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An Implementation of a System Remote Tracking and Control Using Global Positioning System and Global System of Mobile Communication

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ABSTRACT

The theft of vehicles of all types has become common place and a source of concern to the society. The need to prevent such theft or to recover the vehicles after they have been stolen is of paramount importance. The project presented in this paper develops an efficient system of tracking a vehicle, or any object, using the Global Positioning System (GPS) and the Global System of Mobile Communication (GSM). The implementation of this long distance object tracker also uses a microcontroller, in the Arduino development platform that is appropriately programmed to communicate with the GPS and GSM modules. The GSM Modem receives an SMS message from the user of the system to track the location of the stolen vehicle. This message is also processed by the microcontroller which receives position coordinates in the form of longitude and latitude from the GPS and sends them to the GSM modem for transmission to the user's cellular phone. The coordinates are also displayed for viewing on a Liquid Crystal Display (LCD). The user can initiate the action of immobilizing the vehicle from his cellular phone. Through the incorporation of the Google maps Application Programming Interface (API), the position of the vehicle can be viewed on the map. A prototype of the system was built and tested and it achieves the twin objectives of tracking and control of objects from remote locations excellently. The system has applications in other areas such as vehicle fleet management and security monitoring of objects.

Keywords: *GPS, GSM, Object Tracker, SMS, Google Maps API*

1. INTRODUCTION

Over the past decade, real time tracking and management of vehicles using various kinds of technology has become a field of mounting interest. It has now developed into a powerful and marketable package due to continued lowering of cost and the incorporation of various facilities such as anti-theft modules and client identification (Ahmad et al., 2006). A good number of tracking systems have so far been developed with a wide range of tracking facilities. However, the operational cost of most of these systems is high and this prevents them from widespread use.

A cost effective GPS-GPRS based object tracking system which uses the GPRS for its operation was reported by Khondker et al. (2009). A complete embedded system implementation of GPS-GSM based tracking System using SMS was reported by Abed and Ravi (2012). Baburao et al. (2008) discussed GSM and GPS based vehicle location and tracking System, which makes use of existing GSM networks and GPS technology. Hsiao and Chang (2006) developed an analytical model to analyse the optimal location update strategy with the objective of minimum total cost. Montaser et al. (2012) implemented an object tracking system but used separate GPS and GSM modules; moreover their work did not provide any alternate telephone number to report theft of vehicles.

This project focuses on reducing the total cost of object tracking and theft prevention and thus makes use of a single SIM908 GPS/GSM Module (Shanghai SIMCom, 2011) that contains a GSM modem and GPS together and therefore has all that is required to develop GSM and GPS based systems. The incorporation of the in-vehicle tracking unit of this project, working together with a server, makes it possible to monitor the location of a vehicle. This, in turn, discourages dangerous and inefficient driving practices of drivers, in the case of fleet management, which leads to increased vehicle security and driver safety. The vehicle tracking system plays a vital role if it is used in any company or organization for any kind of delivery purposes. Since the driver is aware of the fact that the car is constantly being monitored, he would be careful while driving and he would take the shortest possible route to reach his destination right on time. This system also ensures the recovery of stolen vehicles. If the vehicle does not get to the designated location or is being used by an unauthorized person, the location can be tracked and the vehicle immobilized so that the relevant law enforcement agents can be notified for the vehicle to be recovered.

2. MATERIALS AND METHODS

2.1 System Architecture

The block diagram of the vehicle or long distance tracking system using GPS/GSM is shown in figure 1. The system shown in figure 1 is embedded in the vehicle being tracked. The microcontroller, which in this case is part of the Arduino platform (Margolis, 2012), receives the longitude and latitude coordinates of the location of the vehicle from the GPS module. These coordinates are displayed on the LCD. Upon demand from the user's cellular phone that may be located in a remote location far from the in-vehicle unit, the microcontroller sends an SMS message to the user through the

GSM Modem to indicate the working status of the whole system. However, in the case where the vehicle is stolen or being operated by an unauthorized person, the user can send an SMS message instructing the microcontroller to switch off the ignition which thereby shuts down the vehicle's engine. The system will then send a message back to the owner confirming that the requested action has been performed. The location of the vehicle can be viewed on an Internet-connected computer using the Google map API (Google Maps, 2015). Although shown as separate blocks, the GPS and GSM modules used in this design are contained in a single integrated module known as the SIM 908 GPS/GSM module.

