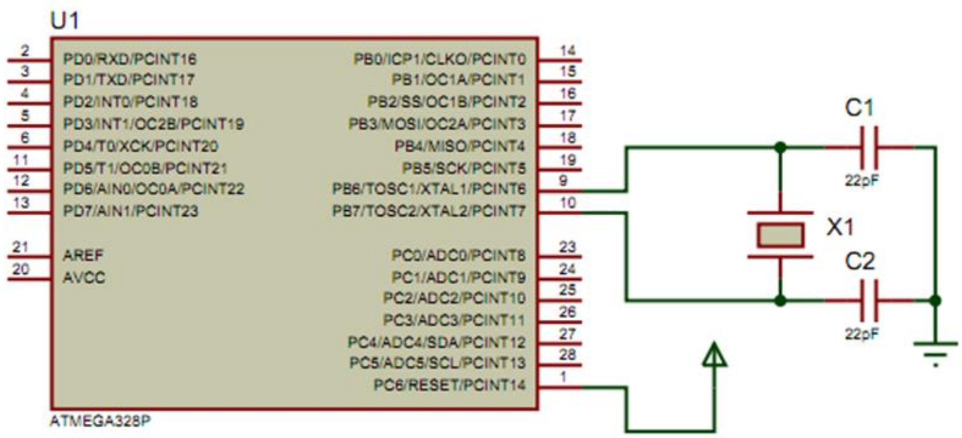


Figure 3.3b Microcontroller Atmega328p

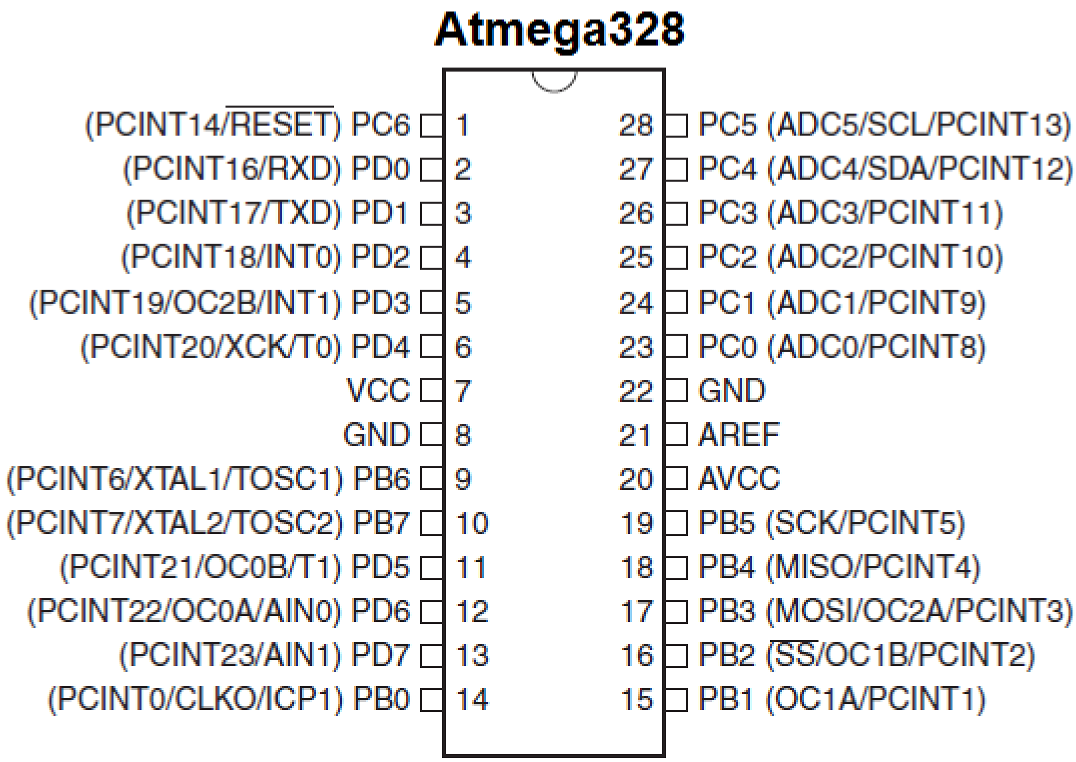


Figure 3.3c Pin Diagram of Microcontroller Atmega328p

3.2.3 Oscillator Unit (clock)

An oscillator is an electronic circuit that generates repeated waveforms. The exact waveform generated depends on the type of circuit that is used in generating them. For the high speed performance required for this project the crystal oscillator is used.

The crystal oscillator is responsible for producing the clock signal required by the circuit (microcontroller). Two capacitors values are normally chosen from the range of values from the datasheet of the microcontroller (ATmega328p) and the standard table below to increase the stability of the oscillator and increase the startup time.

Table 3.2: Capacitor selection for crystal oscillator (from ATmega328p datasheet)

Mode	Frequency	C1	C2
LP	32 kHz	33Pf	33Pf
	200 kHz	15Pf	15Pf
XT	200 kHz	26 -68pF	26 -68pF
	1.0 MHz	15pF	15Pf
	4.0 MHz	20 -30pF	20 -30pF
HS	4.0 MHz	15pF	15Pf
	8.0 MHz	15-33Pf	15-33pF
	20 MHz	15-33Pf	15-33pF
	25 MHz	15-33Pf	15-33Pf

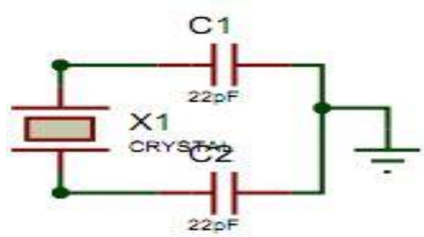


Figure 3.4 Oscillator circuit

The internal frequency of operation required for an instruction to be executed is given by:

$$f_{INT} = \frac{f_{QUARTZ}}{8} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(1)}$$

Where:

f_{QUARTZ} is the crystal frequency

f_{INT} is the internal clock frequency of the microcontroller

$$T = \frac{1}{f_{INT}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(2)}$$

Assume a crystal oscillator Cx1 of 16MHz for this project. The required capacitor values C1 and C2 should be between 15-33pf (from table 3.2). Hence, a 22pf capacitor is chosen for this project.

