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OBJECT TRACKER USING GLOBAL POSITIONING SYSTEM (GPS) AND RADIO LINK

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May 2006

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"I hereby declare that this report is the result of my own effort except as clearly stated in the source of reference"

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Date : 08/05/08

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For My Family, Zurina, Lecturer and all My Friend

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ABSTRACT

The use of satellite aided navigation in the modern transport sector is well established worldwide. Air and sea travel in particular rely heavily on this technique of obtaining accurate and reliable position information. In recent years however, satellite navigation has started to expand into other areas such as recreation and emergency response. There is no doubt that this method of acquiring position is here to stay, and will continue to spawn new applications. In fact, the mass consumer market for satellite navigation related products and services are expected to double in the next three years.

It is in this climate that the project aims to develop a device that will use a satellite navigation system to locate remote objects. Completion of the project will demonstrate the feasibility of the theory, and in such a broadening market, it may be possible to develop the system further into a commercial product.

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ABSTRAK

Penggunaan bantuan arah menggunakan satelit telah digunakan secara meluas di seluruh dunia salam sektor pengangkutan moden. Perjalanan menggunakan udara dan air amat bergantung pada teknik ini untuk mendapatkan kedudukan dalam masa nyata secara tepat dan dipercayai. Dalam beberapa tahun kebelakangan ini, bantuan arah menggunakan satelit telah berkembang ke sektor rekreasi dan bantuan kecemasan. Tidak dapat disangkal lagi bahawa teknik ini akan kekal dan terus berkembang ke sektor-sektor yang lain. Pengeluar produk dan perkhidmatan yang berkaitan bantuan arah menggunakan satelit ini dijangka akan meningkat dua kali ganda dalam 3 tahun yang akan datang.

Di akhir projek ini, akan tercipta satu alat yang akan menggunakan teknik ini untuk mengetahui kedudukan suatu objek yang berada dalam kawasan tertentu. Dengan penyempurnaan projek ini, akan menunjukan teori perlaksanaan dan pada masa sekarang dengan teknologi yang berkembang pesat kemungkinan projek ini boleh dikembang ke pasaran komersial.

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LIST OF ACRONYMS

2D	-	Two Dimensional
3D	-	Three Dimensional
AM	-	Amplitude Modulation
ACK	-	Acknowledgement
CMOS	-	Complementary Metal-Oxide Semiconductor
CEP	-	Circular Error Probability
C/A	-	Coarse/Acquisition
DB-9	-	Type of Connector
DGPS	-	Differential Global Positioning System
DoD	-	Department of Defense
EMI	-	Electromagnetic Interference
FAA	-	Federal Aviation Administration
F/V	-	Frequency-to-Voltage
FPA	-	Final Power Amplifier
FMO	-	Frequency-Modulated Oscillator
FM	-	Frequency Modulation
FCC	-	Federal Communications Commission
GPS	-	Global Positioning System
GGA	-	GPS Position Message
GUI	-	Graphic User Interface
GDOP	-	Geometric Dilution of Precision
GMT	-	Greenwich Mean Time
HPF	-	Pre-Emphasis Network
IF	-	Intermediate Frequency
IPA	-	Intermediate Power Amplifiers
NAK	-	Not Acknowledgement

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NMEA	-	National Marine Electronics Association
OEM	-	Original Equipment Manufactured
P.C	-	Personal Computer
P-Code	-	Precise Code
PRN	-	Pseudo-Random Code
PPS	-	Precise Positioning Service
PCB	-	Printed Circuit Board
RF	-	Radio Frequency
RTCM	-	Radio Technical Commission for Maritime Services
RMC	-	Recommended Minimum Course
S.A	-	Selective Availability
SPS	-	Standard Positioning Service
SBAS	-	Satellite-Based Augmentation System
TTL	-	Transistor to Transistor Logic
U.S	-	United States
UHF	-	Ultra High Frequency
VSWR	-	Voltage Standing Wave Ratio

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The aim of this project is to design and build a device that will acquire its current longitude and latitude from the Global Positioning System (GPS) and then transmit these coordinates to a base station at a different location using a radio link. The base station is to comprise of a radio receiver and a computer, which is to decode the incoming data and display the two dimensional position of the mobile GPS unit on a map of the local area.

