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Basic Concept of GPS and Its Applications

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Abstract: *GPS provides continuous positioning and timing information, anywhere in the world under any weather conditions. Under the US Department of defence, GPS was originally intended for military applications but in the 1980s, they made the system available for civilian use. The scientific uses of GPS is increasing day by day in the field of Military, civil and commercial user.GPS boosts productivity across a wide swath of the economy, to include farming, construction, mining, surveying, package delivery, and logistical supply chain management. Major communications networks, navigation, banking systems, financial markets, and power grids depend heavily on GPS for precise time synchronization. Some wireless services cannot operate without it.*
Keywords: *GPS, Navigation, Time Synchronization, Scientific uses,*

I. Introduction

The GPS concept is based on time. The satellites carry very stable atomic clocks that are synchronized to each other and ground clocks. Any drift from true time maintained on the ground is corrected daily. Likewise, the satellite locations are monitored precisely. GPS receivers have clocks as well however, they are not synchronized with true time, and areless stable.GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities (Three position co-ordinates and clock deviation from satellite time). GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time.

Objectives

The study has been initiated to fulfil the following objectives-

- To analyze the basic concept of GPS.
- To analyze the various applications of GPS.

II. Methodology

The paper is descriptive type and mainly based on secondary data, which has been collected from Books, article in journals, innumerable newspapers and different website.

Review Of Related Literature

Review out published literatures have been examined related to our study-

1.Singal.P. & Chhillar.R.S.(2014) conducted a research study on the various applications of GPS in computer science like wireless video processing & monitoring using mobile, location of automobile in fisheries, marine studies.

2. Verma. P. & Bhatia. J.S. (2013) conducted a research paper and found that the system is about making vehicle more secure by the use of GPS Technology and web application.

3. Hwang.S. & Yu. D. (2012) conducted a research study and found that location awareness and navigation are becoming one of the most important features in mobile phone and smart phone. Personal navigation and location are enlarging the scope of mobile phones.

4. Duncan. M. J., Bandland. H. M. &Mummery. W. K. (2008) conducted a research paper that find out the utility of the global positioning system in the study of health- related physical activity.

Need For The Study:

GPS is a modern technology. The importance of GPS in our daily life is undeniable. This is due to the fact that in today's dynamic world, the applications of GPS rapidly increases. It has a major goal of making tasks easier to execute as well as solving many humankind's problems. It is very importance in the field, like, Health, Crime, Transportation & Communication and the applications of it has been increased. As GPS

continues to advance and direct even more easiness in the field of resources management, there is a need to stress how advantageous it has been to the diverse field of research and development.

Basic Concept Of GPS :

The Global Positioning System (GPS) is a space-based navigations system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites.

What is a GPS?

The Global Positioning System (GPS) tells you where you are on Earth.

Simultaneously it can answers five questions:

"Where am I?" Location?

"Where am I going?"

"Where are you?"

"What's the best way to get there? Navigation?

"When will I get there?" Time?

GPS is "space based satellite navigation system" that can show your exact position on or near the Earth surface, anytime, anywhere, in any weather condition, no matter where you are !The GPS system provides critical capabilities to military, civil and commercial users around the world. The GPS technology has tremendous amount of applications in GIS & Remote Sensing data collection, surveying and mapping. The technology seems to be beneficiary to the GPS user community in terms of obtaining accurate data up to about 100 m for navigation, metre-level for mapping and down to millimetre level for geodetic positing. In simple words it can be said that if one has a small GPS receiver, he can get his position anywhere in the land, sea, air, desert or forest in terms of any co-ordinate system.

Development of GPS :