From equation (1)

$$F_{int} = \frac{F_{quartz}}{8} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Where:

F_{quartz} is the crystal frequency

And F_{int} is the internal clock frequency of the microcontroller

$$F_{int} = \frac{16MHz}{8} = 2\text{MHz}$$

From equation (2)

$$T = \frac{1}{F_{int}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

$$= \frac{1}{2MHz} = 0.5\mu s$$

which is the period for executing an instruction.

<u>3.2.4 GSM modem sim 800l</u>

The GSM modem is wireless modem that works with a GSM wireless network. The GSM module can help in make/receive voice call, send/receive SMS message and allow to connect with the internet through GPRS wireless network, The GSM modem is a specialized type of modem which accepts a SIM card operates on a subscriber's mobile number over a network, just like a cellular phone. It is a cell phone without display. SIM800L is a quad-band GSM/GPRS module, that works on frequencies GSM850MHz, EGSM900MHz, DCS1800MHz and PCS1900MHz. SIM800L features GPRS multi-slot class 12/ class 10 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. SIM800L is designed with power saving technique so that the current consumption is as low as 0.7mA in sleep mode.

The power supply range of SIM800L is from 3.4V to 4.4V. Recommended voltage is 4.0V. The transmitting burst will cause voltage drop and the power supply must be able to provide sufficient current up to 2Amp.

Table 3.3: SIM800L key features

Feature	Implementation
Power supply	3.4V ~ 4.4V
Power saving	Typical power consumption in sleep mode is 0.7mA (AT+CFUN=0)
Frequency bands	• Quad-band: GSM 850, EGSM 900, DCS 1800, PCS 1900. SIM800L can search the 4 frequency bands automatically. The frequency bands can also be set by AT command “AT+CBAND”. • Compliant to GSM Phase 2/2+
Transmitting power	Class 4 (2W) at GSM 850 and EGS Class 1 (1W) at DCS 1800 and PCS
GPRS connectivity	GPRS multi-slot class 12（default） GPRS multi-slot class 1~12 (option)
Temperature range	Normal operation: -40°C ~ +85°C

The GSM modem operates from 3.4V to 4.4V DC supply at 2A. The module and its antenna which changes the electrical signal into electromagnetic waves that can be transmitted over a free space. The module was interface with the microcontroller via Pin 2 and Pin 3 which is PORTD0 and PORTD1 of the microcontroller respectively. The modem consists of six terminals which include the VCC, TXD (transmitter), RXD (receiver), RST (reset) NET (antenna) and GND (ground). The modem is powered through VCC with 4.3V and GND is grounded, the antenna is connected through the NET terminal, The TXD and RXD terminals are connected to the microcontroller as shown in figure 3.5 below.

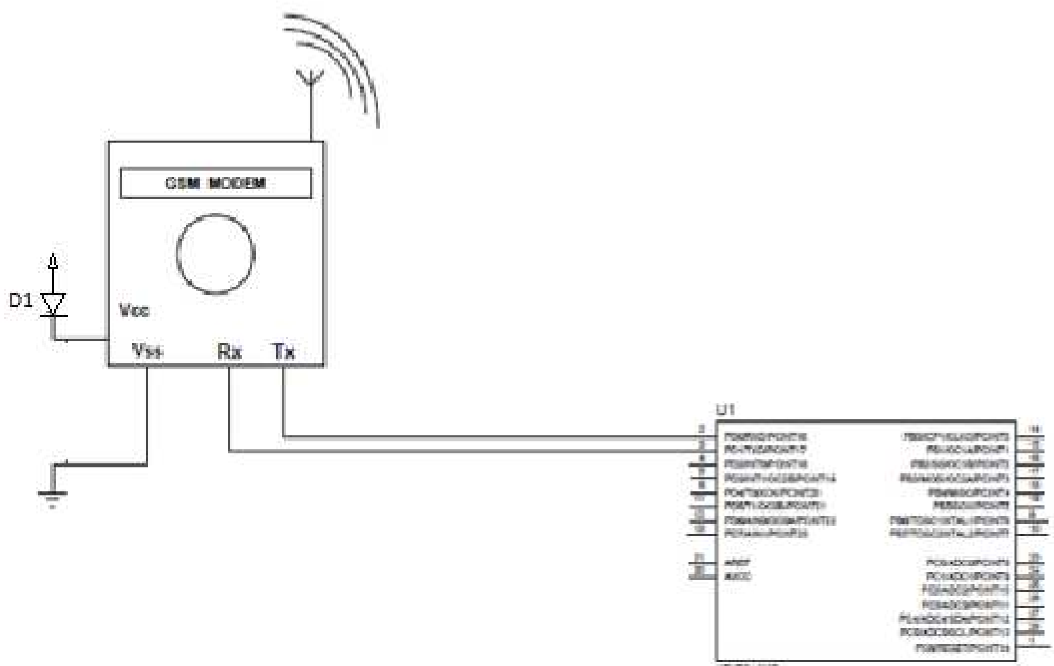


Figure 3.5: GSM modem interfaced to the microcontroller

The voltage supplied from the power supply unit was reduced from 5V to 4.3V by using silicon diode, 4.3V is an acceptable voltage required by the GSM modem as the voltage range is between 3.4V ~ 4.4V. Silicon diode was used because when it is forward biased and the applied voltage is increased from zero, hardly any current flows through the device in the beginning, it is so because the external applied voltage is being opposed by the internal barrier voltage V_B, whose value is 0.7V for silicon diode. As soon as V_B neutralized, current through the device increases rapidly with increasing battery voltage.

The voltage required is gotten from;

$V = V_A - V_B$ .... (5)

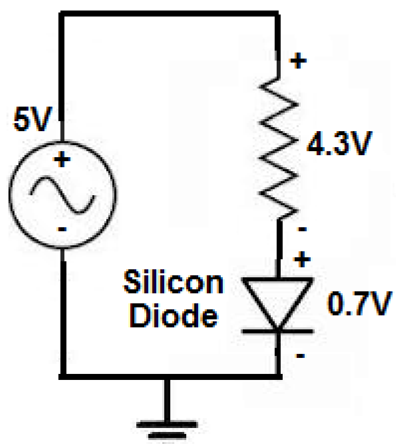
Where,

V_A is the applied voltage = 5V

V_B is the internal barrier voltage of the silicon diode = 0.7V

$V = 5V – 0.7V$

$V = 4.3V$



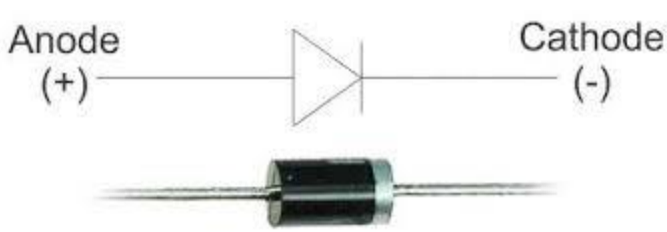


Figure 3.6: Silicon Diode.