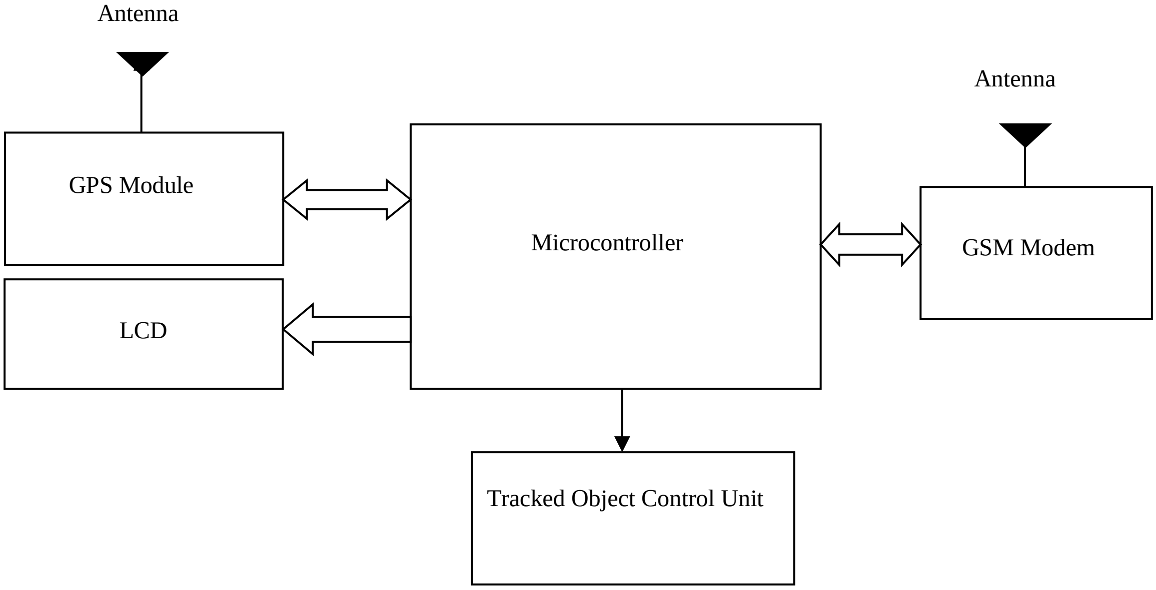


Figure 1. Block Diagram of Tracking System Using GPS and GSM Modules

There may then be the need to inform the relevant security agents of the position of the stolen vehicle. When the vehicle is recovered, it can only be started from the owner's cellular phone with another SMS to the in-vehicle unit. A corresponding SMS message would be sent by the microcontroller to the user's phone to tell him that the action has been performed. In all these cases, the SMS text messages received include GPS coordinates in the form of longitude and latitude. The overall system efficiency depends on the quality of service of the used mobile communication network (Haider et al, 2009).

2.2 Hardware Design

The schematic diagram of the system is shown in figure 2. It comprises the SIM908 GPS/GSM module, the Arduino Uno Rev3 microcontroller module, the LCD and the tracked object control unit. The SIM908 GPS/GSM module selected for this design is compatible with 850/900/1800/1900 MHz frequencies of the cellular network hence its capability to work on most GSM networks around the world. It has a 20-channel high sensitivity GPS receiver and a built-in SIM card holder, making the system compact and power efficient. It also supports the complete standard AT command set plus custom AT command set for GPS. The SIM908 GPS/GSM module is the ideal platform for mobile application in areas such as telematics, fleet management, tracking, security and vehicle navigation (Telit Wireless Solutions, 2015). The Arduino Uno Rev3 microcontroller was selected because it can efficiently handle the requirements of this design and it is relatively cheaper compared to other microcontrollers.

