Improved High-Precision RTK Positioning Through Multipath Reduction and Interference Mitigation

Miguel González-Calvo, Xiaoguang Luo, José Amado Aponte and Bernhard Richter (Switzerland)

Key words: GNSS/GPS; Positioning; Multipath; Interference mitigation; RTK

SUMMARY

Boosted by the rapid development of multi-frequency multi-constellation Global Navigation Satellite Systems (GNSS), both high-precision Real-Time Kinematics (RTK) positioning and Precise Point Positioning (PPP) are more frequently performed under increasingly challenging conditions such as heavy canopy and urban canyons, where the GNSS observables measurement and the navigation messages decoding are severely affected by the multipath propagation phenomenon. The characteristics of this phenomenon are site-specific and cannot be easily modeled, which makes multipath remain a dominant error source in centimeter-level differential positioning. In addition, the increasing amount of ground wireless communication infrastructure results in interference-affected environments, which could significantly degrade both GNSS signal tracking and positioning capabilities. To provide high-quality GNSS measurements and positioning performance in challenging environments, advanced multipath and interference mitigation techniques are considered to be necessary.

In the latest Leica GNSS technology, mitigation techniques for both error sources have been integrated: a novel multipath estimation and correction approach, the possibility to configure digital radio-frequency filters and the usage of High Dynamic Range (HDR) mode. Sophisticated algorithms are used to estimate multipath error and correct it in GNSS observations. In terms of interference mitigation, the so-called HDR mode removes distortions from the spectrum, working efficiently against wide-band and out-of-band interference generators (either intentional ones – jamming –, or interferences generated by normal operation of communication systems) by optimizing the Automatic Gain Control (AGC) to avoid losing GNSS-relevant signal content. Furthermore, programmable digital filters, such as bandpass and notch filters, are introduced to remove near-band and in-band interferences respectively. This paper assesses the benefits of the usage of multipath and interference mitigation techniques to GNSS signal tracking and RTK

positioning. Based on representative data sets, the measurement domain analysis confirms that the new multipath estimation method significantly reduces the code multipath error by up to 60%, particularly in the lower frequency bands L5/E5 and E6/B3. The combined usage of HDR mode and digital filters – both in-band and out-of-band – adapts the power spectral density and allows for an enhanced GNSS signal tracking performance. The position domain analysis focuses on the improvements in availability, accuracy, and reliability of RTK survey scenarios. The results show that, under difficult conditions, applying advanced multipath estimation and interference mitigation techniques considerably improves the RTK fix availability and reduces the presence of large positioning errors caused by incorrect ambiguity fixes.