3.2.5 GPS modem

As earlier discussed in chapter two, The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites.

GPS modules are popularly used for navigation, positioning, time and other purposes. GPS antenna receives the location values from the satellites. The GPS modem operate from 3.3V to 5V system. The module and its antenna help us to accurately calculate the geographical location by receiving information from the GPS satellites. The module was interface with the microcontroller via Pin 4 and Pin 5 which is PORTD2 and PORTD3 of the microcontroller respectively. The modem consists of four terminals which include the VCC, TXD (transmitter), RXD (receiver) and GND (ground). The modem is powered through VCC with 5V and GND is grounded, the antenna is connected through its antenna terminal, The TXD and RXD terminals are connected to the microcontroller as shown in figure 3.7 below.

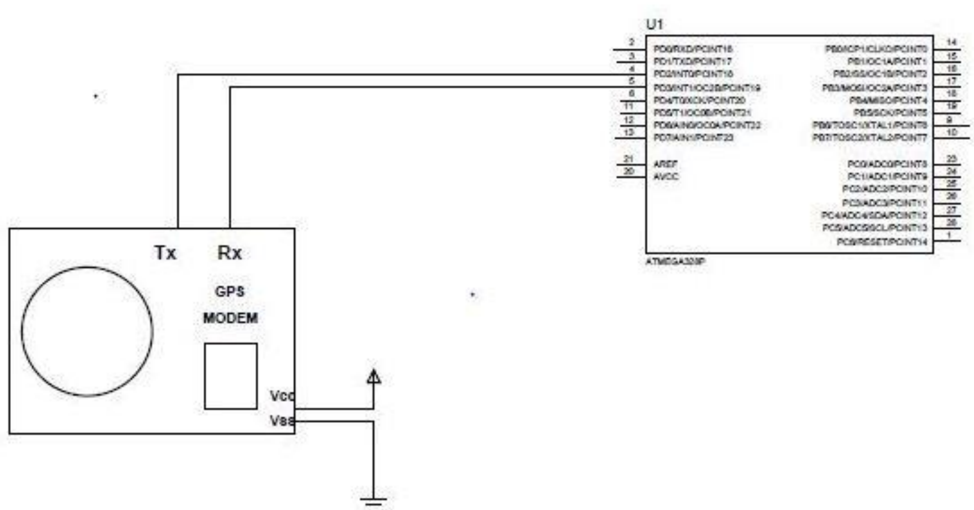


Figure 3.7: GPS modem interfaced to the microcontroller

The overall circuit diagram of the entire project is shown below

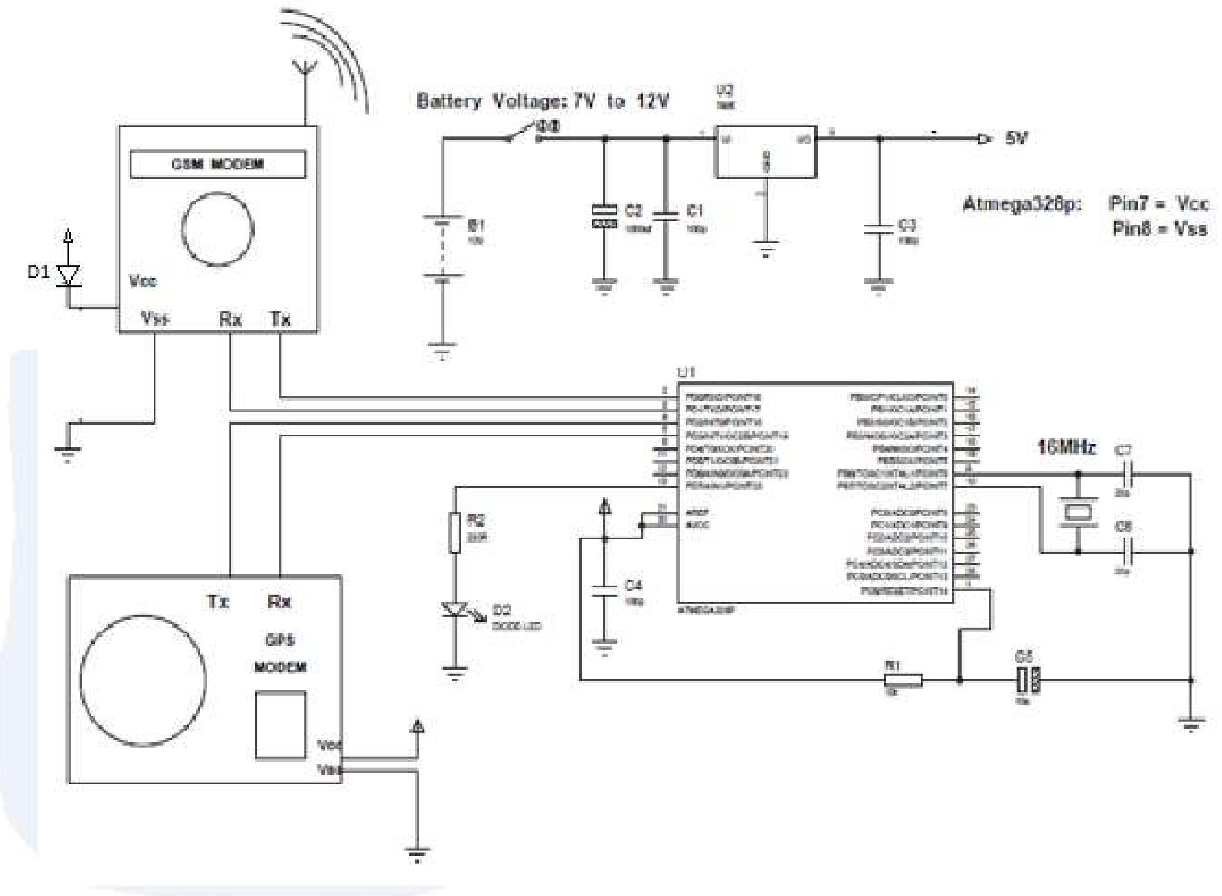


Figure 3.8: circuit diagram of the entire project

3.3. Software Design

This section deals with the program that was written to serve user's purpose. The control program was written in C language and compiled using Arduino integrated development environment which is an integrated applications software development system.