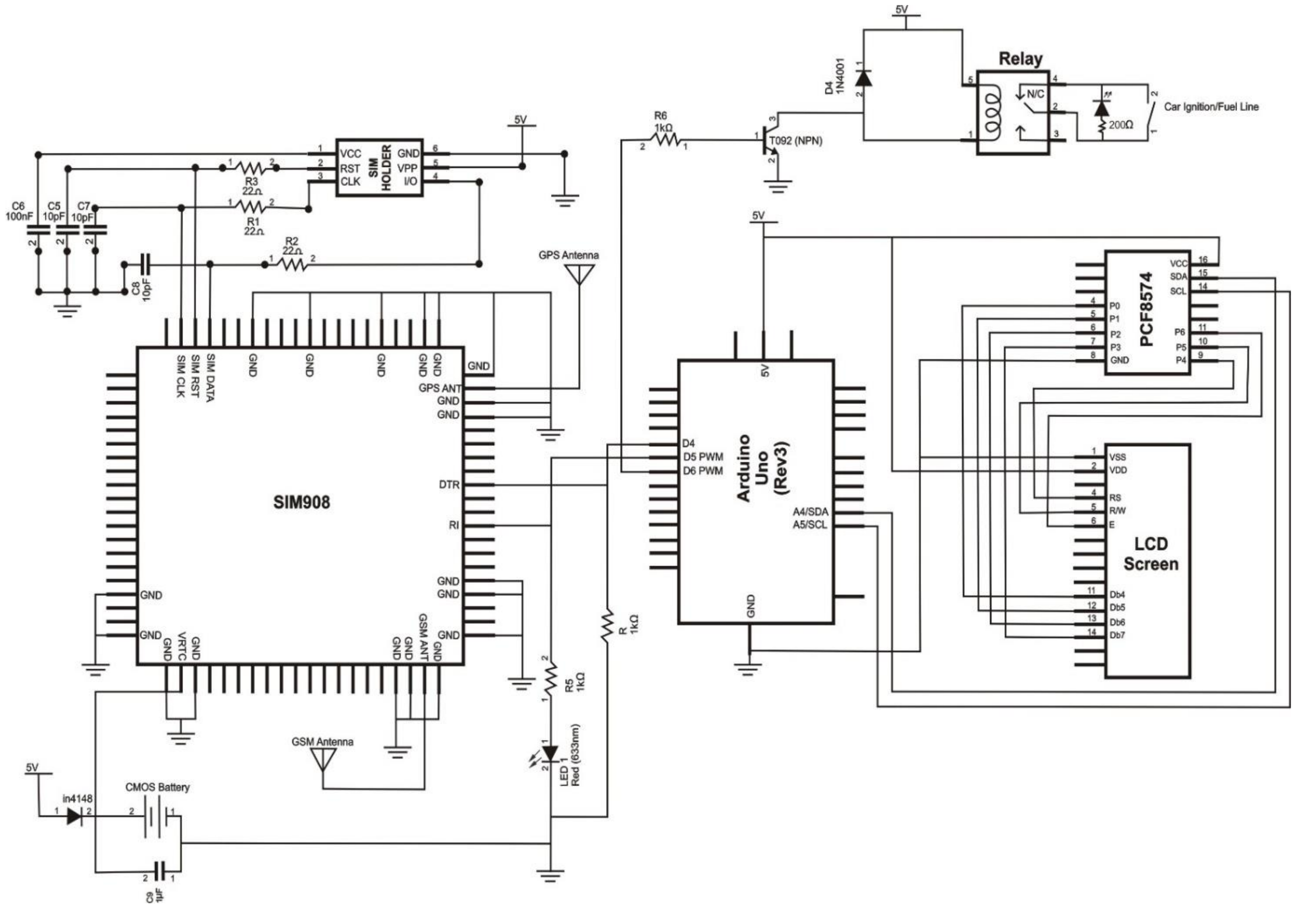


Figure 2. Schematic Diagram of the Design

2.3 Program Flowcharts

The flowchart for the design is shown in figure 3. After the initialization of the GPS and GSM modules, the system checks, in a subroutine, if the user has placed a request for coordinates of the tracked object from the satellites. If the coordinates are available, the GPS module sends them to the user's phone. Another subroutine of the program is used to display the coordinates on the LCD. The third subroutine uses the PHP code and the Google map API to initialize and display the exact location of the tracked object. The programs for the first two subroutines were written in Arduino language which is actually a subset of the C/C++ programming language (Purdum, 2012).

