Implementation of an Embedded System for Real Time Monitoring of Vehicular Movement in Mining Sites

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In partial fulfilment for the award of the degree of

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CERTIFICATE

This is to certify that the thesis entitled "**Implementation of an Embedded System for Real Time Monitoring of Vehicular Movement in Mining Sites**", submitted to the National Institute of Technology, Rourkela by **Himansu Sekhar Pradhan, Roll No. 110EI0254** for the award of the degree of **Bachelor of Technology** in Department of Electronics and Instrumentation Engineering, is a bonafide record of research work carried out by them under my supervision and guidance.

The candidate has fulfilled all the prescribed requirements. The thesis is based on candidate's own work, is not submitted elsewhere for the award of degree/diploma.

In my opinion, the thesis is in standard fulfilling all the requirements for the award of the degree of **Bachelor of Technology** in Electronics and Instrumentation Engineering.

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NIT Rourkela

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Himansu Sekhar Pradhan

ABSTRACT

The designed tracking and monitoring system for opencast mines allows continuous tracking and monitoring vehicles and movable equipment in many opencast mines using Global Positioning System (GPS) receiver[1,2,3], General Packet Radio Service (GPRS)[4] unit, microcontroller along with ZigBee (programmable to operate as routers ,end devices, and coordinators by hardware specific embedded software)[5] shapes a dynamic remote system among them and other static and portable ZigBee gadgets set at key areas. Utilization of the framework would help in keeping up computerized record and investigating the execution of unreasonable scoops and dumpers sent in opencast mines. This would help in advancing the position of dumpers with every scoop relying upon the adjustment in living up to expectations and dumping spots. This would likewise help in keeping up automated participation of dumper administrators and other work force working in an opencast mine. This would further help in giving cautioning to the sign man and dumper administrator, while dumper drawing nearer close vicinity to the sign man. This would help in building two-way message correspondence among the work force occupied with an opencast mine. This would at last help in enhancing generation, efficiency and well-being in opencast mine.

Keywords – Tracking, Monitoring, ZigBee, GPS, GPRS, GSM, Microcontroller, Embedded Systems, Opencast

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ABBREVIATION

1. GPS stands for Global Positioning Systems
2. GSM stands for Global System for Mobile Communications
3. GPRS stands for General Packet Radio Service
4. GUI stands for Graphical User Interface

[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17]

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

To keep a track of the vehicular movement in mines an embedded system is to be developed which sends detail locational information of the vehicles to the control room based on which staff in the control room can send bearings to those vehicles. The weight of the vehicles along with the load quality also needs to be sent to the control room. The mining processes were previously using the commercially available vehicle tracker to keep a track on the vehicles. But those products are not capable of meeting the specific requirements. The usual GSM network strength is very weak in various places. In those places the system was unable to track the vehicles. Again whenever there occurs a network failure the system were not capable to reinitialise by its own. So these were the serious drawback of the commercially available vehicle trackers. Another major problem associated with commercially available vehicle tracker is that none of them are able to update the vehicles location in less than a minute. So a complete path is not achievable by using those available products in the market. Hence there is a need to develop an embedded system that can tackle this problem. An Embedded framework is a specific PC framework that is a piece of a bigger framework or machine. Commonly, it is housed on a chip board with the projects put away in ROM. A few frameworks additionally incorporate a working framework, yet numerous are specialized to the point that the whole rationale can be executed as a solitary project. Aside from the essential equipment it likewise encapsulates the product which contains the algorithmic knowledge.

1.2 MOTIVATION

In the mining process a common challenge is to effectively utilize the earth moving equipment such as dumpers and excavators in real time. If these dumpers can be monitored right from their loading point till the ore processing plant then the cycle time can be greatly reduced. Optimisation of their movement would make the mining process efficient and improve the throughput of the overall system. In normal situations almost all mines suffer from the problem of having access to standard networks for communication as deep mining point is roughly 100 meters below the normal level where ordinarily Global System for Mobile Communications (GSM) network is not available [6]. The structure of the mines also differ from one another.

Hence no standard hardware and software solution exists which could be used for all mines for their process monitoring. Hence, an embedded system is to be developed which will be installed to keep a track of the vehicular movement in mines based on which personnel in the control room can send directions to those vehicles. This work is also motivated by the reported works of [7,8].

1.3 SPECIFIC REQUIREMENTS OF THE SYSTEM

There are many dumpers engaged in mining activity at iron ore mines. They feedstuff the material to the ore processing plant from different loading points. If these dumpers can be monitored right from their loading point till the ore processing plant then the cycle time can be greatly reduced. This would make the mining process efficient and improve the throughput and improve the throughput of the overall system. Hence an electronic system needs to be developed which does the following tasks.

i. Monitoring each vehicle movement through wireless network in the control room.
ii. Monitoring the weight measured and recorded in the weigh bridge in the control room through wireless transmission.
iii. Recording the quality information of the ROM (run-of-mine) material in the control room so that the blending ratio is maintained.
iv. Providing necessary direction to the vehicle for effective management.

To monitor each dumper it may be noted that the deep mining point is roughly 100 meters below the normal level where ordinarily GSM network is not available. Hence a faithful wireless network needs to be installed when the truck inside the mine. The location data from this devoted network need to be transferred to the GSM network which can then be loaded to the control room server.

1.4 OBJECTIVE

i. To design and deploy an efficient embedded electronic hardware system for installation in vehicles.
ii. To develop software system for configuration and operation of the hardware installed in vehicles.
iii. To develop software for control room server for logging of above data in the database.
iv. To develop software for virtual display of the vehicle location over a screen.
v. To provide communication for necessary management of the tracked vehicles.

CHAPTER 2: SYSTEM DESCRIPTION

Vehicle Tracking System is an embedded system infrastructure which offers an easy way to keep a record of a vehicle and obtain information about its location and earlier history [4].

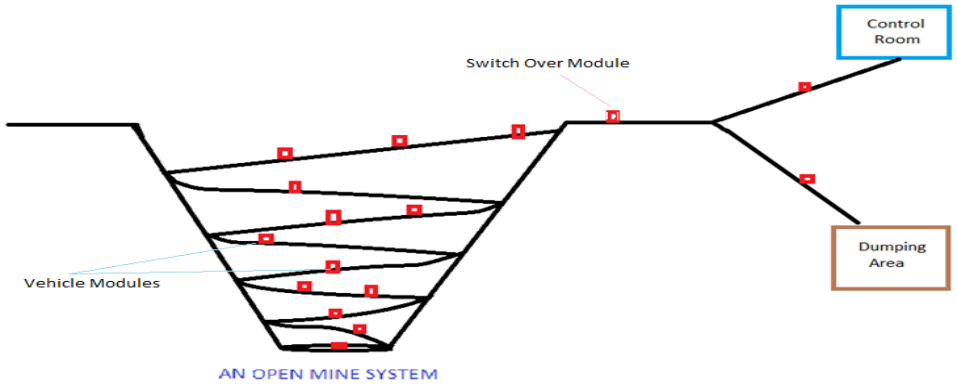


Figure 1. Structure of an Open Cast Mine System under Consideration

A GPS receiver uses microwaves received from 4 GPS satellites to identify its position (in terms of latitude and longitude on the surface of the earth with a negligible slip of 2-5 meters [9],[10]. Furthermore, this is all conceivable continuously, the GPS collector being equipped for producing 5 topographical directions every second. A mini microcontroller processes the data, and transfers it as per requirement to a wireless GSM/GPRS module which directly uploads data to our vehicle tracking server or to the xbee present in the switchover unit. The vehicle's geographical location information is read in from the GPS module by the microcontroller. The vehicle's location information and the vehicle's ID are then transmitted to the web server through GSM/GPRS network. The GSM/GPRS module is utilized for TCP/IP communication [8]. The received vehicle's location information and the vehicle's ID are sent from a form with the GET method for transmission to the server. On the other end, the web interface written in PHP is executed to straightforwardly unite with a database. A vehicle's geographic coordinates and a vehicle's unique ID, obtained from device are recorded in a database table. And a graphical user interface (GUI) has been created to display a vehicle location on Google maps. Once there, one can see all tracking information on the internet.

The units developed in the system are as follows:

2.1 Vehicle Unit

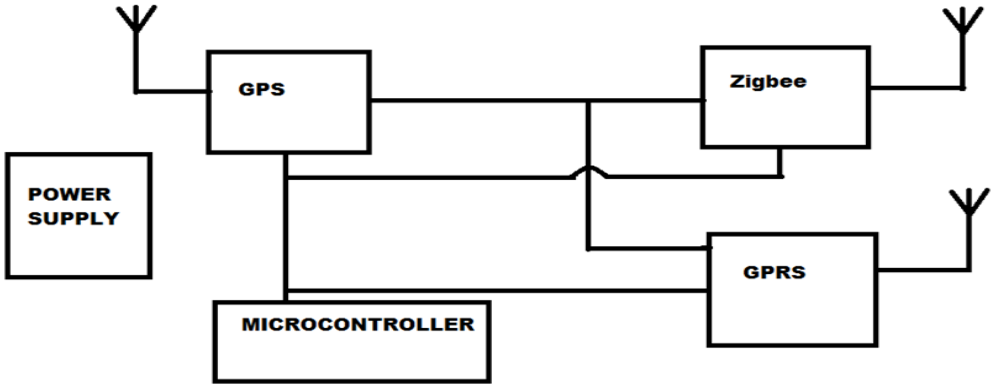


Figure 2. Block Level Diagram of the Vehicle Unit.