3.3.1 Arduino Compiler:

The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. There is typically no need to edit make files or run programs on a command-line interface. Although building on command-line is possible if required with some third-party tools.

The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino programs are written in C/C++.

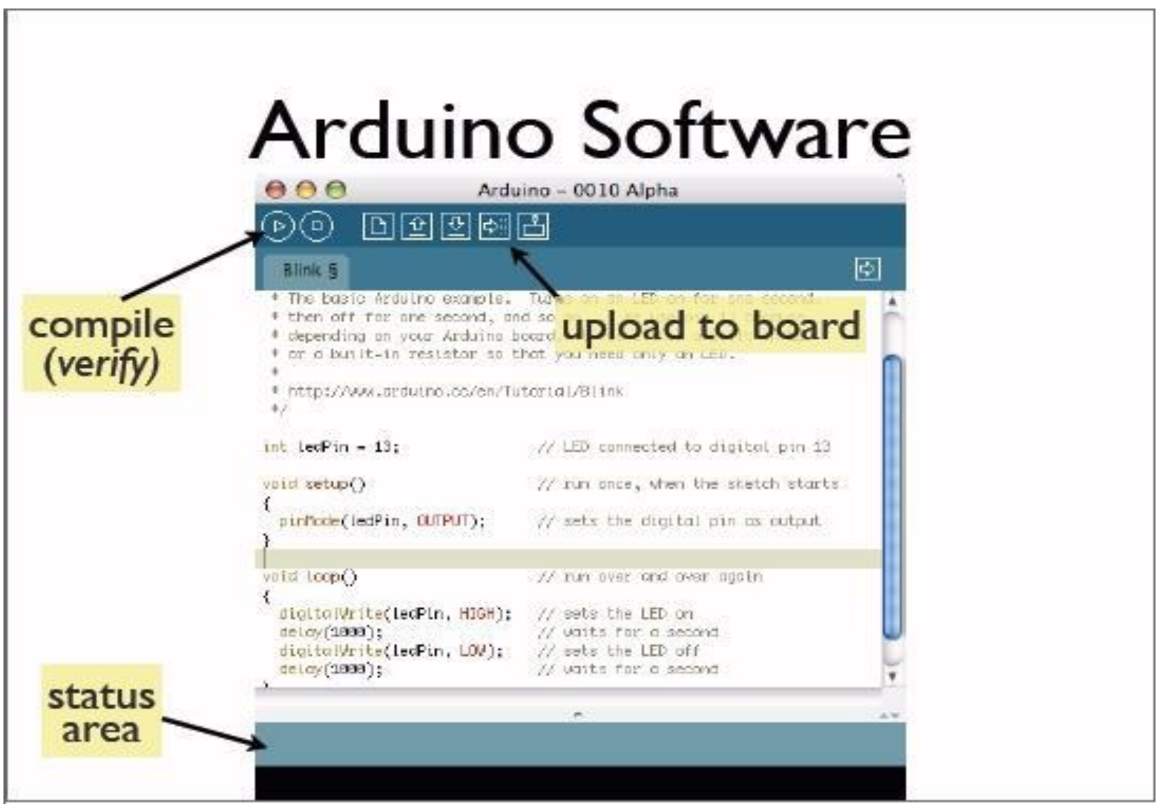


figure 3.9a: screen shot of the programmed IDE

The flowcharts of the program are shown in the figure below.

