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Short baseline solution from multi-antenna synchronized GNSS receiver and its applications for high-precision positioning

Wen Chen (1), Danan Dong (1), Miaomiao Cai (1), Feng Zhou (1), Minghua Wang (2), Zhengqi Zheng (1), Chao Yu (1), and Lei Kuang (1)

(1) East China Normal University,Shanghai,China (dndong@cs.ecnu.edu.cn), (2) Tongji University, Shanghai, China

Multi-antenna synchronized GNSS receiver (using the same receiver clock) is a new type of receivers with low cost, high accuracy and broad range of applications. Using this receiver, single difference carrier phase observations are able to eliminate both the satellite and receiver clock errors simultaneously, which are equivalent to classical double difference model. However, current commercial products of this type of receivers still adopt the double differencing algorithm and hence do not take full advantage of the receiver clock synchronizing for better accuracy, efficiency and broader applications. In this study, we develop a single differencing algorithm for this emerging receiver, especially for short baseline solutions. Our results indicate that the single differencing algorithm enhances the resolving accuracy and efficiency, it also widens the applications. In addition, this innovate algorithm is able to observe the ground-based carrier phase wind-up (GPWU) effects clearly for the first time.
Our major research results are summarized as the followings:
(1) A real-time attitude determination algorithm is developed based on single difference carrier phase observations from multi-antenna synchronized GNSS receiver. Comparing with the double differencing algorithm, it has more observations and redundancy. Its solutions show better repeatability and lower correlations among parameters. In this algorithm, we design an ambiguity substitution approach (ASA), which separates the fractional initial phase from the integer parts of single difference ambiguities effectively, thus narrows the searching space of ambiguities and improves the efficiency and correctness of integer ambiguity fixing.
(2) We construct a Multipath Hemispherical Model (MHM) to mitigate the multipath effects. The MHM is applicable not only for static environment but also for dynamic carriers with static multipath environment such as ships and airplanes.
(3) We also propose the Single Antenna Yaw angle Determination (SAYD) method based on the GPWU. Current GNSS yaw angle determination method requires two antennas. Its accuracy depends on the length of the baseline. However, the SAYD method requires only one antenna and its solution accuracy is independent of the baseline length. Hence our proposed new method for the receiver yaw angle determination demonstrates potential advantage in the ultra-short baseline applications.