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Time Correction Reliability of Satellite Position for Precise Navigation

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Abstract**: *The present work mainly focused on the positional accuracy of Global Position System (GPS). Wherein, the calculations are done on the basis of transit time of each satellite. The individual satellite time is corrected through GPS time with keplerian and time parameters of visible satellites. Different satellites ephemeris data are collected to estimate their transit time for each second. These transit time corrections are done for all visible satellites with reference to ground based GPS receiver, from which the position of satellite is determined. This positional accuracy will be useful for precise navigation.***

Index Terms**: *Precise Navigation, GPS, Time Correction***

I. INTRODUCTION

GPS implies worldwide situating System that has a group of orbiting satellites in space, which can point the accurate area in three measurements like scope, longitude and elevation. GPS also sends the precise and accurate position information that is used to calculate the speed, time and correct location of thing or humans. Advanced mobile phones and autos would now be able to get and unravel GPS in split seconds with great ease. GPS systems are adaptable and can be found in practically any industry area. They can be used for designing the forest map, to help farmers yield their crops and also navigate the vehicles. These are utilized by both civilian and military applications for finding the individuals who needs help. GPS advances are frequently working in numerous zones. GPS each satellite sends signal to the GPS receiver. The GPS tells the distance between the grounds based receiver. and satellite. GPS coordinates are a unique identifier of a precise geographic location on the earth. Navigation is the art of directing a vehicle or a person from one point to another point. As technology advances, radio waves are used for navigation and positioning. Radio waves are generated artificially by transmitters and receivers by radio receivers, using antennas and widely used in mobile radio communication, radar and other navigation systems. Due to matter present in between satellite and the ground base stations the properties of the signal are disturbed by various components.

For deciding the user position, the time must be given as time is variable in earth focused and earth fixed coordinate framework. All of the GPS signals from different satellites are transmitted in a similar time beside the satellite clock blunder. In any case, the majority of the signs connects at the recipient at various occasions as a result of the different pseudo range. The time received is equal to time of transmission and the time of travels. The traverse time is the time of signal arrives at the user from the satellite. In order to measure user's position the receiving time is considered. Once this is chosen as the reference, the transmission time can easily be obtained by subtracting the transit time from receiving time. Since it is therefore transit time is different for different satellites. These

results in the times of transmission for different satellites are approximately equal. Hence difference can be clarified by selecting the time of arrival as the reference. so, that the time of transmission is different. Hence the travels time can be referred as transmission time, which is corrected by considering the transit time denoted by t_c .From the below equation at the travel time, the GPS time can be corrected.

$$t_i = t_{ct} - \Delta t1$$

Ventures of GPS time at time of transmission adjusted by transit time (t_{ct}):

$$t_{ct} = TOW - \text{relative transit time}$$

Calculation of satellite position:

1. Overall time correction ($\Delta t1$):

$$\Delta t1 = df_0 + df_1 (t_{ct} - t_{oc1}) + df_2 (t_{ct} - t_{oc1})^2 + \Delta t_{rc} - T_{GD1} \quad \text{....... (i)}$$

2. The relativistic correction (Δt_{rc}):

$$\Delta t_{rc} = Fe_s \sqrt{a_s} * \sin E1 \quad \text{....... (ii)}$$

3.Eccentricity anomaly(E1):

$$E1 = M1 + e_s * \sin E1 \quad \text{......... (iii)}$$

4.Mean anomaly(M1):

$$M1 = M_0 + n(t_{ct} - t_{oe}) \quad \text{............... (iv)}$$

5. Corrected Mean motion(n1):

$$n1 = \sqrt{\frac{\mu}{a_s^3}} + \Delta n \quad \text{........... (v)}$$

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II. ACQUISITION OF DATA

GPS data formats are six different files in the RINEX format which are provided by the international global navigation satellite system (IGS). These RINEX format gives the raw data of GPS which contain the number of satellites available from each receiver and huge data and health of satellite. The different files are observation file, navigation file, meteorological file, Glonass navigation file, geostationary satellite data file, satellite and receiver clock data file. Each file will have various parameters and these are collected from different points and used for numerous purposes such as tracking, navigating, identifying the location, mapping and timing. Basically, a day data used for accuracy positioning, the parameters are calculated for every 30seconds.The receiver receives the navigation and observation file in the RINEX format transmitted by the GPS satellite.

The Receiver Independent Exchange format (RINEX) is raw data form and it is extracted by python programming. In navigation file, for every two hours the data for all visible satellites throughout the day are same. This file consists of polynomial coefficients of clock corrections (df0, df1, df2), time of epoch (t_{oe}), mean anomaly (M_0), square root of semi major axis (roota), eccentricity (ecc), mean motion (Δn), omega, omega dot, IDOT, IDOC, T_{GD}, SV health and correction for elliptical satellite orbits, etc. There by, the observation file parameters are pseduoranges, Doppler data of L1and L2, carrier phases. This file records contain each second information of satellites which are used for tracking the position. A Novatel GPS station 6 receivers is installed at Indian Meteorological Department (IMD), Machilipatnam. (16^0 12’ N, 81^0 08’ E).The RINEX data is collected for 17 march 2017 for which satellite time correction was done.

