


**VEHICLE TRACKING SYSTEM USING**

**GPS AND GSM TECHNOLOGY**

**MOHAMMAD FAIZUL BIN SABAWI**

**JULY 2009**

“Saya akui bahawa saya telah membaca karya ini pada pandangan saya karya ini adalah memadai dari skop dan kualiti untuk tujuan penanugerahan ijazah Sarjana Muda Kejuruteraan Elektrik (Kuasa Industri).”

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# **VEHICLE TRACKING SYSTEM USING GPS AND GSM TECHNOLOGY**

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**This Report is Submitted in Partial Fulfillment of Requirement For the  
Degree of Bachelor in Electrical Engineering  
(Power Electronic & Drives)**

**Fakulti Kejuruteraan Elektrik  
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**JULY 2009**

## DECLARATION OF THESIS

I hereby, declare that this thesis entitled “Vehicle Tracking System Using GPS and GSM Technology” is a result of my own research, design and idea except for works that have been cited in the references.

Signature : 

Name : MOHAMMAD FAIZUL BIN SABAWI

Date : 3 JULY 2009

## **ABSTRACT**

This project is about the design and implementation of Vehicle tracking system using GPS and GSM technology. It comprises of integration between a GPS receiver, a microcontroller and a GSM module. This combination of technology will produce a tracking system. A tracking system is an integration of two systems which is coordinated by the GPS receiver controller and controlled by users using command interfaces through the GSM module as a transmitter and receiver of data. This project can be divided into two main parts which are hardware and software development. The hardware development includes the GPS and the microcontroller wiring connection, and it's integration with the GSM module. The software development includes develop the microcontroller's source code, GSM message command, the NMEA protocol command. This system is controlled by users using a centralized command interfaces on a computer.

## ABSTRAK

Projek ini adalah berkenaan dengan rekaan dan pengaplikasian sistem pengesanan kenderaan dengan menggunakan teknologi GPS dan GSM. Ia merangkumi integrasi antara penerima GPS, *microcontroller*, dan modul GSM. Kombinasi teknologi-teknologi akan menghasilkan satu sistem pengesanan. Sistem pengesanan ini adalah integrasi dimana ia dikoordinasikan oleh pengawal penerima GPS can dikawal oleh pengguna dengan menggunakan arahan pada *interface* melalui modul GSM sebagai pemancar dan penerima data. Projek ini dibahagikan kepada dua bahagian iaitu pembangunan perkakasan dan perisian. Pembangunan perkakasan merangkumi pedawaian sistem GPS dan *microcontroller*, dan integrasinya dengan modul GSM. Pembangunan perisian pula merangkumi pembangunan kod sumber untuk *microcontroller*, arahan untuk GSM dan arahan untuk protokol NMEA. Sistem ini akan dikawal oleh pengguna melalui *interface* arahan berpusat pada komputer.

## CONTENT

CHAPTER	EVENT	PAGE
	<b>PROJECT TITLE</b>	
	<b>ABSTRACT</b>	
	<b>CONTENT</b>	
	<b>LIST OF TABLE</b>	
	<b>LIST OF FIGURE</b>	
	<b>LIST OF ABBREVIATIONS</b>	
	<b>LIST OF APPENDICES</b>	
<b>1</b>	<b>INTRODUCTION</b>	
	1.1 Background	1
	1.2 Concept	2
	1.3 Objective	3
	1.4 Scope	4
	1.5 Problem Statement	5
	1.6 Outline	6
<b>2</b>	<b>LITERATURE REVIEW</b>	
	5.1 History Of Global Positioning System (GPS)	7
	5.2 GSM Technology	8
	2.2.1 GSM modem	10
	2.2.2 Subscriber Identity Module (SIM)	10
	5.3 Similar project	10
	5.4 Components Theory	12
	2.4.1 RS232 serial port	12
	2.4.2 POP Builder Kit	14
	2.4.3 Furuno GH-81 series GPS receiver	15



