EECE-5554 Robot Sensing and Navigation
LAB-2 Report

Abstract – This document provides the analysis report of the collected data using the RTK GNSS device. We wrote a driver to get the "GNGGA" data string, from which required GPS and UTM data are stored. The 4 types of data sets were collected –Stationary data set in an open spot, moving/ walking in an open spot, stationary data set in an occluded spot, and moving/ walking in an occluded spot.

I. Introduction to RTK (Real-Time Kinematic)

RTK is a method that uses satellite and ground signals, base and satellite stations with high accuracy and precision to the centimeter level to calculate the position and navigate in real-time.

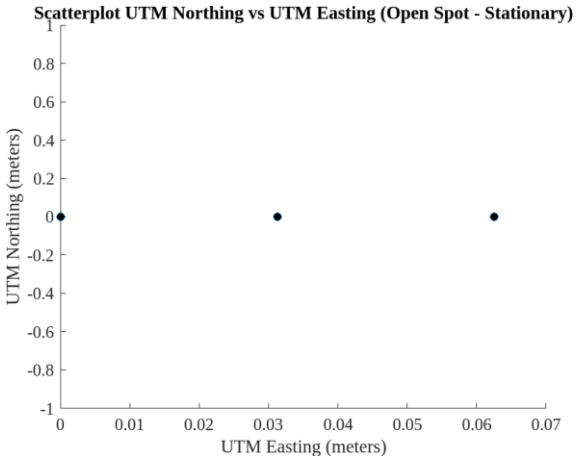
II. Differences between RTN GNSS and GNSS

The RTN GNSS uses both satellite signals and a network (MaCORS – used in this lab) that has fixed reference stations with receivers to provide signal corrections, this can't be used globally as the reference stations are not available at all locations. Where GNSS uses signals directly from multiple satellites for positioning that can be used globally.

III. Source(s) of error in RTK GNSS

The major sources of errors are – Multi-path errors, Atmospheric errors, Signal blockage, Noise errors, Receiver errors, and Human errors.

IV. Analysis



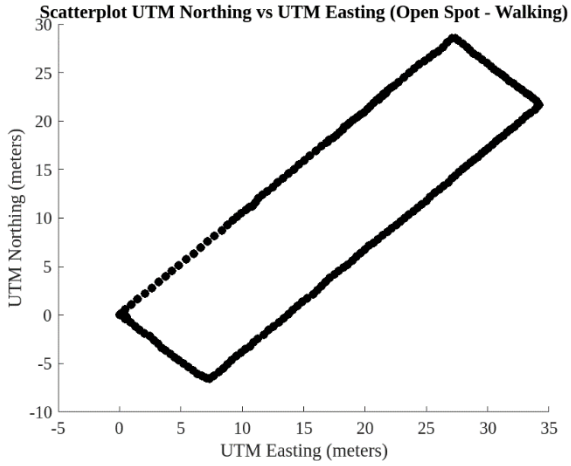
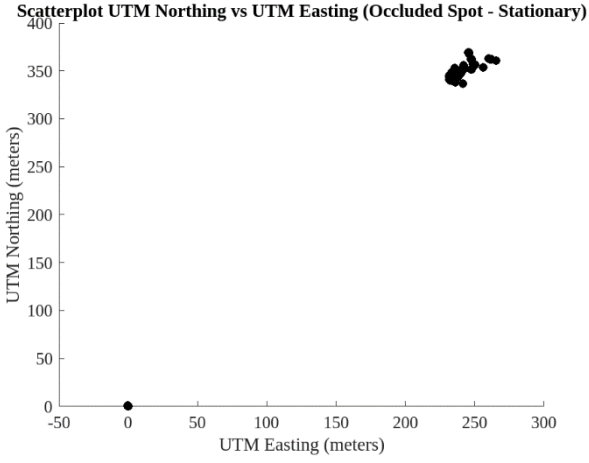


Figure 1: (a) Open_Stat data set on Columbus Garage's roof ***(b) Open_walk data set on Columbus Garage's roof***



