A Study on Multi-GNSS Precise Point Positioning from India

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Demand for increasing solution accuracy using satellite-based navigation system resulted in various techniques, methods and algorithm; by late 90s Precise Point Positioning (PPP) technique was developed [1] and since then is being improved through active research. From the user viewpoint, PPP approach uses dual frequency, undifferenced, pseudorange and carrier phase observations with precise satellite ephemeris and clock products instead of broadcast satellite and clock products. The method is expected to provide centimeter level precision in static or kinematic operation [2]. PPP implementation include Real-time solution, Post Processed solution and PPP positioning services provided by various public and commercial agencies [2]. Because of the accuracy capabilities, PPP is used extensively by GNSS users and researchers for high precision applications. Many users use online PPP position services those accepts appropriate RINEX data from the user sent through email or online utilities and utilizes International GNSS Service (IGS) data products [3] generated from a network of global reference stations, implement PPP and send back the results to the user. Because of ease, cost-effectiveness and reliability, such online PPP services are used by users and researchers. Although GPS PPP was implemented first, subsequently GLONASS and GPS+GLONASS PPP implementation was initiated subsequently [2]. It is interesting to study the PPP solution provided by different constellations or combinations. The discussion would be useful during GNSS precise positioning applications or during setting up of GNSS base stations for differential positioning.

This paper presents the comparison results of PPP solutions obtained through GPS, GLONASS and GPS+GLONASS hybrid constellation observations. The data are collected using a Javad DELTA G3T geodetic receiver and a GryAnt G3T antenna over 24 hours each for consecutive 7 days from GNSS Laboratory, The University of Burdwan, INDIA (GLB) and processed through CSRS-PPP online service (NRCAN) provided by Natural Resource, Canada [4]. The deviations (95%) of the Earth Centered Earth-Fixed (ECEF) coordinates obtained from NRCAN are shown in Table 1. Observation of the results reveals that, in horizontal coordinate, consistent sub centimeter accuracy may be achieved using PPP in GPS+GLONASS, GPS and in most cases for GLONASS operation in order of decreasing accuracies. However, GLONASS results show slightly higher variation than the GPS cases. PPP provides centimeter level vertical accuracy, and again GPS+GLONASS hybrid data provides slightly better results in comparison to the single-constellation operations. The results would be useful in understanding the advantages of online PPP services for research and applications.

Table 1: Comparison of deviation (95%) of ECEF coordinates obtained using NRCAN online PPP service

Coordinate	X (m)			Y (m)			Z (m)		
Date	GPS	GLO	GPS+GLO	GPS	GLO	GPS+GLO	GPS	GLO	GPS+GLO
17/12/2019	0.004	0.009	0.004	0.007	0.013	0.007	0.015	0.033	0.015
18/12/2019	0.003	0.004	0.003	0.009	0.008	0.006	0.013	0.019	0.010
19/12/2019	0.003	0.005	0.003	0.008	0.009	0.006	0.014	0.021	0.011
20/12/2019	0.003	0.004	0.002	0.008	0.008	0.005	0.013	0.018	0.010
21/12/2019	0.003	0.004	0.002	0.009	0.008	0.005	0.013	0.016	0.010
22/12/2019	0.003	0.004	0.002	0.008	0.008	0.005	0.013	0.017	0.010
23/12/2019	0.003	0.004	0.002	0.008	0.007	0.005	0.012	0.017	0.010

References

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