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Global Positioning System

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***Abstract*: GPS is a satellite-based radio navigation system owned by United Government and operated by the United States Air Force. It gives the geo location and time information to the person on the earth irrespective of the location. Majority of these services enables airborne, land, and sea users to know their exact velocity, location, and time whenever and wherever on Earth. GPS consists of 24 satellites out of which 21 are active and 3 are spares which are located at an altitude of near about 10600 miles from the surface of the earth. Features which make GPS an attractive are the ability to provide high positioning accuracies, the capability to determine accurate time and velocity accuracies, readily available signals in any part of the world, the free services charge, and all-weather service delivery system. Despite the above advantages, a number of challenges that still affecting the transmission of signals still exist within the limits of GPS technologies. Majority of these challenges includes errors such as inaccuracies associated with the reported location of satellites, errors in receiver's clock, and number of visible satellites, which can affect position reading or impede signal reception.**

***Keywords*: Global Positioning Systems US government and GPS Introduction**

A. What is global positioning system?

GPS is the satellite-based radio navigation system owned by United Government and operated by the United States Air Force. It gives the geo location and time information to the person on the earth irrespective of the location. GPS consists of 24 satellites out of which 21 are active and 3 are spaces which are located at an altitude of near about 10600 miles from the surface of the earth. The orbital period is 11 hours 58 minutes and satellites are distributing in six orbital planes with equally spaced angles. To find our location at least four (4) GPS satellites should be available beyond the horizon. In terms of structure and composition, each satellite has an atomic clock, a computer and a radio. Each radio understands its own clock and orbit thereby enabling it to broadcast continuously any changes in time and position. For instance, any minor corrections are made on each day after each GPS satellite verifies its own sense of position and time with other stations located on the ground.
The basis of GPS is "triangulation" from satellites. GPS receivers on the ground are fitted with computers that are capable of triangulating its own sense after obtaining bearings from the other three of the four GPS satellites located in the same horizon. We can also calculate geographic location and altitude of object if we could also receive signal from fourth satellite. Interestingly, we can also calculate our speed, our direction and time to reach the specified destination. Older GPS calculates the locations in the forms of latitudes and longitudes of location but now advanced and specialized GPS receivers can be programmed to store vital data that are usable in map making and as well important for Geographic Information Systems.

2. History

Global Positioning Systems (GPS) is a satellite-based radio-positioning systems that provide three-dimensional course, position, and time information to users. The radios send, receives, and provides time and location information at any time, place, and weather provided the GPS radios are not obstructed from the four other orbital satellites. GPS technologies also helps to find out velocity and altitude of a user. GPS is designed by US Department of Defense and owned by US government. GPS was used primarily designed for Military of US but after made its use global, now it is used in rapidly expanding sets of applications. The Global Positioning System consists of 24 satellites that are in circular orbits around the Earth with the orbital period of approximately 12 hours. The satellites are distributed across six orbital planes that are equally spaced in angles. Each Global Positioning Satellite is built with an atomic clock, a computer, and a radio. The GPS project was launched in the United States in 1973 to overcome the limitations of previous navigation systems. It was initially developed for use by the United States military and became fully operational in 1995. Civilian use was allowed from the 1980.

A. Working of the GPS

As earlier mentioned, the Global Positioning System consists of twenty-four satellites, 21 of which are active while three are spares and are located at an altitude of 10600 miles above the surface of the earth. The satellites are arranged in orbits in a manner such that at any time of the day, at least four satellites are visible above the earth's horizon. The receivers on the ground detect their positions in reference to the GPS satellites. The stations located on the ground provide precise monitoring of the orbit at every level of the satellite and measures the travel time signals transmitted between the four satellites and the receiver. In turn, the accurate direction, location, and speed is the measure.

B. GPS segments

GPS segments are categorized into three distinct segments that include control segment, user segment, and space segment. For space segment, there are 24 satellite that are orbiting around the earth currently. The speed of satellites is nearly 7,000 miles per hour, and satellites are spaced such that at least four satellites can send signals to receivers on earth. From each GPS receiver, coded radio signals are sent to earth and each signal contains particular information. The information includes the particular satellite sending the information, the exact position of the satellite, date and time the signal was sent, and whether the satellite was performing properly. Monitoring, control, and replacement of space satellites and GPS technology is done by the US Department of Defense. The control segment constantly checking the conditions of satellites and intensity of signals. Finally, the user segment of the GPS systems has the receiver which calculates location, time, speed, directions and altitudes of the user. It receives signals from satellites but does not sends back the signals.