1.2 PROJECT OBJECTIVE

The aim of this project is to design and build a device that will acquire its current longitude and latitude from the U.S. Global Positioning System (GPS) and then transmit these coordinates to a base station at a different location using a radio link. The base station is to comprise of a radio receiver and a computer, which is to

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decode the incoming data and display the two dimensional position of the mobile GPS unit on a map of the local area.

Currently, no known mobile GPS products with built-in radio transmitters exist on the commercial market.

1.2.1 Possible Uses

i. In orienteering games, the organizers can utilize this system to easily keep track of all the participating teams as they make their way around the course. The audience is likely to enjoy the event more if an automatically updated map displaying the positions of all the teams was made available. Also, by keeping accurate tabs on the players, the safety of the game is increased.

ii. A similar system can be used to monitor the progress of buses so that the time of arrival at any given bus stop can be easily calculated. By using GPS to acquire position, the need to place complex sensors along every single bus route is eliminated. The collected information will not only inform passengers of waiting times, but will also enable the control room to space out buses by instructing drivers to speed up or slow down.

iii. This system can be adapted to provide security for objects that are at risk of being stolen. By fixing a transmitting unit on to an object, a base station will be able to pinpoint the exact location of that object at anytime by simply decoding the received signals.

iv. If the GPS co-ordinates are very accurate, the system can be used in land surveying operations. This greatly improves on the old method of using tape measures and may even have an advantage over laser measuring equipment, which need a direct line of sight to operate.

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1.3 PROJECT SCOPE

In general, this project are separated into three phase which is Global Positioning System, Radio Link and Software.

1.3.1 Global Positioning System (GPS)

This project will be using a GPS unit to acquire the position data (latitude and longitude) from the GPS satellite and this GPS unit will be connected to transmitter module.

1.3.2 Radio Link

This project will be using a transmitter module and a receiver module to send the GPS signal through a radio link. The receiver will be connected to a PC at the base station

1.3.3 Software

By using a specific software, the receive data signal will be encode and display the information to user.

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CHAPTER II

LITERATURE REVIEW

2.1 GLOBAL POSITIONING SYSTEM (GPS)

2.1.1 Introduction to GPS

Currently there are two satellite-based radio navigation systems available worldwide. The NAVigation Satellite Timing And Ranging Global Positioning System (NAVSTAR GPS) as developed in 1978 by the U.S. Department of Defense and four years later, the Global Navigation Satellite System (GLONASS) was developed by the Soviet Union. These two systems permit land, sea, and airborne users to determine their three-dimensional position, velocity, and time 24 hours a day, in all weather, anywhere in the world. Both systems are available for civil use. Furthermore, devices are now being developed that uses both systems simultaneously to increase accuracy.

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2.1.2 GPS Operation

The whole idea behind GPS is to use satellites in space as reference points for locating positions here on earth. If it can accurately measure the vector from three objects it can "triangulate" position anywhere on earth. Distance from the satellite is measured by calculating the time it takes for a radio wave to travel from the satellite to our GPS receiver. It multiplies this time by the speed of light to get the distance. Because radio waves travel at 300 million meters a second, the clocks used to measure the travel time must be extremely accurate (i.e.: hundredths of a nanosecond, 1 nanosecond = 1 billionth of a second).

For one satellite, the distance *(d1)* of a GPS unit is equal to the time its takes the radio signal to travel between the two, multiplied by the speed of the radio signal (the speed of light). The time of the signal is determined by measuring the difference between the same parts of the coded signals. The set of all points where our GPS receiver could be at that distance *(d1)* can now be represented as the surface of a sphere in the figure 2.1.

