Unfailing Expertise of Centimeter GPS/GLONASS Surveying in Afforest Milieu

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Abstract

This paper presents a unfailing technology for GPS/Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS) analysis beneath thorny observational surroundings, The know-how is pedestal on the speedy motionless and Real-Time Kinematic (RTK) connive. Test analyses for the urbanized technology were carried out on a point in a dense forest, with a high degree of obscurity for habit entrée. The go with of the pose were firm by three GPS/GLONASS earpiece positioned in a stripe on a special base, which were not tongue by a fixed aloofness of 0.5 m. The test analysis were accomplish via Topcon HiPer Pro beneficiary with 10-Hz RTK pose and get-together statistics at a assortment rate of 10 Hz. handy tests for the presented technology showed that rapid static analysis based on three rover GPS/GLONASS beneficiary were a quite able machinery in forest environments (unlike the RTK) and allowed for unfailing centimeter exactitude of the gritty pose to be attain in 5-min observational jamboree.

***Keywords**: traces doling out, boo-boo analysis, estimation, Global poses System, least tetragons manners, depth slips.*

1. Introduction

Enduring global navigation satellite system (GNSS) reference station is currently widely Used in many countries, make possible the sculpt of error related to distance decor relative, i.e., ionosphere and troposphere errors. In Poland, an allusion posting set of connections system [the so-called Active Geodetic Network European Position grit System (ASGEUPOS)] for the amassing total mother country was launch in mid-2008. The ASG-EUPOS system consists of around 100 GNSS station and offers real-time services for Real-Time Kinematic (RTK) examination and for differential GPS (DGPS) code dimensions [6]. The system also enables the continual hand out of data from static observations for any user, even though the negligible inspection period is as much as 15 min and GNSS analysis must be achieve on peak with good right of entry to dependencies.

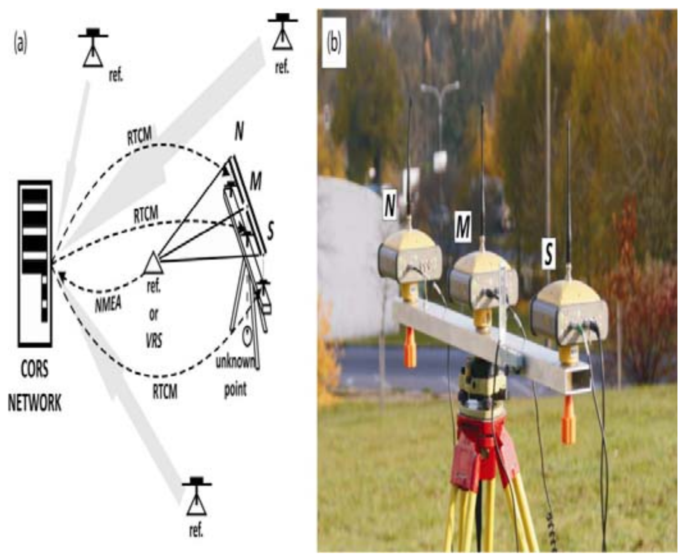

Fig.1. GNSS surveying based on the new method. (a) Technology concept. (b) Live view of the technology.

2. Hardware and Software Pattern

Test Area The size, which are both in the RTK and rapid static technologies, were performed based on the KROL situation of the ASG-EUPOS network positioned ca. 860 m from the place where the accomplish research was carried out using Topcon HiPer Probeneficiary. Communiqué with the KROL category was provided using the Networked Transport of Radio Technical expenses for Maritime Services (RTCM) via Internet Protocol (NTRIP). The data from the modem were simultaneously sent to the three rover beneficiary with a suitably designed RS232 serial cable and RS232-LEMO cables, which convey the data to the elected ports of the beneficiary (see Fig. 2). The same lead were engaged when conveyance the RTK kindness fallout to the portable

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computer using the GGA sentence of the National Marine Electronics humanity standard. Efficient announcement between the GNSS receiver and the net book was provided via RS232-USB converters.

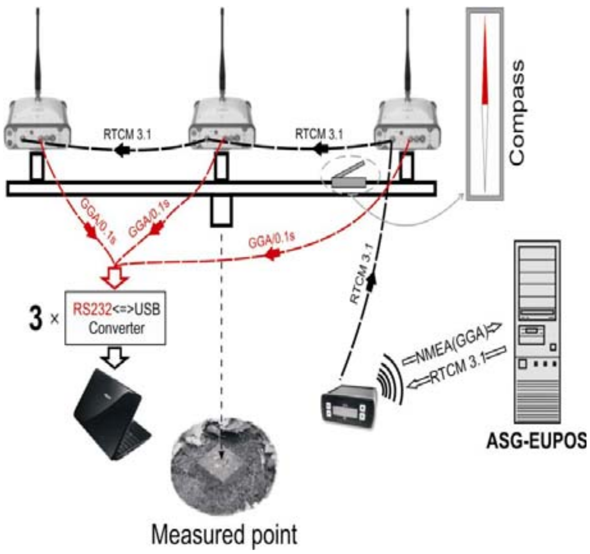

Fig.2. Hardware setup of the PS/GLONASS unit.

