International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 18 (2015) pp 39451-39453
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Analysis of Positioning Performance about VRS and RTK

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Abstract
As the demand on the precise positioning for the moving objects has been increased in the various industry fields, many studies have been conducted to analyze real time kinematic technique and its practical usage. GPS RTK surveying has an issue that the positioning error increases as the base line distance between the reference station and rover station increases. However, nowadays, an accuracy assessment that can handle such issue is surely required because of the modernization of GLONASS, Galileo project, and other improvements of satellite receiving conditions such as COMPASS, SBAS etc. In this study, we compared the positioning performance about VRS and RTK surveying method. As a result, RTK could receive more satellite signal at least 5 and positioning performance is better than VRS in satellite shadow area. In the satellite shadow area like under the bridge or nearby building, RTK surveying could improve the positioning performance.

Keywords: Real Time Kinematic, Virtual Reference Station, Accuracy Analysis, GNSS, Positioning

1. Introduction

Today, GNSS (Global Navigation Satellite System) is used the most for acquiring location information and is widely used in various fields such as survey, cadastration, management of national reference stations, construction site and military operations [1-2]. After the VRS (Virtual Reference Station) service had been started by NGII (National Geographic Information Institute), there has been a huge paradigm change in GNSS survey [3-4]. Now it is possible to survey with 1cm accuracy in real-time using a receiver and virtual control point [5-6]. However, the positioning performance of VRS is decreased in satellite shadow area like around buildings or under the bridge, since the VRS only services GPS and GLONASS [7]. This is the reason why the comparison of positioning performance between VRS and RTK. The main purpose of this study is to represent the positioning performance of VRS and RTK in real-time positioning. In this study, analysis of positioning performance about VRS (Virtual Reference Station) and RTK (Real Time Kinematic) method were performed.

2. Real-Time Positioning

To analyze the positioning performance of VRS and RTK, the surrounding area of World Cup Stadium in Daejeon was decided to study area. The study area has both good satellite receiving area and shadow area like around buildings or bridges, and which will make it suitable for the study. Fig. 1 shows the location of study area.

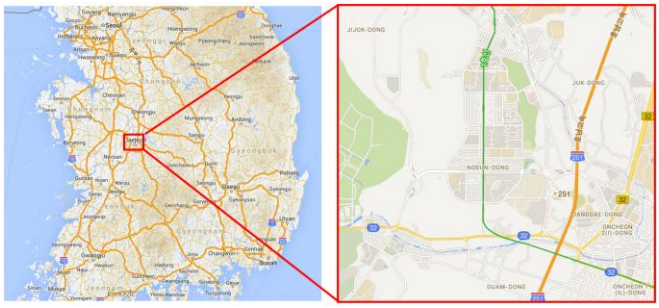

Fig. 1. Study Area

In this study, Trimble R10 GNSS receiver was used for data collection in study area. R10 can perform both VRS and RTK. R10 also receives all the existing satellite signal of GPS (Global Positioning System), GLONASS (GLObal Navigation Satellite System), COMPASS, Galileo and SBAS. Fig. 2 shows R10 GNSS and table 1 shows specification of R10 GNSS [8].

Fig. 2. R10 GNSS

Table 1. Specification of R10

Item	Specifications
Satellite signals tracked simul taneously	– GPS: L1C/A, L1C, L2C, L2E, L5 – GLONASS: L1C/A, L1P, L2C/A, L2P, L3 – SBAS: L1C/A, L5 (For SBAS satellites that support L5) – Galileo: E1, E5a, E5B – BeiDou (COMPASS): B1, B2 – QZSS, WAAS, EGNOS, GAGAN
Accuracy (horizontal)	3 mm + 0.1 ppm RMS(static) 8 mm + 1 ppm RMS(Real Time)
Accuracy (vertical)	3.5 mm + 0.4 ppm RMS(static) 15 mm + 1 ppm RMS(Real Time)
Channels	440
Update rate	1Hz
Satellite tracking	GPS, GLONASS, WAAS/EGNOS/MSAS
Dimensions (W×H)	11.9 cm x 13.6 cm
Weight	1.12 kg with internal battery

The experiment was conducted in two ways of a VRS method using 1 GNSS receiver and a method using 2 receivers as base and rover. Total 35 areas were surveyed including flatland, around buildings and under the bridge. Fig. 3 shows survey points.

Fig. 3. Survey Points

3. Analysis of Positioning Performance

As a result of surveying, RTK surveying shows higher accuracy than VRS. This is because there are many satellites available for surveying. RTK surveying turns out to use at least 5 more satellites than VRS surveying. The rows highlighted in yellow in table 2 are nearby buildings and under bridges area. VRS shows 2 times higher DOP (Dilution Of Precision) than RTK in these area (yellow rows). The surveying result in the study area presented VRS accuracy of up to 0.051m. These areas are not good for receiving satellite signal as under bridges. The effect of real time surveying by the number of satellites was shown in the study. If Galileo and COMPASS services available after the acceleration of VRS service, GNSS surveying performance will be largely improved. The results of surveying using VRS and RTK are shown in the Table 2.