3. Primary functions of global positioning systems

There are specific some features that make GPS systems so attractive. These includes the ability to provide high accuracies in position and capability to determine accuracy in time and velocity, readily available signals in any part of the world, free of cost of service, and all-weather service delivery system. It is calculated that the number of civilian users exceeds the number of military users. Keeping this in mind it is seen that GPS technology is accepting globally very fast. GPS was initially designed for military purposes and it have very good impact in this field. Military ships, aircraft, tanks, and equipment use GPS technology for navigation purposes, it improves weapon technology and also helps in determining target destination. In aviation industry, aircraft and airplane pilots uses GPS technology to find route navigation and airport approaches. GPS technology is also using in environmental phenomenon like to check hurricanes, disaster prone areas, forest fires etc. Interestingly, GPS technology can also be used to find out the location which is submerged by natural disasters. GPS technology is also utilizing in ground transportation like vehicles tracking systems and vehicles navigation systems. Drivers can see their location on the map and can reach their destination within expected time shown by GPS. Other systems are designed to automatically design a route and provide turn-by-turn directions to provide guidance to drivers. Rail transport systems also use GPS technologies to find the location of other trains on the same route to stop collision and also to check the traffic flows on the route, estimation of time, speed and distance covered by the trains. It is also used in marine systems for navigation under water, routing traffic, locating navigational hazards and marine mapping. Moreover, commercial fisherman use GPS technology to identify areas with optimum fishing opportunities and as well to track the migration of fishes. Space science also utilizes GPS technologies to track and control the behavior and motions of satellites in orbit. Scientists track space shuttles and rockets through GPS technologies. Furthermore, mapping roads, rail systems, and surveying land maps is possible with the utilization of GPS technologies.

A. Accuracy of global position systems

The accuracy of GPS systems depends on precision of signals that comes from GPS satellite to GPS receivers. The quality and types of receivers also plays an important role in precision and accuracy. Majority of GPS receivers have accuracy ranging from -10m to +10m. The accuracy of most GPS systems is affected by errors like clock errors, satellite location error (orbital error), signal multipath that makes GPS signals bounce off objects, and number of visible satellites, which can affect position reading or impede signal reception.

4. Characteristics of global positioning systems

In order to obtain accurate information from Global Positioning Systems, certain factors should be put into consideration during the making of GPS tools. First, the GPS tool should be durable to ensure that it is capable of withstanding rigors work and continued usage. Second, the ability of the GPS tool to obtain and maintain the most reliable signal strength irrespective of existence of obstructions such as the location, changing weather conditions, and the sensitivity of the receiver. Third, GPS components consume a lot of power and therefore, battery life is a critical factor to consider during the acquisition of GPS equipment. Other features to be consider include the portability ranges, cellular signal reliability, the length of acquiring GPS signals from satellites, configuration complexities, and ease of use among others.

A. GPS competitors

Other satellite navigation systems in use or various states of development include:

- *GLONASS*: Russia's global navigation system. Fully operational worldwide.
- *Galileo*: A global system being developed by the European Union and other partner countries, which began operation in 2016, [165] and is expected to be fully deployed by 2020.
- *Beidou*: People's Republic of China's regional system, currently limited to Asia and the West Pacific, global coverage planned to be operational by 2020.
- *IRNSS:* A regional navigation system developed by the Indian Space Research Organization (ISRO).
- *QZSS:* A regional navigation system in development that would be receivable within Japan.

5. Conclusion

Analysis and discussion of Global Positioning System has revealed that while designing the system designers had different intentions but now GPS technology is not using in finding location, also in the provision of accurate and reliable

navigation information. It also provides information about time, speed, direction, and altitude from sea level. Today, GPS is used in almost every field of life for example underwater navigation, airline and aircraft navigation, ground transportation and also in commercial purposes like driver navigation for specified destination or commercial fisherman. At this moment, it is very difficult to think of a life without GPS. The evaluation and analysis of the structure, operation, and application of GPS system have shown that maintaining a GPS technology is a very tedious task because of its increasing day to day use in daily life. Global Positioning Systems have a potential future judging from the current technological advancements. Today, nearly every device from small mobile phone to big military tanks all are built using GPS technology. Importantly, GPS is advancing at an increasing rate so it is still expected to see more on it. Despite from above advantages, there are number of challenges that still impede the transition of signals still exists. Majority of these challenges are errors in satellite location in space, receiver clock error, signal multipath, and numbers of satellites which are visible, all these are affecting position reading and impede signal reception. These errors in turn led to an inaccurate position and navigation information. These challenges can be avoided by ensuring that GPS receivers and equipment are evaluated to test their reliability. Factors that must be considered during evaluation are durability, reliable signal strength, and consumption of power. At last, the potential in GPS technology provided corrective measures be taken and there is still a need to research on the vulnerabilities to ensure its sustainability.

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