3. RTK Performance in Forest Environments

Comparable to the rapid static method, the RTK spot results from the RTK appraisal with three beneficiaries were divided into 18 5-min sessions, which had parallel time equivalents in sessions act upon by the rapid static method. The finest elucidation in the form of a unfailing position was searched in each session. The knowledge of the constant distance between individual beneficiary, i.e., N−S = 1 m, N−M = M− S = 0.5 m, and the constant height of the whole survey unit were used for this purpose. Before starting to process the results, the tolerable diversity (for horizontal positions) between the aforementioned values was arbitrarily adopted at the level of 2 cm (*dD*). The height difference among the beneficiary (N, M, and S) could not exceed 5 cm (*dH*). The values of tolerance for horizontal and plumb verge were empirically determined and can be misrepresented depending on the vital precision. To unearth the optimum solution, we tried to obtain a trustworthy spot for immediate quantity with three beneficiary (N–M–S).The FIXED RTK solutions, which were taken into financial credit for each solution for a given measurement epoch, had to fulfill the aforementioned arithmetic surroundings.

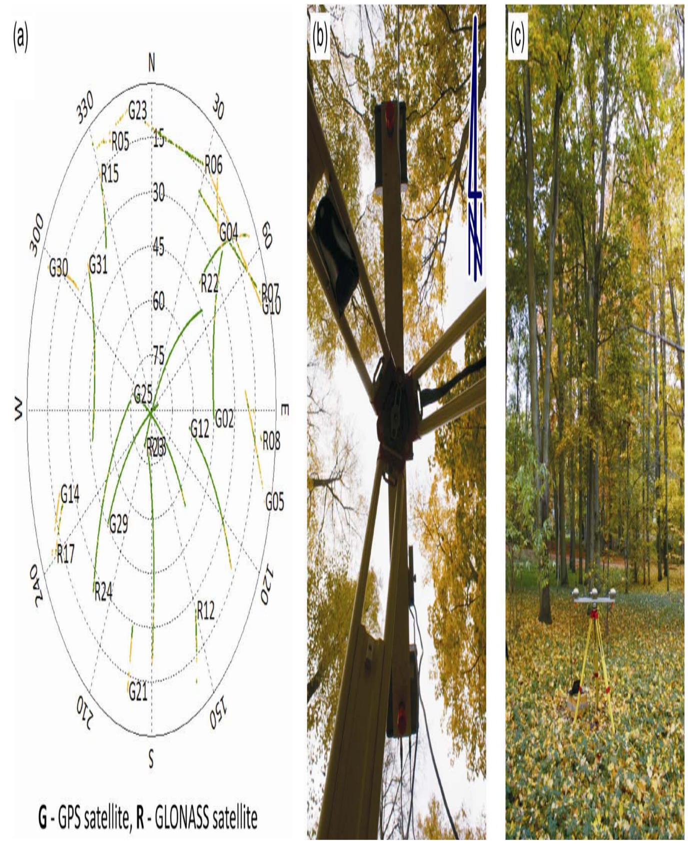

Fig.3. (a) Satellite configuration.

4. Rapid Static Performance in Forest Environments

Eighteen 5-min sessions were acquire for each earpiece for the duration of the speedy static survey, i.e., for the north, middle, and south beneficiary. Every single one harmonize of this beneficiary were drastically computed relative to the KROL station using the GPS and GLONASS systems. The software Topcon Tools v. 6.11 was used for baseline subtraction in situation dispensation. Fig. 5 shows a sketch of the FLOAT or FIXED baselines obtained in individual session with manifest points whose harmonize were determined. The local time of the execute dimensions with an ordinal come to was moreover endow with for each sitting. The final result is the coordinate (similar to the RTK survey) obtain by (1). In most cases, it was doable to obtain the harmonize of at least two beneficiary (M–S, N–M, N–S), which also allowed unfailing harmonize of the middle point (M) to be firm.

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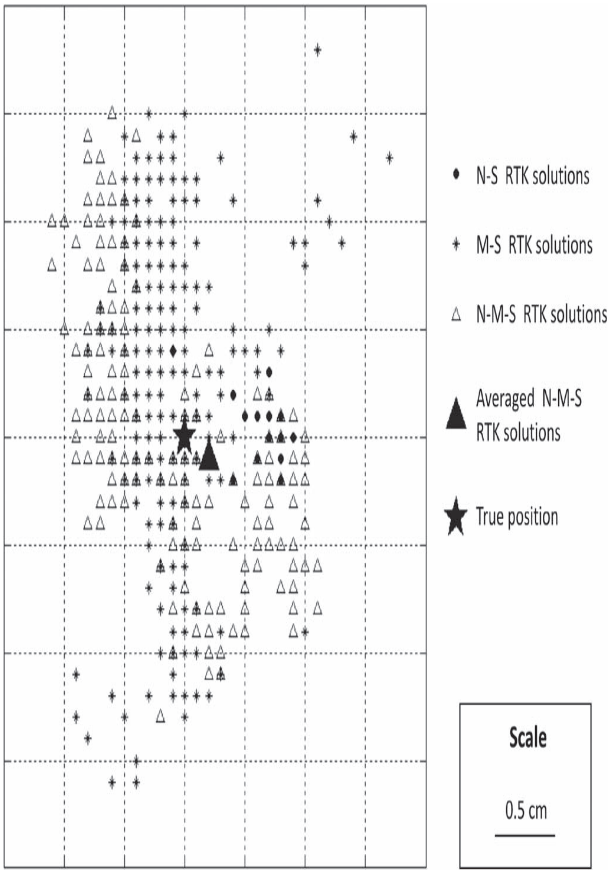

Fig. 4. Unfailing RTK solutions obtained in the fourth session.

