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Unit IV

GPS Surveying

Syllabus

Introduction & components of GPS, Space segment, control segment and user segment, Elements of Satellite based surveys-Map datums, GPS receivers, GPS observation methods and their advantages over conventional methods.

GPS Surveying

Introduction:

GPS or Global Positioning System is a network of orbiting satellites that send precise details of their position in space back to earth. The signals are obtained by GPS receivers, such as navigation devices and are used to calculate the exact position, speed and time at the vehicles location.

Components of GPS:

The Global positioning system consists of three main components:

1. GPS Ground control stations

The ground control component includes the master control station at Falcon Air Force Base, Colorado Springs , Colorado and monitor stations at Falcon AFB, Hawaii Ascension Island in the Atlantic , Diego Garcia in the Indian Ocean , and Kwajalein Island in the South Pacific. The control segment uses measurements collected by the monitor stations to predict the behaviour of each satellite's orbit and atomic clocks. The prediction data is linked up to the satellites for transmission to users. The control segment also ensures that GPS satellite orbits remain within limits and that the satellites do not drift too far from nominal orbits.

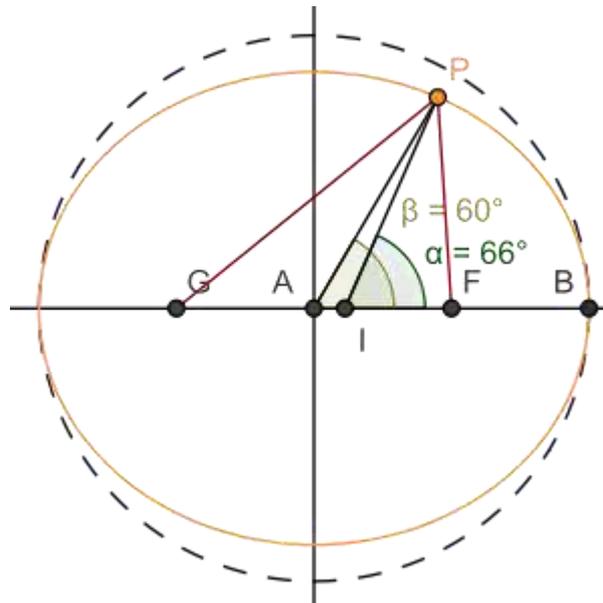
2. GPS satellites

The space segment includes the satellites and the Delta rockets that launch the satellites from Cape Canaveral in Florida, United States. GPS satellites orbit in circular orbits at 17,440 km altitude, each orbit lasting 12 hours. The orbits are tilted to the equator by 55° to ensure coverage in Polar Regions. The satellites are powered by solar cells to continually orientate themselves to point the solar panels towards the Sun and the antennas towards the Earth. Each satellite contains four atomic clocks.

3. GPS receivers

When you buy a GPS, you are actually buying only the GPS receiver and get free use of the other two main components, worth billions of dollars - compliments of the Government of the United States. Elements of Satellite based surveys-Map datum:

In surveying and geodesy, a datum is a reference system or an approximation of the Earth's surface against which positional measurements are made for computing locations. Horizontal datum is used for describing a point on the Earth's surface, in latitude and longitude or another coordinate system.



GPS receivers:

Any navigation solution provided by a GNSS Receiver is based on the computation of its distance to a set of satellites, by means of extracting the propagation time of the incoming signals travelling through space at the speed of light, according to the satellite and receiver local clocks.

Notice that satellites are always in motion, so previous to obtaining the navigation message, the satellite's signal is detected and tracked. The receiver's functional blocks that perform these tasks are the antenna, the front-end and the baseband signal processing (in charge of acquiring and tracking the signal).

Once the signal is acquired and tracked, the receiver application decodes the navigation message and estimates the user position. The Navigation Message includes:

- Ephemeris parameters, needed to compute the satellite's coordinates.
- Time parameters and Clock Corrections, to compute satellite clock offsets and time conversions.
- Service Parameters with satellite health information.
- Ionospheres' parameters model needed for single frequency receivers.
- Almanacs that allow computing the position of all satellites but with a lower accuracy than the ephemeris.

The ephemeris and clocks parameters are usually updated every two hours, while the almanac is updated at least every six days.

The GPS Signal in Space is specified in the following documents:

- IS-GPS-200E: Interface between the space segment of the Global Positioning System and the navigation user segment of the GPS for radio frequency link 1 (L1) and link 2 (L2)

- **IS-GPS-705A:** interface between the space segment of the Global Positioning System and the navigation user segment of the GPS for radio frequency link 5 (L5).
- **IS-GPS-800:** interface between the space segment of the Global Positioning System and the navigation user segment of the GPS for signal L1 Civil (L1C) transmitted in the frequency band of L1.

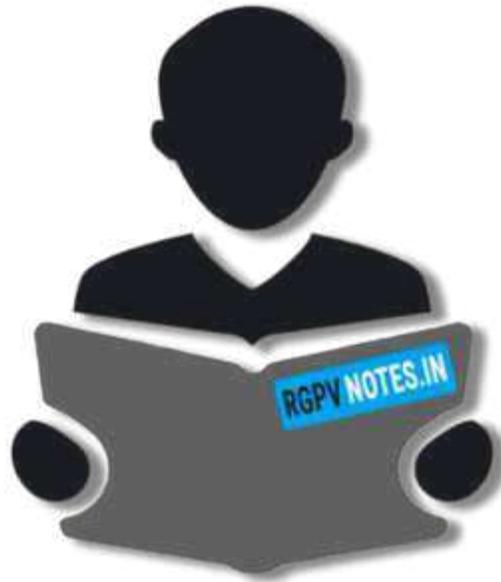
GPS observation methods and their advantages over conventional methods:

The main positioning modes for GPS surveying and navigation are:

- **ABSOLUTE or POINT positioning:** coordinates are in relation to a well-defined global reference system.
- **DIFFERENTIAL or RELATIVE positioning:** coordinates are in relation to some other fixed point. In GPS surveying this is referred to as baseline determination.
- **STATIC positioning:** coordination of stationary points, either in absolute or relative mode. This is generally synonymous with the SURVEYING mode of positioning, based on the analysis of carrier phase observations.
- **KINEMATIC positioning:** coordination of moving points, either in absolute or relative mode. This is generally the NAVIGATION mode of positioning, based on pseudo-range observations.

The GPS surveying technique offers many benefits and advantages over traditional surveying methods.

- **Highly Accurate and Fast Process** – The GPS technology supports the surveying process by providing data with highest accuracy. This equipment is also faster when compared with conventional surveying equipment. Because the data collection process is faster, the time for getting final results and making decisions is shorter.
- **Time, Cost and Labor Saving Technique** – The traditional and conventional surveying can be very costly and time consuming process. In the past, surveyors had to make several visits to one site in order to gather accurate data. With the GPS surveying this is no longer necessary. This type of surveying reduces equipment and labor that was once required for completion of a surveying task. A single surveyor can now complete all the tasks in one day, what in the past took a whole team to do.
- **Not Affected By Weather Conditions** – Another big benefit is that the GPS surveying is not affected by weather conditions like snow, rain, high or low temperatures. Unlike the traditional surveying techniques, the GPS surveying is not affected by constraints like the line of site visibility



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