Improving Multi-GNSS Solutions with 3D Building Model and Tree Information

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Key words: GNSS/GPS; Positioning; multi-GNSS; Urban Positioning; 3DMA; tree information; Ray Tracing; NLOS

SUMMARY

Urban positioning using the Global Navigation Satellite System (GNSS) is important for many applications, for example autonomous driving. The level of performance highly depends on the environment it is used in. In particular, the urban environment presents great challenges, such as obstructions which lead to Non-Line-of-Sight (NLOS) signals and multipath effects to common GNSS receivers. Especially in this regard, the biggest challenge today is that positioning in a densely built-up area, such as inner cities, is much more difficult than in open space. To analyse the influence of urban environment in detail, 3D building models and tree information can be used as an innovative surveying approach.

In this contribution we focus on the development of an algorithm to identify Line-of-sight and NLOS signals as well as the different impacts of buildings and trees on GNSS signals. Therefore, already established 3D-mapping-aided analyses are extended by using tree coordinates as additional information, by which we use a 3D building model of the city of Hanover and Open-Street-Map tree coordinates, the latter being supplemented by own measurements. Different 3D tree representations (e.g. cylinder-dome model and trunk-sphere model) are then developed and compared. For this purpose, a four-hour kinematic multi-GNSS code and phase measurement session with multiple receivers along a repeated trajectory in the urban area of Hanover serves as the data basis. Our algorithm is used to predict which observations are subject to influences from buildings and trees on GNSS signals, resulting in signal interruptions, disturbances, and multipath effects. Detailed GNSS signal analyses to determine repeatability in satellite constellations and carrier-to-noise-density ratio (C/N0) are presented.

Based on previous analyses, we perform an adapted weighting model applied to a multi-GNSS single point positioning algorithm that incorporates the environmental information. For verifying the effectiveness of this model, we compare the performance of this weighting model with already established weighting models (e.g. considering satellite elevation, C/N0 or unity weighting).
