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Route Planning for Network RTK – Based Urban Navigation with High Integrity

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High accuracy positioning is an important part in the future applications of the Intelligent Transportation Systems (ITS) such as autonomous driving in urban environments. Global Navigation Satellite System (GNSS) exploiting differential techniques from reference stations namely Real Time Kinematic (RTK), is capable to provide the most precise and accurate absolute solution for a navigation system. Network RTK uses several reference stations to produce corrections which provide the availability of the service in a wider area. Integrity measures such as Protection Level (PL) and Position Error (PE) are parameters that can give an indicator about the quality of the positioning. In urban environments where the surrounding buildings obscure the signals coming from the satellites, the signal coming to the receiver may fall into four different situations: line-of-sight (LOS), non-line-of-sight (NLOS), multipath and blocked. In these areas the number of available signals for positioning decreases and also some of the available signals reach the receiver in multipath or NLOS conditions, which degrade the signal strength as well as inducing respective errors in code and phase observations.

For this contribution a kinematic test was performed in urban environments of city Hannover, mounting RTK receiver on top of a van driving 1 km loop for twelve times. The reference trajectory is calculated by tightly coupling the GNSS data with a high grade IMU data. The GPS/GLONASS RTK corrections are provided by the local service provider (SAPOS). Having a level 2 of details (LoD2) 3D city model, it is possible to use the known ephemerides of the satellites to predict the signal availability for a specific receiver position considering NLOS and multipath situations. This prediction of the satellite visibility, is then used in an Extended Kalman Filter (EKF) to solve the positioning problem. As this solution is based on the predicted visible satellites, it works as a prediction of the positioning. Based on this solution, the Protection Levels (PL) are calculated. The Ray Tracing algorithm also provides us with the code and phase observation errors caused by NLOS and multipath cases. These errors (assuming that they are the main driving errors for deviation in the coordinates domain) are then feed to our positioning algorithm as the observation vector to have an estimate of the position error (PE). On the other hand, the receiver itself provides an estimate of the PL. We calculate the PE by comparing the RTK solution of the receiver and the reference trajectory. Finally, we compare the predicted PL and PE with the real observed PL and PE, considering a horizontal alert limit (HAL) of 10 cm. The results so far, show a partial agreement between the PLs of the predicted and the real data, but there is more space for improvement by considering the C/N_0 degradation of the signals and large multipath or NLOS signals. The route will be selected based on reliable solutions which are evaluated by the percentage of the nominal operation in each round.