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Initial Analysis of the Accuracy of Position Determination Using ASG-EUPOS NAVGEO (RTK VRS) Service

1. Introduction

One of the topics that has long been a subject of research is improving GNSS/RTK technique. Noting its great potential (enabling real time positioning to centimeter accuracy), researchers are developing tools to put them to practical use for land survey measurements, precise navigation or machine control systems.

A conventional RTK system consists of a receiver at a known location (reference station), at least one mobile receiver (rover), and a radio link for sending data from the reference station to the rover receiver. Unfortunately, the radio link, playing the communication task, has a few drawbacks. The most important one is the typical short transmission range of low-powered systems caused by obstacles located in the path between a base station and a mobile receiver. Another drawback is signal interference, which can reduce transmission range and cause poor signal quality [3].

Facing all these drawbacks researchers developed systems for mobile Internet access like GSM (GPRS, EDGE or UMTS) which can easily provide a fast and reliable implementation of RTK/DGPS corrections into a GPS rover receiver in the area covered by a mobile phone network [4].

ASG-EUPOS is one of such systems streaming GNSS data over Internet. It was developed as a part of Project EUPOS – European Position Determination System [5] and is a new multifunctional system of precise satellite positioning in Poland [1]. It makes GNSS corrections and raw observations collected at 116 reference stations accessible to the users, what provides precise real time positioning, post-processing and supports navigation in the whole area of Poland. This new system, which is based on reference stations network including EUREF-POL, POLREF and EUVN points, accomplishes ETRF89 reference system [2].

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One of the most accurate real time positioning services provided by ASG-EUPOS is NAVGEO service, which is RTK VRS network solution. It enables streaming of RTCM corrections for applications requiring a high level of accuracy by using the latest mobile communication technologies such as GPRS or UMTS in any area covered by a cell-phone network [6].

2. Methodology of Studies

Noting great potential of RTK technique, authors decided to put NAVGEO service into test as a potential tool for map and geographical databases updating. Testing the performance of this service is based on field experiments and the analysis of both the accuracy and availability of RTK data using mobile wireless transmissions

Thirty test points were situated (permanently fixed) in the area of University of Warmia and Mazury in Olsztyn in various conditions (Fig. 1). All points were determined by static occupation with recording interval set to 5 seconds and 10-degree elevation mask using the latest Topcon HyperPro GPS/GLONASS receivers. All static measurements were conducted in March, when tree canopies were not yet covered by the leaves. For post-processing purposes reference data was obtained from nearby OLSZT permanent station using ASG-EUPOS POZGEO D service.

Fig. 1. Localization of test points

RTK tests were divided into two measurement sessions. The first one was conducted in the beginning of April when the tree canopies were still not covered by the leaves. The second set of measurements (May) was obtained in some areas with obstacles in the form of leaves (points: 4, 8, 10, 13, 14, 17, 20, 26), what did not cause significant deterioration of measurement results. Figure 2 shows two of these points.

Fig. 2. Localization of points 15 and and 13 (open area and covered by tree canopies)

After the field surveys, the raw measurements recorded by all the receivers were processed in the office using TopconTools software. Precise coordinates from post-processing were used to compare with receiver RTK results.

3. Equipment and System Configuration

The GPS equipment used for all experiments was a dual-frequency GPS/GLONASS TOPCON HyperPro receivers. These receivers support RTCM 3.1 data streams. To establish the Internet connection in the controller for RTK technique, cell phone was used. This mobile device worked on Plus mobile network

using GPRS technology. The controller was configured to record all the measurement results in the plane national coordinate system "2000", using Polish geoid model.

4. Field Test Results

All the RTK experiments were conducted in the area of University of Warmia and Mazury. ASG- EUPOS VRS service was used, which enables RTK corrections. After setting all the equipment, establishing the wireless Internet connection, all the points were measured three times each and results with the highest precision were only considered. Unfortunately GLONASS corrections were not delivered due to lack of GLONASS option in the receivers at nearby reference stations. All RTK results were compared to static session results. Figures 3, 4 and tables 1, 2 show coordinate differences between post-processed and RTK results for experiment 1 and experiment 2 respectively.