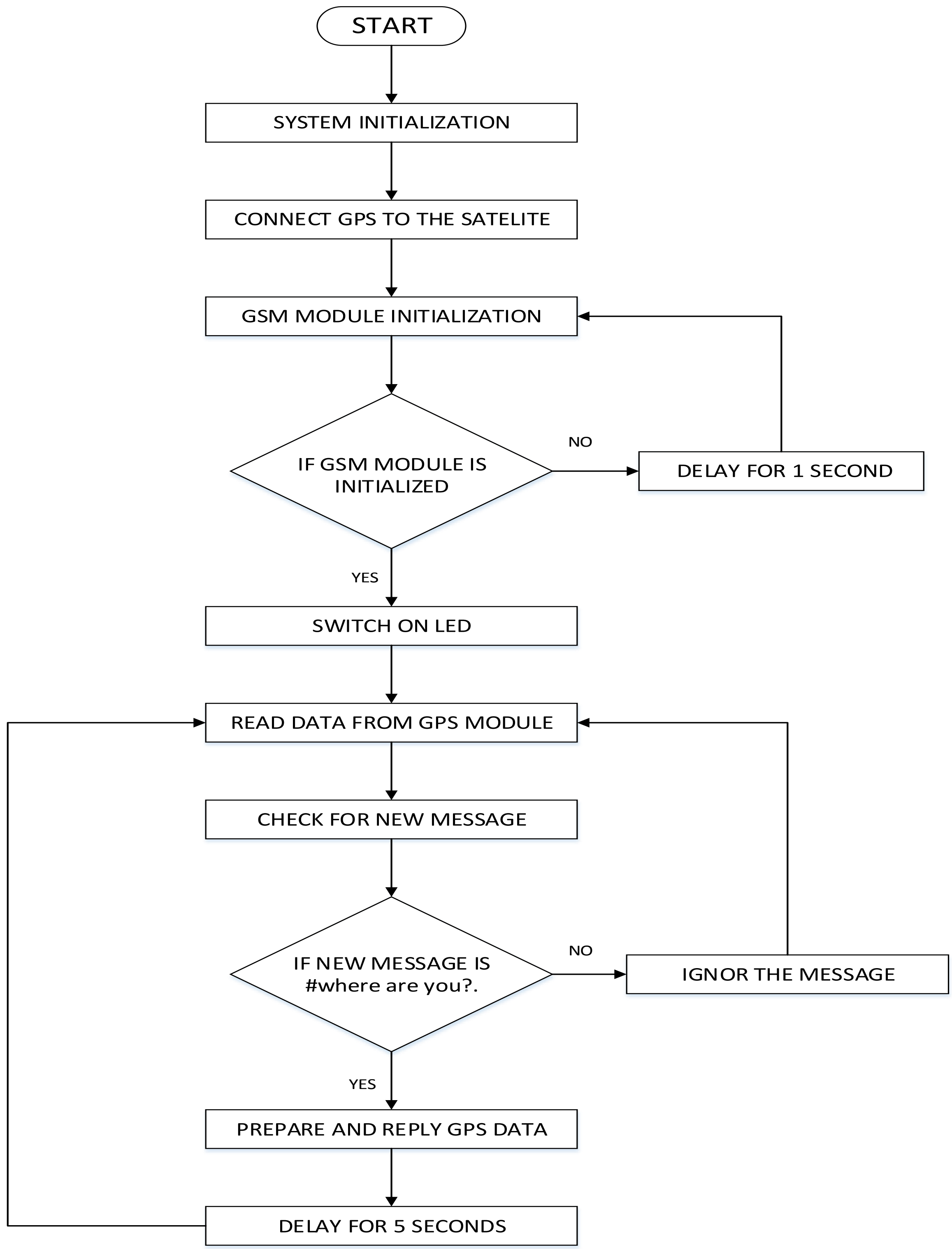


Figure 3.9b: System software flowchart

3.4 Construction Procedure and packaging

This section details the stages involved in the construction, project assembling and packaging. The various components on the system circuit diagram was implemented and soldered on Vero board.

3.4.1 Circuit Construction

The circuit board consists of the Vero board and all other components mounted on it. In the construction, the Vero board was cleaned with a brush to remove dirt from its surface which might affect soldering quality.

Subsequently, following the circuit diagram, the components were mounted on the board one after the other and soldered. The microcontroller was not directly soldered to the board but was mounted on an IC socket, this is to prevent heat damage and for ease of replacement. Units like the power switch and adapter terminal were connected to the board via flexible wires.

In the soldering process, care was taken to ensure that the soldered joints have good mechanical and electrical contact. Also great care was taken to ensure that the components were not damage from excess heat from the soldering iron. The following procedures were followed in the soldering process.

- A 40W pencil type soldering iron was used.
- A good quality lead solder was used.
- For the iron to properly conduct heat, the soldering tip was well tinned (coated with a thin layer of solder). To keep the tip clean, it was wiped from time to time on a damp spurge or cloth.
- All component lead and copper fort pads were cleaned and free of oxidation at the time of soldering by lightly brushing them with steel wool.

- The top of the soldering iron was firmly being placed against the wire lead and copper pad to heat the connection to be soldered.

Before soldering semiconductor components such as transistors, diode etc. the lead near semiconductor was held with needle nose pliers or tweezers to prevent the heat from the soldering iron from getting into the component.

- Soldering flux is applied to the connection as it is being heated. Care was taken not to apply solder directly onto the top of the iron.
- Enough solder was applied to form a tin, smooth coating in all metal part in the connection.
- The heat was allowed on the connection for an instant after application of the solder has been stopped. This is to aid the flow of solder and insure against 'Poor' or 'cooled' solder connections.
- Care was taken not to move the soldered connection until the solder has cooled (solidified), thus reducing the possibilities of improper soldering.
- Excess lead lengths were cut as close as possible to the soldering connections.

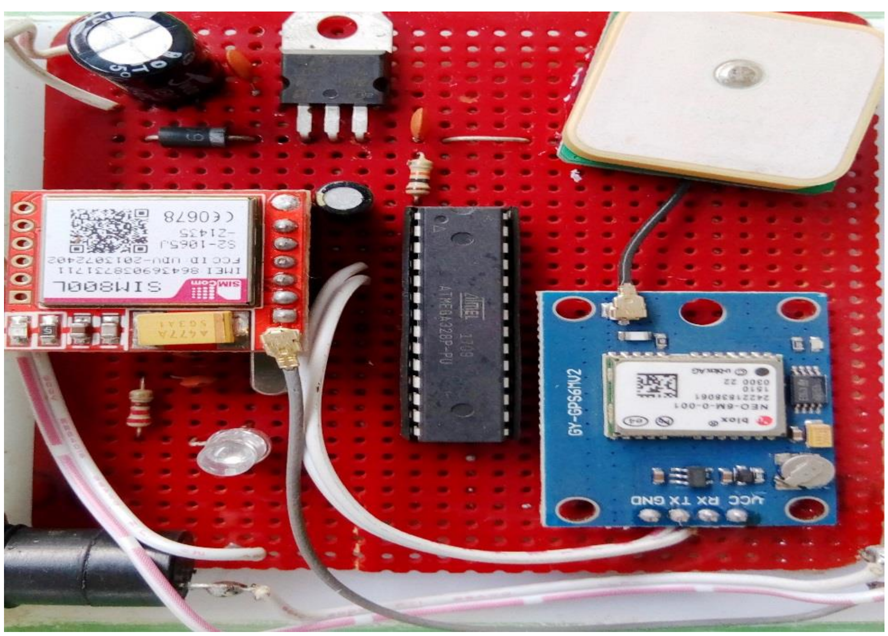


Figure 3.9c: Constructed circuit

3.4.2 Casing Construction

The packaging material was practically made from a sheet of thin Plastic casing. Using a meter rule and pencil, the required shape and size for the casing was marked. The parts were then joined together. Using a hand drill with tiny drilling bit, screw holes and other relevant ventilation holes were performed.

Factors that were considered before choosing a specific shape and size include, a large enough space inside the enclosure to prevent over compression of the circuit board.

3.4.3 Packaging

Having constructed the circuit board and the casing, the circuitry was placed in the casing to provide support and avoid damage, due to the nature of components used in the construction, the project was assembled. Assembling was simply fixing the circuit board firmly in the casing and ensuring that there was no conducting object inside the casing and also that casing was not too small for the circuit board since this might cause compression which might result to breakage or the Vero board crack. Proper connections were made between the units. This was a bit complicated and demand great care and attention since the use of a lot of connecting wires were involved.

3.4.4 List of Tools Used in Construction

1. Soldering iron
2. Pair of pliers
3. Side cutter
4. Lead solder
5. Tweezers

CHAPTER FOUR: PERFORMANCE AND COST EVALUATION

This chapter deals with the experiment carried out in order to test the workability of this project, as well as the cost evaluation of all the components used in the construction of this project.

4.1 Design Simulation

Prior to the construction of the project, the circuit was first designed using Proteus. The control program was written in C language and compiled using Arduino integrated development environment which is an integrated applications software development system, and then embedded on the microcontroller. This was done in order to see how the circuit would work under real conditions. The GPS modem was connected to the microcontroller and the GSM modem was also connected so as to send commands to the circuit and see real time simulation of the VEHICLE TRACKER. With the whole setup, a simulation was established and the circuit was seen to perform the required tasks and then real construction of the project began.