On the above diagram it is shown that a GPS module is connected serially with both xbee and GPRS module. A microcontroller is connected with all the other modules for controlling purpose. A separate power supply module is required for the operation of various devices. This unit is to be installed in the vehicle to be tracked. The microcontroller receives GPS data, then it checks for availability of GSM network. If GSM network is available then it directly upload the obtained data to our vehicle tracking sever using the GPRS. In case of unavailability of gsm network the microcontroller sends the data by the transmitter xbee.

2.2 Switchover Unit

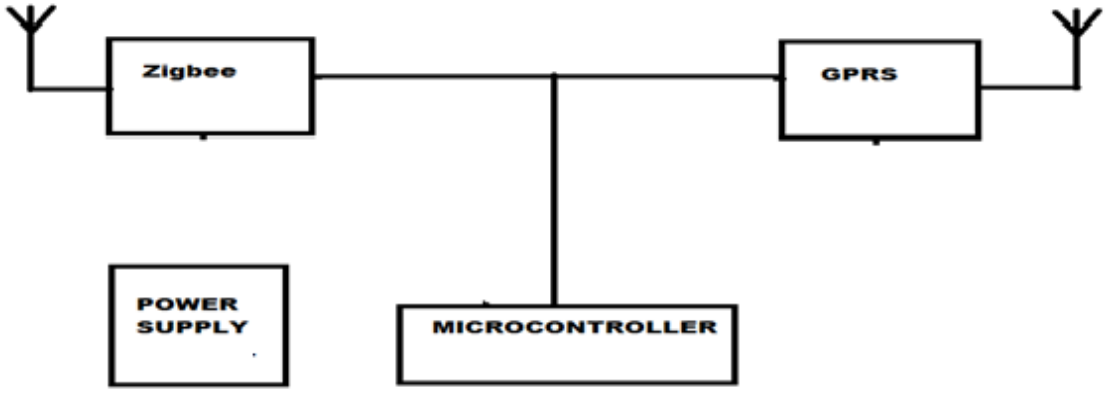


Figure 3. Block Level Diagram of Switchover Unit

This module is placed permanently in a place where standard GSM network is available. In this module xbee, microcontroller and the GPRS module are connected together by means of

serial interface. The xbee receiver receives the data transmitted by the transmitter xbee contained inside the vehicle unit. Then this data is given to the serial input of the microcontroller. Then the microcontroller will upload the obtained data to our vehicle tracking sever using the GSM unit.

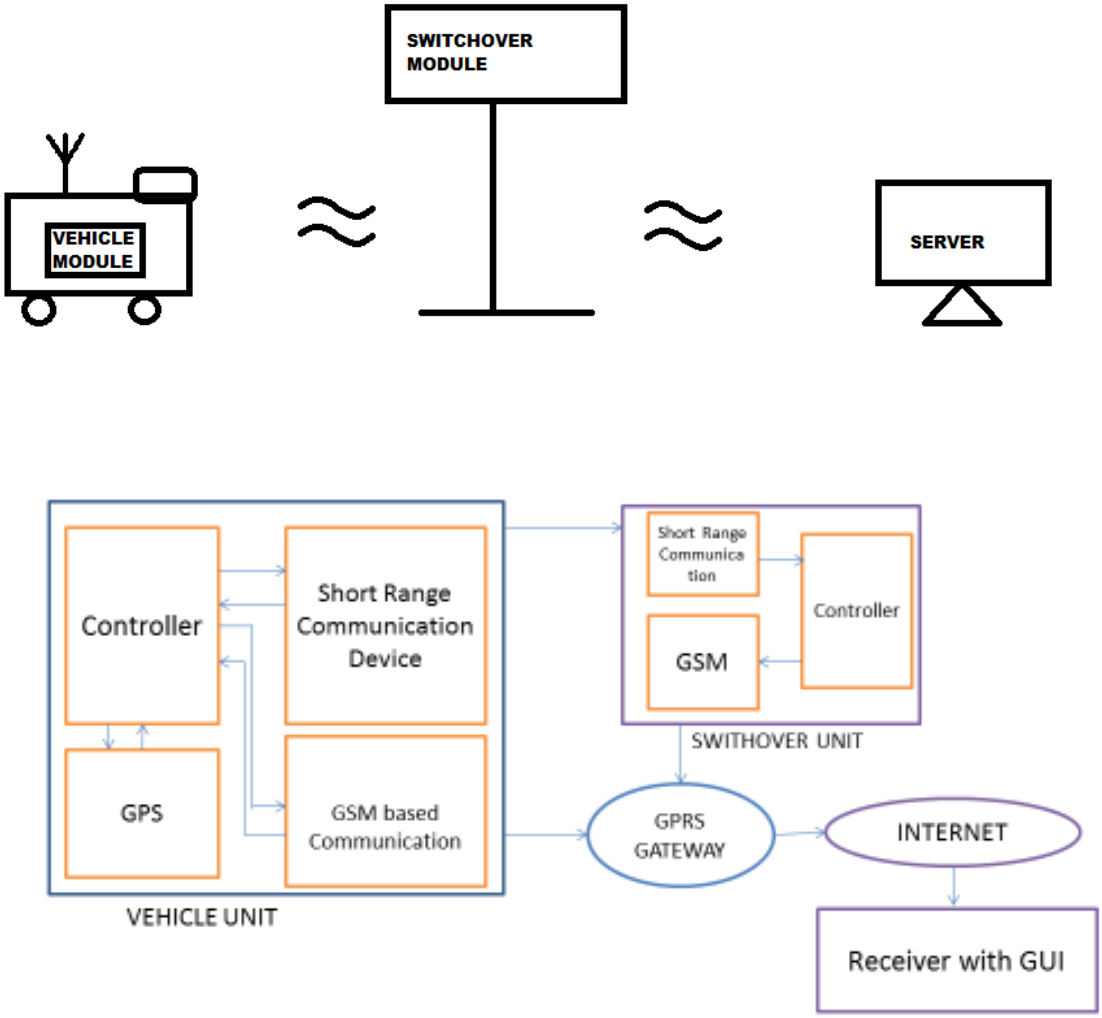


Figure 4. Proposed Block Level Diagram of the Complete Embedded System

CHAPTER 3:

INDIVIDUAL COMPONENT DESCRIPTION

3.1 GPS Receiver [17]

The GPS receiver is a complete GPS engine module that highlights super affectability, ultra-low power and little frame element. [17] The GPS signal is connected to the antenna of the module, and a complete serial information message with position, speed and time data is exhibited at the serial interface with NMEA convention or custom convention. It is taking into account the elite highlights of the Media Tek 3329 single-chip structural engineering, Its –165 dBm following affectability develops situating scope into spot like urban gorches and thick foliage environment where the GPS was impractical anytime recently. [17] The little frame variable and low power utilization make the module simple to coordinate into compact gadget like PNDs, cell telephones, cams and vehicle route framework

3.1.1 Applications [17]

i. This device has application in Location Based Service LBS.
ii. It can be used as Portable Navigation Device.
iii. It has great use in vehicle navigation system. [17]

3.1.2 Features

The special features used in this device are as follows:

i. The sensitivity -165 dBm
ii. Very fast Time To First Fix (TTFF) at minimal signal level
iii. Small power intake which is typically 45mA @ 3.3V
iv. It uses NMEA 0183 compliant protocol. [17]
v. It also supports Universal Serial Bus Interface
vi. The operating voltage ranges from 3.0 V to 4.2 V
vii. The operating temperature ranges from -40 to 85℃
viii. It incorporates SMD type which is provided with stamp holes
ix. It has a very small form factor which is 15x13x2.7mm
x. RoHS compliant. [17]

3.1.3 Interfaces Configuration. [17]

3.1.3.1 Power Supply:

A regulated power is required for the SKG13C. The input voltage Vcc ought to be from 3 V to 4.2 Volts territory, the current should not be under 100mA. Suitable decoupling must be conveyed by outside decoupling hardware (10uF and 1uF). It can decrease the Noise from power supply and increase stability of power. [17]

3.1.3.2 Antenna: [17]

The SKG13C GPS receiver is designed for supporting the active antenna or passive antenna connected with pin RF_IN. The gain of antenna should not be more than 25dB. [17] The maximum noise figure should be no more than 1.5 dB and output impedance is at 50 Ohm. [17]

3.1.3.3 UART Ports: [17]

The module supplies one full duplex serial channels UART. These serial connections are at 2.85V LVTTL logic levels, if need different voltage levels, use appropriate level shifters. the data format is fixed: X, N, 8, 1, i.e. X baud rate, no parity, eight data bits and one stop bit, no other data formats are sustained, LSB is sent first. It is strap pin, defaulting must pull up. [17] The RXD0 & TXD0 suggested to pull up (10KΩ). It can rise the stability of serial data.