<b>3</b>	<b>METHODOLOGY</b>	
	3.1 Project methodology	20
	3.2 Project's flow	22
	3.3 Project planning	24
	3.4 Equipment	
	3.4.1    Multimeter	27
	3.4.2    AC-DC adaptor	28
	3.4.3    RS232 to USB converter	28
	3.5 Hardware	
	3.5.1    Hardware connection	29
	3.5.2    Software	30
	3.5.3    Serial Communication	32
<b>4</b>	<b>RESULT AND ANALYSIS</b>	
	4.1 Experimental Setup	
	4.1.1    POP-168 Setup	34
	4.1.2    Circuitry Design	37
	4.1.3    Software Design	39
	4.2 Problem Analysis	
	4.2.1    Unknown GPS Protocol	43
<b>5</b>	<b>CONCLUSION</b>	
	5.1 Introduction	47
	5.2 Recommendation	47
	5.3 Result and Discussion	48
	<b>REFERENCES</b>	50
	<b>APPENDICES A-B</b>	52

## LIST OF TABLE

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
3.1	Project's planning	23

## LIST OF FIGURE

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	Overall concept of project	3
1.2	GPS-Microcontroller wiring diagram.	4
2.1	Telit GM862 module used for a tracking system	12
2.2	RS232 Cable	13
2.3	Pin assignment for RS232	14
2.4	RS 232 Pin Assignments (DB9 PC Signal Set)	14
2.5	POP builder kit	15
2.6	POP168 Match Box	16
2.7	Furuno GH-81	17
2.8	GH-81 low power 5 second current usage	18
2.9	GH-80 and GH-81 current comparison	19
3.1	project flowchart	20
3.2	Digital multimeter & Analog multimeter	25
3.3	AC to DC adaptor	26
3.4	USB to RS232 converter	26
3.5	wiring diagram	27
3.6	example of received data	28
4.1	Arduino interface	30
4.2	microcontroller detected on the computer	31
4.3	Bootloader button	31
4.4	Compiling process completed	32
4.5	Arduino upload button	33

## **LIST OF ABBREVIATIONS**

GPS	Global Positioning System
GSM	Global System for Mobile
NMEA	National marine Electronics Association
DOD	Department of Defense
SA	Selective Availability
IOC	Initial Operational Capability
FOC	Full Operational Capability
UMTS	Universal Mobile Telecommunications Service
UART	Universal Asynchronous Receiver/Transceiver

## LIST OF APPENCIDES

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
1	Furuno GH-81 series	52
2	POP168 interface board schematic	54
3	MAX232 RS-232 Dricer/Receivers	56

## **CHAPTER 1**

### **INTRODUCTION**

The “Vehicle Tracking System using GPS and GSM Technology” project 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 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, speed, and time obtained from the GPS receiver and will displayed on the computer screen. This chapter will be covering the general background of this project, its concept, objectives, scope and the problem statement.

#### **1.1 BACKGROUND**

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

Vehicle tracking systems are commonly used by fleet operators for fleet management functions such as routing, dispatch, on-board information and security. Other applications include monitoring driving behavior, 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 application 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, get driving directions and add nearby last-minute appointments to itineraries. Benefits include increased productivity, reduced driving time and increased time spent with customers and prospects.

It is has been reported that, with this system, the users has been 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. Reducing the average speed of the vehicles also improve the fuel efficiency. Productivity also will be increased through better budgeting of time and resources.

