

GPS & ITS APPLICATIONS

Yojna Arora¹

Abstract- GPS is a widely used tool for navigation & position tracking. It is free of charge. It is also useful in finding user's position in time. It is employed in finding location and the corresponding changes on the earth surface with greater precision. There are numerous applications of GPS covering almost every domain. It is been used from past two decades providing precision and accuracy over other methods such as Radar.

Keywords – Global positioning System, GPS Applications, Geodynamics, Power System, Agriculture & GPS

I. INTRODUCTION

Global Positioning System (GPS) is a space based satellite navigation system that provides location & time information in all weather conditions anywhere on or near the earth where there is an unobstructed line Of sight (LOS) to four or more GPS satellites. Initially GPS was launched with 24 satellites [1], with its control with US Department of Defence (DOD). A GPS receiver calculates its position by [precisely timing the signals sent by GPS satellite high above the earth. Each satellite constantly sends message that contains:

1. The time at which the message was transmitted
2. Satellite position at the time of message transmission

There are three segments to be considered in functioning of GPS. These are] 2]:

1. **User Segment** : It refers to the GPS message receiving device which is present with the receiver
2. **Space Segment** : It refers to the functionality which is supported at the satellite end
3. **Control Segment**: it refers to the functionality been performed by the stations on the earth which are acting as an interface for communication between the satellite

There are numerous applications of GPS existing at present. The paper provides the enlisting of some of them. The rest of the paper constitutes in Section 2 Some of the factors affecting eh accuracy of GPS, followed by Positioning of GPS in section 3, then the Signal propagation and lastly a brief description of some of GPS applications followed by Conclusion

II. FACTORS AFFECTING GPS

There is a complete interface of layers existing on between the satellite and the user's GPS

¹ *Department of Computer Science & Engineering Amity University, Haryana, India*

receiving device. Thus their arise a large number of factors that affect the functioning. Some of them as explained in [2] are enlisted as:

1. The type of GPS technique which is employed i.e. autonomous, Differential GPS (DGPS), WAD GPS etc.
2. The existing surrounding environment conditions (Satellite Visibility & multipath)
3. The number of satellites in the view
4. The geometry of satellite
5. The conditions of ionosphere persisting
6. The quality of underlying GPS receiver
7. The Distance from the reference receiver

All these factors have to be taken into consideration since these affect the functionality of GPS to a great extent [3]

III. PRECISION & ACCURACY

Precision is defined as the closeness to the mean of observation

Accuracy is defined as closeness to truth Accuracy is measured in terms of 2DRMS i.e.

2DRMS = $2 \cdot \sqrt{sp^2 + sly^2}$

Sp: Standard deviation of latitude

Sly: Standard deviation off longitude

There is 95-98% probability that the position will be within the stated 2D accuracy

Circular Error Probable (CEP) = $0.59(spas)$

CEP is the radius of the circle that will contain approximately 59% of horizontal position measurement reported by the GPS receiver.

The CEP precision for each method will depend upon the quality of GPS

Autonomous < 10m

WAD-GPS: 0.2-3m

RTK: 0.05-0.5m

/Post processed: 0.02-0.25

There can various sources of obstructions for the GPS signals which will result in affecting its accuracy and precision. Some of them are trees, Tall Buildings, fences, cables. The corresponding effect which they have is:

1. Reduced number of satellites seen
2. Reduces strength of Satellite Geometry
3. Satellite Signal Multipath
4. Corruption of GPS measurement

Other Sources of errors are:

1. Signal delay by ionosphere
2. Signal delay by Troposphere
3. Receiver Noise
4. Orbit Error

IV. SIGNAL PROPAGATION

The GPS signal is propping aged as follows:

1. Signal triggered with time from satellite clock is sent By the satellite
2. About 66 ms later(22000 km) later the signal arrives at the receiver
3. Time at which the signal is received is given by the receiver clock. The difference between the transit and the receive time is called the pseudo range
4. The Signal passes through eh ionosphere(10-100m delay) and atmosphere(2.3-3.0 delay)
5. To determine the accurate position from the range data, need to account for all those propagation effect and time offset

V. APPLICATIONS [4]

There are various applications of GPS, since GPS is used for navigation and shrivelling, it is required in many domains. Ranging from, GEODETIC [5], GEODYNAMICS[6], POWER SYSTEM[7]. Some other applications of GPS are explained as follows :

1. Agriculture

The combination of GPS and GIS has given rise to the site specific farming an approach to precision agriculture. GPS based applications in precision farming are used for: Farm Planning Field mapping Soil Sampling Tractor Guidance Tractor scouting Yield mapping it also helps farmers to work in bad weather conditions such as rain dust fog and darkness when visibility is quiet low. With the help of Precision agriculture, gather the Geographic information regarding the Plant-Animal-Soil requirements before hand and then applying the relevant treatment in order to increase the productivity.

The collaboration of GPS and GIS with better quality of fertilizers and other soli enhancements, weeds, pesticides can help a farmer greatly in protecting the natural resources in a long run. The location information is collected by GPS receiver for mapping field boundaries, roads, irrigation systems, and problem areas in crops such s weeds and disease.

2. Aviation

GPS is used in aviation throughout the world in order to increase the safety and efficiency of flights. Space-based position and navigation enables three-dimensional position determination for all phases of flight from departure, en route, and arrival, to airport surface navigation.