Like so many other high-tech developments, GPS is maintained by the United States government and is freely accessible to anyone with a GPS receiver. 1973-Decision to development a satellite navigation system for military, 1974-1979 conducted system tests US air force and navy, 1977- first receiver test was conducted without placing the satellite in the orbit. Signal received from pseudo- satellites. The concept started in the late '60s but the first satellite was launched in February 1978. 1978-85 a total of 11 Block I satellites were launched. 1979 Decision to expand GPS with 18 satellites in space. 1980-1982 Financial Crisis occurs when the sponsors questioned the usefulness of the system. 1983- Civilian use of GPS was allowed after soviet union shot down Korean airplane that get lost over soviet territory. 1986-GPS Programme suffered a setback due to the accident of challenger, which was supposed to carry block II satellites to the orbit. Then delta rockets were used for the purpose. 1988- Numbers of satellites were increased to 24. 1989-First Block II satellites were installed and activated and The Magellan Corp. introduced the first hand-held GPS receiver. 1990-1991 Temporal deactivation of SA during Gulf War. In 1992 GPS was used in "Operation Desert Storm 1993- Initial operation capability (IOC) was announced and decided worldwide civilian use free of cost. 1994-Last block II satellites complete the satellite constellation. 1995-Full operational capability was announced. On March 1996, the President decided to make GPS free for civilian users. 2000- Final deactivation of SA to give positional accuracy of 20m from 100m.2005- Launching of the II RM GPS satellite that supports the new military M signal and the second civil signal L2C. GPS project was developed in 1973, to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. The current system became operational on June 26, 1993 when the 24th satellite was launched. Bradford Parkinson, Roger L. Easton, and Ivan A. getting are credited for inventing the GPS.

Different Navigation Systems :

Other satellite navigation systems in use or various states of developments are:

NAVSTAR - Navigation Satellite Timing & Ranging GPS, United States' global navigation system. Fully operational worldwide.

GLONASS - Global Navigation Satellite System, Russia's global navigation system. Fully operational worldwide.

GALILEO - On the name of famous Space Scientist GALILEO, A global system being developed by the European Union and other partner countries, planned to be fully deployed by 2019.

BEIDOU - People's Republic of China's regional system, currently limited to Asia and the West Pacific.

COMPASS - People's Republic of China's global system, planned to be operational by 2020

IRNSS - Indian Regional Navigation Satellite System, India's regional navigation system, covering India and Northern Indian Ocean.
QZSS - Japanese regional system covering Asia and Oceania

System Description :
GPS Technology and its application can be conceived by understanding the three components of GPS. Its three components are:
A. THE SPACE SEGMENT: Consists of satellites and transmitted signals.
B. THE CONTROL SEGMENT: Consists of ground stations (located around the world) that make sure the satellites are working properly.
C. THE USER SEGMENT: Consists of receivers, which you can hold in your hand or mount in your car.

The Space Segment :
The Space Segment of the system consists of the GPS satellites. These space vehicles (SVs) send radio signals from space. The Space Segments - consists of the group of minimum 24 Satellites & the signals -that are broadcast by them, which allow user to determine position velocity & time. The basic functions of satellites are - To receive & store data uploaded by Control Segment. Maintain accurate time by means of on board ATOMIC CLOCKS & Transmit information & signals to users on TWO L- band frequencies. Out of 52 constellation of GPS Satellites, the 11 were launched as a experimental satellite in Feb 1978 under so-called `Block 1`Phase, `Block 2` & `Block 2 A` were launched from 1989 onwards. Full operational capability was declared on 17 July in 1995. Currently 12 of these satellites are re-designed as the part of `GPS Modernisation Programme.

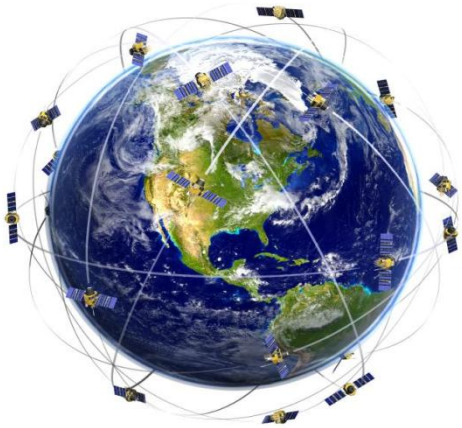

Fig: Space Segment

The Special Features Of The Space Segment :
The Operational GPS Constellation consists of minimum 24 satellites, each in its own orbit, approximately about 20,200 km. above the Earth, in 12 hours (nearly 11hrs 58 min). There are often more than 24 operational satellites as new ones are launched to replace older satellites. The satellite orbits repeat almost the same ground track (as the earth turns beneath them) once each day. The orbit altitude is such that the satellites repeat the same track and configuration over any point approximately each 24 hours (4 minutes earlier each day). There are six orbital planes (with nominally four SVs in each), equally spaced (60 degrees apart), and inclined at about fifty- five degrees with respect to the equatorial plane. At any time of the day as many as 12 Satellites are visible above an observer's horizon, but all of them are not above 15 degree signals. This constellation provides the user with between five and eight SVs visible from any point on the earth. Minimum 4 GPS satellites are needed for determination of ground location with the GPS Receiver. PDOP is defined as Positional Dilution of Precision & that value should be less than 6. This factor is a measure of the quality of satellite receiver geometry.