## **1.2 CONCEPT**

The overall concepts of this project are shown in figure 1.1. The output of this system will be the data obtained from the GPS receiver. The data contains information such as speed, position and time. The data from the GPS receiver will be send using GSM module to the receiving end. On the receiving end, the GSM modem will receive the data and displayed it on the screen of the computer. The computer also can be used to send command to the GPS receiver through the GSM module

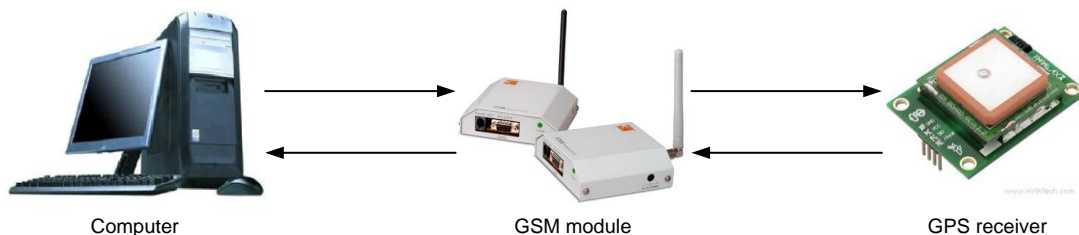


Figure 1.1 : Overall concept of project

For the first part of this project, the GPS receiver will be paired with the AVR microcontroller. This part is essential to ensure smooth operation for the GPS receiver. A software will be develop using C programming language to operate the microcontroller.

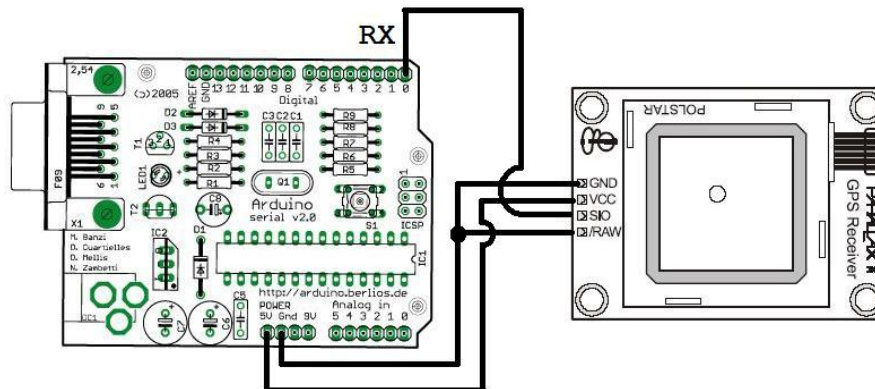


Figure 1.2 : GPS-Microcontroller wiring diagram.

The next phase of this project is to integrate the GPS-Microcontroller with the GSM module. The integration will need an addition of GPS modems to transmit the data from the GPS receiver to the computer for display.



### 1.3 OBJECTIVE

The objective of this project is to design and develop a Vehicle Tracking System using GPS and GSM Technology. In order to fully understand both GPS and GSM technology, the research and study on how both technology works is essential to complete the whole project. The objectives of this project are:

- I. To study and investigate the basic operation of the GPS module
- II. To design and develop the GPS/GSM tracking system
- III. To come with my own hardware of GPS/GSM tracking system.

### 1.4 SCOPE

The scope of this project is to study and design the GPS/GSM Vehicle Tracking system that can give an output of the information such as time, position, and speed from the GPS receiver. The users will also be able to send command to the GPS receiver using the GSM technology.

The project can be divided into two big part, the first part, the GPS and the AVR microcontroller pairing. The second part, the GPS-Microcontroller and the GSM integration.

For the first part, focus will be on the GPS system and how to pair it to the microcontroller. The study on the how GPS works will be conduct to understand its operation and command set (NMEA) that will be used. The AVR Microcontroller is also an important device to understand as it is a to control the operation of the GPS receiver. The microcontroller using C programming language to operate.

The second part will be the GPS-Microcontroller and the GSM integration. The study on GSM technology will be conduct in this phase. It is important in order to transmit the data from the GPS receiver to the computer using the GSM technology. The correct GSM command set will be essential to make sure the data is on the right path and transmitted correctly.