The role of GPS in Aviation is :

- Area Navigation allows aircraft to fly user preferred routes from way point to waypoint where waypoint does not depend upon the ground infrastructure
- New & Efficient Air routes made possible by GPS are continuing to expand
- Improved approaches to airports, which significantly increase operational benefits and safety, are now being implemented even at remote locations
- Potential decommissioning and reduction of expensive ground based navigation facilities, systems, and services
- Reduced aircraft delays due to increased capacity made possible through reduced separation minimums and more efficient air traffic management, particularly during inclement

weather.

3. **Environments**

In order to sustain earth's environment with the human's needs, there is a need for better decision making in association with more updated information. Such decisions are supposed to be taken by Government & Private Organisations but both of them are facing the biggest challenge of gathering accurate & timely information. GPS is the tool which helps greatly in this situation.

Some of the benefits which are provided by GPS to Environment are :

- In order to provide a comprehensive analysis of environmental concerns, GPS data collection system are complimented with GPS packages
- GPS/GIS data collection system efficiently recognize Environmental patterns and trends
There is no need for digitizing the fields data transcription, it can be analyzed quickly without this preliminary requirement
- Environmental Disasters such as fires and oil spills can be more accurately tracked.
- Precise positional data from GPS can assist scientists in crustal and seismic monitoring.
- Monitoring and preservation of endangered species can be facilitated through GPS tracking and mapping.

4. **Marine [8]**

In the case of Maine's search and rescue operations GPS has provided a great support. GPS provides the fastest and most accurate method for mariners to navigate, measure speed, and determine location. This enables increased levels of safety and efficiency for mariners worldwide.

Some of the benefits of GPS in Marine are :

- Allows access to fast and accurate position, course, and speed information, saving navigators time and fuel through more efficient traffic routing.
- Boaters get precise navigation information.

Improves precision and efficiency of buoy positioning, sweeping, and dredging operations.

For container management in port facilities, enhancement in efficiency and economy is achieved

Increases safety and security for vessels using the AIS

5. **Public Safety & Disaster Relief**

GPS serve as a technique in disaster management & rescue operations, since in such real time situations, time is the critical component. In order to save lives and reduce loss of property the need is to know about the relevant information by time, knowing the precise location of landmarks, streets, buildings, emergency service resources, and disaster relief sites reduces the effect. GPS has proven to be of great importance at the time of Tsunami, Katrina and Rita that were havoc in the parts of the world. The rescue team with the collaboration of GPS, GIS and remote sensing gave rise to the rescue operations by correctly locating the site and other relevant information's.

6. Surveying [9]

GPS is widely used in surveying and by map keepers. Telephone lines, fire hydrants, sewer lines and many such can easily be mapped by using GPS. The images of various sites can be taken very easily and fast by using GPS technology

7. Mobile Phones

GPS proved to be a very efficient feature in Smart phones. GPS is not only used for navigation purposes but also for many other applications in phone which are dependent on GPS. GPS also provides the service providers in improving their efficiency and quality of service as it can give the feedback as to what signal strength is available.

8. Robotics

Robotics field has been benefitted greatly by GPS as it helps the robots in navigation and performing various tasks

9. Military purpose

Initially developed for the help of military, GPS has covered almost all the areas and applications. Apart from navigation purposes in military, GPS helps in other fields like in tracking the target using Drone technology. It is also used for the guidance of missiles and projectiles

Some other benefits of GPS in this domain are : [10]

- Provide positional information to individuals having mobile devices in the case of emergency
- Flood Prediction Capabilities are enhanced along with the monitoring of Seismic precursors
- GPS also helps the meteorologist in storm tracking and flood predictions
- Helps scientists in anticipating earthquakes

To contain and manage forest fires, aircraft combine GPS with infrared scanners to identify fire boundaries and "hot spots."

VI. CONCLUSION

GPS is a very important tool for navigation and tracking purposes. Its popularity has increased drastically and covered almost all the domains. This paper explains about GPS and its components. It also discusses about Accuracy and Precision which are the two major factors affecting the performance of GPS. Lastly the applications of GPS are explained in a detailed manner.

REFERENCES

- [1] Branford, W Parkinson, & Spliker, "Global Positioning System : Theory and Applications, Volume 1, American Society of Aeronautics, 1996
- [2] Gobi S. "Introduction to GPS: Principles and Applications", Tata McGraw Hill Publishing Company Limited, New Delhi
- [3] A E Rabbery, "Introduction to GPS: The Global Positioning System", Artech Publishers, 2006
- [4] P Singal & R S Chiller, "A review on GPS & its applications in computer science", International Journal of Computer Science and Mobile Computing, Vol 3, Issue 5, 2014

-
- [5] Thomas A. Herring, Geodetic Applications of GPS, Vol. 87, No. 1, January 1999
 - [6] H. Yavasoglu', E. Tari', M. Sahin', H. Karaman', T. Erden', S. Bilgi], S. Erdogan', Applications of Global Positioning System (GPS) in Geodynamics: With Three Examples From Turkey, Afyon Kocatepe University Department of Geodesy and Photogrammetry.2005
 - [7] Philip Moore and Peter Crossley, GPS applications in power systems, POWER ENGINEERING JOURNAL FEBRUARY 1999 33
 - [8] Henry, Saravanan & Kulathuran, "Applications of GPS in Fisheries and Marine Studies", International Journal of Advance Research in Computer Science , Vol 2, No 6, 2011
 - [9] Kundu & Chandana, "Remote Sensing and GPS" , Tapati Publisher , 9/4 Tamar Lane, Kolkatta, 2014
 - [10] P Verma & J H Bhatia, "Design & Development of GPS and GSM based Tracking system with Google based monitoring" in International journal in CComputer Science Engineering and applications, vol 3, no 3, 2013