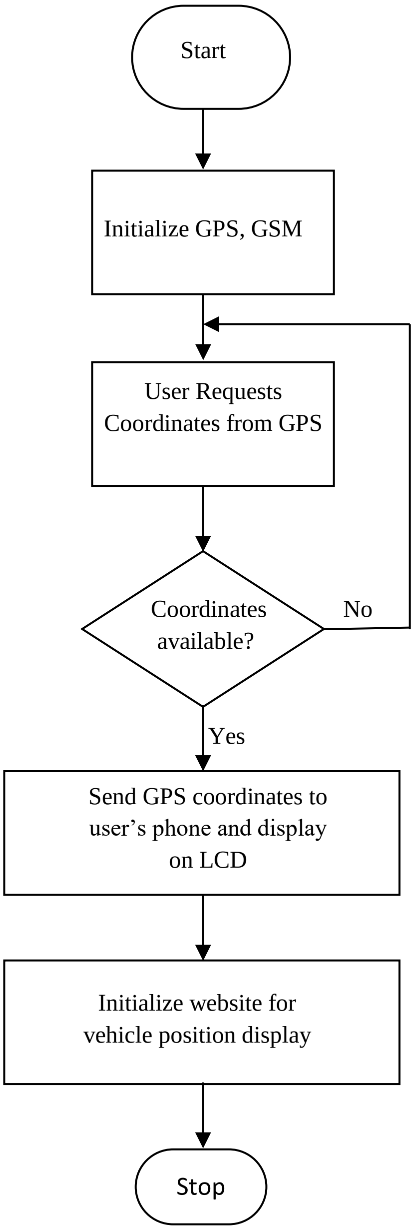
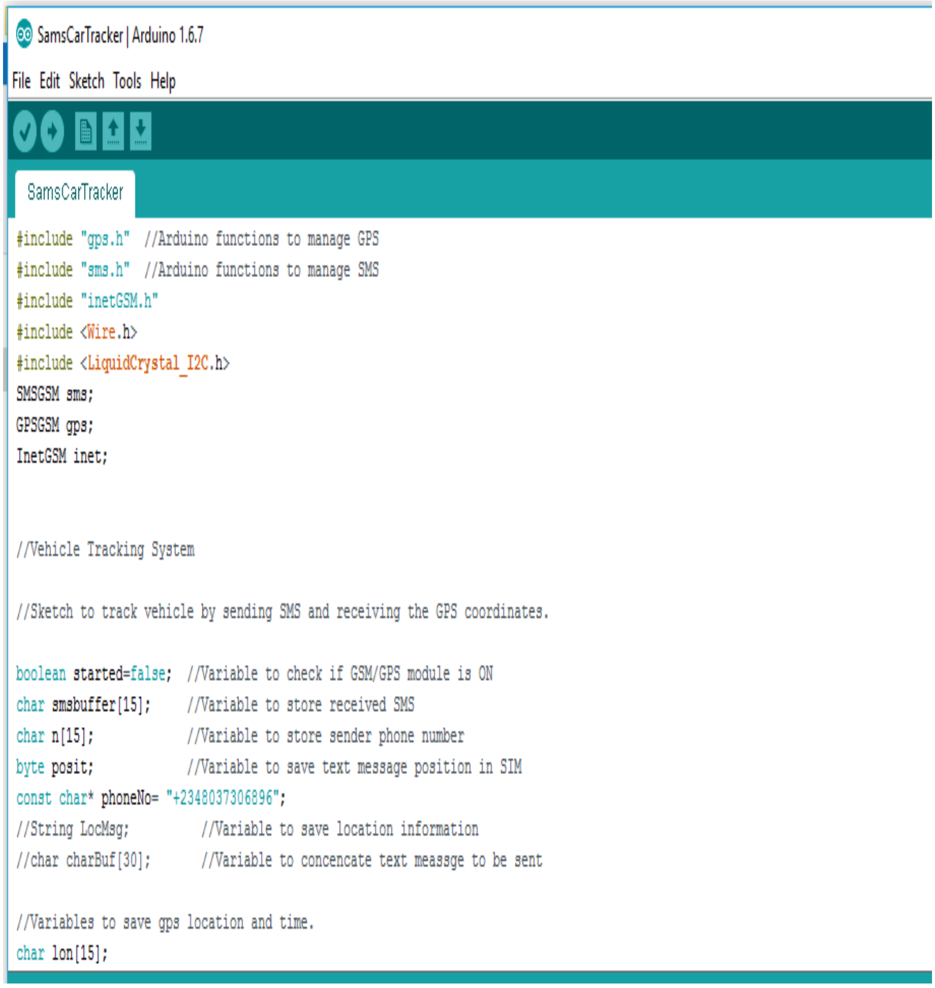


