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Satellites selection algorithm for NavIC based services in Multi-GNSS Environment

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ABSTRACT:GPS isa standardised and well-established satellite navigation system with a wide range of uses. It is frequency preferred due to its superior performance and speed. The precision of a GPS system, which is restricted by the geometry of visible satellites, is a key issue in PNT service to all dependents. With the introduction of various constellations, research is still underway to integrate different constellations to get appropriate geometry, i.e., Dilution of Precision (DOP).

The DOP values for the receiver located at GPCET (15.790N, 78.070E), Kurnool, India, are investigated using the GPS, GLONASS, Galileo, BeiDuo, and NavIC (Navigation Indian Constellation) constellations. Because it specifies inaccuracy in 3D position and time, GDOP is an instructional parameter. Because of the obscured sky view in metropolitan areas, GPS or NavIC users would be able to pick up higher elevation satellite signals. When the elevation mask angle is 300, this means GDOP by GPS alone is 19.22 and 3.44 by the combined constellations (GPS+NavIC). As a result, combining GPS and NavIC is ideal for obtaining goodgeometry and improving the accuracy of PNT services in and around India.

1. INTRODUCTION

A global navigation satellite system (GNSS) is a constellation of satellites that broadcast time and orbital information for navigation and positioning. The positioning principle is based on resolving a basic geometry issue requiring a user's distances (ranges) from a collection of at least four GNSS satellites with known coordinates. The user's receiver determines these ranges and satellite coordinates using signals and navigation data broadcast by satellites, the resulting user coordinates can be estimated to an accuracy of several metres.

The Global Navigation Satellite System (GNSS) has many more satellites than a single positioning system. The satellite selection algorithm is required in order to reduce the processing burden of receivers (or) to decrease GNSS receiver hardware computation. The geometric dilution of precision (GDOP), which is determined by the positions of available satellites and receivers in a single positioning system and is proportional to positioning accuracy. The association between positional inaccuracy and User Equivalent

Range Error (UERE) was then thoroughly investigated. The GDOP was weighted by each system's UEREs, and the satellite was chosen based on the new weighted GDOP. The algorithm's usefulness was demonstrated by simulation results.

2. METHOD

The GDOP is a significant index that can be used to quantify performance of the GNSS based positioning, and a good structure of satellite sky distribution premise precise positioning. The GDOP of multi-GNSS satellites distributed over the sky can be calculated as given below.

$$\text{GDOP}=\sqrt{(Q_{11}+Q_{22}+Q_{33}+Q_{44})} \quad (2.1)$$

Where Q_{jj} $(j = 1,2,3,4)$ indicates an element of Q = $(H^T H)^{-1}$and, H indicates the coefficient matrix, which is calculated by the satellites azimuth angle α_i and elevation angle β_i (i =1…n) as given below.

Effect of one satellite on the GDOP

As we have seen in previous section the GDOP is being influenced by the satellite constellation configuration parameters and spatial distribution of satellites. Here we discuss the effect of a single satellite on the GDOP. Assume that there are 'm' number of satellites in the field of view is selected for positioning, and the GDOP of 'm' satellites is GDOP_m , then remove a particular satellite (i) and the GDOP of 'm-1' satellites is $GDOP_{m-1}^{i}$, the coefficient matrix of i[th] satellite h_i= $[e_{i1}\ e_{i2} e_{i3}\ 1]$. The relationship between GDOP of 'm' satellites (GDOP_m) and 'm-1' satellites (GDOP_{m-1}^{i}) is deduced as given below,

$$\text{GDO}P_{m-1}^{i2} = \text{GDO}P_m^2 + \text{trace}\frac{Q_m^T h_i^T h_i Q_m}{1-h_i Q_m h_i^T} \quad (2.2)$$

From the above equation, i[th] satellite GDOP contribution ($\Delta GDOP_m^i$) is described as,

$$(\Delta GDOP_m^i)^2 = \text{trace}\frac{Q_m^T h_i^T h_i Q_m}{1-h_i Q_m h_i^T} \quad (2.3)$$

From the above equations it is clear that the smaller $\Delta GDOP_m^i$, the lesser the satellite's contribution.

