#67 Received 01/20/2015

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Weighted Quasi-optimal and Recursive Quasi-optimal Satellite Selection Techniques for GNSS

Abstract:
The interoperability of Global Navigation satellite Systems (GNSS) such as GPS, GLONASS and Galileo in near future will permit access to more number of satellite constellations.The user satellite geometry and the ranging errors under the assumption of uniform, uncorrelated, zero-mean ranging error statistics affect the performance of GNSS. Dilution of Precision (DOP) is the parameter used to measure the effect of satellite geometry on the positional accuracy. Lower the DOP better the positional accuracy.

Among the total number of visible satellites, a subset of satellites should be selected such that it gives near optimal or optimal DOP. In general, more than four satellites are selected as a subset to increase the estimation robustness and to minimize the degradation in the estimation accuracy. The conventional techniques such as highest elevation satellite selection algorithm, Kihara's maximum volume method and four-step satellite selection method impose huge computational load with the increase of satellites being tracked.

Therefore, satellite selection techniques with minimal Floating Point Operations (FLOPs) are required to improve the performance of GNSS systems in real-time. In view of this, two prominent fast satellite selection techniques namely, Quasi-optimal and Recursive quasi-optimal techniques that provides quasi geometries along with conventional techniques are analyzed. In this work, to obtain near-optimal geometries with fast satellite selection techniques, appropriate weight functions are applied.

Two types of Parametric weight functions namely 'satellite elevation angle' and a 'combined form of elevation and Carrier to Noise ratio (CNR) with multipath scaling factor' are used to improve DOP. The multipath scaling factor is calculated using reflection coefficient parameter. The results obtained due to our approach are encouraging.

The techniques with the weight functions are evaluated for GPS constellation data and also for combined GPS and GLONASS constellations data. The GPS data is obtained from the receiver (make: Novatel, model: DL4 plus) located at Research and Training Unit for Navigational Electronics (17.29 N, 78.51 E), Hyderabad and GPS and GLONASS data is obtained from the receiver (make: Leica, model: GRX1200GGPRO) located at National Geophysical Research Institute (17.30 N, 78.55 E), Hyderabad. Two days typical data one corresponds GPS only receiver (30th March 2012) and the other one corresponds to GPS plus GLONASS data (20th April 2012) are used for the analysis. For these days weight functions with quasi-optimal technique did not aid in improvement in DOP. However, significant improvement in the estimation of DOP is noticed when weight functions are used in conjunction with recursive quasi-optimal technique. Using recursive quasi-optimal technique alone maximum Geometric DOP (GDOP) observed for GPS constellation is 28.31, with the proposed two types of weight functions the maximum GDOP is 5.47 and 4.51 respectively.

The minimum GDOP noticed over 24 hours duration is 1.7. Similarly for combined GPS and GLONASS with parametric weight functions, the maximum GDOP noticed is 5.83 and 4.75. The minimum GDOP noticed over 24 hours duration is 1.5. Therefore, from the results it is evident that the proposed parametric weight functions with recursive quasi-optimal technique aid in obtaining near optimal DOP with relatively less processing time.