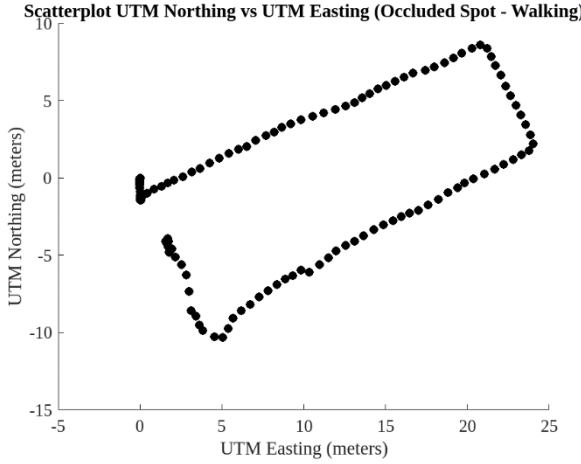
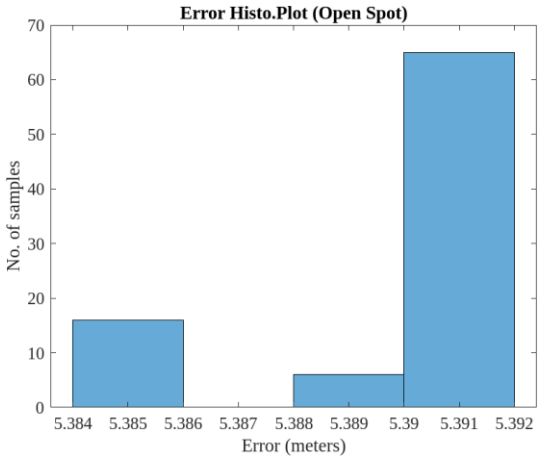


Figure 2: (a) Occ_Stat data set at Bruke's Street ***(b) Occ_Walk data set in front of snell***



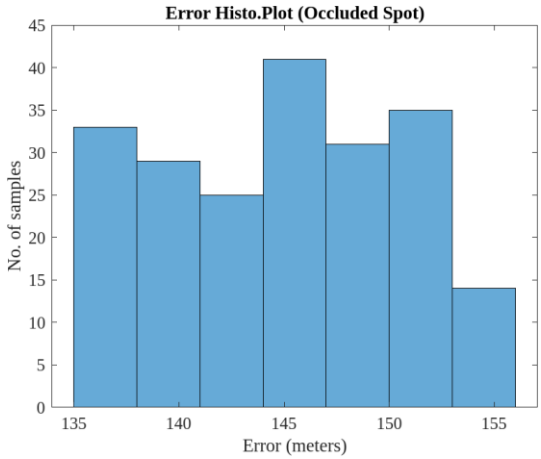


Figure 1: (a) Histogram of Open_stat data ***(b) Histogram of Occ_stat data***

V. Conclusion

a. *What do the error tell you about RTK GNSS navigation and without RTK?*

The RTK GNSS has high accuracy and precision compared to GNSS without RTK as the RTK sends the error corrections which results in error reduction and gives an output of less than 1 meter. (Can compare LAB1 and LAB2 open spot stationary data set results).

b. *What can you say about the distribution of noise in the signal?*

The distribution of noise signal does have an effect on the signal as it fluctuates the frequency and varies the data. As we can see in Figure 2 (a), the distribution of noise and signal blockage had a high impact on accuracy but not much on precision.

c. *Why is this distribution different than GNSS data collected in Lab 1?*

The distribution of RTK GNSS data is different from GNSS data because the RTK receives error corrections through the base station and receiver. The GNSS data requires additional processing to improve accuracy and precision, but it can't attain as much as GNSS with RTK.

d. *How are your moving data different in the open and occluded cases? Does this have anything to do with GNSS fix quality?*

The fix quality has changed from (5) in open spot to (4) occluded spot, where the quality has decreased. As we can see from Figure 1 (b) and Figure 2 (b), there is a slight inaccuracy and breaks in the data plot.

e. *How are your stationary data different in the open and occluded cases? Does this have anything to do with GNSS fix quality?*

The fix quality has changed from (5) in open spot to (1) occluded spot, which represents very low fix quality. From Figure 1 (a) and Figure 2 (a), it can be observed that the precision is precise, but the accuracy is low.

VI. References

(Some interesting research papers related to RTK GNSS are listed)

[1] S. Mahato, G. Shaw, A. Santra, S. Dan, S. Kundu and A. Bose, "Low Cost GNSS Receiver RTK Performance in Forest Environment," 2020 URSI Regional Conference on Radio Science (URSI-RCRS), Varanasi, India, 2020.

[2] S. Takahashi, N. Kubo, N. Yamaguchi and T. Yokoshima, "Real-time monitoring for structure deformations using hand-held RTK-GNSS receivers on the wall," 2017 International Conference on Indoor Positioning and Indoor Navigation (IPIN), Sapporo, Japan, 2017.