GPS NAVIGATION SYSTEM

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To my beloved mother and family

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In the name of Allah, The Most Loving and The Most Compassionate

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ABSTRACT

A general automotive navigation system is a satellite navigation system designed for use in automobiles. It typically uses GPS to acquire position data to locate the user on a road in the unit's map database. In the other side an automated guided vehicle or so called automatic guided vehicle (AGV) is a system designed to perform an unmanned travel of a vehicle. This vehicle can be used in many area especially dangerous places such as at harbor, surveying and military purpose. There are two main sensors AGV use for navigation, a wired sensor and a wireless sensor. The purpose of this project is to combine the concept of both systems to produce a prototype of an AGV navigated by a combination of GPS receiver and digital compass instead of using camera, guide tape, laser, inertial or gyroscopic. The project called as GPS Navigation System. The whole project can be divided into two main parts. The first part is concern on the hardware development where all electronics component are connected via the circuit design using wire wrapping technique. A GPS receiver, digital compass, RF receiver, and keypad are the input components while RF transmitter, LED, and LCD display are the output components. All of this input and output devices are connected to a PIC14F8550 microcontroller. The second part is about software programming which used to control the whole operation of the system. The program is written using MikroBasic and downloaded to the PIC18F4550 using PIC programmer after compiled into a *.hex file. As a conclusion, this system is designed to enable user to control and define the destination of a vehicle from a base station wirelessly and the advantage comes from the key component, GPS receiver which enable the vehicle to do movement in any direction according to the signal received from the base station without need a track.

ABSTRAK

Sebuah sistem navigasi kenderaan biasa adalah sistem navigasi satelit yang direka untuk kegunaan kereta. Ia menggunakan penerima GPS untuk mendapatkan data tentang posisi untuk menempatkan pengguna di atas satu jalan dalam pengkalan data peta unit. Di sudut yang lain pula sebuah AGV adalah sebuah sistem yang direka untuk melaksanakan satu perjalanan kenderaan tanpa pemandu manusia. Kenderaan ini boleh digunakan di banyak kawasan terutamanya di tempat yang berbahaya seperti di pelabuhan, peninjauan dan tujuan ketenteraan. Biasanya AGV menggunakan dua pengesan utama untuk tujuan navigasi iaitu pengesan berwayar dan pengesan tidak berwayar. Tujuan projek ini adalah untuk menggabungkan konsep dari kedua-dua sistem ini untuk menghasilkan satu prototaip bagi sebuah AGV yang dipandu oleh satu kombinasi penerima GPS dan kompas digital sebagai ganti dari menggunakan kamera, pita pandu, laser, inertia dan gyroscopic. Project ini dipanggil GPS Navigation System. Keseluruhan projek dibahagikan kepada dua bahagian. Bahagian pertama berkaitan dengan pembangunan perkakas di mana semua komponen elektronik disambungkan melalui sebuah litar menggunakan teknik pintalan wayar. Bahagian kedua ialah berkenaan dengan program perisian yang digunakan untuk mengawal keseluruhan operasi sistem. Program ditulis dengan menggunakan perisian Mikrobasic dan dimuat turun ke dalam PIC18F4550 menggunakan PIC programmer setelah dikumpulkan kepada fail *.hex. Kesimpulannya, sistem ini direka untuk membolehkan pengguna mengawal dan menentukan destinasi sebuah kenderaan dari sebuah stesen asas secara tanpa wayar dan kelebihannya datang dari komponen utama iaitu penerima GPS yang membenarkan kenderaan membuat pergerakan dalam mana-mana arah berdasarkan isyarat yang diterima dari stesen asas tanpa memerlukan satu trek khusus.

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LIST OF ABBREVIATIONS

AGV	-	Automated Guided Vehicle
GPS	-	Global Positioning System
IO	-	Input & output
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
RF	-	Radio Frequency
Transceiver	-	Transmitter & receiver
UART	-	Universal Asynchronous Receiver Transmitter

LIST OF SYMBOLS

dc	-	Direct Current
Gnd	-	0 Volt Ground
R_x	-	Receive
T_x	-	Transmit
V	-	Volts
Vcc	-	+ 5 Volts Direct Current

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CHAPTER 1

INTRODUCTION

1.1 Background

Today, many electronic devices are automated and unmanned. Recently, various types of guiding systems for vehicles or so called automated guided vehicle (AGV) have been proposed to perform unmanned travel of a vehicle due to safety aspect of human lives. This vehicle can be used in many areas such as at harbor, surveying and military purpose. An example is a robot that travels into a mine field to detonate a dangerous mine. This robot could use GPS coordinates to navigate to a specific location to perform the necessary tasks such as automatic storekeeper.