3.1.3.4 Backup Battery Power:

In occasion of a power failure on VCC pin, real time clock and back up RAM are provided through pin V_BCKP. This allows the SKG13C GPS Receiver to make progress from power failure with either a hot start or a warm start. [17] The receiver performs a cold start upon powered up, if no Backup Battery is connected. A bypassing capacitor (1uF) at V_BCKP pin should be added, if we use backup battery. It can reduce noise and increase the stability. [17]

3.1.3.5 USB Ports:

The SKG13C has built in great speed USB 2.0 interface and it may be used to interface host devices. Supports only 3.3V power supply. [17] Do not connect USB +5V supply to VDDUSB; in its place use external +3.3V regulator powered from USB +5V supply. [17]

3.1.4 NMEA 0183 Protocol

The NMEA protocol, whose records start with a $ and with carriage return/line feed, is an ASCII-based protocol. GPS specific messages all begin with $GPxxx, where xxx is a identifier of the message. NMEA messages have a checksum and it allows detection of degraded data transfers. The SkyNav SKG12A upkeeps the following NMEA-0183 messages: GGA, RMC VTG, GLL, GSA, GSV, ZDA. This module default NMEA-0183 output is set-up GGA, GSA, RMC, GSV, and 9600 is set as the default baud rate. [17]

3.1.5 Interpretation of GPS data

$GPRMC,161229.487,A,3723.2475,N,12158.3416,W,0.13,309.62,120598,,*10

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC position	161229.487		hhmmss.sss
Status	A		A=data valid or V data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		ddmmyy
Magnetic Variation		degrees	E=east or W=west
Checksum	*10		
<CR><LF>			End of message termination

Figure 5. RMC Data Format

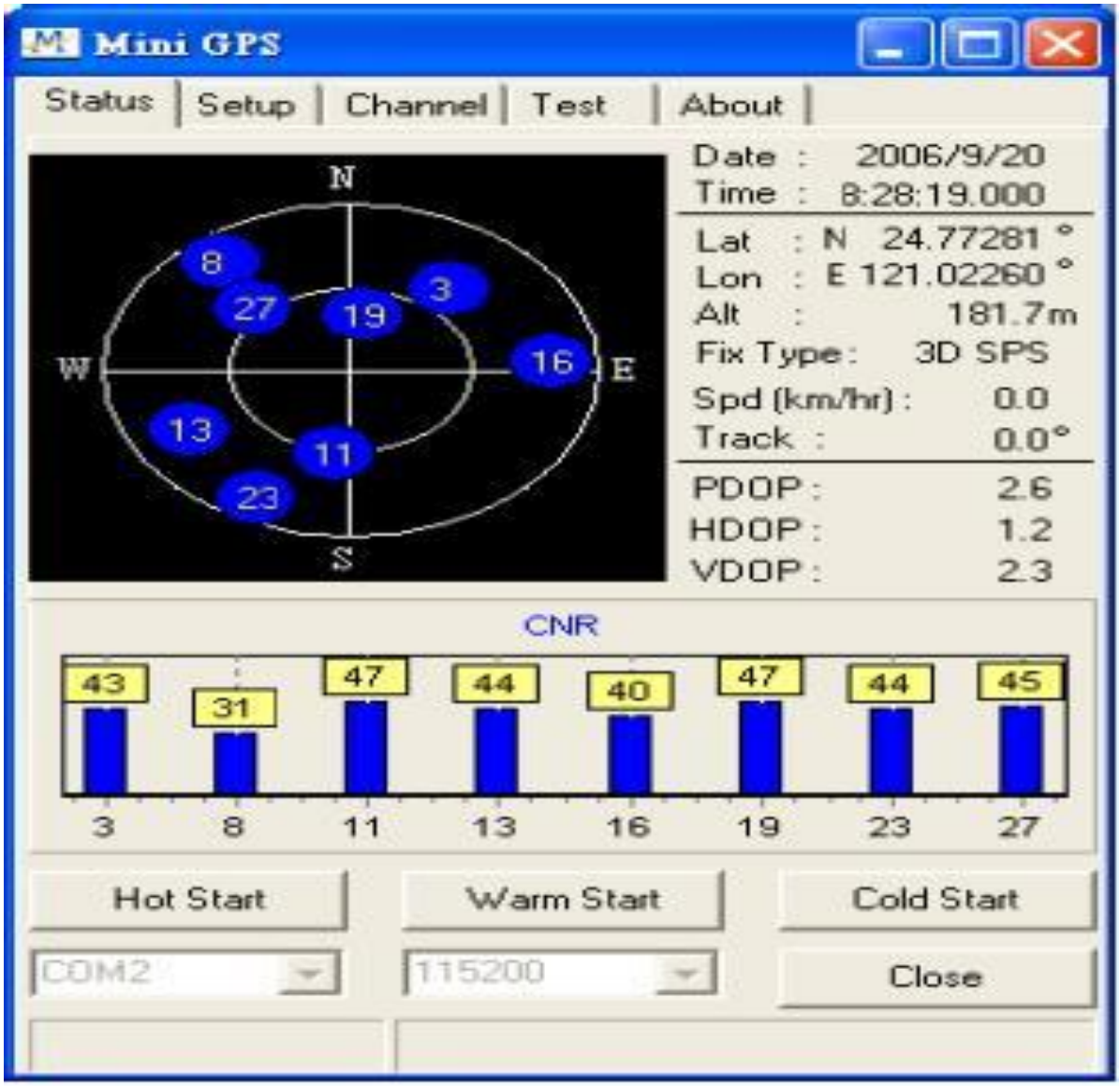


Figure 6. Mini GPS tool used to show the obtained geographical information.

The above figure shows the obtained geographical information by using Mini GPS tool. A GPS receiver is connected by means of serial interface to a pc. This device should be detected by a com port of the pc. Then the Mini GPS tool is turned on. This tool specifies different parameters such as date. Time, latitude, longitude, altitude, fix type, speed, track etc. It has also specifications for cold start, hot start and warm start.