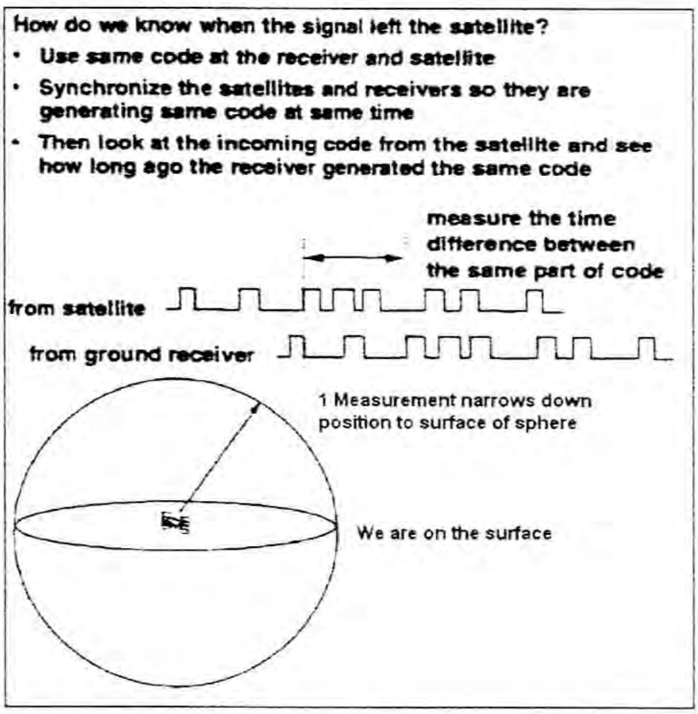

Figure 2.1: Sphere formed using time to calculate a distance from a receiver position to a satellite

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If the distance is measured to a second satellite and find out that it is *(d2)* meters away. That tells that not only on the first sphere but also on a sphere at its respective distance from the second satellite. Or in other words, somewhere on the circle where these two spheres intersect. This intersection is the circle as seen in Figure 2.2.

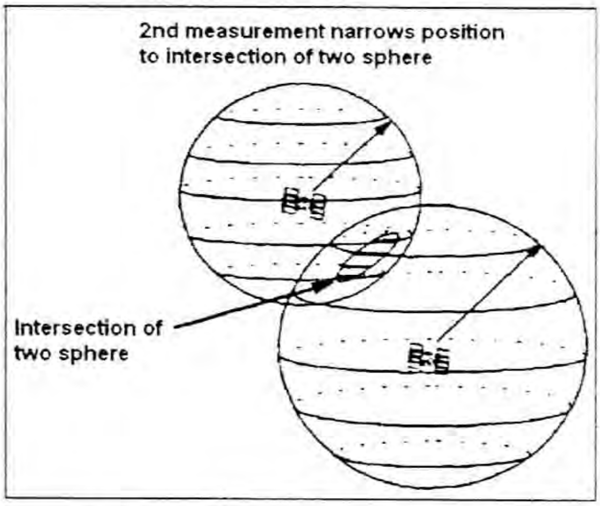

Figure 2.2: Circle formed by measuring the distance from position to two satellites

If another measurement is make to a third satellite at distance *(d3)*, this narrows possible positions down to two points shown in Figure 2.3. So by ranging from three satellites it have narrows position down to two points in space.