The Control Segment :
Control Segments formerly consists of 5 tracking stations situated at Hawaii, Ascension Island, Diego Garcia, Kwajalein & the Master Control facility is located at Schriever Air force Base(Formerly Falcon AFB) in Colorado Springs. Newly added control stations after 2005 are Washington DC England, Ecuador, Argentina, Bahrain and Australia. These Monitor stations measure signals from the SVs, which are incorporated into orbital models for each satellites. Master stations collect the data about the satellites of this system continuously from the other tracking stations. MCS process the tracking data for computation of satellite ephemerides (or co-

ordinate) & satellite clock parameters. The Master control station uploads ephemeris and clock data to the SVs. The SVs then send subsets of the orbital ephemeris data to GPS receivers over radio signals. The MCS also monitor the position of satellites at any instant of time, the functional capacity of the satellites & variation of the navigation data. The computation of satellite's Ephemeris & Clock errors are most important tasks of control stations, as both variables are important to get high accuracy.

Global Positioning System (GPS) Master Control and Monitor Station Network

The User Segment :

The GPS user segment consists of the GPS receivers and the user community. GPS receivers convert SV signals into position, velocity and time estimates. Four satellites are required to compute the four dimensions of X, Y, Z (Position) and Time. GPS receivers are used for navigation, positioning, time dissemination and other research. Navigation in three dimensions is the primary function of GPS. Navigation receivers are made for aircraft, ships, and ground vehicles and for hand carrying by individuals. Precise positioning is possible using GPS receivers at reference locations providing corrections and relative positioning, geodetic control and plate tectonic studies are example. Time and frequency dissemination, based on the precise clocks on board the SVs and controlled by the monitor stations, is another use for GPS, Astronomical observatories, telecommunications facilities, and laboratory standards can be set to precise time signals or controlled to accurate frequencies by special purpose GPS receivers. Research projects have used GPS signals to measure atmospheric parameters.

Applications Of GPS :

The United States government created the system, maintains it and makes it freely accessible to anyone with a GPS receiver.The global positioning system provides critical capabilities to military, civil and commercial users around the world.

A. ROAD TRAFFIC CONGESTION : A navigation device has a GPRS receiver for receiving real time information about or slow average speed on a stretch of motorway, indicating congestion. The device calculates a new itinerary to avoid the congestion, based on historically record speeds on secondary roads weighed by the current average speed in the congestion area.

B. TECTONICS : GPS enables direct fault motion measurement of earthquake between earthquake GPS can be used to measure crustal motion and deformation to estimate seismic strain build up for creating seismic hazard maps

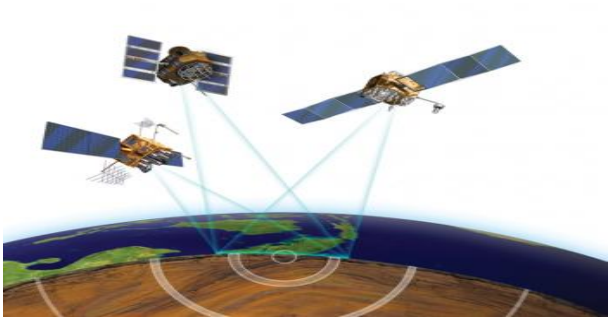

Fig: Geoscientists use GPS to make precise measurements of position And ground motion

C. GPS AND TERRORISM : GPS is very important to determine the location of terrorist attacker's. For example, on the Gurudaspur strike, Indian intelligence agencies had determined that the GPS sets used by the terrorist were first turned on in Sargodha a home to Pakistan's largest airbase-on July 21, 2015, six days before the attack. The set were then programmed with digital waypoints, which led the attackers the border to their targets in Punjab. (The Indian Express, October 27, 2015)

D. GPS OF MINING : The use of RTK GPS has significantly improved several mining operations such as drilling, shovelling, vehicle tracking and surveying, RTK GPS provides centimetre-level positioning accuracy.

E. GPS AND TOURS : Location determines what content to display, for instance, information about an approaching point of interest.

