Advanced Science and Technology Letters
Vol.62 (Sensor 2014), pp.83-86
http://dx.doi.org/10.14257/astl.2014.62.21

Assessment of Positioning Accuracy by GNSS Ephemeris

Joon Kyu Park[1], Kap Yong Jung[2*]

[1] Dept. of Civil Engineering, Seoil University,
28, Yongmasan-ro 90-gil, Jungnang-gu, Seoul, Korea
jkpark@seoil.ac.kr

[2] Dept. of Civil Engineering, Graduate School, Chungnam National University
99 Daehak-ro, Yuseong-gu, Daejeon, Korea
jungjusa@hanmail.net

Abstract. This study is for the analysis of influences of ephemeris on GNSS positioning, and influences of the ephemeris were investigated by executing the relative positioning with CORS data observed in South Korea. Results of applications of ultra-rapid ephemeris, rapid ephemeris and precise ephemeris were shown to be differ from the standard data for less than 1.4cm. Through this study, it was possible to evaluate the influences of ephemeris on the relative positioning and also, the study suggests of the possibility of the applicability of ultra-rapid and rapid ephemeris.

Keywords: GNSS, Ephemeris, Relative positioning

1 Introduction

As for GNSS positioning, there could be various error factors including errors in orbits of satellites and visibility errors of a receptor and/or a satellite as well as errors caused by an ionosphere and convection zone[1]. Especially, the distance between a GNSS satellite and a receptor is calculated with a position data of a satellite, which is the ephemeris of a satellite, so as ephemeris is inaccurate, positioning accuracy and preciseness on the ground would be lowered as well[2][3]. GNSS ephemeris transmits ephemeris, which is a anticipated by the master control station, Florida, U.S., which is also known as broad cast, in a form of a navigation message to users[4]. At the time of writing in 2013, this broadcast is deemed to have an error of about 1m[5]. Therefore, it would be challenging to obtain the precise baseline vector if it is measured with the broad cast.

To cope with such issues, there has been an international joint study on the calculation of precise ephemeris of GPA satellites, and as one of such efforts, the IGS(International GNSS Service, which is participated by about 360 observatories throughout the world, was established in January 1994 and has calculated and supplied of the precise ephemeris of GNSS satellites ever since[6][7][8].

Even though the application of the broadcast onto the GNSS positioning has the lower preciseness than of precise ephemeris, still it could be faster and simpler[9]. For the application

* Corresponding author.

ISSN: 2287-1233 ASTL

of precise ephemeris, you may have to wait up to 18 days. Therefore, users have been in charge of determining the type of ephemeris to be used for the process of GNSS data and these decisions are usually made based on the required level of preciseness, urgency, and the length of the baseline to be measured. Despite of such circumstances, ultra-rapid and rapid ephemeris provided by the IGS can be applied in real-time or within up to 2 days, much shorter than of precise ephemeris, as shown in Table 1. Moreover, their accuracy level is outstanding[10]. Therefore, in this study, the results of positioning were evaluated per ephemeris with data of the CORS(Continuously Operating Reference Station) and the influence of GNSS positioning over ephemeris was analyzed to support of a possibility and properness of ultra-rapid and rapid ephemeris on the precise point positioning.

2 Data acquisition and processing

In this study, data from the national geographic information institute and the DGPS satellite center of the ministry of land, transport and maritime affairs was used for analyzing the influence of GNSS positioning over satellite ephemeris. RINEX files form 51 observatories were collected and then, processed with the Bernese S/W.

Data observed from the 18th to 20th of August, 2013 was collected and then, processed by the precise point positioning and the relative positioning. Observed data was processed by the precise point positioning and the relative positioning with Bernese BPE. The relative positioning was employed with SUWN as its standard point and data was processed by classifying into the ultra-rapid, the rapid and the precise ephemeris to evaluate the influence of ephemeris onto positioning. To correct a deviation generated by physical motion of the earth, information on the earth rotation and the polar motion was employed, and as for a delay in the troposphere, Saastamoinen model and Niell Mapping Function were used. Also, only observed data with altitude of 10°or above was produced to minimize the influence of multi-pass. For the antenna satellite-oriented offset compensation, the complete compensation model was used.

3 Results and analysis of data

The relative positioning is a technique which is mainly used for the precise position determination and it requires a number of receptors. to evaluate the influence of ephemeris onto positioning, data observed from the 18th to 20th of August, 2013 was processed by classifying into the ultra-rapid, the rapid and the precise ephemeris. The relative positioning was employed with SUWN as its standard point.

To understand the influence of ephemeris on the relative positioning, the average of results of the relative positioning with the precise ephemeris for three days was set as a standard. Table 1 ~ 3 show the part of deviation according to component.

