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An Approach for High-precision Stand-alone Positioning in a Dynamic Environment

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In this study, an algorithm is developed for precise positioning in dynamic environment utilizing a single geodetic GNSS receiver using carrier phase data. In this method, users should start the measurement on a known point near the project area for a couple of seconds making use of a single dual-frequency geodetic-grade receiver. The technique employs iono-free carrier phase observations with precise products. The equation of the algorithm is given below;

Sm(t(i+1))=SC(ti)+[ΦIF (t(i+1))-ΦIF (ti)]

where, Sm(t(i+1)) is the phase-range between satellites and the receiver, SC(ti) is the initial range computed from the initial known point coordinates and the satellite coordinates and ΦIF is the ionosphere-free phase measurement (in meters). Tropospheric path delays are modelled using the standard tropospheric model.

To accomplish the process, an in-house program was coded and some functions were adopted from Easy-Suite available at http://kom.aau.dk/~borre/easy.

In order to assess the performance of the introduced algorithm in a dynamic environment, a dataset from a kinematic test measurement was used. The data were collected from a kinematic test measurement in Istanbul, Turkey. In the test measurement, a geodetic dual-frequency GNSS receiver, Ashtech Z-Xtreme, was set up on a known point on the shore and a couple of epochs were recorded for initialization. The receiver was then moved to a vessel and data were collected for approximately 2.5 hours and the measurement was finalized on a known point on the shore. While the kinematic measurement on the vessel were carried out, another GNSS receiver was set up on a geodetic point with known coordinates on the shore and data were collected in static mode to calculate the reference trajectory of the vessel using differential technique.

The coordinates of the vessel were calculated for each measurement epoch with the introduced method. With the purpose of obtaining more robust results, all coordinates were calculated once again by inversely, i.e. from the last epoch to the first one. In this way, the estimated coordinates were also controlled. The average of both computed coordinates were used as vessel coordinates and then compared with the known-coordinates those of geodetic receiver epoch by epoch.

The results indicate that the calculated coordinates from the introduced method are consistent with the reference trajectory with an accuracy of about 1 decimeter. In contrast, the findings imply lower accuracy for height components with an accuracy of about 2 decimeters. This accuracy level meets the requirement of many applications including some marine applications, precise hydrographic surveying, dredging, attitude control of ships, buoys and floating platforms, marine geodesy, navigation and oceanography.