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Testing of a Combined Hatch Filter / RAIM Algorithm for SPP Smartphone Kinematic Positioning in GNSS Harsh Environments

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The release of Android Raw GNSS Measurements API in mid-2016 has enabled the reconstruction of pseudorange, carrier-phase, Doppler and carrier-to-noise density (CN0) observables in low-cost, smart devices. This technical development has opened the door to numerous applications that necessitate increased Position-Velocity-Time (PVT) quality metrics. However, despite the recent advances in the field, deficiencies inherent to smartphones GNSS antenna and chipset, still account for excessive biases in the raw GNSS observables and for severe multipath effects in the satellite signal. RAIM (Receiver Autonomous Integrity Monitoring) techniques is one way to monitor and increase the performance of the PVT solution of a GNSS receiver. It is an augmentation method to detect and eventually reject anomalous (blunders or outliers) measurements and compute protection levels that bound position errors to preset limits.

The implementation of RAIM technique to smartphone GNSS data is very limited and confined only to static positioning scenarios. This study presents the results obtained from the testing of the classic RAIM technique in a series of kinematic positioning trials in urban environment using two cotemporary smartphone devices (i.e., Xiaomi Mi 8 and One Plus Nord2 5G). In order to reconstruct a real use case, the smartphones were mounted on the vehicle dashboard. The reference trajectory was obtained using a tactical grade GNSS/IMU system (NovAtel® PwrPak7, iMAR IMU-FSAS) fixed on the NTUA test vehicle roof-top sensor platform.

At a pre-processing stage the raw GNSS data have undergone through a Hatch filer. This step allows to smooth iteratively the noisy code pseudorange measurements using the precise (but ambiguous) phase carrier measurements. Data analysis includes two processing strategies. We employ the PANG-NAV open-source software released by LabPANG (PArthenope Navigation Group Laboratory) to compute the SPP (Single Point Positioning) solution in two ways. We produce the standard and the RAIM-based SPP solution using different parameter setups. The paper presents quantitative results and comparisons between the two smartphone-based solutions and the reference trajectory, and reveal the potential (benefits and limitations) of using the RAIM technique for smartphone positioning.