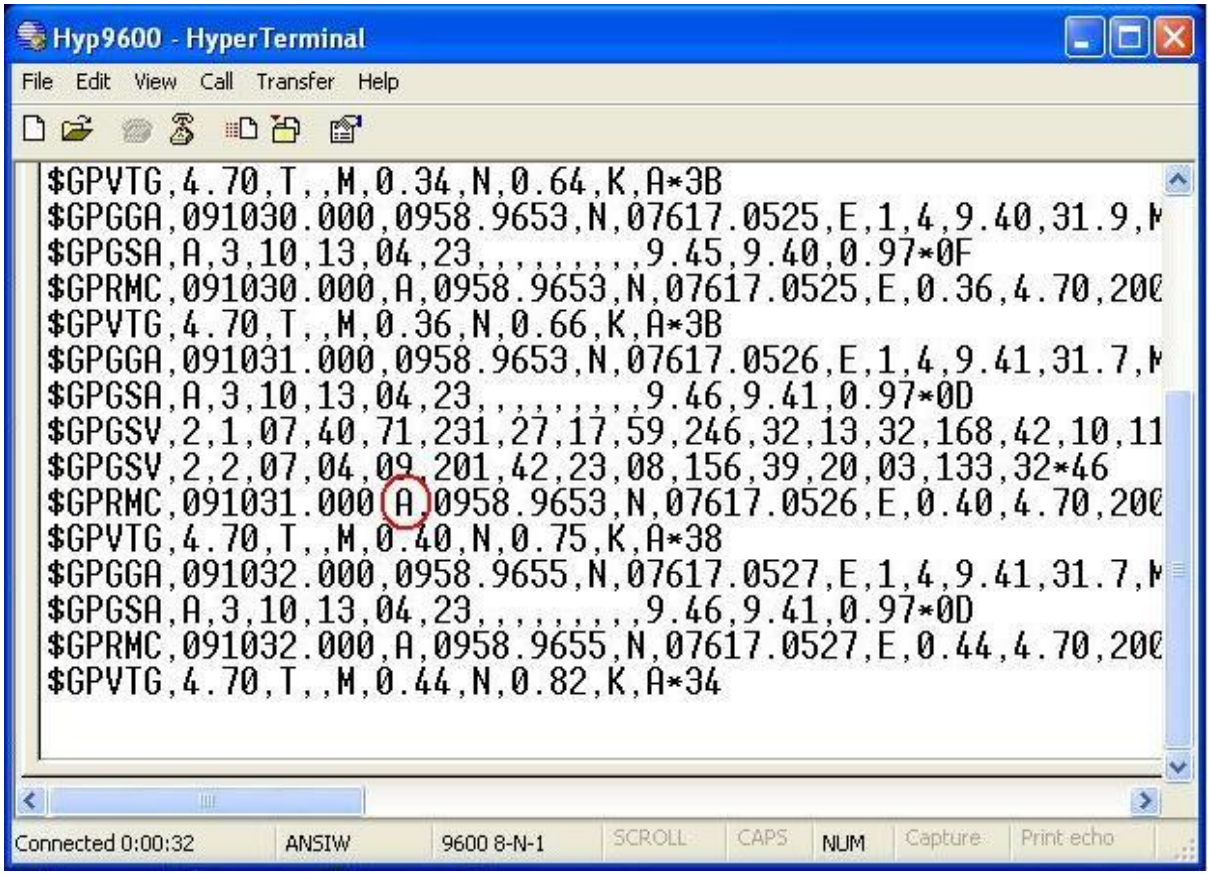


Figure 7. Received GPS data over Hyper Terminal

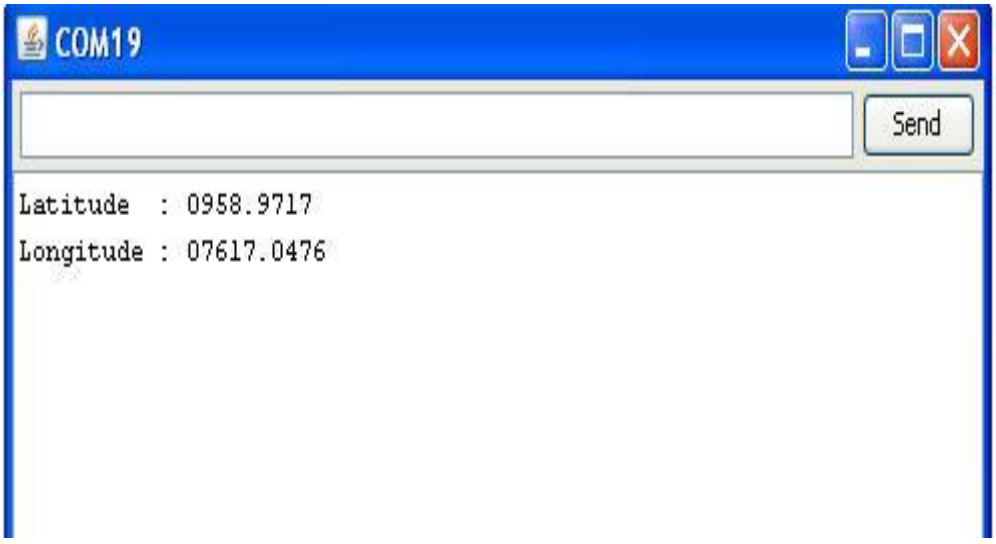


Figure 8. The data received on serial monitor, when Arduino board receives GPS data

The above figure shows the extracted geographical information by the microcontroller from the received GPS data. The obtained latitude and longitude information is shown on the serial monitor of the pc by using the option present on the Arduino IDE.

3.2 XBee

This is the ZigBee XBP24BZ7SIT-004 module from Digi. This new Series 2 B increases upon the power output and data protocol of the Pro Series2. [16] This modules permit us to create complex mesh networks based on the ZigBee ZB ZigBee mesh firmware. [16] These modules permits a very reliable and modest communication between micro-controllers, computers, systems, really anything with a serial port! This also supports Point to point and multi-point networks. [16]

Series 2B modules use a different hardware configuration from the prior models. While they will communicate with Series 2 XBee modules, they are not well-matched with the obsolete Series 2.5 Modules. [16]

3.2.1 Features [16]

i. 3.3V @ 295mA.
ii. 250kbps Max data rate [16]
iii. 63mW output (+17dBm)
iv. 1 mile (1600m) range
v. RPSMA connector [16]
vi. Fully FCC certified
vii. It has 8 pins for digital IO
viii. 128-bit encryption [16]
ix. It supports configuration over air
x. It also supports command sets, can be AT or API.
xi. External Antenna Required
xii. Manufacturer part no XBP24BZ7SIT-004

To establish communication between two ZigBee modules, one need to configure both the devices. For the configuration purpose a software named XCTU is used. XCTU is an application software which is free and supports multi form. Furthermore it is compatible with Microsoft windows and MacOS. This software provides simple graphical view for configuration and architecture. To configure a ZigBee module connect it to a pc using serial interface, which will be shown in one of the com ports present in the pc. Then open the XCTU software and run a test to identify the device with a unique serial number. If the test run fails then retry the process. After getting success in the test run then click on the modem configuration button. Then click on read option to explore different configurations about the modem. Then give a ID to the device and set different parameters. After completing all these parameter initialisation then click on write button to save those settings. Repeat the same procedure for the other ZigBee module .Note that both the devices should have same ID so as to make communication among them.

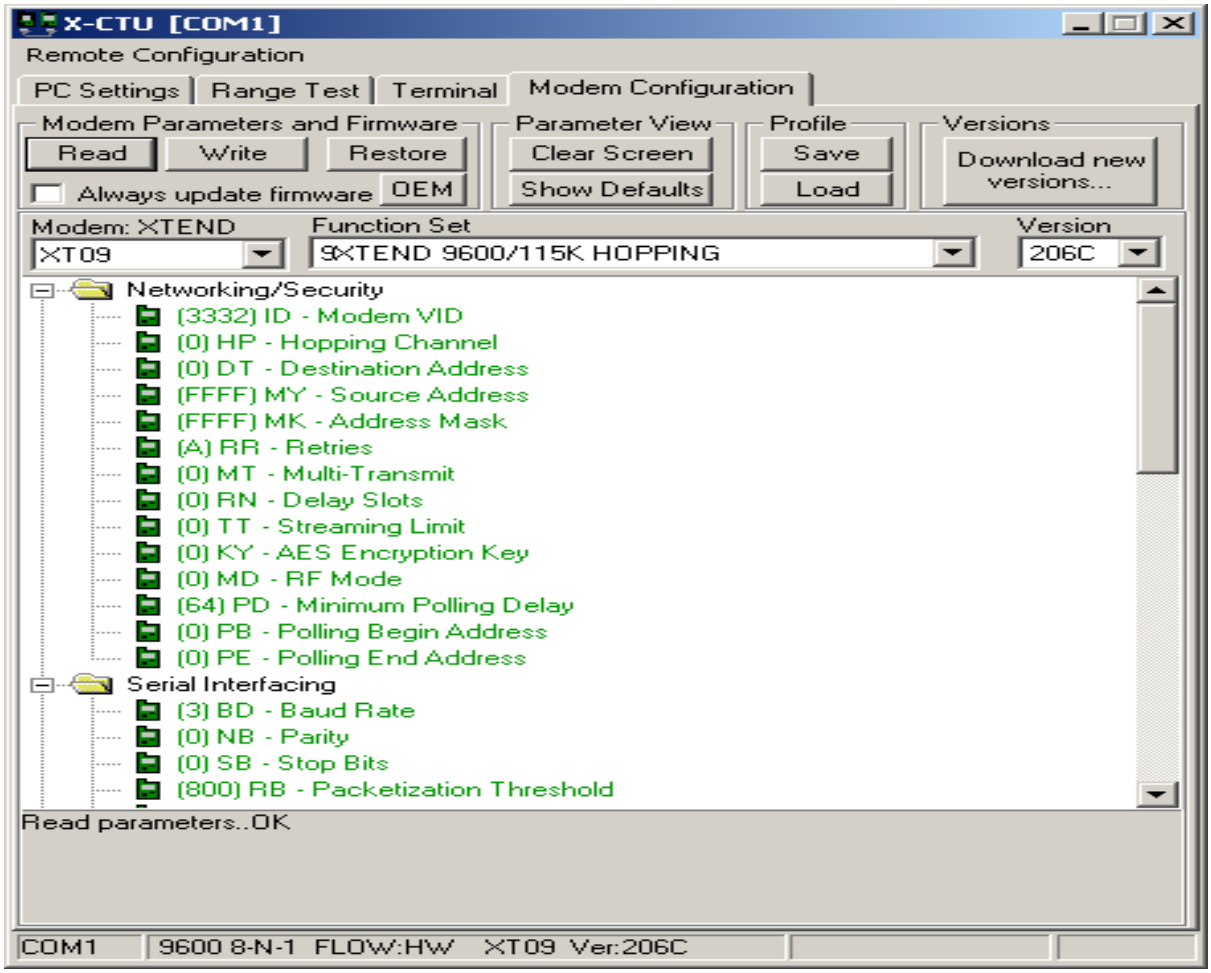


Figure 9. Device identification and network initialization of xbee module by using xctu software

3.3 SIM 900 -TTL UART GSM/GPRS Modem

Working frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. Exceptionally minimal in size and simple to use as module GSM Modem. This Modem is planned with 3V3/5V TTL interfacing circuitry and it permit us to interface to 5V microcontrollers (PIC, Arduino, AVR etc.) as well as 3V3 Microcontrollers (ARM,ARM Cortex XX, etc.) directly. The baud rate is configurable from 9600-115200 using AT command. Originally Modem is in Auto baud mode. This Modem is having internal TCP/IP stack which enables us to connect with internet via GPRS. In M2M interface, this modem is fit for SMS as well as DATA transfer application. This modem requires only two wires (Tx, Rx) with the exception of Power supply to interface with microcontroller/Host. The built in Low Dropout Linear voltage regulator permits us to interface extensive variety of unregulated power supply (4.2V -13V). Utilizing this modem, you will have the capacity to send & Read SMS, join with web by means of GPRS through straightforward AT commands. [15]