4.2 Testing

Testing is the process of evaluating a system or its component(s) with the intent to find whether it satisfies the specified requirements or not. In simple words, testing is executing a system in order to identify any gaps, errors, or missing requirements in contrary to the actual requirements. It is an assessment intended to measure the respondents' knowledge or other abilities of a system. Technically, it is a technique used to evaluate the functionality of a system. Different types of test were carried out before, during and after the construction work. These include the primary and secondary test. The primary test was carried out before and during the construction work while the secondary test was carried out towards the end of the construction and after the construction work.

4.2.1 Primary Test

Under the primary test, two tests were carried out which are; continuity test and insolation test.

4.2.1.1 Continuity test

A continuity test is the checking of an electric circuit to see if current flows (that it is, in fact, a complete circuit). A continuity test is performed by placing a small voltage (wired in series with an LED or noise producing component such as a piezoelectric speaker) across the chosen path. If electron flow is inhibited by broken conductors, damaged components, or excessive resistance, the circuit is "open". Devices that can be used to perform continuity tests include multimeter which measure current and specialized continuity testers which are cheaper, more basic devices, generally with a simple light bulb that lights up when current flows.

On this project, a continuity test was carried out on the Vero board strips to ensure the continuity line from one end to the other (no breakage where continuity is required and no bridges needed). This is also referred to as open circuit or short circuit test.

4.2.1.2 Insulation/Isolation test

An electrical isolation test is a resistance test that is performed between one or more electrical circuits of the same subsystem. The test often reveals problems that occurred during assemblies, such as defective/wrong component, improper component placement/orientation, and wire insulation or insulator defects that may cause inadvertent shorting or grounding to chassis, in turn, compromising electrical circuit quality and product safety. This test was carried out on the project to ensure no leakage current between the insulation of conductors.

4.2.2 Secondary Test

This is the type of test that is performed during and towards the end of the construction. Two tests were carried out under this test; power supply test and software test.

4.2.2.1 Power Supply Test

This was carried out basically to ascertain the voltage rating and of course the maximum current required to power the entire circuitry.

4.2.2.2 Software Test

Software testing is a process, to evaluate the functionality of a software application or program with the intention of finding whether the developed software meet the specified requirements and to identify the defects to ensure that the product is defect-free in order to produce the quality product. Software testing is needed in order to detect the bugs in the software and to test if the software meets the intended requirements.

4.3 Performance Test

The procedures of the experiment and the analysis of result obtained from the experiment will be discussed as follows:

After all the components were soldered on the Vero board, various tests were carried out. The set up was found to be properly working. The circuitry was further placed in the casing and packaged. A registered MTN SIM card with sufficient recharge amount to make outgoing SMS was inserted into the GSM modem. The device was connected to a car battery which serve as the power source and then the SMS command '#where are you?.' was sent to the device. A report was replied back from the device with details of the location i.e. the coordinates (Latitude and Longitude) values. This experiment was repeated fifteen times with the device placed at fifteen different locations.

Table 4.1 Experimental Result Table

S/N	TESTS	SMS COMMAND SENT	ACTUAL GEOGRAPHICAL LOCATION OF THE TRACKING DEVICE	RESPONSE RECEIVED
1	Test 1	#where are you?.	Sangere, Near Al-jazeera Bakery	Latitude:934997 Longitude:1251649
2	Test 2	#where are you?.	Near Adamawa hospital Yola	Latitude:921209 Longitude:1247203
3	Test 3	#where are you?.	Kabir Umar Hall MAUTECH Yola	Latitude:935060 Longitude:1249962
4	Test 4	#where are you?.	AMA Midala Fuel Station Vinikilang, Mubi Road	Latitude:930257 Longitude:1247643
5	Test 5	#where are you?.	Near Target Junction, Jimeta	Latitude:927160 Longitude:1245262
6	Test 6	#where are you?.	Near Babz Lounge, Police Roundabout, Jimeta	Latitude:925879 Longitude:1245717
7	Test 7	#where are you?.	Near Duragi Hotels, Barracks Road	Latitude:923843 Longitude:1245355
8	Test 8	#where are you?.	Near Sare Kosam, Yola	Latitude:921096 Longitude:1246779
9	Test 9	#where are you?.	Yola International Airport	Latitude:926649 Longitude:1242551
10	Test 10	#where are you?.	Total Filling Station, Near Jimeta Modern Market	Latitude:927526 Longitude:1243396
11	Test 11	#where are you?.	San Hussain Mall, Near Jimeta Modern Market	Latitude:927645 Longitude:1243883
12	Test 12	#where are you?.	Near Mubi Roundabout	Latitude:927882 Longitude:1245152
13	Test 13	#where are you?.	Opposite Jimeta Shopping Complex	Latitude:927497 Longitude:1245216
14	Test14	#where are you?.	Near Adamawa State Board of Internal Revenue	Latitude:927398 Longitude:1246255
15	Test 15	#where are you?.	Opposite Ribadu Square, Jimeta	Latitude:926929 Longitude:1246373

The following plate shows the SMS sent to the vehicle tracker with the SMS received from the vehicle tracker.

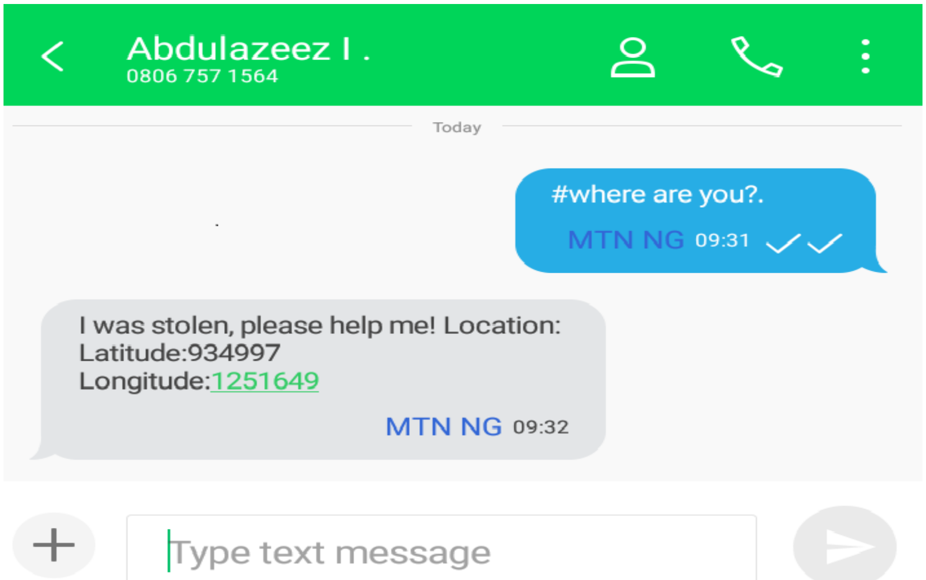


figure 4.1 *screen shot of SMS sent and SMS received from the tracking device*

4.4 Discussion of Result

The objective of this project using GSM and GPS modules in order to track vehicle location was achieved as illustrated by the result above. When the SMS command '#where are you?.' was sent to the device. A report was replied back from the device with details of the location i.e. the coordinates (Latitude and Longitude) values.