Hybrid Algorithm for Satellites Selection (HASS):

The important feature of any GNSS satellite selection algorithm is to pick a few satellites from the field of view that must fulfil the requirements of positioning.To reduce the computation time, complexity and deprived of affecting the position accuracy, we propose a hybrid satellites selection algorithm based on optimum satellites selection method and GDOP contribution of individual satellites. This proposed algorithm is mainly intended to use in India and its surroundings in multi-GNSS environment, and steps are as follows:

1. From the multi-GNSS receiver data, consider satellites whose elevation angle (θ) is greater than the cut-off elevation angle (θ^0) and which are healthy according to Carrier to Noise Ratio (CNR), receiver hardware noise and Space Vehicle (SV) health.
2. Execute the optimum satellites selection algorithm for NavIC satellites and select a subset of four satellites with smallest

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GDOP value, if the satellites in view are greater than four.

3. Compute GDOP for remaining satellites of all other constellations (NavIC, GPS, GLONASS, BeiDou, Gallileo), and contribution of each satellite *i.e.*,$\Delta GDOP$.Select a satellite whose $\Delta GDOP$ is small among the remaining satellites and add to the subset.Test the GDOP results of the selected satellites. Ifthe selected satellites GDOP is less than the previous value, the selected subset is finalized. On the other hand, if the selected satellites GDOP is greater than the previous value, exclude that satellite.Repeat the Steps until the desired number of satellites selection.Test the GDOP results of the selected satellites. If the selected satellite's GDOP is in the acceptable range, they will be used for positioning. On the other hand, if the selected satellites GDOP is not in the acceptable range, the desired number of satellites whose $\Delta GDOP$ is large will be used for positioning.

3. RESULTS

Example of a hybrid satellites selection:

Data collected on 1 October 2020 from Multi-GNSS receiver station established at GPCET, Kurnool, India is used as a sample. 42 satellites observed in the sky for NavIC/GPS/GLO/BDS/Galileo systems at the first epoch including seven NavIC satellites, eight GPS satellites, six Galileo satellites, six GLONASS satellites and fifteen BDS satellites. For all the satellites CNR, receiver

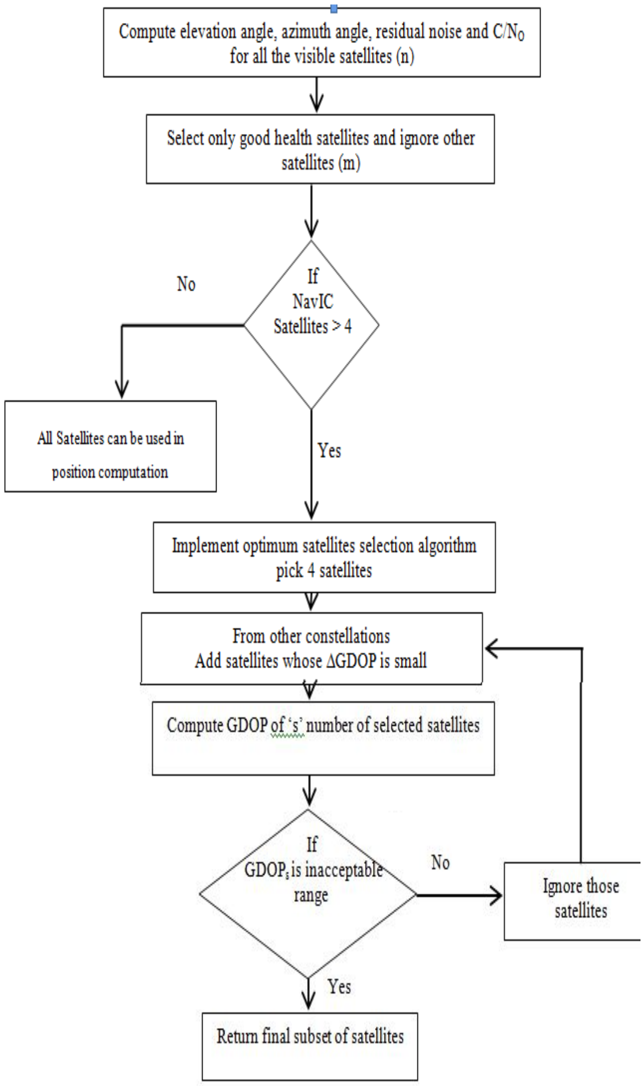

Figure 1: Various Steps of Hybrid satellites selection algorithm

noise and SV health are verified, only healthy satellites are considered and details presented in Table 1.

Step 1: The unhealthy satellites of all the constellations are removed based on the SV Health, receiver noise in CP and elevation masking angle (elevation cut-off = 10^0). There are 32 healthy satellites in the field, which is excess of the number of satellites to be selected *i.e.* eight. The sky plot of all the healthy satellites in view is shown in Figure1.