5. Quality Control of Gps/Glonass Data Obtained In the Forest Environment

There are a quantity of poles spaced out error sources distressing the code and phase dimensions used in the RTK and rapid static pose. Most of these errors can be purge using degree of difference performance as of their spatial correlation, e.g., the end product of the ionosphere or troposphere layer. For high exactness field examination, the main source of error (and difficult to eliminate) is multipath. The notion of multipath consists of the recording of reflected signals by the GNSS earpiece besides the direct signal from the satellite. There are two potential of warning sign manifestation. It can be reflected by an obstacle eminence near the receiver (e.g., buildings and trees) or imitate off the soil and reach the receiver's feeler. As of the lobby group of satellites along the orbit and the continually shifting geometry of satellites, the level of multipath force varies in time and depends on the altitude of a prearranged protectorate.

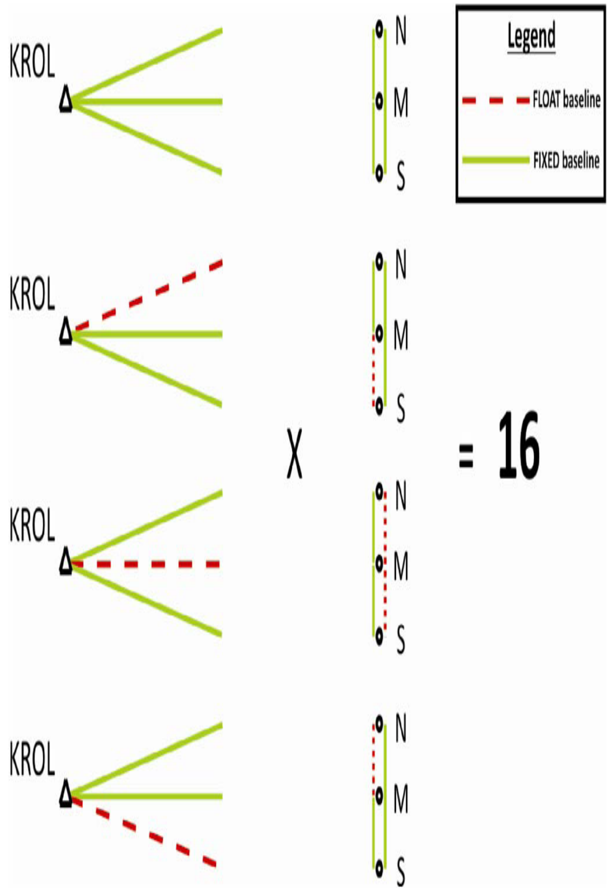

Fig. 6. Diagram of possible baselines in the unfailing rapid static approach.

6. Quality Control of Gps/Glonass Data Obtained In the Forest Environment

There are adding up to of pole apart error sources upsetting the code and phase measurements used in the RTK and rapid static positioning. Most of these errors can be eliminated using differential techniques because of their spatial correlation, e.g., the effect of the ionosphere or troposphere layer. For high accuracy field analysis, the main source of error (and difficult to eliminate) is multipath .The impression of multipath consists of the recording of reflected signals by the GNSS receiver besides the direct signal from the satellite. There are two possibilities of signal reflection. It can be reflected by an obstacle standing near the receiver (e.g., buildings and trees) or reflected off the ground and reach the receiver's antenna. Because of the movement of satellites along the orbit and the continually changing geometry of satellites, the level of multipath impact varies in time and depends on the altitude of a given satellite.

7. Summary and Conclusion

Extensive observational fabric, i.e., over 160 000 depth epochs, was unruffled from the GPS/GLONASS (10 Hz) scope conceded out in Park. Raw GPS/GLONASS surveillance statistics and coordinates obtained by the RTK method with a 0.1-s sum interval were simultaneously confirmation for the duration of the experiment for three GNSS beneficiary. They were set on a extraordinary depth beam wished-for for this idea. The GPS/GLONASS data were alienated into 18 5-min rapid static sessions and equivalent RTK height (10 Hz) gathering and were then analyzed. The use of two navigation systems for the RTK spot resulted in the position frequency caused enrichment in the FIXED determinations. The scope underneath dense tree canopies caused four (out of 18) trustworthy solution to be obtain in the RTK position during the manner experiment. The rapid static measurement performs much better, with 78% of the sessions being unfailing according to the adopt assumptions. The RMS error of the MCNA/CNA variants for the determination of the northern component, the eastern component, and the height were 0.008/0.007, 0.017/0.012, and 0.024/0.029 m, respectively.

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