

## Chapter 7

# Introduction to Global Satellite Positioning System (GPS)

Jenq-Muh Hsu

*National Chiayi University, Chiayi, Taiwan, R.O.C.*

### ABSTRACT

*Understanding the right positions and directions of people and objects is a significant issue from the ancient eras to the present. In the past, people often launched a war in order to satisfy the craving for the dominating powers and spread their realms. In the recent, Global Satellite Positioning System (GPS) has become the one of most popular positioning technologies. GPS can provide users precise positioning information, no matter wherever that may present their own positions. The early GPS positioning technology has been widely used in military, marine use, until recently gradually applied into our daily life, e.g., automotive navigation, geodesy surveying, etc. In this chapter, we will briefly introduce some GPS issues including the origins of GPS, GPS system architecture, and related GPS applications.*

### INTRODUCTION

Understanding the right positions and directions of people and objects is a significant issue from the ancient eras to the present. In the past, people often launched a war in order to satisfy the craving for the dominating powers and spread their realms. When the army is marching during the fighting, it does not allow the army to get lost in the woods or the dense fog. It needs a method or a tool to offer the army to navigate and move to the right place.

South Pointing Chariot (South Pointing Chariot, 2009) invented in the ancient Chinese civilization is a complex-gearing mechanism without using the magnet to point the same direction while the chariot is around in any movement. South Pointing Chariot only moves on the ground, it can not be used to point the right direction whiling sealing due to the no effect of gearing operation on the sea. The other usual positioning and navigating tool is the compass.

The compass has the magnet which can interact with the magnetic field of the earth to always point the same position in north. Although the actual

DOI: 10.4018/978-1-60566-840-6.ch007

positioning is a magnetic North Pole, not a true North Pole, it is enough to use in positioning and navigation. Therefore, the compass has been widely used in many positioning and navigating applications. The compass still has a little accurate positioning problem affected by magnetic interference in natural environment, but it has no serious influence on using the compass.

Nowadays, the most famous positioning and navigation service is Global Satellite Positioning System (GPS) (Global Positioning System, 2009; EI-Rabbany, 2002; Kaplan et al., 2006). It uses the satellites orbiting around the earth in space to broadcast positioning signals. A GPS receiver receives the signals and calculates out its current position. That is, GPS provide a worldwide positioning and navigation service for any kind of communication and transportation, such as aircrafts, vessels, vehicles, pedestrians, etc. GPS is developed by the U. S. Department of Defense (DoD) in early 1970s. At the beginning of constructing GPS, it is only used for military purpose, but it has freely opened for civilian use on July 2000s. Therefore, GPS is now a dual-use system that can be accessed by both military and civilian users in various positioning precision for some national security factors considered by U.S. government.

As mention above, vehicles having built-in GPS navigation system will be a main trend to provide the driving assistance and navigation service in the future. In next section, we will describe the principle of GPS system in detail.

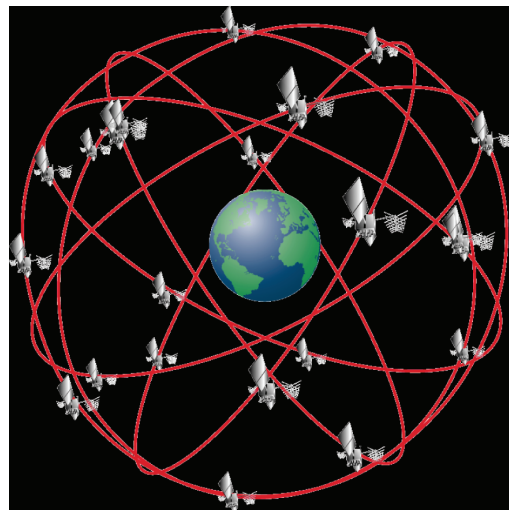
## **PRINCIPLE OF GLOBAL POSITIONING SYSTEM**

The GPS is a satellite-based positioning and navigation system. GPS provides continuous positioning and timing information anywhere in the world under any weather conditions. GPS is also a passively one-way ranging system and it can serve unlimited number of users. That is, users only take

the GPS receivers to receive enough GPS signals without bidirectional communications among them. GPS receives will be able to calculate out the user positions they locate now.

GPS system generally consists of a constellation of 24 operational satellites (Leick, 2004). In order to ensure continuous worldwide converge for GPS positioning service, six orbital planes of satellites are organized and each four satellites are placed in an orbital plan. There are four to ten GPS satellites will be visible anywhere in the world under this constellation geometry. The sketch map of GPS constellation is shown in Figure 1. A GPS satellite routes around the earth in a nearby circular orbit, an elliptical shape, with an inclination of 55 degrees to the equatorial plane. The maximal radius of GPS orbit is about 26,560 kilometers measured from the earth center. The orbit period of GPS satellite is approximately 12 sidereal hours, which is about 11 hours and 58 minutes. Thus, GPS satellite will run around the earth twice per day. In order to ensure the availability of GPS positioning service, the number of satellites in the GPS constellation has always been more than 24 operational satellites.

*Figure 1. The GPS constellation*



9 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/introduction-global-satellite-positioning-system/39522](http://www.igi-global.com/chapter/introduction-global-satellite-positioning-system/39522)

## Related Content

---

### Evaluating Organisational Readiness for Virtual Collaboration

Peter Galland Janice Burn (2010). *Networking and Telecommunications: Concepts, Methodologies, Tools, and Applications* (pp. 937-946).

[www.irma-international.org/chapter/evaluating-organisational-readiness-virtual-collaboration/49786](http://www.irma-international.org/chapter/evaluating-organisational-readiness-virtual-collaboration/49786)

### ParaCom An IoT based affordable solution enabling people with limited mobility to interact with machines

(2022). *International Journal of Hyperconnectivity and the Internet of Things* (pp. 0-0).

[www.irma-international.org/article//285586](http://www.irma-international.org/article//285586)

### An Exploration of the Cybersecurity Workforce Shortage

Darrell Norman Burrell (2018). *International Journal of Hyperconnectivity and the Internet of Things* (pp. 29-41).

[www.irma-international.org/article/an-exploration-of-the-cybersecurity-workforce-shortage/210626](http://www.irma-international.org/article/an-exploration-of-the-cybersecurity-workforce-shortage/210626)

### The Impact of a Global Recession on Millennials in the Job Market

Sthokozile Mambaand Andrishah Beharry-Ramraj (2022). *Handbook of Research on Global Networking Post COVID-19* (pp. 156-172).

[www.irma-international.org/chapter/the-impact-of-a-global-recession-on-millennials-in-the-job-market/309605](http://www.irma-international.org/chapter/the-impact-of-a-global-recession-on-millennials-in-the-job-market/309605)

### Analysis of the US Privacy Model: Implications of the GDPR in the US

Francisco García Martínez (2019). *International Journal of Hyperconnectivity and the Internet of Things* (pp. 43-52).

[www.irma-international.org/article/analysis-of-the-us-privacy-model/234344](http://www.irma-international.org/article/analysis-of-the-us-privacy-model/234344)