Evaluation of an Algorithm to solve Multipath Effect in DGPS/GLONASS

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INTORODUCTION

Differential GPS (DGPS) is a ground-based augmentation system to correct the pseudorange offset errors observed by a user receiver using the correction data produced at a reference station located near the user. GLONASS is the only available world-wide GNSS service other than GPS. Combined GLONASS with DGPS can improve availability compared to DGPS. However, for range correction in DGPS/GLONASS as well as DGPS, the multipath is one of the dominant error sources especially under poor satellite geometry. The positioning accuracy of DGPS/GLONASS is generally lower than that of DGPS-only correction due to a larger GLONASS pseudorange measurement noise even under an open sky. Carrier smoothing technique like Hatch filter can be used in order to mitigate multipath effect [1]. However, it is known that the effect of ionospheric divergence between code and carrier measurements degrades the performance of this method. The amount of the multipath and receiver noise can be estimated by using dual-frequency carrier measurements [2]. This method has no such divergence problem by eliminating ionospheric delay term in estimation process. However, this method assumes that the average of the multipath for a period is zero in order to exclude carrier phase bias. As general conclusion, this method requires long convergence time to achieve good performance. For a short period, the offset in the averaged multipath is involved in the correction. This becomes a problem especially in real-time processing to generate the differential corrections.

The main objective of this paper is to estimate GPS and GLONASS multipath errors using a linear combination (LC) of single-frequency code and dual-frequency carrier phase measurements and to apply them to correct the remaining errors of the range correction of DGPS/GLONASS in order to improve the accuracy. Moreover, we also discuss what averaging strategy is suitable for this multipath correction.

MUTIPATH CORRECTION TECHNIQUE

In order to remove the remaining error in differential positioning due to the multipath, we estimate the mixed multipath and receiver noise with so-called MP1 LC that consists of the single-frequency code and dual-frequency carrier phase measurements. It should be noted that the noise in a carrier phase measurement is much smaller than that of code measurements, so remaining errors in the estimated noise can be considered as only L1 code multipath and receiver noise. However, carrier phase bias still remains in the LC, so the estimated multipath and receiver noise needs to be averaged for a constant epoch during integer ambiguity is constant. Moreover the mean value of them has to be subtracted from the original values in order to exclude the bias. For real-time processing, it is not possible to average the values over the whole period. So a sequential averaging technique is employed to eliminate the constant bias in this study.

RESULTS AND CONSIDERATIONS

Firstly, the noise of GLONASS is slightly larger than that of GPS. This is considered to be due to lower SNR in GLONASS than in GPS. Secondly, it is found that positioning accuracy of both DGPS and DGPS/GLONASS with multipath and receiver noise correction technique is more accurate compared to those without correction even in the short averaging time.

CONCLUSIONS

In this paper, we focused accuracy improvement and application to real-time processing with the multipath and receiver noise correction technique using dual-frequency carrier phase measurements in DGPS/GLONASS. Multipath and receiver noise correction technique by using dual carrier frequency is much useful in DGPS/GLONASS, and also positioning accuracy with DGPS/GLONASS is nearly equal or improved compared to that with DGPS.

REFERENCES

[1] RTCM Special Committee, "RTCM 10402.3 Recommended Standard for Differential GNSS Service," Ver. 2.3, No. 104, August 20, 2001.

[2] Rocken, C., Meertens, C., Stephens, B., Braun, J., Van- Hove, T., Perry, S., Ruud, O., McCallum, M., Richardson, J., "UNAVCO Academic Research Infrastructure Receiver and Antenna Test Report," UNAVCO, Boulder, CO, November 1995.