3.3.1 FEATURES [15]

i. The used product is of High Quality
ii. For internet data transfer purpose it has in built powerful TCP/ IP protocol stack. The data transfer occurs over General Packet Radio Service.[15]
iii. It is also having a provision for playing the audio signal. For this purpose it is having an connector for audio interfacing purpose.
iv. Many LEDs are available to show different status, again many controller pins are also available at connector. [15]
v. For this modem the operating temperature in normal conditions lies in the range from -21 °C to +56 °C.
vi. The used modem is quad band with GSM/ GPRS having frequency of 850/ 900/ 1800/ 1900 MHz
vii. Two provisions: 3 V 3 or 5 Volts interface which is used for straight communication with MCU set

viii. The baud rate for this modem is Configurable using some standard AT commands.
ix. Special SMA Connector are provided with GSM L Type antenna.
x. Every GSM modem requires a SIM card for its operation. For this purpose a holder is provided for this purpose.
xi. For debugging process the status of the network is shown by means of some built in LEDs.
xii. The voltage input to the modem must be in the range of 5V-12 Volts DC. [15]

3.3.2 SPECIFICATIONS [15]

i. Frequency : 850/ 900/ 1800/ 1900 MHz.[15]
ii. The Dimensions of the used module is 24*24*3 mm.
iii. The weight of the module is 3.4g
iv. The various operations of the modem is controlled via specified AT commands
v. The device consumes very less power which is 1 mA in sleep mode.
vi. Class 10/8 multi-slot
vii. Uses class B mobile station
viii. GSM phase 2/2+
ix. Class 4 (2 W @850/ 900 MHz)
x. Class 1 (1 W @ 1800/1900MHz)

3.3.2.2 Specifications for SMS via GSM/GPRS for this module are as follows: [15]

i. The device supports point to point MO and MT for SMS purpose
ii. Cell broadcasting feature enabled. [15]
iii. Text and PDU mode

3.3.2.3 Software features [15]

i. 0710 MUX protocol
ii. embedded TCP/UDP protocol
iii. FTP/HTTP [15]

3.3.2.4 Special firmware [15]

i. FOTA

ii. Specifications for Voice
iii. Tri-codec
iv. Half rate (HR)
v. Full rate (FR)
vi. Enhanced Full rate (EFR) [15]
vii. Hands-free operation
viii. MMS [15]
ix. Java
x. Embedded AT

3.3.2.5 AMR [15]

i. Half rate (HR)
ii. Full rate (FR)

3.3.3 Interfaces [15]

i. An interface for audio is present.
ii. For communication with different devices serial port pins such as RXD and TXD are present at 2mm Pitch RMC. [15]
iii. Serial port status and controlling pins at 2mm Pitch RMC are provided.
iv. For power supply purpose DC power pins at 2mm pitch RMC are provided
v. SMA Antenna Connector [15]
vi. AT cellular command interface

3.3.4 Turn on GSM Modem Using the PWRKEY Pin (Power on) [15]

The Modem can be turned on by driving the PWRKEY to a low level voltage for a short time (2-3 sec) and release hence. The specified pin has to be pulled up-to 2.9V in the GSM Modem. [15]

3.3.5 Turn off GSM Modem [15]

Ways that can be adopted to turn off the GSM Modem:

i. Normal power down procedure- Modem is turned off using the PWRKEY pin of GSM

ii. Normal power down procedure- GSM Modem is turned off using AT command
iii. Under-voltage or over-voltage spontaneous shutdown - Take effect if over-voltage or under-voltage is noticed. [15]
iv. Under-temperature or over-temperature automatic closure- Take effect if over-temperature or under-temperature is noticed. [15]

3.3.6 Turning off GSM Modem Using the PWRKEY Pin (Power down) [15]

GSM Modem can be turned off by driving the PWRKEY to a low level voltage for a short time (2- 3 sec) and then release. This technique lets the modem log off from the system and permits the product to go into a protected state and spare information before totally separating the power supply. Prior to the end of the switching off process the GSM Modem will convey result code:
'NORMAL POWER DOWN'

After this, the AT commands can't be executed. The modem enters the POWER DOWN mode. [15] POWER DOWN can also likewise be demonstrated by STATUS pin, which is a low level voltage in this mode. [15]

3.3.7 Turn off GSM Modem Using AT Command

AT command "AT+CPOWD=1" to turn off the modem. This command permits the GSM Modem to log off from the network and lets the GSM Modem to move in into a secure state and save data before totally disconnecting the power supply. [15] Prior the end of the switching off process the GSM Modem will convey result code:
'NORMAL POWER DOWN'

3.3.8 Power Saving [15]

Two methods for the GSM Modem to go into a low current status. "AT+CFUN" command is used to fix GSM Modem into minimum functionality mode and DTR hardware interface signal can be utilized to lead system to be in SLEEP mode. [15]

3.3.9 Sleep Mode (refers to Slow Clock Mode) [15]

We can control SIM900 GSM Modem to enter or way out the SLEEP mode in client applications by using DTR signal. At the point when DTR is in high level and there is no on air and hardware interrupt (such as GPIO interrupt or data on serial port), GSM MODEM will enter SLEEP mode spontaneously. In this mode, GSM MODEM can at present get paging or SMS from system yet the serial port is not open. [15]

3.3.10 Serial Interfaces [15]

The GSM module is planned as a DCE (Data Communication Equipment), taking after the traditional DCE-DTE (Data Terminal Equipment) connection. The GSM Modem and the client (DTE) are joined through the following signal. Supports baud rate from 1200bps - 57600bps. Serial port. [15]

i. TXD: Send data to the RXD signal line of the DTE
ii. RXD: Receive information/data from the TXD signal line of the DTE

Following baud rates: 1200, 2400, 4800, 9600, 19200, 38400 and 57600 bps are supported by the serial port of GSM module. Factory setting is allowed as auto bauding. [15] This issues you the adaptability to put the GSM engine into operation regardless of what baud rate your host application is arranged to. To exploit auto bauding mode, particular consideration ought to be paid to the accompanying prerequisites:

Synchronization between DTE and DCE:

At the point when DCE controls on with the auto bauding enabled, client should first send "A" to synchronize the baud rate. It is prescribed to hold up 2 to 3 seconds prior to sending "AT" character. After getting the “OK” response, DTE and DCE are effectively synchronized. [15]

Limitations on auto bauding operation

i. The serial port has to be functioned at 8 data bits with no parity and 1 stop bit (factory setting).
ii. The Unsolicited Result Codes like "RDY", "+CFUN: 1" and "+CPIN: READY” are not shown when we activate the ME while auto bauding is enabled. This is because of the way that the new baud rate is not configured unless DTE and DCE are effectively synchronized as previously described. [15]

3.3.11 AT Command Syntax [15]

At the point when DCE powers on with the auto bauding mode enabled, client must first send “A” to synchronize the baud rate. [15] It is suggested to hold up 2 to 3 seconds prior to sending

“AT” character. DTE and DCE are effectively synchronized, after getting the “OK” response The “AT” or “at” prefix must be set towards the starting of each Command. To end a Command line enter <CR>, also called as carriage return or \r. [15]
Commands are trailed by a response that includes <CR><LF><response><CR><LF>. Just the reactions are exhibited in the document here, <CR><LF> are discarded purposefully.
Example- with Local Echo enabled:
Transmit- AT\r
Receive- AT\r\r\nOK\r\n

To establish a TCP client connection first of all the module should be connected to GSM or GPRS network. We can use ‘AT+CREG?’ and ‘AT+CGATT?’ to obtain the information regarding the status of the registered network, whether the modem is connected to the GPRS or not. We can use ‘AT+CPIN?’ to get the status of the PIN. ‘AT+CSQ’ command is used to obtain the strength of the network. After all these we can go for ‘AT+CSTT’ to start task and set APN. Then use ‘AT+CIICR’ to bring up a wireless connection that may be GPRS or CSD. After this ‘AT+CIFSR’ command is used to get the local IP address. After obtaining the local IP we can go for starting up the connection using ‘AT+CIPSTART’. Then after receiving ‘CONNECT OK’ response from the server side we can go towards sending the data to be uploaded in the database. This is achieved by using ‘AT+CIPSEND’ command, which returns SEND OK after successfully sending the data to remote server.

CHAPTER 4: SYTEM DESIGN

The PCB design has done to reduce the overall size of the product. A printed circuit board (PCB) supports mechanically and electrically joins electronic modules/components by means of conductive tracks, pads and other features etched from copper sheets which are laminated onto a nonconductive substrate. It requires the additional design effort to lay out the circuit .The manufacturing and gathering can be automated. Manufacturing circuits with PCBs is inexpensive and faster than other wiring methods as components are fixed and wired with only one single part. Here we have made a shield that will consist of the power supply, GPS, xbee and other required components. Arduino will be placed above this shield and GSM module will be placed below the shield with proper connections. A special tool called EAGLE is used for the PCB design.

4.1 Schematic Design

The schematic consists of all the electrical connections among the required components. The schematic is the first step of PCB design. Here in our design we are having a provision of supplying the power through battery as well as through adapter. We are also having a battery low indication circuit in our design. Different LEDs are used to indicate the status of the components like GPS, xbee etc.