F. NAVIGATION : Navigators value digitally precise velocity and orientation measurements. With the help of GPS roads or paths available, traffic congestion and alternative routes, roads or paths that might be taken to get to the destination. If some roads are busy (now or historically) the best route to take, The location of food, banks, hotels, fuel, airports or other places of interests, the shortest route between the two locations, the different options to drive on highway or back roads.

G. DISASTER RELIEF : Depend upon GPS for location and timing capabilities of earthquake, flood wildfires.

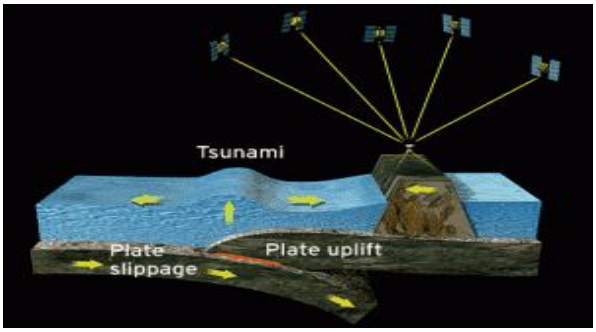

Fig: Warn Japan Earthquake

H. GPS-EQUI RADIO SONDES AND DROPSONDES : Measure and calculate the Atmospheric pressure, wind speed and direction up to 27 km from the earth's surface.

I. FLEET TRACKING : The use of GPS technology to identify, locate and maintain contact reports with one or more fleet vehicles in real time.

Hand Gps

A Taxi Equipped With Gps

J. CELLULAR TELEPHONY : Clock synchronization enables time transfer, which is critical for synchronizing its spreading codes with other base stations to facilitate inter-cell hand off and support hybrid GPS/ cellular position detection for nibble emergency calls and other applications.

K. ROBOTICS : Self-navigation, autonomous robots using GPS sensors, which calculate Latitude, Longitude, Time, speed and heading.
L. SPORT: Used in footballs and rugby for control and analysis of the training load
M. SURVEYING : Surveyors use absolute locations to make maps and determines property boundaries. The surveying and mapping community was one of the first to take advantage of GPS because it dramatically increased productivity and resulted in more accurate and reliable data. Today, GPS is a vital part of surveying and mapping activities around the world.
N. AUTOMATED VEHICLE : With the help of GPS location and routes for cars and trucks to function without a human driver.
O. AGRICULTURE : GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping. GPS allows farmers to work during low visibility field conditions such as rain, dust, fog, and darkness.

Fig: Farming with the help of GPS

P. FISHING AND GPS : Synoptic maps of the main concentrations of fisherman villages, fishing ports and beach landing points, markets, processing, freezing and transhipment points, coastal landforms can be studied with the help of GPS.
Q. OIL LEAK AND GPS : GPS tracking technology is helping with the study by examining how currents are influence by winds and waves and measuring wind speed to find out how oil would spread from the ocean, onto the beach. Many instruments are being used in the study to gather as much data as possible. After data is collected, researchers plan to use 3D pictures of oil transports and hope to come up with more information about oil spills, how to mitigate their damage, and how to protect the environment.

Fig: In 2010, GPS helped cleanup crews respond to the massive oil leak in the Gulf of Mexico.

R. ASTRONOMY : Both positional and clock synchronization data is used in astrometry and celestial mechanics calculations. It is also used in amateur astronomy using small telescope to professionals observations, for example, which finding extra solar planets.
S. GPS AND FORESTATION : GPS Technology Makes Tree Planting More efficient. Deforestation and disappearing wildlife habitats are a big problem in the modern world. Manufacturing industries use state-of-the-art technologies to produce and sell more paper and wood products, but there is growing concern over the devastation wrought by their methods of obtaining materials. The rate with which large, luscious forests are being cut down. The trees are being removed much more quickly than we can hope to replant, as trees take many years to grow to their full potential. One solution-orientated man is leading team, developing ways to replant forests as quickly and efficiently as possible, using GPS technology.
T. CARTOGRAPHY: Both civilian and military cartographers use GPS extensively.

III. Conclusion

Like the Internet, GPS is an essential element of the global information infrastructure and revolutionary technology that changing and operate in the various field of development. The free, open, and dependable nature of GPS has led to the development of hundreds of applications affecting every aspect of modern life. GPS technology is now in everything from cell phones and wristwatches to bulldozers, shipping containers, and ATM's.

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