4.5 How to Track the Location on Actual Map

It would be time consuming to track location on Printed maps. But nowadays various websites are available on internet which shows online map. Google maps is one of the main and useful website. We use any one of these websites to track or find the location of vehicle. We can track the location using the Longitude and Latitude values received in the SMS. Using these maps, you can get the exact location as well as directions and the time to go to those places from your current/desired location.

The following plates shows the Screen shot of the location on actual Google map.

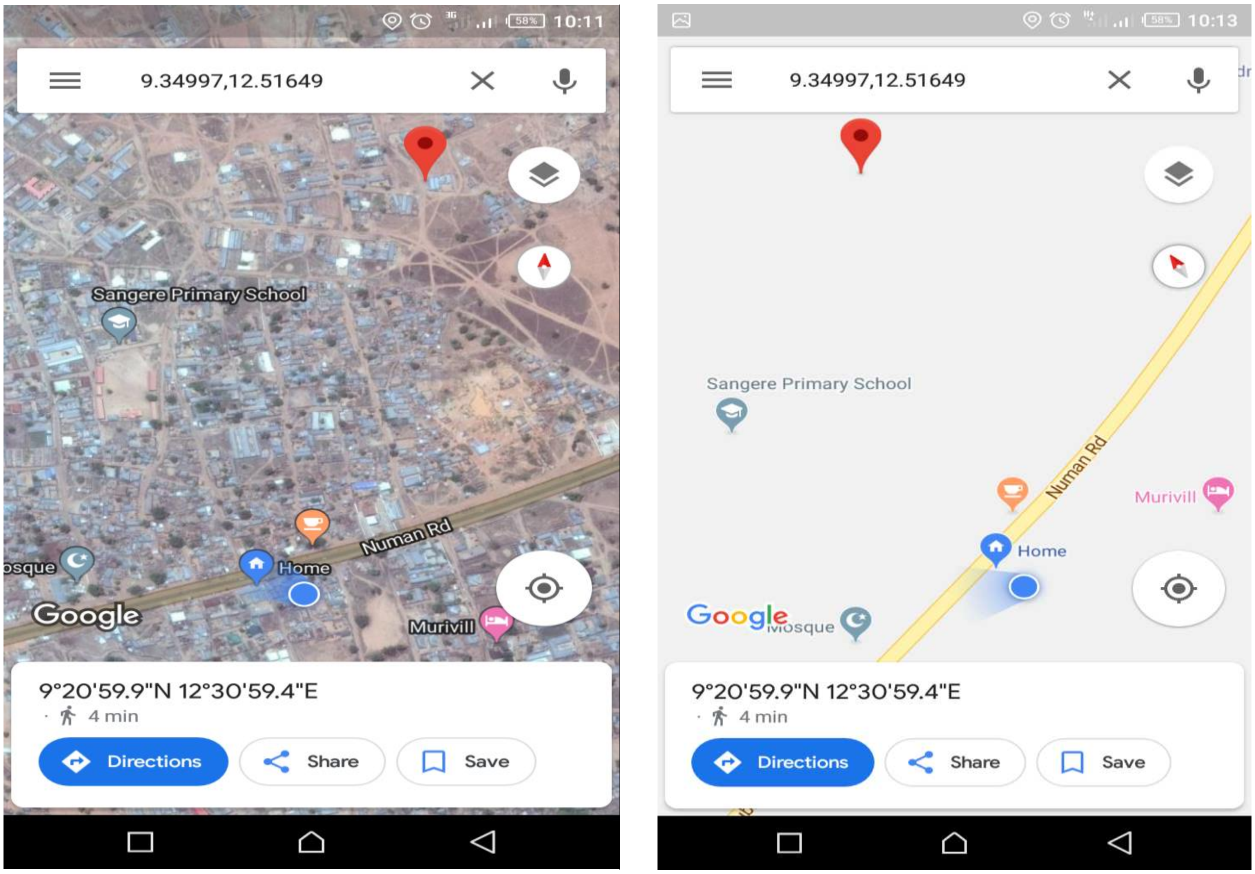


Figure 4.2 *screen shot of the location on actual map*

4.6 Cost Evaluation

Before any project can be considered to be reasonable, it has to be cost effective i.e. economical in design and construction. This cost determines how prosperous that particular project is going to be used. In view of this, the project is seen to be cost effective as most components are readily available locally. The packaging as seen is a plastic casing. From the cost evaluation table below it can be deduced that the cost of producing a unit is quite expensive due to the procedures and methods of carrying out the project in a local setting. It should therefore be noted that for a mass production on a commercial scale the cost will reduce as much as 50% of the cost of producing a unit as components will be purchased in bulk.

The cost of the components used in the construction of this project is shown in table 4.2 below:

Table 4.2: List of Components and cost evaluation.