## 1.5 PROBLEM STATEMENT

With skyrocketing fuel, maintenance and insurance costs have become an accepted way of life for owners and managers in the service, delivery and transportation industries. The good news is that there is a light at the end of that long, dark, financially depleting tunnel. However, technology has always created alternative pathway for businesses. Technology aid can significantly reduce fuel and maintenance costs, and increase productivity.

For over a decade, GPS vehicle tracking systems have proven to be effective in determining the precise location of a vehicle or asset. GPS tracking uses a system of satellites orbiting the earth to find an approximate placement of the receiver within a few meters of its actual location. Systems range from the passive, battery operated tracking key, to the highly sensitive, active or real time systems with various installation options. Both are designed to enhance fleet efficiency and profitability by monitoring driver location and speed.

Passive GPS tracking means that the GPS receiver stores all location information to be accessed or downloaded at a later time. Passive systems are generally limited to vehicle tracking only and are useful to individuals and businesses which typically do not need to view information in real time. Real time GPS systems employ wireless networks (GSM) that accurately determine the exact location of a vehicle. The user instantly receives location data from the GPS receiver while the vehicle is still in motion. Real time systems are most widely used by companies who wish to monitor fleet vehicles and other assets.

## **1.6 OUTLINE**

The introduction chapter covers the background, concept, objective, scope, and problem statement. In literature review, it explains the GPS history, GSM communication technology and previous similar project. The approach and method apply in this project are present in the methodology chapter. Preliminary results are cover in chapter four while the last chapter covers conclusion.

## **CHAPTER 2**

### **LITERATURE REVIEW**

In this chapter, the articles of the GPS history, GSM communication technology, brief on the components theory and a couple of similar projects are covered.

#### **2.1 HISTORY OF GLOBAL POSITIONING SYSTEM (GPS)**

The GPS System was created and realized by the American Department of Defense (DOD) and was originally based on and run with 24 satellites (21 satellites being required and 3 satellites as replacement). Nowadays, about 30 active satellites orbit the earth in a distance of 20200 km. GPS satellites transmit signals which enable the exact location of a GPS receiver, if it is positioned on the surface of the earth, in the earth atmosphere or in a low orbit. GPS is being used in aviation, nautical navigation and for the orientation ashore. Further it is used in land surveying and other applications where the determination of the exact position is required. The GPS signal can be used without a fee by any person in possession of a GPS receiver.

In 1973, Decision has been made to develop a satellite navigation system based on the systems TRANSIT, TIMATION und 621B of the U.S. Air Force and the U.S. Navy. Four years later, First receiver tests are performed even before the first satellites are stationed in the orbit. Transmitters are installed on the earth's surface called Pseudolites (Pseudo satellites). By 1985, a total of 11 Block I satellites are launched into the orbit. Decision has been made to expand the GPS system. Thereupon the resources are considerably shortened and the program is restructured.

At first only 18 satellites should be operated. 1988 the number of satellites is again raised to 24, as the functionality is not satisfying with only 18 satellites.

Launching of the first Block I satellite carrying sensors to detect atomic explosions. This satellite is meant to control the abidance of the agreement of 1963 between the USA and the Soviet Union to refrain from any nuclear tests on the earth, submarine or in space. When a civilian airplane of the Korean Airline (Flight 007) was shot down after it had gone lost over Sovjet territory, it was decided to allow the civilian use of the GPS system. In 1986, the accident of the space shuttle "Challenger" means a drawback for the GPS program, as the space shuttles were supposed to transport Block II GPS satellites to their orbit. Finally the operators of the program revert to the Delta rockets intended for the transportation in the first place.

In 1989, the first Block II satellite was installed and activated. Temporal deactivation of the selective availability (SA) during the Gulf war. In this period civil receivers should be used as not enough military receivers were available. On July 01, 1991 SA is activated again. The Initial Operational Capability (IOC) is announced in 1993. In the same year it is also definitely decided to authorize the world wide civilian use free of charge.