III. METHODOLOGY

Satellite position can be corrected by calculating the transit time of visible satellites with references to the receiver. Transit time is estimated from subtracting the time of week and relative transit time .instantaneous time is calculated from difference of transit time and overall time correction. The time and keplerian parameters of all the visible satellites are extracted from the RINEX navigation file. Time parameters are toc(clock parameters sec),df0,df1,df2(polynomial co-efficient for clock correction).keplerian parameters √a(square root of semi major axis),e(eccentricity),M0(mean anomaly with reference time),n(corrected mean motion),Δn(mean motion difference) .for precise positioning ,the parameters are estimated for every second .a program ‘time correction.m’ computes the time correction of all visible satellites. This time information is considered as t_{second}. Instant time is estimated as

$$t_i = t_{second} - toe$$

The GPS receivers on the baseline and also for the receiver position estimation of same satellites are used for the instant time calculation. If the value of t_i is less than 302400 sec of GPS week, the value of t_i is measured as

$$t_i = t_i - 604800$$

and if it is greater than 302400 sec of GPS week, the value of t_i is measured as

$$t_i = t_i + 604800$$

This t_i is used to calculate the position information of the receiver. The variations in “t_i” cause errors in calculating the receiver position on the baseline. This instantaneous time is to be smoothed before the calculation of receiver position.

IV. RESULT AND DISCUSSIONS

GPS data of visible satellites for one day is analyzed for the position of satellite. with reference to the receiver, the transit time of visible satellite is calculated and the overall time correction is also calculated .Time correction of eight different satellites(14,27,24,20,15,29,21,28) for one second, five second and ten second as shown in figure 1,figure 2,and figure 3.

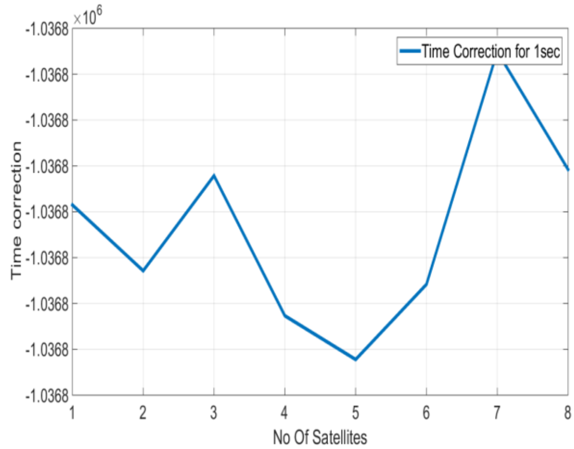

FIGURE1:Time correction for eight different satellite one second data.

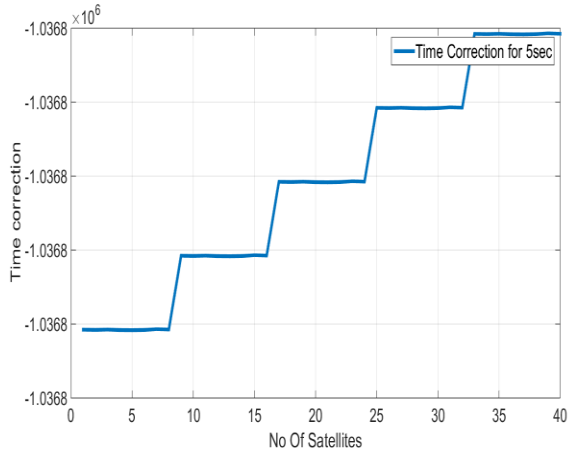

FIGURE2:Time correction for eight different satellite five second data.

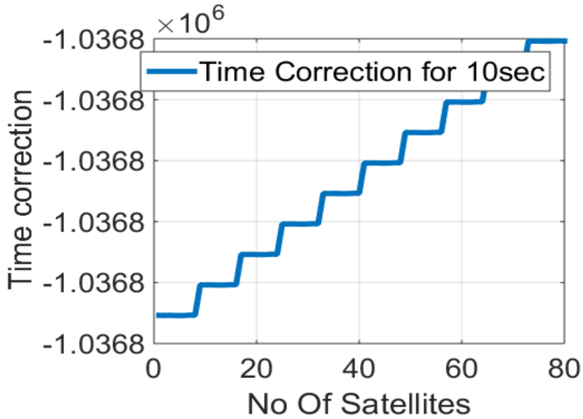

FIGURE3:Time correction for eight different satellite ten second data.

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In GPS data,for every instant of time 8 to 9 satellites are visible.In the calculation of pseudo range if the same transit time is considered for all visible satellites at any instantaneous time may lead to a erroneous position estimation.The present work focuses on satellite time correction leads to different transit time for all visible satellite at any instantaneous time.A nearest approximation of this transit time for calculation of pseudo range will lead to precise positioning in GPS real time application.

V. CONCLUSION

In the present work the transit time of different satellites data with reference to the GPS receiver over a baseline is consider for precise positioning of a receiver .The time correction for eight satellites of one second, five second, ten second data is calculated .The analysis of transit time for each satellite using position of satellite method can correct the time correction for precise navigation. Least mean square, Dilution of precision are the sophisticated signal algorithm for the better precise navigation.

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