Performance Assessment of RTK-GNSS Navigation under Different Conditions

1. INTRODUCTION

The aim of this report is to access the performance of RTK-GNSS Navigation system under different environment conditions. Also, the accuracy of RTK data and GPS data (from the analysis of GPS performance) will be compared to conform the improvement in accuracy by implementing the RTK technique.

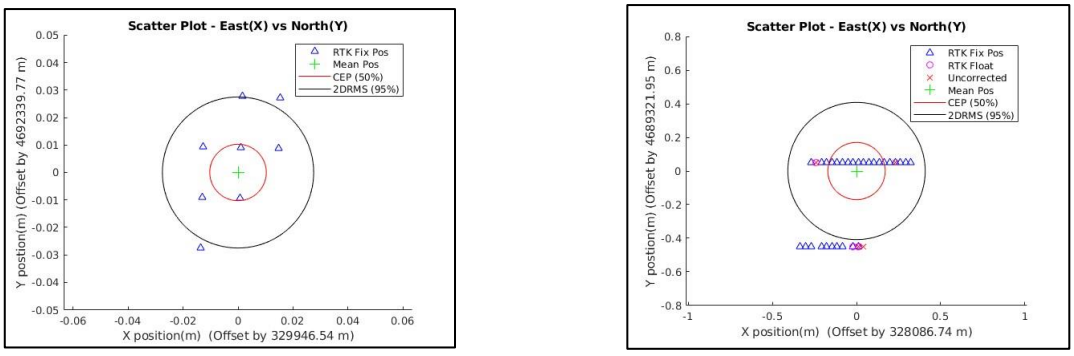
2. BACKGROUND

GPS is generally used for navigation purpose but it can only provide accuracy of 5 to 20 meters [1]. In order to increase the accuracy, RTK-GNSS is used which can provide centimeter-level accuracy. This involves two GPS receivers, one is stationary, at a known point, known as "Base" and other is moving/stationary at unknown point, known as "Rover". The Base receiver transmits data over a radio link and the Rover calculates precise position by using the signals it receives from the satellites and the data it receives via the radio from the Base. The idea is to eliminate the main error sources, such as tropospheric and ionospheric delay, satellite clock errors, and orbit errors by receiving the signals at a known location and cancelling out the common errors between Base and Rover in real time [2].

3. FIELD TESTS, ANALYSIS AND RESULT

3.1 Stationary Rover in Open and Occluded area

In order to study the performance of RTK-GNSS in stationary scenario under Open and Occluded environment conditions, two data sets are collected. One in ground, which was completely open and other in area surrounded by buildings. Below are the scatter plots for both the data sets:



(a) (b)

Fig. 1. Scatter Plot, CEP and 2DRMS in XY at stationary pos (a) Open area (b) Occluded area

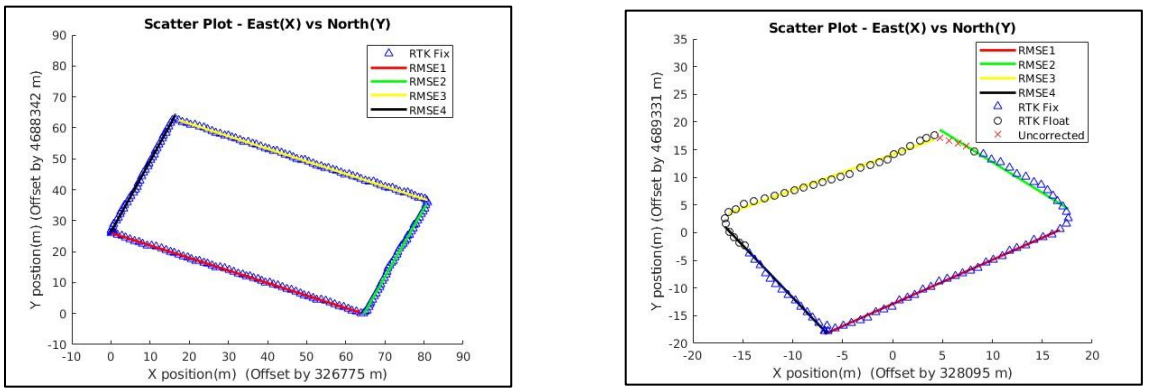
It is clearly visible from the plot that with the implementation of RTK technique, centimeter level accuracy is achieved in open area and decimeter level in occluded area. This is also confirmed from the Table 1 that standard deviation, CEP and 2DRMS for RTK-GNSS is very less as compared to GPS data, thus the data is much more accurate. In obstructed area, the deviation is more as compared to open area, is mainly due to multipath error [3] and, also due to presence of RTK float and uncorrected data (Table 3).

Table 1. Standard deviation, CEP and 2DRMS under different environment conditions

Location	Measuring Method	Standard deviation (m)			CEP (m)	2DRMS (m)
		X	Y	Z		
Open	RTK GNSS	0.004	0.013	0.049	0.01	0.027
Occluded	RTK GNSS	0.14	0.15	0.053	0.17	0.41
Open	GPS	2.76	1.18	2.46	2.33	6.014

3.2 Moving Rover in Open and Occluded area

For evaluating the performance of RTK GNSS in moving scenario under Open and Occluded environment conditions, again two data sets are collected. Below are the scatter plots for both the data sets:



(a) (b)

Fig. 2. Scatter Plot in XY in moving condition with best fit lines (a) Open area (b) Occluded area

Figure 2 shows the scatter plot in East-North direction and the best fit line for each straight paths. The best fit line closely follows the plot, and this is also evident from the Table 2 which shows error less than 0.35m in open area and 0.6m in occluded area. From this result, it is clear that RTK-GNSS performed excellently and provided far better results than GPS alone.

Table 2. Root Mean Square Error under different environment and measuring conditions

Location	Measuring Method	Condition	RMSE (m)
Open	RTK GNSS	Moving	0.34
Occluded	RTK GNSS	Moving	0.6
Open	GPS	Moving	4.4

As in Open area, there was no obstruction and hence rover can receive the correction signal most of the time, and no multipath and, hence can achieve high accuracy than the Occluded area [1] which is clear from Table2. This is also supported by the fix quality data in Table 3.

Table 3. Quality indicators percentage ratio

Location	Condition	RTK Fixed (%)	RTK Float (%)	Uncorrected (%)
Open	Stationary	100	0	0
Occluded	Stationary	98.63	0.68	0.69
Open	Moving	100	0	0
Occluded	Moving	63.5	32.3	4.2

4. CONCLUSION

This report dealt with the performance evaluation of the RTK-GNSS under different test conditions. It is shown that the RTK-GNSS can achieve accuracy of centimeter level. Though RTK cannot achieve Fix at all locations but still it provides better accuracy than the GPS.

REFERENCES

[1] K. M. Ng, J. Johari, A. Ahmad, B. N. Laja, "Performance Evaluation of the RTK-GNSS Navigating under Different Landscape," *International Conference on Control, Automation and Systems (ICCAS)*, 2018, pp. 1424-1428.

[2] Lee, IS., Ge, L. "The performance of RTK-GPS for surveying under challenging environmental conditions." *Earth Planet Sp* 58, 515-522 (2006).

[3] Cetin Mekik, Ozer Can. "Multipath Effects in RTK GPS and A Case Study" *Journal of Aeronautics, Astronautics and Aviation, Series A, Vol.42, No.4* pp.231 – 240 (2010).