Table 1. Deviation - Ultra Rapid

No.	CORS	8.18		
		dX(m)	dY(m)	dZ(m)
1	ANHN	0.006	-0.003	0.001
2	ANSG	0.004	-0.001	0.000
3	BOEN	-0.002	0.004	-0.001
4	CHCN	0.007	0.001	-0.002
5	CHEN	0.000	0.007	0.008
⋮	⋮	⋮	⋮	⋮

Table 2. Deviation - Rapid

No.	CORS	8.18		
		dX(m)	dY(m)	dZ(m)
1	ANHN	0.007	-0.004	0.001
2	ANSG	0.003	0.000	0.000
3	BOEN	-0.001	0.003	-0.002
4	CHCN	0.007	0.001	-0.002
5	CHEN	0.003	0.006	0.006
⋮	⋮	⋮	⋮	⋮

Table 1. Deviation - Final

No.	CORS	8.18		
		dX(m)	dY(m)	dZ(m)
1	ANHN	0.007	-0.005	0.000
2	ANSG	0.003	0.000	0.000
3	BOEN	-0.001	0.003	-0.002
4	CHCN	0.008	0.001	-0.002
5	CHEN	0.003	0.006	0.005
⋮	⋮	⋮	⋮	⋮

The relative positioning with the ultra-rapid ephemeris shows a deviation of –1.2cm ~ 1.4cm from the standard, and –1.4cm ~ 1.5cm and -0.8cm ~ 1.4cm for rapid ephemeris and precise ephemeris, respectively. RMSE has the distribution of ±0.001m ~ ±0.004m, and there was no distinctive tendencies upon ephemeris.

In case of the relative positioning, there was up to 1.4cm deviation from the standard, and RMSE was found to be less than ±0.004m in all cases. Since the relative positioning uses a standard point of which a coordinate is known to generate the compensation and apply it to an unknown point, its deviation caused by ephemeris might have been less than the precise point positioning. In other words, it is possible to determine the accurate position with the ultra-rapid ephemeris.

4 Conclusion

This study was aimed to analyze influences of ephemeris on GNSS positioning. With CORS data observed in South Korea, the relative positioning were conducted and influences of the ultra-rapid, the rapid and the precise ephemeris on GNSS positioning were evaluated. In the relative positioning, there was a deviation of up to 1.4 cm from the standard data, and RMSE was shown to be ±0.004m or less in all cases. It was possible to evaluate the influence of ephemeris on the precise point positioning and the relative positioning, and this study suggests that it would be available to employ the ultra-rapid and the rapid ephemeris on the precise position determination.

Acknowledgments. This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science, ICT & Future Planning(NRF-2012R1A1A1004414).

References

1. C. M. Lee, K. D. Park, S. U. Lee, "Comparison of Real-Time lonospheric Delay Correction Models for Single-Frequency GNSS Receivers : Klobuchar Model and NeQuick Model", Korean Journal of Geomatics, Vol. 28, No. 4, (2010), pp.413-420.
2. D. Cooksey, "Understanding the Global Positioning System (GPS)", Montana State University-Bozeman, Montana, (2014), http://www.montana.edu/gps/understd.html (last date accessed: 29 May 2014).
3. J. H. Park, Y.H. Oh, "A Study Design and Performance Improvement of the High-Sensitivity Receiver Architecture Based on Global Navigation Satellite System", The Journal of the Korea Institute of Electronics Engineers, Vol. 54, No. 4, (2008), pp.9-21.
4. S. H. Jo, J. Y. Kang, S. H. Ko, "Requirements Analysis and Need for GNSS Alternative PNT", The 8th Conference on National Defense Technology, 12-13 July, seoul, (2012), pp.386-395.
5. IGS Organization, International GNSS Service, IGS Central Bureau, California, (2014), http://igscb.jpl.nasa.gov (last date accessed: 29 May 2014).
6. R. Ebner, W. E. Featherstone, "How well can online GPS PPP post-processing services be used to establish geodetic survey control networks", Journal of Applied Geodesy, Vol. 2, No. 3, (2008), pp.149-157.
7. J. M. Kang, Y. W. Lee, M. G. Kim, J. K. Park, "Positional Accuracy Analysis of Permanent GPS Sites Using Precise Point Positioning", Korean Journal of Geomatics, Vol. 26, No. 5, (2008), pp.529-536. (in Korean with English abstract).
8. J. Kouba, P. He´roux, "Precise point positioning using IGS orbit and clock products", GPS Solution, Vol. 5, No. 2, (2001), pp.12-28.
9. J. X. Wang, B. H. Iz, C. P. Lu, "Dependency of GPS positioning precision on station location", GPS Solution, Vol. 6, No. 1, (2002), pp.91-95.
10. A. M. Hasan, K. Samsudin, A. R. Ramli, "GPS/INS Integration Based on Dynamic ANFIS Network", International Journal of Computer Applications, Vol. 5, NO.3, (2012), pp.1-22.