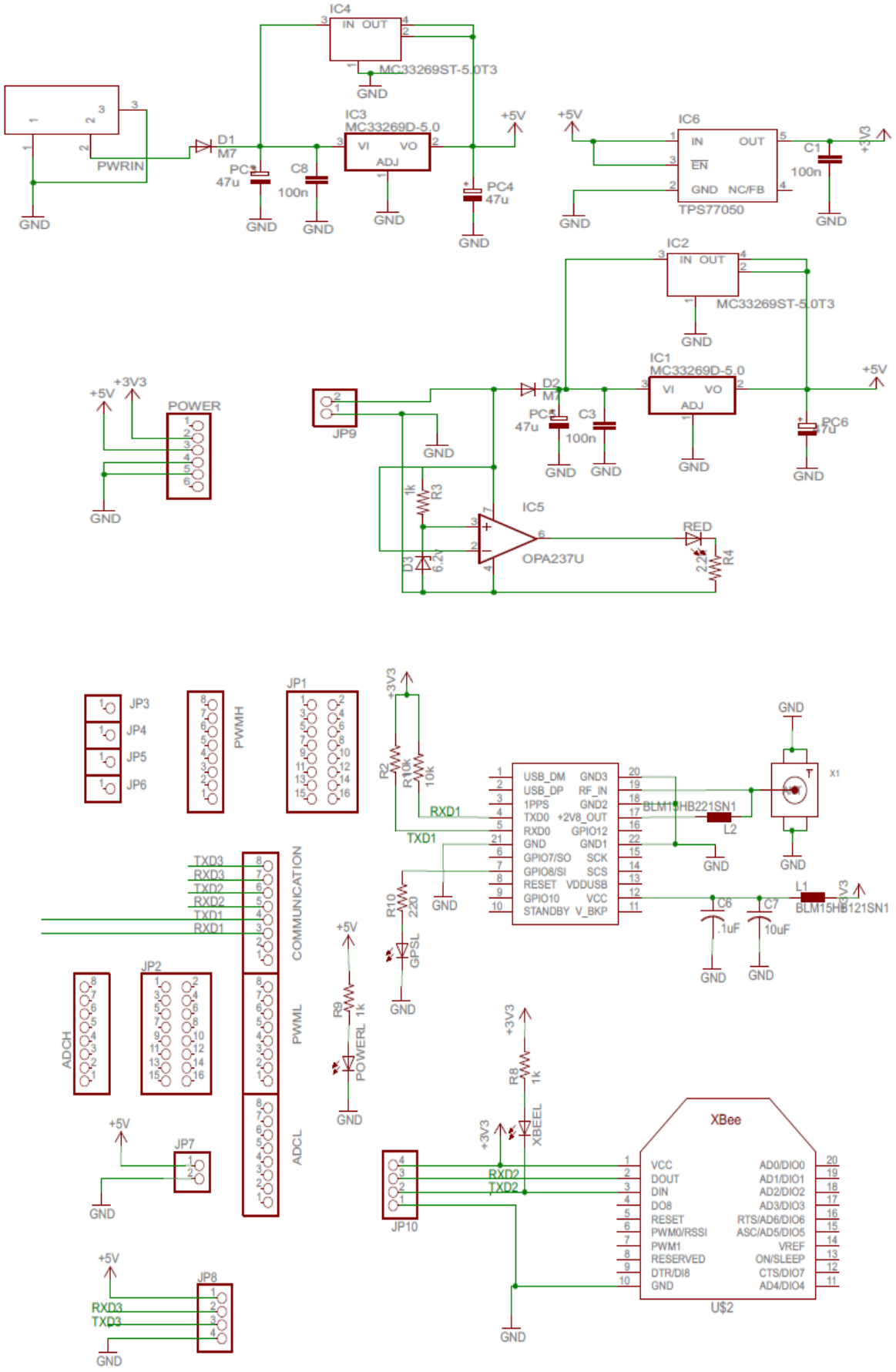


Figure 10. Schematic Diagram of the Vehicle Unit by using PCB CAD

4.2 Physical System Layout Design

In this step the placement and routing of the components are done. The GPS and xbee requires external antennas so SMA connectors are used in the shield. The placement and routing are most important steps of PCB design because they decide the size and effectiveness of the product.

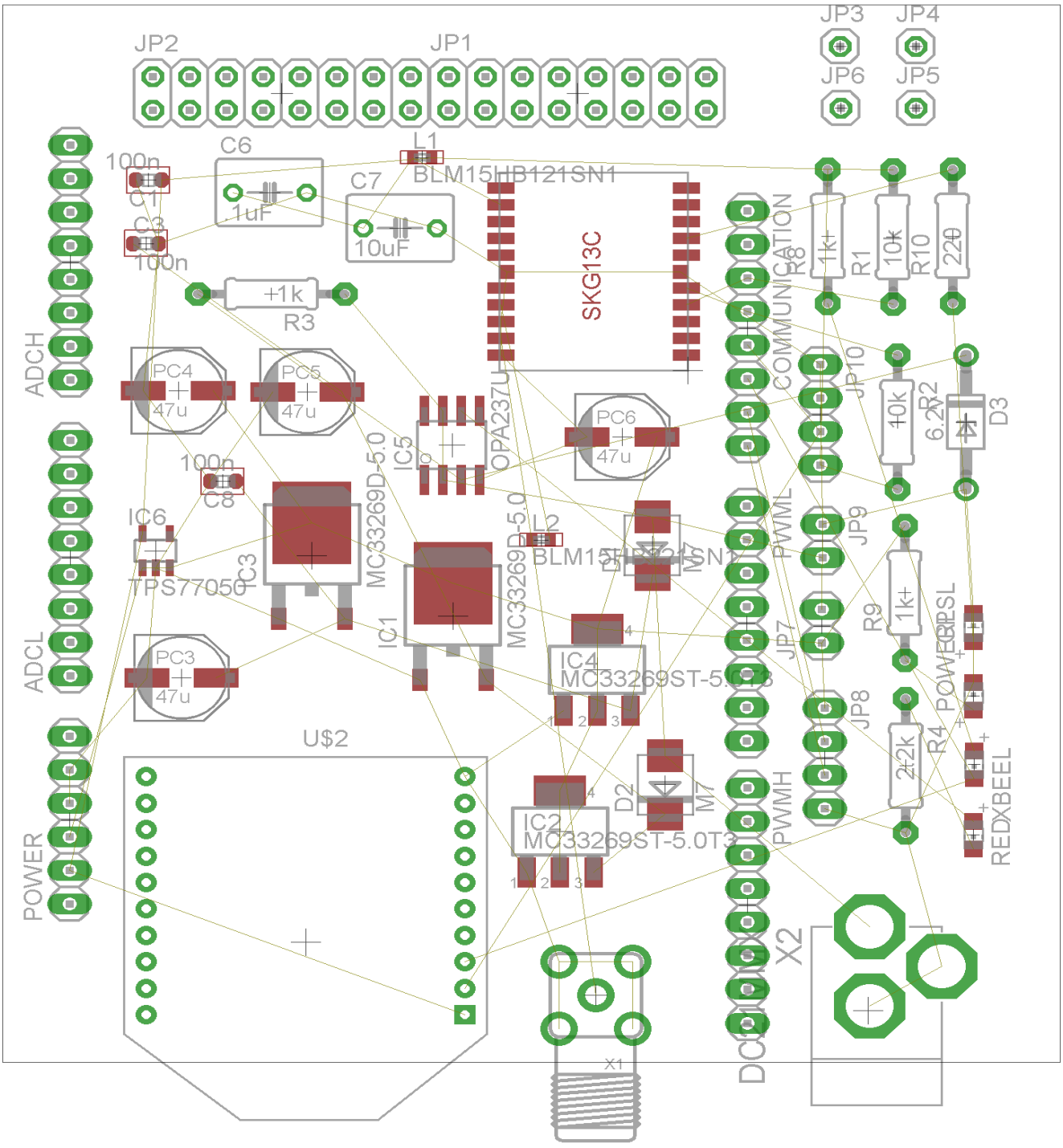


Figure 11. Printed Circuit Board Layout of the Vehicle Unit

CHAPTER 5: RESULTS AND DISCUSSION

Fig. 11 shows our vehicle tracking system layout. It can help us to understand how the project is implemented.

