LAB-2 RTK GPS – REPORT

EECE5554: ROBOT SENSING AND NAVIGATION

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Introduction:

Real time kinematic (RTK) positioning, this experimentation on GPS module is done using 2 GPS's which are calibrated as base and rover stations this method is implemented to achieve accurate location which decreases the amount of distortion in position data by giving a standard point in relation with the base module. This data sends a fix value to the rover module to correct the position error and brings it to centimeter accuracy.

In this process the base station is fixed at a particular point and the rover can be moved to desired location. The distance is then calculated by the time difference between the pseudo random code generated by the satellite and the same code generated in the receiver and multiplying it with the speed of light gives the distance.

Distance = (Satellite time – Receiver time) * (3*10^8)

The base station is the receiver the gets GNSS data from the satellites and finds the error comparing it with the fix location then transmit the calculated errors to the rover module and the rover then uses this error fix with the data it gets from GNSS for centimeter precession.

Analysis of stationary data:

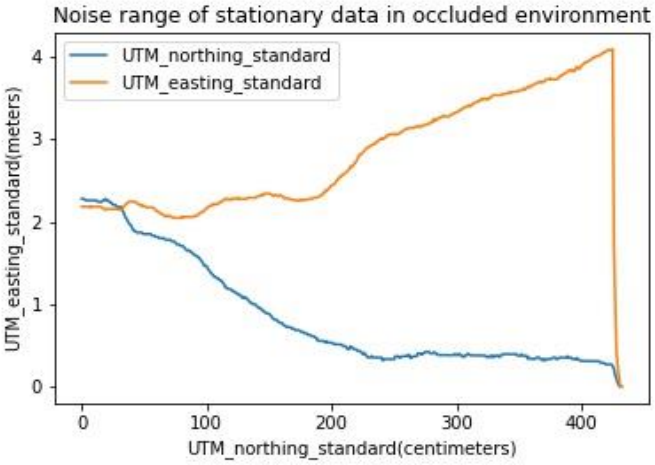

Figure 1: Occluded environment's noise range in stationary position

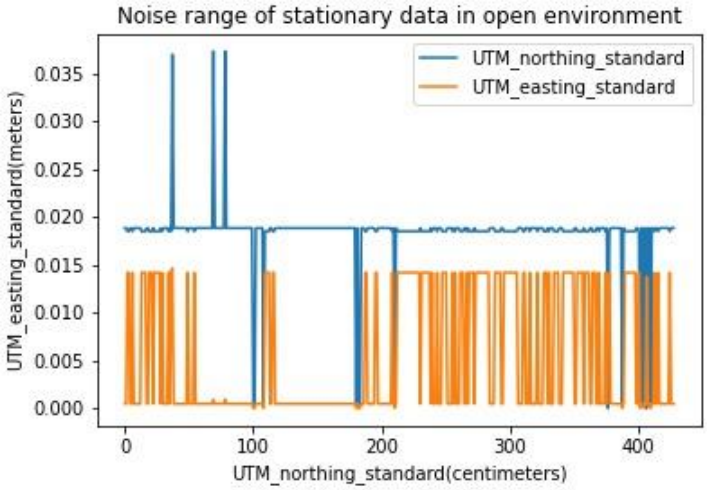

Figure 1: open environment's noise range in stationary position

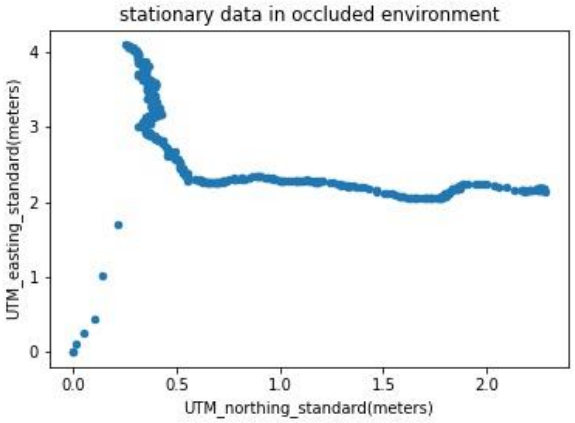

Figure 3: Stationary data in occluded environment

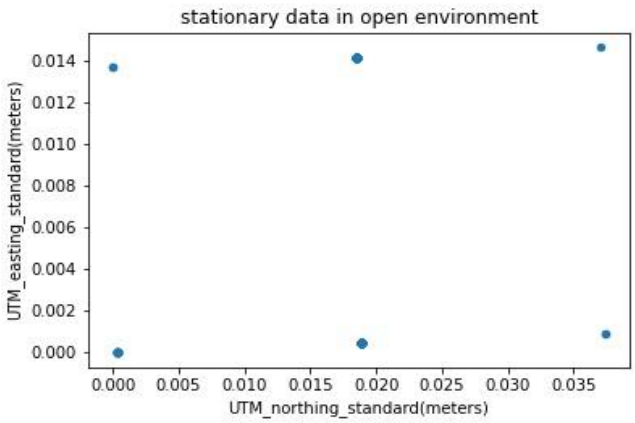

Figure 4: Stationary data in open environment