The last Block II satellite completes the satellite constellation in 1994. Full Operational Capability (FOC) is announced the following year. In 2000, final deactivation of the selective availability and therefore improvement of the accuracy for civilian users from about 100 m to 20 m.

## **2.2 GSM TECHNOLOGY**

GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or 1800 MHz bands. Some countries in the Americas (including Canada and the United States) use the 850 MHz and 1900 MHz bands because the 900 and 1800 MHz frequency bands were already allocated.

GSM has used a variety of voice codecs to squeeze 3.1 kHz audio into between 5.6 and 13 kbit/s. Originally, two codecs, named after the types of data channel they were allocated, were used, called Half Rate (5.6 kbit/s) and Full Rate (13 kbit/s). These used a system based upon linear predictive coding (LPC). In addition to being efficient with bitrates, these codecs also made it easier to identify more important parts of the audio, allowing the air interface layer to prioritize and better protect these parts of the signal. GSM was further enhanced in 1997 with the Enhanced Full Rate (EFR) codec, a 12.2 kbit/s codec that uses a full rate channel. Finally, with the development of UMTS, EFR was refactored into a variable-rate codec called AMR-Narrowband, which is high quality and robust against interference when used on full rate channels, and less robust but still relatively high quality when used in good radio conditions on half-rate channels.

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. Picocells 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.

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).

### **2.4.1 GSM MODEM**

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

### **2.4.2 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 or her information after switching handsets. 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, and is illegal in some countries.

### **2.3 SIMILAR PROJECTS.**

There has been many other project on the internet that uses the same concepts applied on this project. But most of the project use a combined GPS and GSM module, as it is easier to operate. Here is the example of the project found on the internet:

1. GPS/GSM tracking system using Telit GM862 module.

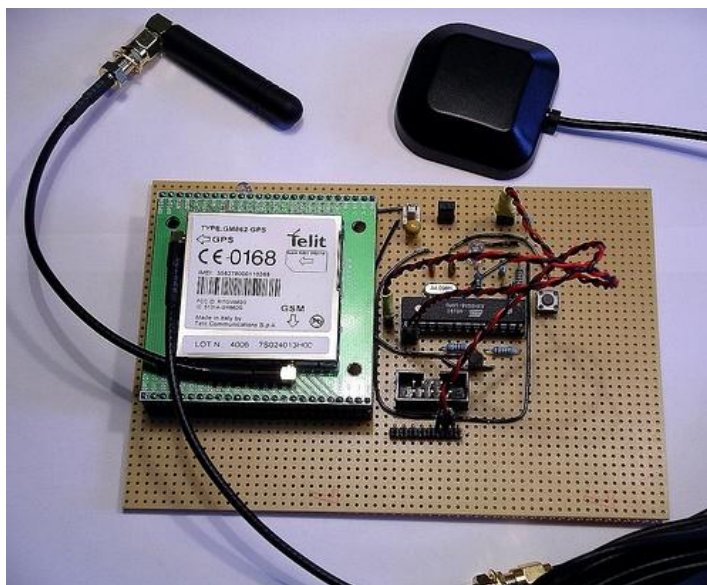


Figure 2.1 : Telit GM862 module used for a tracking system [11]

The inventor is unknown but his goal is to build a kind of a mobile tracker. There are many different use cases we can think of but one of the obvious is a device, that is able to report where it is. This device can be put in the car and it could trigger an alarm, if the car got stolen. It actually could tell you where it is.

There are already mobile tracking devices out there, but they seemed to be too expensive and too closed for our needs. Another option is one of these new Nokia N95 which have built-in GPS. They are really nice, but about 600€, which is not a bargain.

The idea was to combine a microcontroller with a GSM and a GPS modul. The Telit GM862 is used in this project, which is a GSM modul with an built in GPS receiver. This module offers quad band GSM, has SiRF III GPS built in. This project also able to become a mobile phone if equip with a speaker and a microphone because it also offers data, voice, sms and fax communication.