Figure 3: Flowchart of the System Design

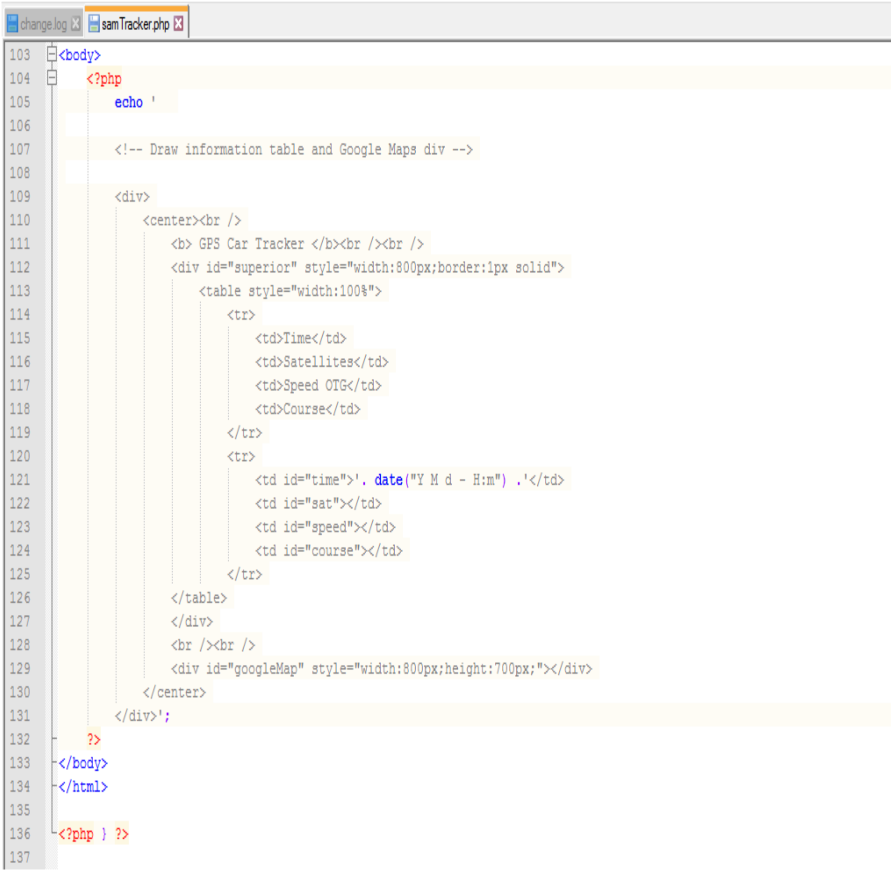
3. RESULTS

Screenshots of the completed program sketch and the PHP code are shown in figures 4 and 5. Figure 6 shows the various component modules assembled on an aluminium casing. The completed prototype is shown in figure 7, while figures 8, 9 and 10 show the received coordinates on the LCD, cellular phone message and the vehicle position on the Google map respectively. After the construction of the prototype the system was tested to verify its ability to track and control a vehicle and it was found to work efficiently.




```
#include "gps.h"  //Arduino functions to manage GPS
#include "sms.h"  //Arduino functions to manage SMS
#include "inetGSM.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
SMSGSM sms;
GPSGSM gps;
InetGSM inet;


//Vehicle Tracking System

//Sketch to track vehicle by sending SMS and receiving the GPS coordinates.

boolean started=false;  //Variable to check if GSM/GPS module is ON
char smsbuffer[15];     //Variable to store received SMS
char n[15];             //Variable to store sender phone number
byte posit;             //Variable to save text message position in SIM
const char* phoneNo= "+2348037306896";
//String LocMsg;          //Variable to save location information
//char charBuf[30];       //Variable to concencate text meassge to be sent

//Variables to save gps location and time.
char lon[15];
```

