Global Position System Technology (GPS)

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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.GPS is one of the greatest EM application that is used tom locate objects any where of the world**

I.Introduction

The Global Positioning System (GPS) is a satellite-based navigation system that was developed by the U.S. Department of Defense (DoD) in the early 1970s. Initially, GPS was developed as a military system to fulfill U.S. military needs. However, it was later made available to civilians, and is now a dual-use system that can be accessed by both military and civilian user [1]. GPS provides continuous positioning and timing information, any- where in the world under any weather conditions. Because it serves an unlimited number of users as well as being used for security reasons, GPS is a one-way-ranging system. That is, users can only receive the satellite signals[2].

II. Overview of GPS

GPS consists, nominally, of a constellation of 24 operational satellites. This constellation, known as the initial operational capability (IOC), was completed in July 1993. The official IOC announcement, however, was made on December 8, 1993 .To ensure continuous worldwide coverage, GPS satellites are arranged so that four satellites are placed in each of six orbital planes –see Fig 1. As discussed later, only four satellites are needed to provide the positioning, or location information [2].

GPS satellite orbits are nearly circular (an elliptical shape with a maximum eccentricity is about 0.01), with an inclination of about 55 degree to the equator.
The semi major axis of a GPS orbit is about 26,560 km (i.e., the satellite altitude of about 20,200 km above the Earth's surface). The corresponding GPS orbital period is about 12 sidereal hours (~11 hours, 58 minutes)[3].

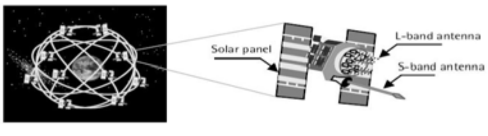

Fig 1 GPS Constellation

III .GPS Segments

GPS consists of three segments: the space segment, the control segment, and the user segment (Figure 2). The space segment consists of the 24-satellite constellation introduced in the previous section.
Each GPS satellite transmits a signal, which has a number of components: *two sine waves (also known as carrier frequencies), two digital codes, and a navigation message*. The codes and the navigation message are added to the carriers as binary bi-phase modulation. The carriers and the codes are used mainly to determine the distance from the user's receiver to the GPS satellites[2].

The navigation message contains, along with other information, the coordinates (the location) of the satellites as a function of time. The transmitted signals are controlled by highly accurate atomic clocks onboard the satellites.

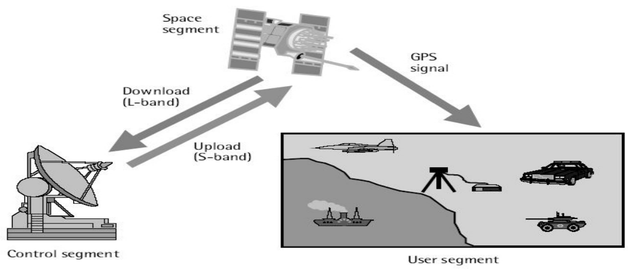

Fig GPS Segments[4]

The control segment of the GPS system consists of a worldwide network of tracking stations, with a master control station (MCS) located in the United States at Colorado Springs, Colorado. The primary task of the operational control segment is tracking the GPS satellites in order to determine and predict satellite locations, atmospheric data, and other considerations. This information is then packed and uploaded into the GPS satellites through the S-band link[3].

The user segment includes all military and civilian users. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her

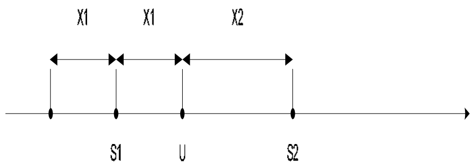

Fig 3 One-Dimensional User Position[4]

position anywhere in the world. GPS is currently available to all users worldwide .
The carrier frequency of the GPS is in the L band (2–1) GHz of the microwave range.

The position of a certain point in space can be found from distance measured from this point to some known positions in space. Let us use some examples to illustrate this point.
In Figure 5, the user position is on the x-axis; this is a one-dimensional case. If the satellite position S1 and the distance to the satellite x1 are both known[2].

The user position can be at two places, either to the left or right of S1. In order to determine the user position, the distance to another satellite with known position must be measured. In this figure, the positions of S2 and x2 uniquely determine the user position U[2].

Figure 4 shows a two-dimensional case. In order to determine the user position, three satellites and three distances are required. The trace of a point with constant distance to a fixed point is a circle in the two-dimensional case. Two satellites and two distances give two possible solutions because two circles intersect at two points. A third circle is needed to uniquely determine the user position[2].
For similar reasons one might decide that in a three-dimensional case four satellites and four distances are needed. The equal-distance trace to a fixed point is a sphere in a three-dimensional case. Two spheres intersect to make a circle.
This circle intersects another sphere to produce two points. In order to determine which point is the user position, one more satellite is needed [2].

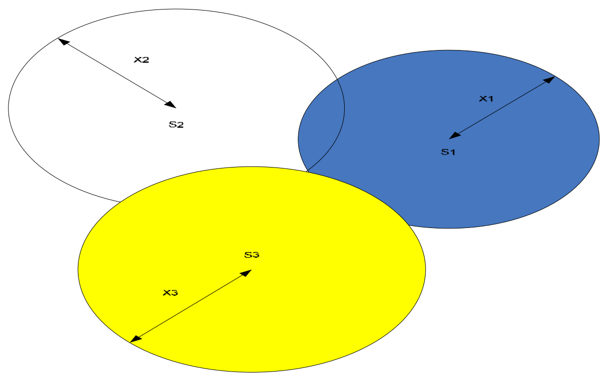

Fig 4 Two-Dimensional User Position[4]

In GPS the position of the satellite is known from the ephemeris data transmitted by the satellite. One can measure the distance from the receiver to the satellite. Therefore, the position of the receiver can be determined.the problem we still face is how to locate the user.

IIII .Basic Equations for Finding User Position

In this section the basic equations for determining the user position will be presented.
Assume that the distance measured is accurate and under this condition three satellites are sufficient. In Figure 4, there are three known points at locations r1 or (x1, y1, z1), r2 or (x2, y2, z2), and r3 or (x3, y3, z3)- these location correspond to satellites location -and an unknown point at ru or (xu, yu, zu)which is the user location.
If the distances between the three known points to the unknown point can be measured as ρ1, ρ2, and ρ3, these distances can be written as

$$\rho 1 = \sqrt{(X_1 - X_u) + (Y_1 - Y_u) + (Z_1 - Z_u)} \qquad (1)$$

$$\rho 2 = \sqrt{(X_2 - X_u) + (Y_2 - Y_u) + (Z_2 - Z_u)} \qquad (2)$$

$$\rho 3 = \sqrt{(X_3 - X_u) + (Y_3 - Y_u) + (Z_3 - Z_u)} \qquad (3)$$

Because there are three unknowns and three equations, the values of xu, yu, and zu can be determined from these equations. Theoretically, there should be two sets of solutions as they are second-order equations. These equations can be solved relatively easily with linearization and an iterative approach[3].
In GPS operation, the positions of the satellites are given. This information can be obtained from the data transmitted from the satellites.

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REFRENCE

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