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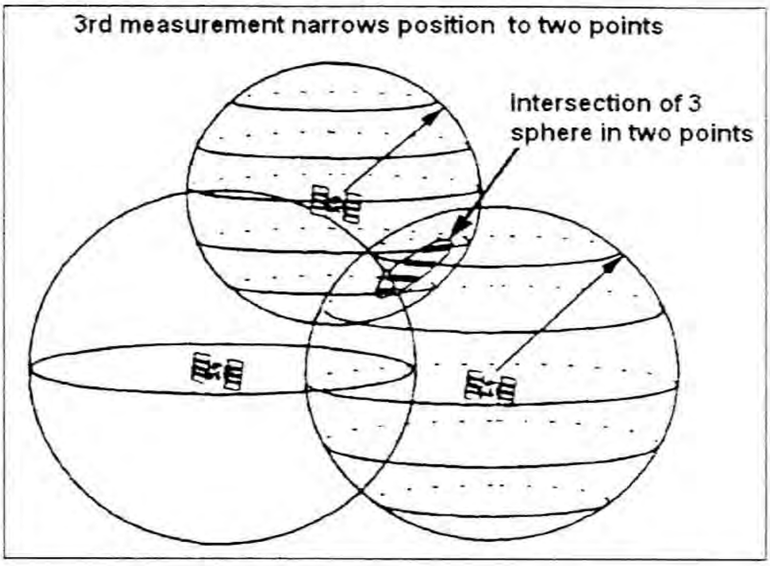

Figure 2.3: Two points formed by measuring the distance from our position to three satellites

To decide which of these two points our true location is it could make a measurement from a fourth satellite. However, usually one of the two points is a ridiculous answer (either out in space, underground, or traveling at an impossible velocity) and can be rejected without a measurement. To be able to fix position with only three satellites requires that there be accurate clocks not only in the satellites but also in the receiver units. A clock at the receiver unit is needed to ensure that the signals are perfectly synchronized. Because these clocks are so expensive, it is impossible to put them in receivers. Instead, receivers use the measurement from a fourth satellite to remove clock errors. Figure 2.4 shows how the receiver senses the error.

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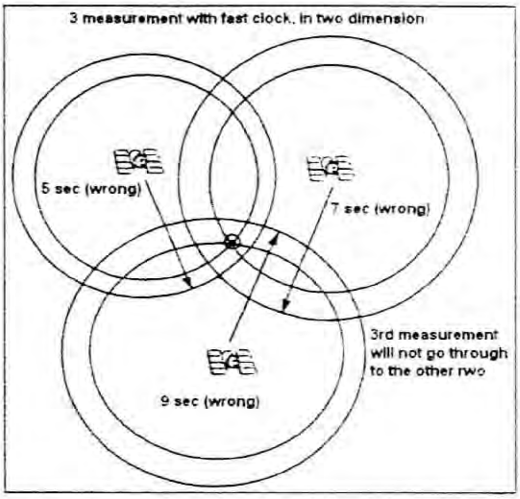

Figure 2.4: Clocks errors prevent the three ranges from intersecting in a single point

When a GPS receiver gets a series of measurements that do not intersect at a single point, the computer inside the receiver starts subtracting (or adding) time until it arrives at an answer that lets the ranges from all satellites go through a single point. It then works out the time offset required and makes appropriate adjustments. Because of this, four satellites are required to cancel out time errors if you require three dimensions. Figure 2.5 shows the employment of a fourth satellite for 3D work.

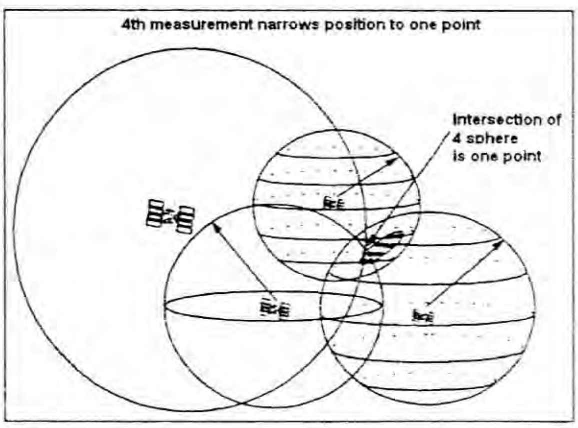

Figure 2.5: Fourth satellite used to solve the four unknowns, X, Y, Z, and time

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