S/N	Components Description	Rating	Quantity Used	Cost per unit (Naira)	Total cost(Naira)
1	LED		1	10.00	10.00
2	Electrolytic Capacitors	1000µF	1	50.00	50.00
3		10µF	1	30.00	30.00
4	Ceramics Capacitors	22Pf	2	30.00	60.00
5		104Pf	2	40.00	80.00
6	Resistors	10kΩ	1	20.00	20.00
7		220Ω	1	10.00	10.00
8	ATmega328p Microcontroller		1	1700.00	1700.00
9	GSM Module SIM800l		1	4500.00	4500.00
10	Silicon Diode		1	30.00	30.00
11	LM 7805 Regulator		1	50.00	50.00
12	GPS Module		1	5000.00	5000.00
13	Power Cable cord		1	50.00	50.00
14	Jumper wire		5yards	30.00	150.00
15	Lead		10yards	30.00	300.00
16	Vero board		1	150.00	150.00
17	Switch button		1	50.00	50.00
18	16MHz Crystal oscillator		1	150.00	150.00
19	Adapter terminal		1	50.00	50.00
20	Plastic casing		1	500.00	500.00
21	SIM Card		1	200.00	200.00
22	Miscellaneous				2000.00
	TOTAL				**15,140.00**

CHAPTER FIVE: CONCLUSIONS

5.1 Summary

The project entitled "design and construction of a GSM and GPS based advanced vehicle tracking system" was successfully executed using GSM modules and GPS modules, LED, Microcontroller and a voltage regulator. In this project, a device was developed that would track vehicle location and send the information to a control unit at the user side. The entire system was cordinated and controlled by a microcontroller, which makes the system to be user friendly. The system was well packaged and its applications were also highlighted. The overall performance of the constructed system was evaluated by testing the system performance fifteen times with the device placed at fifteen different locations and the results obtained were as expected and it also confirmed the accuracy of the system. Finally, the cost evaluation of the system was also presented.

5.2 Conclusions

The main objective of this project work, which is design and construction of a GSM and GPS based advanced vehicle tracking system was achieved. From the results obtained, the system can be seen to effectively track vehicle location. In order to avoid theft, the system will provide the location coordinates of the vehicle. This system is becoming increasingly important in large cities and it is more secured than other systems. Nowadays vehicle theft is rapidly increasing and with this device we can have a good control in it. The vehicle can be recovered by only sending a simple SMS.

5.3 Recommendations

Based on the design and construction of a GSM and GPS based advanced vehicle tracking system, the following recommendations were suggested for Further research;

- The size of the kit can be reduced by using GPS and GSM on the same module.
- We can monitor some parameters of vehicle like overheat or PMS leakage.
- The system can be further improved by upgrading it to stop the vehicle at any point through the SMS.
- The kit can be used for detection of bomb by connecting it to the bomb detector.
- With the help of high sensitivity vibration sensors, we can detect the accident. whenever vehicle unexpectedly had an accident on the road with help of vibration sensor we can detect the accident and we can send the location to the owner, hospital and police.

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APPENDIX

#source code

```
                    LIBRARIES
//*************************************************************************
#include <TinyGPS.h>
#include <SoftwareSerial.h>

                    INITIALIZATION
//**************************************************************************
#define START_LED_PIN              7
#define NORMAL_LED_PIN             6
#define SWITCH_PIN_1                   9
#define SWITCH_PIN_2          A5

long latitudeRead,longitudeRead;

SoftwareSerial gpsSerial(2,3);
TinyGPS myGPS;

void send_message(String Number, unsigned int index);
void get_Number_and_message(void);
int gsmResponse(String ATcommad);
void gsm_init(void);
void exit(void);


String lat = "";
String lon = "";
String received_message = "";
//**************************************************************************


                  PINS CONFIGURATIONS
//**************************************************************************

void setup()
{
        pinMode(START_LED_PIN, OUTPUT);    digitalWrite(START_LED_PIN, LOW);
  pinMode(NORMAL_LED_PIN, OUTPUT);   digitalWrite(NORMAL_LED_PIN, LOW);
        pinMode(SWITCH_PIN_1, OUTPUT);     digitalWrite(SWITCH_PIN_1, LOW);
  pinMode(SWITCH_PIN_2, OUTPUT);     digitalWrite(SWITCH_PIN_2, LOW);
```

```
        for (int k = 0; k < 10; k++)
        {
                digitalWrite(START_LED_PIN, HIGH);
                delay(500);
                digitalWrite(START_LED_PIN, LOW);
                delay(500);
        }
  digitalWrite(START_LED_PIN, HIGH);
  Serial.begin(9600);
  gpsSerial.begin(9600);
  delay(1000);
  gsm_init();
  digitalWrite(START_LED_PIN, LOW);
  digitalWrite(NORMAL_LED_PIN, HIGH);
}
//*************************************************************************

//*******************RECEIVING AND PROCESSING OF SMS ***********************
//***************ALSO COMMUNICATING WITH THE SATELITE *********************
void loop()
{
        while(gpsSerial.available() > 0)
        {
                if (myGPS.encode(gpsSerial.read()))
                {
                        myGPS.get_position(&latitudeRead,&longitudeRead);
                        lat = "Latitude:" + latitudeRead;
                        lon = "Longitude:" + longitudeRead;
                }
        }
        while (Serial.available() > 0)
        {
                received_message=Serial.readString();
        }

        if (received_message.length()>40) get_Number_and_message();
        else received_message="";
}

//*************************************************************************

//                      FUNCTIONS
//*************************************************************************
```

```
//******************** GSM MODULE INITIALIZER ******************************
void gsm_init(void)
{
	while(gsmResponse("ATE0\r\n") <= 1);
	while(gsmResponse("AT+CMGF=1\r\n") <= 1);
	delay(1000);
	return;
}

int gsmResponse(String ATcommad)
{
	int index_of_OK = 0;
	String return_string = "";

	Serial.print(ATcommad);
	while(Serial.available() == 0);
	return_string = Serial.readString();
	index_of_OK = return_string.indexOf("OK");
	delay(1000);
	return index_of_OK;
}
//*************************************************************************

//********************************** EXTRACTING THE RECEIVED MSG AND GETTING
THE SENDER NUMBER ******************************

void get_Number_and_message(void)
{
	String phone_Number = "";
	String message = "";
	int index_of_character = 0;
	int index_of_dot = 0;

	index_of_character = received_message.indexOf('"');
	phone_Number = received_message.substring(index_of_character,
index_of_character+16);
	index_of_character = received_message.indexOf('#');
	index_of_dot = received_message.indexOf('.');
	message = received_message.substring(++index_of_character, index_of_dot);
      message.trim();
	if (message.equals("WHERE ARE YOU?")) send_message(phone_Number, 0);
	else received_message = "";
	return;
}
```

```
//****************REPLY MESSAGE TO THE SENDER ******************************

void send_message(String Number, unsigned int index)
{
        Serial.print("AT+CMGF=1\r\n");
        delay(5000);
        Serial.print("AT+CMGS=");
        Serial.print(Number);
        Serial.write(0x0D);
        delay(5000);
        Serial.print("I was stolen, please help me! Location:");
        Serial.print(lat);
     Serial.print(lon);
        Serial.write(0x1A);
        received_message = "";
        return;
}
```