Figure 4. Screenshot of the Completed Program Sketch



```
<body>
    <?php
        echo '

        <!-- Draw information table and Google Maps div -->

        <div>
            <center><br />
                <b> GPS Car Tracker </b><br /><br />
                <div id="superior" style="width:800px;border:1px solid">
                    <table style="width:100%">
                        <tr>
                            <td>Time</td>
                            <td>Satellites</td>
                            <td>Speed OTG</td>
                            <td>Course</td>
                        </tr>
                        <tr>
                            <td id="time">'. date("Y M d - H:m") .'</td>
                            <td id="sat"></td>
                            <td id="speed"></td>
                            <td id="course"></td>
                        </tr>
                    </table>
                </div>
                <br /><br />
                <div id="googleMap" style="width:800px;height:700px;"></div>
            </center>
        </div>';
    ?>
</body>
</html>

<?php } ?>
```

Figure 5. Screenshot of the PHP Code

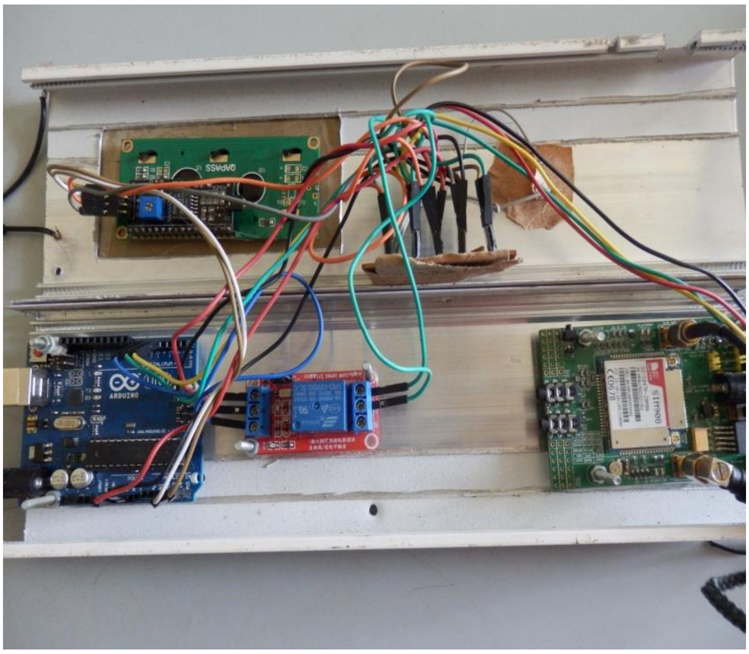


Figure 6. The Various Modules of the Tracker Installed in the Casing

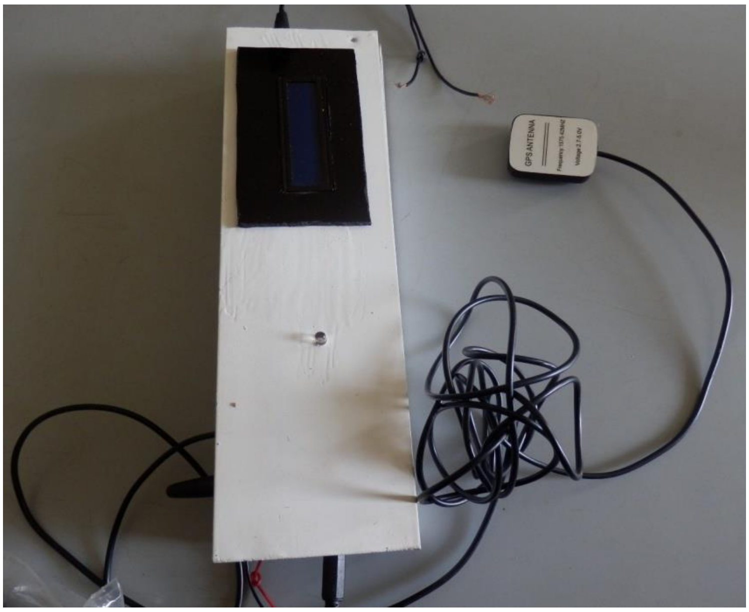


Figure 7. The Completed Prototype of the Tracker

Figure 8. Coordinates Displayed on the LCD of the Tracker

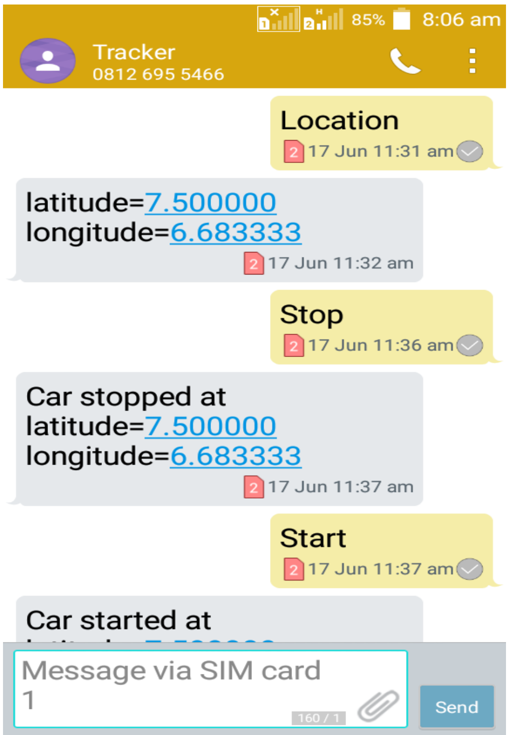


Figure 9. Coordinates Received on the Cellular Phone

Time	Satellites	Speed OTG	Course
2017 Feb 12 - 08:02	1	122.5	120

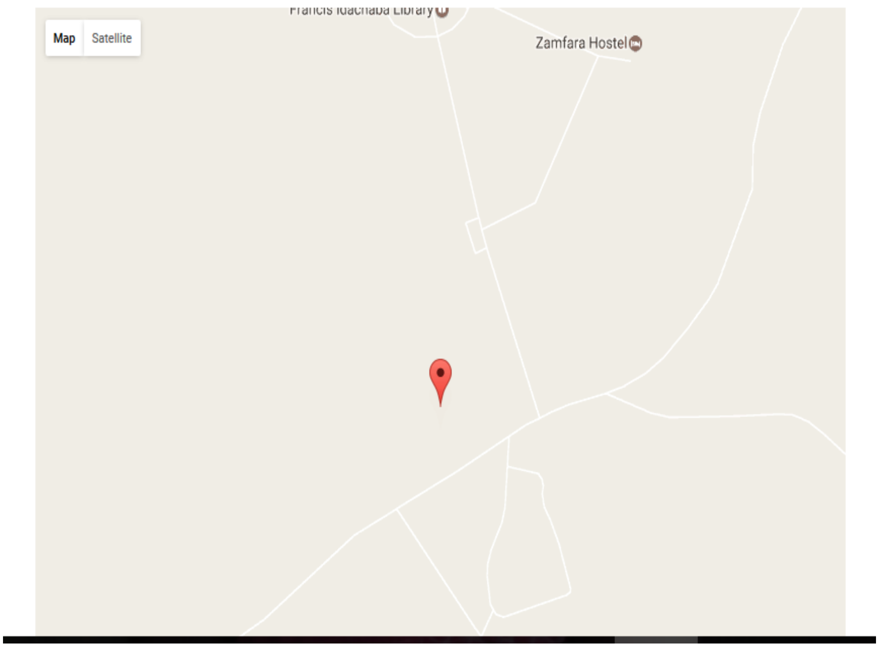


Figure 10. Vehicle Position displayed on Google Map

4. DISCUSSION

The system was constructed and tested, and it responded efficiently, giving a satisfactory accuracy of the vehicle position, taking into account some limitations such as weather conditions, multipath errors, obstructions such as tall trees and buildings, and the internet and mobile network provider effectiveness and availability. It was observed that the system would not work inside of a room as the GPS receiver needs a clear line-of sight to be able to acquire the coordinates from the GPS satellites. The accuracy of a tracking device in locating the object being tracked depends on the quality of the GPS receiver used as well as physical conditions earlier highlighted. The system presented in this report was found to have an accuracy of ten meters. While testing the system, it was observed that there were delays between receiving and sending text messages between the system and the cellular phone of the user after every request. The SIM cards of all the major mobile network providers in the country were used in the tests and they provided satisfactory results although the delay times varied from one network provider to the other.

5. CONCLUSION

A vehicle tracking system using the GPS and GSM modules has been successfully designed and implemented. The system can be used to track any object from a long distance as long as the tracked object is within the coverage of a GSM network. The system can be used not only for thwarting theft of vehicles but also can be modified for applications in fleet management and security monitoring of goods.

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