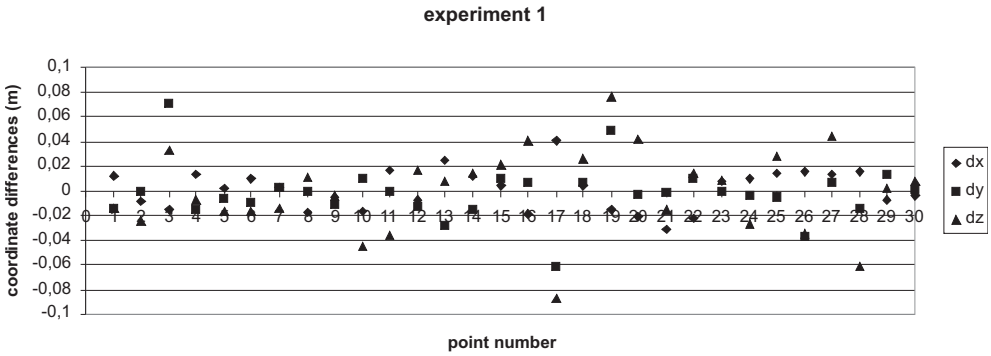

Fig. 3. Coordinate differences for experiment 1

Table 1. Accuracy of experiment 1 results

	dx	*dy*	*dz*
MIN	–0.031	–0.061	–0.087
MAX	0.041	0.070	0.076
AVERAGE	0.001	–0.002	0.000
STDEV	0.016	0.023	0.034

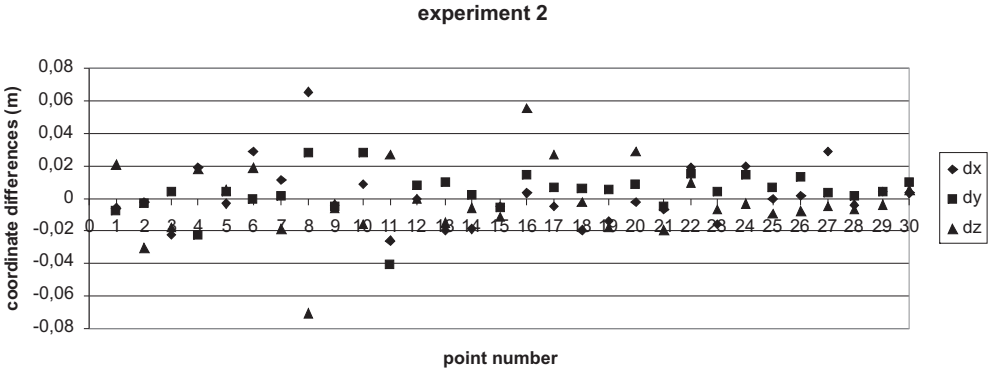

Fig. 4. Coordinate differences for experiment 2

Table 2. Accuracy of experiment 2 results

	dx	*dy*	*dz*
MIN	–0.026	–0.041	–0.071
MAX	0.065	0.028	0.055
AVERAGE	0.001	0.004	–0.002
STDEV	0.019	0.013	0.023

When comparing the post-processed positions to that of RTK experiment1 and experiment 2 results, the differences were at the millimeter/centimeter level, and the maximum differences did not exceed 8 centimeters. It means that while using fast Internet connection, carrier-phase data are fully synchronized while processing the RTK navigation solution.

Considering the measurements in scenario with obstacles in the form of tree canopies covered by leaves, RTK results were then very precise and centimeter level of accuracy was obtained.

5. Summary and Conclusions

The paper presented an Internet-based RTK experiment results using ASG-EUPOS NAVGEO service for providing accurate centimeter-level positions. The field experiments showed that the performance of the system is suitable for putting it to practical use for land survey measurements that require centimeter level of accuracy.

While using a fast wireless Internet connection, there is no latency of the reference data. ASG- EUPOS VRS service was very precise, even in the urban environment. However there where some places (tree canopies or buildings) where obtaining RTK fixed solution lasted over ten minutes. In such situations, combination of GPS and GLONASS constellations could speed up all the measurements.

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