1.2 Problem statement

With so many dangers arising today and because of the advancement of technology, there is a need for automated and unmanned devices. The military has a need for GPS guided systems to protect the lives of soldiers. Civilians also could benefit from GPS guided systems by making everyday navigation easier and safer.

1.3 Project objective

The project goal is to develop a GPS guided system that will successfully navigate to a series of pre-defined coordinates. The project objectives are:

- Develop a system that will be sturdy enough to cover mostly flat terrain while carrying a payload of electronic equipment including the global positioning system
- Develop a system that will be able to establish its own location on earth and use information from the global positioning system to navigate to a user defined GPS coordinate
- Vehicle will be able to follow a path of points provided by a user

1.4 Project Scopes

This project concentrates to construct a mini vehicle capable navigating to the point defined by user. This effect is to be accomplished using a GPS to allow the vehicle to become aware of its position on the earth. To develop the whole project, it consists of three methods which are the concept of GPS navigation system, the electronics structure, and the software programming.

The concept of GPS navigation system is on the combination of GPS receiver and RF transceiver. The GPS will establish the vehicle's current position and the RF transceiver to communicate the vehicle with the base station. The electronics structure consists of two systems which are base station and the vehicle. PIC18F4550 microcontroller used to control the whole operation of the system. Software programming is based on MikroBasic instruction sets. It contains a program designed for a GPS navigation system act functioning as instructions given to and will be performed by the electronics structure.

1.5 Thesis outline

Chapter 1 explains the background of the project, the project objectives, scopes, and the literature review for GPS navigation system. The concepts of GPS receiver is the major element for the development of the system.

Chapter 2 is about the theory behind the key component used in this project, the GPS receiver and digital compass. It also covers the literature review of these components.

Chapter 3 focuses on the methodologies for the development of the electrical structure and the implementations of microcontroller programming. It gives a brief review on the concept of GPS navigation, the electronics structure for hardware development, and the programming for the operation of the system.

Chapter 4 discusses on the results obtained of the whole progress. All discussions are concentrating on the result and performance of the GPS navigation system. The discussion is valuable for future development of any system similar to this project.

Chapter 5 is about the conclusion for the project and future recommendation to improve the effectiveness, function, application and accuracy of the system. Besides, there is cost and commercialization section where all the cost involved in this project and either the project can be commercialized are discussed.

In addition, there are a few references and appendices are attached together at the end of this thesis to enable the reader make a fast reference for each component used in this project.

CHAPTER 2

THEORY & LITERATURE REVIEW

2.1 Introduction

This chapter will provide the theory of the key components, GPS receiver and digital compass. Besides, it gives the information about the literature review about these components. This information is very useful to help the author to understand how these component functioning and their performance.

2.2 Theory

2.2.1 How GPS work

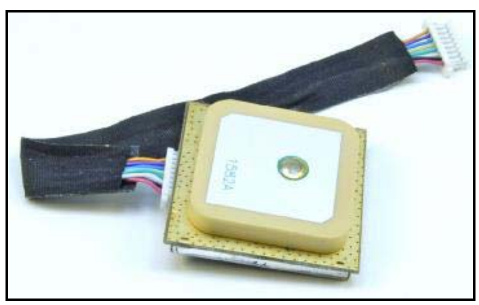

Figure 2.1 GPS receiver

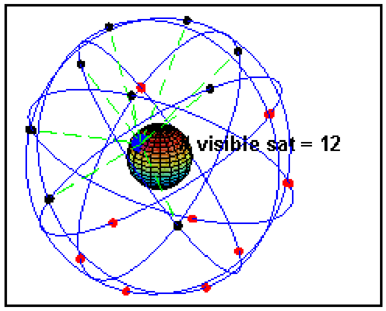

Figure 2.2 GPS concept

First of all, when people talk about GPS, they actually refer to GPS receiver since the GPS transmitter is the satellites around the earth. Figure 2.1 shows the concept of a GPS receiver. The GPS system consists of 24 satellites. The number may vary slightly as new ones are launched and old ones are retired. Each satellite is in an 11,000 mile orbit and transmits a very weak signal. The system is monitored and maintained by the U.S. Military. The satellites only broadcast to the user and the user only receives. There is no charge for use.

