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Performance Analysis of SBAS Aided GNSS Positioning

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The navigation solution of multi-GNSS can be further improved with help of additional ranging signals from Satellite Based Augmentation systems (SBAS). Apart from ranging, SBAS satellites provide differential corrections and integrity monitoring ability. Several SBAS systems are operational in various parts of the world, such as WAAS (U.S.A), EGNOS (Europe), Beidou (China), MTSAT (Japan) and GAGAN (India) [1]. In the present study the satellite signals of multi-GNSS (GPS, GLONASS and Galileo) along with SBAS satellite signals visible at the GCET station are considered for evaluation of accuracy of the position. The error in the estimated position of GNSS receiver is usually described by terms accuracy and precision. The degree of closeness of an estimate to its true position, which is an unknown value is accuracy and precision is the degree of close of observations to their mean value. To quantify accuracy and precision, 2D-RMS horizontal and vertical error and 3D position error are calculated. The measured accuracy is evaluated instead of formal and predicted accuracy. The standard deviation of position error along x, y and z-axis have to be calculated from the estimates and is given as [2],

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})}{n-1}};\ \sigma_y = \sqrt{\frac{\sum_{i=1}^{n}(y_i-\bar{y})}{n-1}};\ \sigma_z = \sqrt{\frac{\sum_{i=1}^{n}(z_i-\bar{z})}{n-1}}$$

The following relations are used to determine error in 2D and 3D positioning,

$$2D-RMS = \sqrt{{\sigma_x}^2 + {\sigma_y}^2};\ 3D-RMS = \sqrt{{\sigma_x}^2 + {\sigma_y}^2 + {\sigma_z}^2}$$

Multi-frequency GNSS receiver of make Septentrio, Nv (Model: PolaRxs pro) capable of tracking GNSS (GPS, GlONASS, Galileo) and SBAS (WAAS, GAGAN, EGNOS) satellite signals was setup at Geethanjali College of Engineering and Technology (GCET), Hyderabad, India. A typical day data of 9th Oct. 2018 is considered for the analysis. The SBAS satellites available at site include GAGAN, WAAS and MTSAT. L1 SBAS satellites up to maximu six are visible. A maximum 22 and a minimum of 17 satellites are visible over 24 duration in a day. The error in X,Y, Z coordinates are depicted Figure 1.

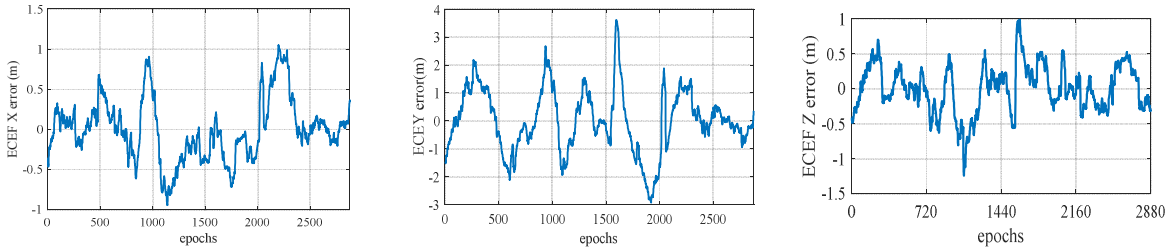

Figure 1. SBAS aided GNSS position error in X, Y and Z cooridmates

The 2D and 3D position error are around 1.25 m. With this accuracy the coordinates of location are derived and are represented in X (1199419.67493542 m), Y (5965113.2901434 m) and Z (1908094.81560625 m).

[1] Richard B. Langley, Peter J.G. Teunissen, and Oliver Montenbruck, "Principles of GNSS", Handbook of GNSS, Springer International Publishing, 2017, pp.3-23.

[2] S. Subirana J, J.M. Juan Zornoza and M. Hernández-Pajares, "GNSS Data Processing: Fundamental and Algorithms", ESA manual Vol.1, May 2013.