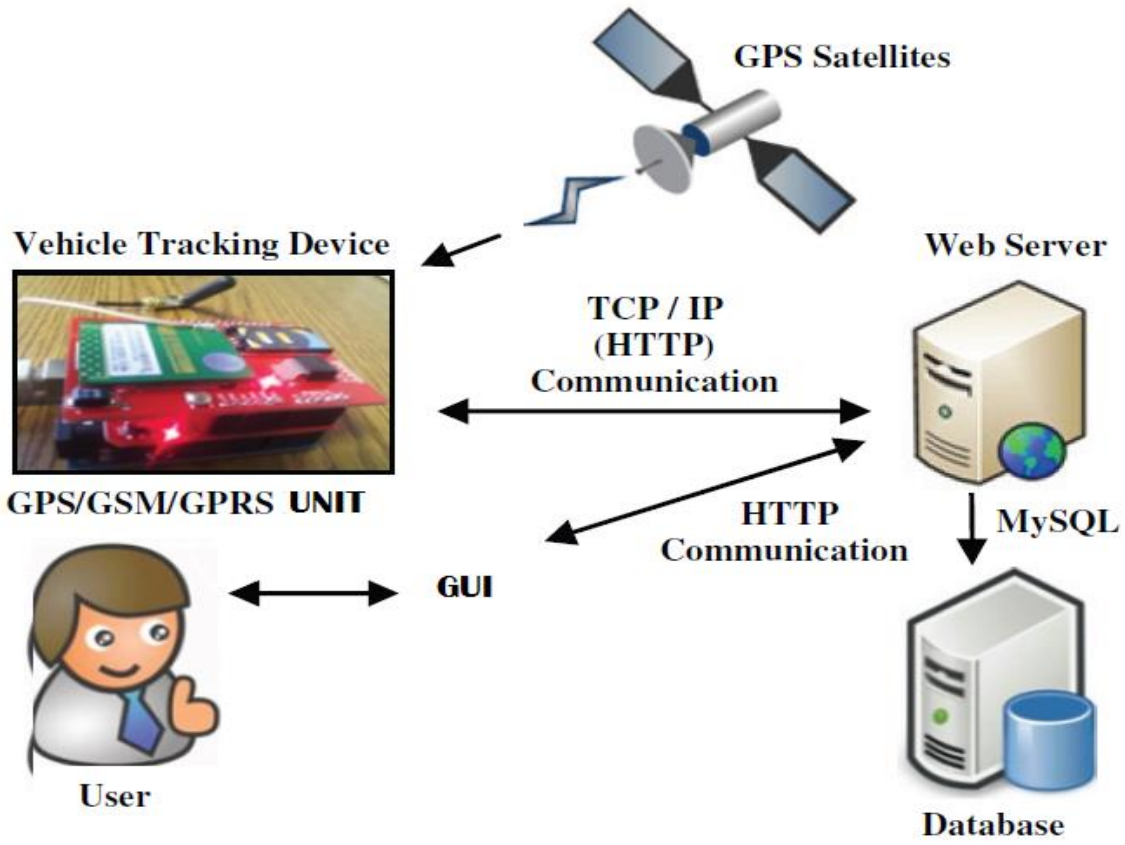


Figure 12. The Proposed Vehicle Tracking System Topology

As demonstrated in the chart, beginning from the satellite at the highest point of the diagram, the GPS module geographic coordinates are obtained from the satellites [9]. The vehicle's location info is perused in from the GPS module by the microcontroller. The vehicle's location information and the vehicle's ID are then transmitted to the web server through GSM/GPRS network. The GSM/GPRS module is utilized for TCP/IP communication [8, 14]. The obtained vehicle's location information and the vehicle's ID are sent from a structure with the GET method for transmission to the server [14]. On the other end, the web interface written in PHP is executed to specifically associate to a database. A vehicle's geographic coordinates and a vehicle's unique ID acquired from device are recorded in a database table [14]. Also a graphical user interface (GUI) has been made to display a vehicle location on Google maps. The system has the capacity of tentatively exhibit its viable execution to track a vehicle's location at whatever time from anywhere [14]. The concept has very wide scope of commercialization for

many such mining and other scenarios. In fact in normal terrestrial environments also the product has been reportedly observed to have better performance than commercially available vehicle trackers.

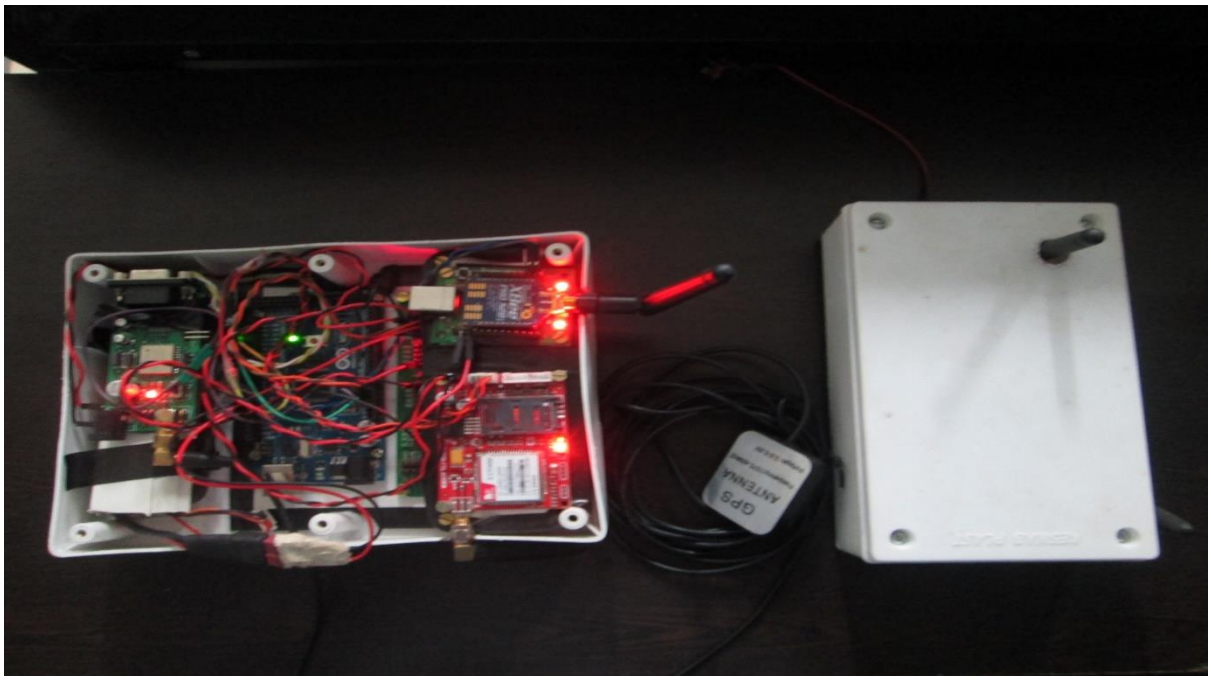
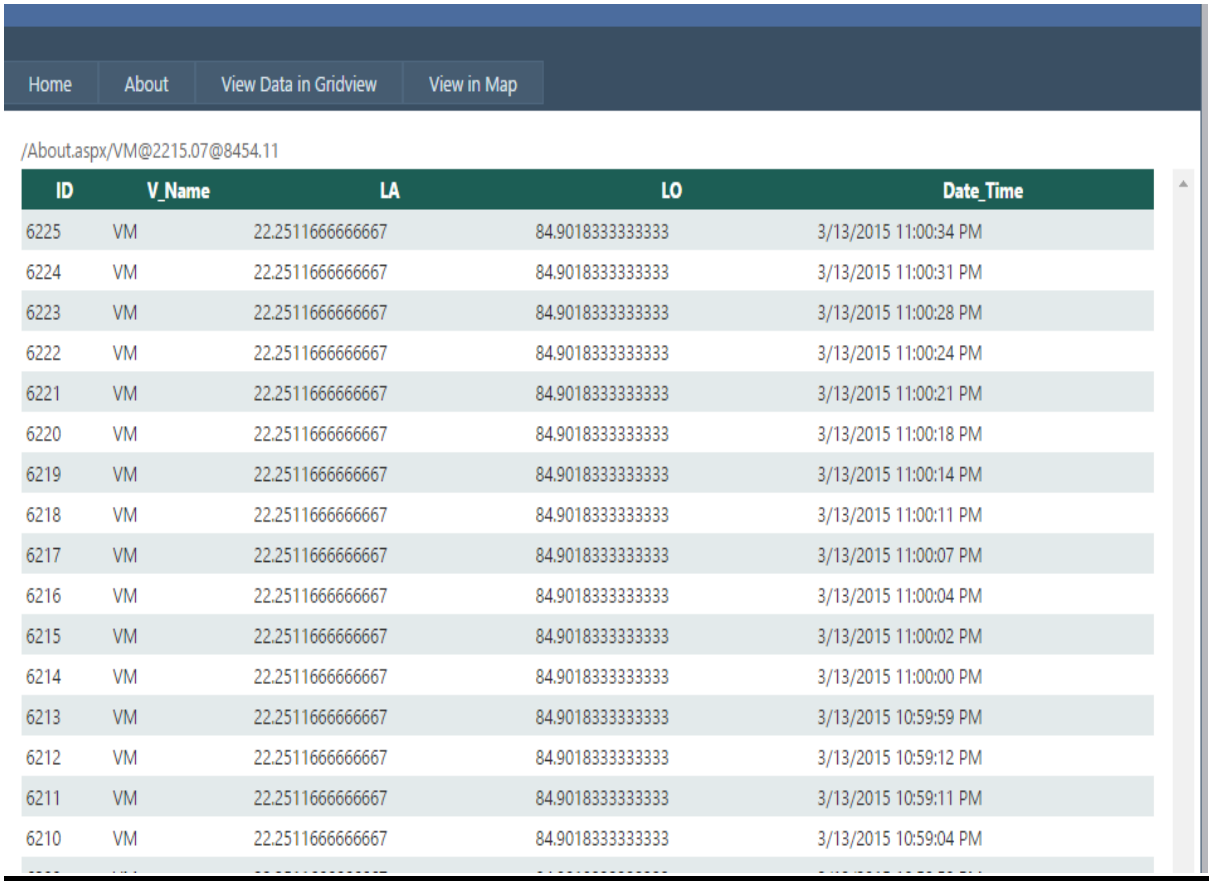


Figure 13. Snapshot of the developed Vehicle unit and Switch Over unit.