To start with, assume that all of the satellites and the receiver have a perfect internal clock. This is not the case, but it makes a good starting point. Each satellite transmits a coded signal. Consider this signal to be like the peaks and ridges along the edge of a super long key. This code is generated as a function of time. The receiver is also able to generate the same code. The receiver matches the incoming code to the internally generated code except that there is a delay caused by the signal's travel time between the satellite and the receiver. The receiver measures how much it has had to shift the timing of its code to match the incoming code. Since the receiver knows how much time it took the signal to reach the receiver and the speed of travel of the signal, it can then calculate the distance from the satellite.

If someone know how far he is from one satellite then he knows that he is somewhere along an imaginary sphere around that satellite. If he knows how far you are from two satellites, then he is somewhere along the intersection of where these two spheres, which is a circle. If he adds another satellite, then he is somewhere where this third sphere intercepts the circle created by the intersection of the other two spheres. The sphere will most likely intercept the previous circle at two points.

One of these points is where he is, and the other is not a reasonable solution – somewhere in outer space. Thus by knowing where you are relative to these three satellites the receiver with a perfect clock can know where it is.

Although no clock is perfect, the satellites have atomic clocks - pretty close. The clock in the GPS receiver is closer in technology to an inexpensive digital watch. Light travels at 186,000 miles per second. If the receiver time was off by 1/100 of a second the calculated distance would be off by 1,860 miles.

For each receiver to have its own cesium clock would make GPS technology prohibitively expensive and non-portable. What the GPS receiver does is to use a cheap clock similar to a digital watch and add one more satellite to the calculation to correct the time in the receiver. The receiver shifts the time calculation back and forth so that all of the imaginary spheres around the satellites intercept at one point.

2.2.2 How digital compass work

Figure 2.3 Digital compass

The electronics compass such as Honeywell family is generally a device for determining aircraft direction using the magnetic field of the Earth. This technology is called magneto-inductive and is the largest advancement in compass technology since the fluxgate was invented 60 years ago. The operation of the compass is based on the principle of electromagnetic induction with the Earth's magnetic field acting as the induction field for an electric generator. Because the direction of the Earth's magnetic field is aligned nearly north-south, the electrical output of the generator will vary depending on its orientation with respect to the Earth's magnetic field. This variation in the generated voltage is measured, allowing the Earth inductor compass to determine direction.

2.2.3 Using GPS & digital compass for navigation

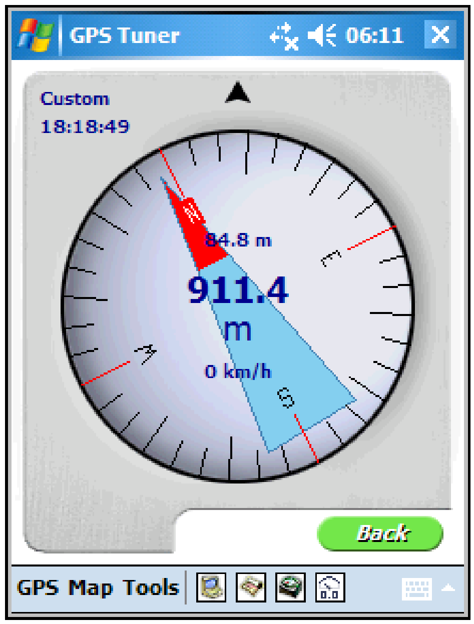

Figure 2.4 GPS & digital compass navigation

For three-dimensional navigation you need to receive four satellites. Think of it as one satellite for each dimension and one for the time.

For two-dimensional navigation user can scrape by with only receiving three satellites. If user knows his altitude, the GPS can treat the center of the earth as a satellite reducing the number of required satellites by one. User’s distance from the center of the earth is the radius of the earth plus your altitude. This is why aviation GPS models have barometric altimeter input and user may occasionally see a handheld GPS ask for his altitude during poor reception conditions.

Newer GPS receivers use the extra signals above the minimum that is required to further refine the position for increased accuracy. This is known as an over determined solution.