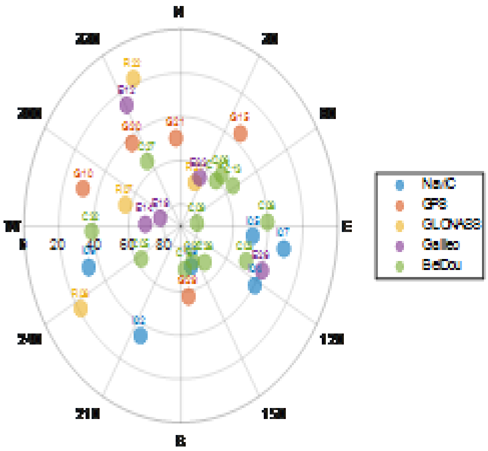

Figure 2 : The skyplot of all the healthy satellites in view.

Step 2: The NavIC has six healthy satellites which are greater than four, so implemented optimum satellites selection method and selected a subset of four satellites I02, I03, I06 and I07 which contribute to the minimum GDOP of 3.4.

Step 3: The GDOP for remaining 28 satellites is 1.66 and contribution of each satellite to the GDOP

Step 4: From the remaining satellites, chosen four satellites such as C06, C08, C09 and C13 which are contributing minimum to the GDOP, added to the subset.

Step 5: The GDOP of eight satellites; I02, I03, I06, I07, C06, C08, C09 and C13 is computed using eqn. (1) and (2), and it is observed as 3.28.

Step 6: The satellite selection results passed the GDOP test, so we can use these eight satellites for positioning. The skyplot of selected satellites is shown in Figure 3.

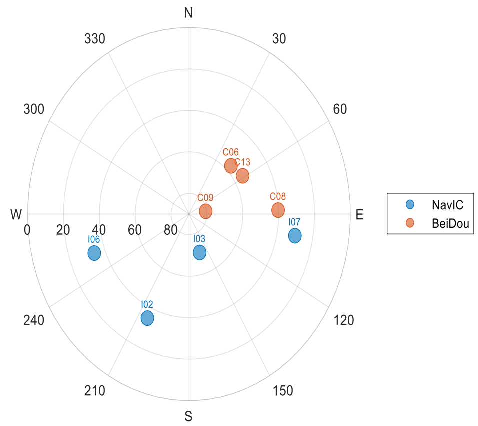

Figure 3: The Hybrid satellites selection model selected eight satellites skyplot.

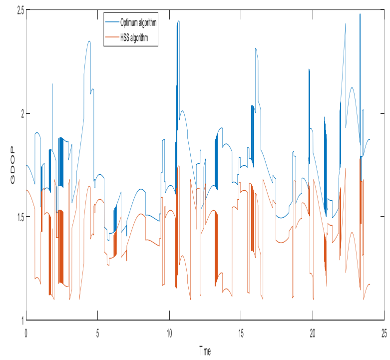

Figure 4 : The GDOP of multiple systems selecting eight satellites by HSS algorithm.

The multi-GNSS data of the GPCET station collected on 2020 was used to compute GDOP of HSS algorithm in multiple systems including eight satellites and then the results compared with optimal satellites selection algorithm. The GDOP of the hybrid satellites selection algorithm and optimal algorithm are shown in Figure 4.

4.CONCLUSION

The data displayed in Figure indicate how a multi-GNSS system with eight satellites was employed for positioning. The GDOP less than 1.5 and the GDOP less than 1.0 if the hybrid satellites selection algorithm is employed to pick satellites. Furthermore, the GDOP ratio of the hybrid satellites selection algorithm to the ideal method is statistically examined, and it is found to be less than 2.

According to the findings, a lower GDOP can be achieved in a multi-GNSS system by utilising a hybrid satellites selection method to select only a few satellites, resulting in increased position accuracy.

5.REFERENCES

[1] R.B.Langley,Dilutionofprecision,GPSWorld10(5)(May.1999)52–59.

[2] H. Sairo, D. Akopian, J. Takala, Weighted dilution of precision as quality measure in satellite positioning, IEEProc.150 (6)(Dec.2003)430–436.

[3] M.R. Mosavi, Applying genetic algorithm to fast and precise selection of GPS satellites,AsianJ. Appl. Sci. 4 (2011)229–237.

[4] E.D. Kaplan, C.J. Hegarty, Understanding GPS: Principles and Applications, second ed.,ArtechHouse, Inc.,Norwood,MA, 2006, p. 48.

[5] Indian Space Research Organization, Indian regional navigation satellite system program. http://isro.gov.in/irnss-programme