Table 2. Surveying Results of VRS and RTK

No.	ID	RTK						VRS					
		H RMS	V RMS	PDOP	HDOP	VDOP	Number of satellite	H RMS	V RMS	PDOP	HDOP	VDOP	Number of satellite
1	gg26	0.006	0.011	1.4	0.7	1.2	21	0.008	0.011	2.5	1.3	2.2	13
2	gg27	0.010	0.014	1.6	0.9	1.3	19	0.007	0.014	2.9	1.6	2.3	10
3	gg28	0.007	0.013	1.5	0.8	1.3	20	0.008	0.013	2.7	1.4	2.3	13
4	gg29	0.006	0.010	1.5	0.8	1.3	20	0.006	0.01	2.7	1.4	2.3	15
5	gg30	0.006	0.010	1.3	0.7	1.1	21	0.006	0.01	2.3	1.3	2.0	15
6	gg31	0.007	0.012	1.8	0.9	1.5	22	0.006	0.012	3.2	1.6	2.7	11
7	gg32	0.010	0.013	1.3	0.7	1.1	20	0.021	0.035	2.3	1.3	3.2	14
8	gg33	0.005	0.009	1.3	0.7	1.1	21	0.005	0.009	2.3	1.3	2.0	15
9	gg34	0.006	0.009	1.4	0.8	1.2	23	0.008	0.009	2.5	1.4	2.2	15
10	gg35	0.006	0.009	1.4	0.8	1.2	26	0.008	0.009	2.5	1.4	2.2	15
11	gg36	0.012	0.014	1.6	0.9	1.4	20	0.025	0.033	2.9	1.6	2.5	15
12	gg37	0.006	0.010	1.4	0.7	1.2	20	0.007	0.01	2.5	1.3	2.2	14
13	gg38	0.006	0.012	2	0.9	1.7	22	0.006	0.012	3.6	1.6	3.1	11
14	gg39	0.008	0.014	2.1	1	1.8	20	0.006	0.014	3.8	1.8	3.2	13
15	gg40	0.007	0.012	1.7	0.9	1.4	20	0.007	0.012	3.1	1.6	2.5	13
16	gg41	0.008	0.011	1.4	0.8	1.1	20	0.005	0.011	2.5	1.4	2.0	14
17	gg42	0.006	0.011	1.6	0.8	1.5	20	0.005	0.011	2.9	1.4	2.7	12
18	gg43	0.006	0.011	1.6	0.7	1.4	20	0.006	0.011	2.9	1.3	2.5	14
19	gg44	0.006	0.011	1.6	0.7	1.4	20	0.006	0.011	2.9	1.3	2.5	14
20	gg45	0.006	0.011	1.7	0.8	1.5	21	0.006	0.011	3.1	1.4	2.7	13
21	gg46	0.005	0.010	1.5	0.7	1.3	20	0.008	0.01	2.7	1.3	2.3	14

22	gg47	0.008	0.012	1.6	0.9	1.3	21	0.006	0.012	2.9	1.6	2.3	12
23	gg48	0.008	0.012	1.5	0.9	1.2	21	0.006	0.012	2.7	1.6	2.2	12
24	gg49	0.008	0.012	1.5	0.9	1.3	20	0.006	0.012	2.7	1.6	2.3	12
25	gg50	0.010	0.015	2.8	1.5	2.3	18	0.028	0.039	5.0	2.7	4.1	12
26	gg51	0.006	0.012	1.6	0.7	1.4	20	0.005	0.012	2.9	1.3	2.5	14
27	gg52	0.011	0.015	1.9	1.1	1.6	20	0.008	0.015	3.4	2.0	2.9	14
28	gg53	0.011	0.190	1.7	0.9	1.4	18	0.031	0.048	3.1	1.6	2.5	12
29	gg54	0.006	0.009	1.4	0.8	1.2	20	0.006	0.009	2.5	1.4	2.2	14
30	gg55	0.006	0.009	1.3	0.7	1	20	0.006	0.009	2.3	1.3	1.8	15
31	gg56	0.010	0.015	1.4	0.7	1.2	20	0.028	0.041	2.5	1.3	2.2	15
32	gg57	0.010	0.016	1.4	0.7	1.2	20	0.031	0.051	2.5	1.3	2.2	15
33	gg58	0.010	0.015	1.4	0.7	1.2	19	0.029	0.038	2.5	1.3	2.2	14
34	gg59	0.011	0.190	1.8	0.9	1.5	17	0.023	0.029	3.2	1.6	2.7	12
35	gg60	0.006	0.010	1.4	0.7	1.2	20	0.008	0.01	2.5	1.3	2.2	15

4. Conclusion

This study was aimed to analyze the surveying performance of VRS and RTK. The VRS surveying used 1 receiver and the single base RTK used 2 receivers for base and rover. Flatland, around buildings and under bridges area had been surveyed using abovementioned methods and the surveying results were compared. As a result of surveying, RTK surveying has better accuracy than VRS. This is due to the availability of a number of satellites. RTK surveying is likely to use at least 5 more satellites than VRS surveying. In the case of VRS, DOP has jumped up 2 times than RTK in the around buildings and under the bridge area. In this study, the effect of real time surveying by the number of satellites is presented. GNSS surveying performance will be enhanced once Galileo and COMPASS start the service according to the acceleration or VRS service.

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Received: Month xx, 20xx