The concept explained above show that the GPS receiver can establish its precise position on any place on the earth. When the GPS receiver mounted on the vehicle, it will establish the current position of the vehicle and sending the information to the PIC18F4550 microcontroller. This data will be compared to the point defined by the user from the base station and moving the vehicle automatically according to the relative different between this two data and the direction determined by the digital compass.

2.3 Literature review

2.3.1 GPS

Whether you are using a very economical handheld GPS receiver, an expensive marine chart plotter, or an integrated flight management system on an airliner, many of the principles of navigation are similar. Different receivers have different keystrokes and menu selections to accomplish certain tasks. This is certainly true from manufacture to manufacture, but this is even true between different receivers made by the same manufacture. (John Bell, 2008)

Another issue is where to get waypoints. Before you can navigate with a GPS. It is necessary to describe where you want to go to the GPS receiver. There are a variety of methods for getting these coordinates. Some are as easy as pointing and clicking on a mapping GPS. There are also ways to get coordinates using a computer including Internet sites. Maps and charts are also useful for finding coordinates. Using a road map for flying would obviously be improper. However, a road map might be ideal for using with a basic GPS for a canoe trip. A proper topographic map may be better in such a case. However, the time and expense of acquiring such a map may be overkill when a road map or free map from the ranger station might be adequate. (John Bell,2008)

One of the biggest advantages of GPS is that it provides information on the direction that you are traveling. This is unique in that most systems in the past have only provided information on the direction that a vessel is pointing. (John Bell, 2008)

You may have noticed that the amount of time it takes for your GPS to calculate a position varies. It will take an especially long time to get an initial fix when you first start it and it will get a fix very quickly when you start it again after just shutting it down. The GPS has two types of data on the location of the satellites and their orbits. The first is a rough idea of where each satellite is located and is called the almanac. This almanac data is good for a couple of months. If the GPS does not have a current almanac it will take about 15 minutes to download. The second type of data is the fine data more technically referred to as the ephemeris data. Each satellite broadcasts the almanac which is applicable to all of the satellites, but only broadcasts its own ephemeris data. The ephemeris data takes 18 seconds to download and is good for a couple of hours. It is this ephemeris data that the GPS actually uses for deriving a position. The almanac is used for deciding which satellites to ―look for. For most 12 channel parallel receivers, the GPS will start looking for the satellites that it expects that it can receive based on it‘s current position and time using the almanac data. The GPS assumes that it is where it was last shut down and the clock is correct. However, you can change the position and time, this is called initialization. No accuracy is required in this initial position. (John Bell, 2008)

If the Almanac data is grossly out of date, the GPS will not have the correct data to calculate which satellites to look for. The almanac data takes 12.5 minutes to download. Thus, you should leave the receiver on for at least 15 minutes to a half hour every couple of months to get a fresh almanac. (John Bell, 2008)

The GPS satellite signal is very weak and easily blocked, putting your hand over the receiver will usually be enough to block it. I would imagine that the designers of GPS would rather have had a stronger signal, but you have to consider the problem of getting power to run a transmitter in space. Given all of the various limitations of payload weight and size, I would imagine that the satellite transmitters are as powerful as possible given the various constraints of getting them into space. The implication for the user is that signal availability can be an issue in a number of circumstances. One factor is where you locate the antenna, which I discuss in more detail in the Choosing a GPS receiver chapter. The other factor is where you are trying to use the GPS. (John Bell, 2008)

If you are boating and flying, signal reception is seldom a factor because you are generally out in the open. Where this becomes a factor is using the GPS in a city, hiking in heavy tree cover, etc. Added to the blocking of the signal is something called Multi Path error, where the signal bounces off of buildings or rocks before reaching the receiver. The GPS works on the principle of calculating the distance the signal has traveled from the satellite. If the signal zig-zags around a little by bouncing off of things, this increases the distance and introduces and error. I use GPS for finding my way around cites on layovers. I expect the signal to be spotty. Needless to say, it is possible to find your location in a city without a GPS. However, the GPS can be a useful tool. I will find that walking down the street I often lose the satellite lock. When I am at a street corner, I find that I am usually able to get a good position because the receiver's view of the sky has been improved. (John Bell, 2008)

2.3.2 Digital compass

The magneto-inductive technology is able to electronically sense the difference in the earth's magnetic field from your vehicle's magnetic field. Some digital compass used in automobile has an embedded microcontroller that subtracts out user's auto mobile magnetic field (distortion) from the stronger earth magnetic field, providing highly accurate compass readings. (ASD, 2006)