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Single-baseline RTK GNSS Positioning for Hydrographic Surveying

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Positioning with GNSS technique can be carried out in two ways, absolute and relative. It has been possible to reach a few meters absolute point positioning accuracies in real time after disabling SA permanently in May 2000. Today, accuracies obtainable from absolute point positioning using code observations are not sufficient for most surveying applications. Thus to meet higher accuracy requirements, differential methods using single or dual frequency geodetic-grade GNSS receivers that measure carrier phase have to be used. However, this method requires time-cost field and office works and if the measurement is not carried out with conventional RTK method, user needs a GNSS data processing software to estimate the coordinates. If RTK is used, at least two or more GNSS receivers are required, one as a reference and the other as a rover. Moreover, the distance between the receivers must not exceed 15-20 km in order to be able to rapidly and reliably resolve the carrier phase ambiguities.

On the other hand, based on the innovations and improvements in satellite geodesy and GNSS modernization studies occurred within the last decade, many new positioning methods and new approaches have been developed. One of them is Network-RTK (or commonly known as CORS) and the other is Single-baseline RTK. These methods are widely used for many surveying applications in many countries. The user of the system can obtain his/her position within a few cm level of accuracy in real-time with only a single GNSS receiver that has Network RTK (CORS) capability. When compared with the conventional differential and RTK methods, this technique has several significant advantages as it is easy to use and it produces accurate, cost-effective and rapid solutions.

In Turkey, establishment of a multi-base RTK network was completed and opened for civilian use in 2009. This network is called CORS-TR and consists of 146 reference stations having about 80-100 km interstation distances. It is possible for a user to determine his/her position with a few cm accuracy in real time in Turkey. Besides, there are some province municipalities in Turkey which have established their own local CORS networks such as Istanbul (with 9 reference stations) and Ankara (with 10 reference stations). There is also a local RTK base station which disseminates real time position corrections for surveyors in Çorum province and is operated by Çorum Municipality. This is the first step of establishing a complete local CORS network in Çorum (the municipality has plans to increase this number and establish a CORS network within a few years). At the time of this study, unfortunately, national CORS-TR stations in Çorum Province were under maintenance and thus we could not receive corrections from our national CORS network. Instead, Çorum Province's local RTK reference station's corrections were used during the study.

The main purpose of this study is to investigate the accuracy performance of the Single-baseline RTK GNSS system operated by Çorum Municipality in marine environment. For this purpose, a kinematic test measurement was carried out at Obruk Dam, Çorum, Turkey. During the test measurement, a small vessel equipped with a dual-frequency geodetic-grade GNSS receiver, Spectra Precision ProMark 500, was used. The coordinates of the vessel were obtained from the Single-baseline RTK system in ITRF datum in real-time with fix solutions. At the same time, the raw kinematic GNSS data were also recorded to the receiver in order to estimate the known coordinates of the vessel with post-processed differential kinematic technique. In this way, GPS data were collected under the same conditions, which allowed precise assessment of the used system. The measurements were carried out along the survey profiles for about 1 hour. During the kinematic test, another receiver was set up on a geodetic point at the shore and data were collected in static mode to calculate the coordinates of the vessel for each epoch. As mentioned above, the vessel coordinates were estimated very accurately by using data collected on shore and vessel by using differential GNSS technique.

The Single-baseline RTK-derived coordinates were compared with those obtained from the post-processing of the GNSS data for each epoch. Computed differences show that the coordinates agree with the relative solutions

at 7 cm and below in position. Some marine applications like precise hydrographic surveying, monitoring silt accretion and erosion in rivers, lakes, estuaries, coastal waters and harbor areas; marine geodynamics; automatic docking; dredging; construction work; attitude control of ships, buoys and floating platforms, require high accuracy better than 0.1 m in position and height. Results obtained from this application show that Single-baseline RTK and/or CORS systems can reliably be utilized for the above mentioned marine applications and some others especially for positioning as a strong alternative to the conventional differential methods.