5.1 Testing Web Server and Database

Some actual experimental data for a vehicle's location information, collected and uploaded to a database taking into account a test run, is listed in Figure below. The experimental results display the minimum time interval of 3 seconds for updating the vehicle's location information. Figure 13 shows the present vehicle location on the map. It is also having additional options to see past locations of the vehicle.



ID	V_Name	LA	LO	Date_Time
6225	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:34 PM
6224	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:31 PM
6223	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:28 PM
6222	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:24 PM
6221	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:21 PM
6220	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:18 PM
6219	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:14 PM
6218	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:11 PM
6217	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:07 PM
6216	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:04 PM
6215	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:02 PM
6214	VM	22.2511666666667	84.9018333333333	3/13/2015 11:00:00 PM
6213	VM	22.2511666666667	84.9018333333333	3/13/2015 10:59:59 PM
6212	VM	22.2511666666667	84.9018333333333	3/13/2015 10:59:12 PM
6211	VM	22.2511666666667	84.9018333333333	3/13/2015 10:59:11 PM
6210	VM	22.2511666666667	84.9018333333333	3/13/2015 10:59:04 PM

Figure 14. GUI showing details of the vehicle location

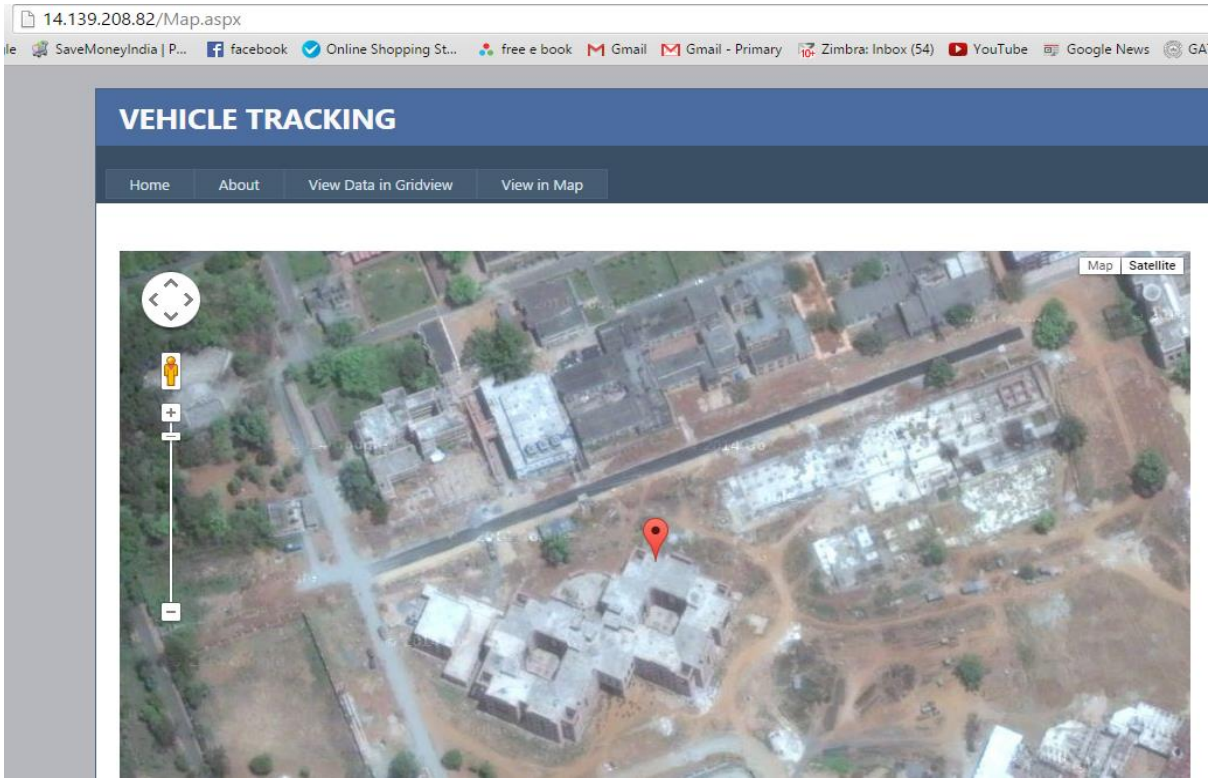


Figure 15. GUI showing the current location of the vehicle in map

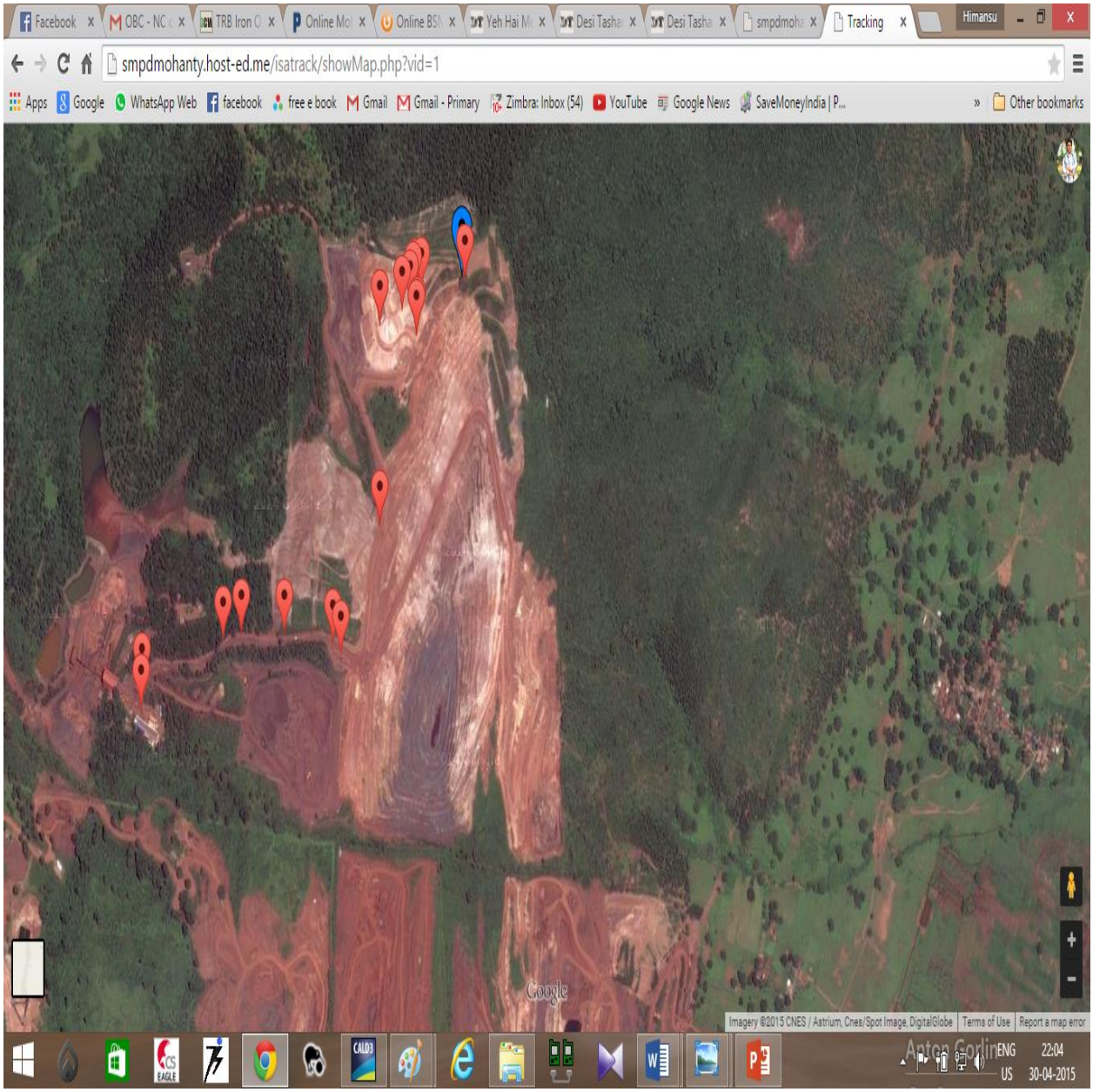


Figure 16. GUI showing the vehicle location (Tested at iron ore mine, Tensa "*Jindal Steel and Power Ltd"*)

CHAPTER 6: CONCLUSION AND SCOPE FOR FUTURE WORK

We have implemented and tested a vehicle tracking system to track the accurate location of a moving or stationary vehicle in real time. The product is designed to be deployed in TRB iron ore mine of Jindal Steel and Power Ltd at Tensa. This document has described the design, use and implementation of vehicle tracking system. In this work, the device is composed of a microcontroller, ZigBbee and GPS/GSM/GPRS unit to obtain the vehicle's location information and upload it to a server through GSM/GPRS network. Moreover, our implementation is of minimal cost that is based on easily accessible off-the-shelf electronic devices. The outcomes show the better performance towards achievable implementation of the model. It is also robust as the data regarding the vehicle under consideration is reached within 3 seconds to the assigned control station. Further investigation and exploration can be done on extending this system to numerous other applications.

The future work includes exploration of this product which will enable more optimization in the same GUI. Optimisation in the code is to be done to achieve an effective communication system. On the hardware front the device miniaturization has another scope for next level of activity.

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