This data is collected in carter football ground for non-occluded region and for occluded region it is collected from near curry center. And it shows the how the data is affected by its surroundings.

Direction/Type of Region	Non-occluded	Occluded
UTM Easting	0-1.4 (cm)	0-4(m)
UTM Northing	0-3.5(cm)	0-2(m)

Table 1: Values of UTM easting & northing in occluded and non-occluded regions

In comparison to data from occluded regions, open region data is more accurate. The distortion caused by the trees and buildings has an impact, causing multipath error in the data for the occluded zone. Currently, the inaccuracy in the occluded region is measured in meters whereas open field error is in centimeters.

Analysis of walking data:

The carter football stadium is where the walking data for unobstructed areas is collected, whereas the terrace of the student curry center building is where the data for obstructed areas is collected. The analysis indicates that the data for the occluded zone is more skewed than the data for the non-occluded region. As we can see, the loop does not fully cover in the occluded zone but is ideal for the non-occluded zone. We can estimate the root mean square error for each side of the loop, providing us with a clear understanding on how much the points are off.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} \|y(i) - \hat{y}(i)\|^2}{N}},$$

y(i) = predicted value

y^(i) = Actual value

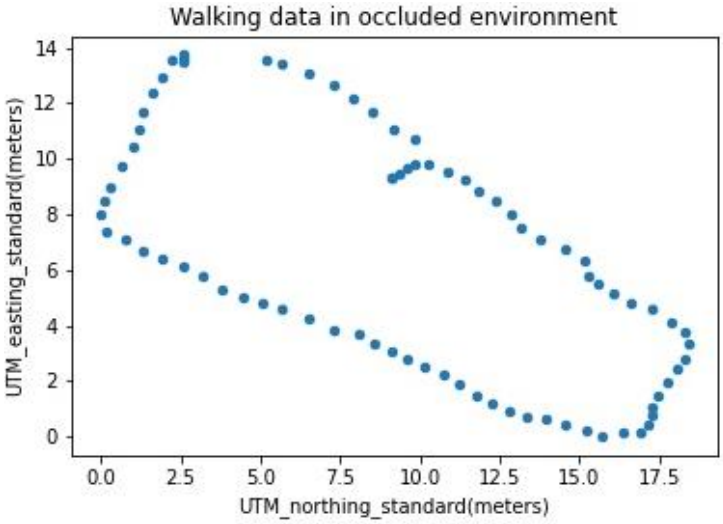

Figure 5: Walking data in occluded environment

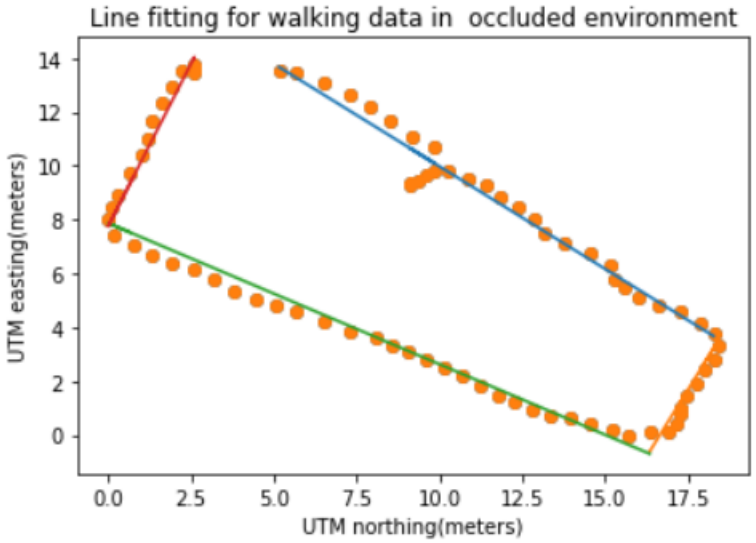

Figure 6: Line fitting for Walking data in occluded environment

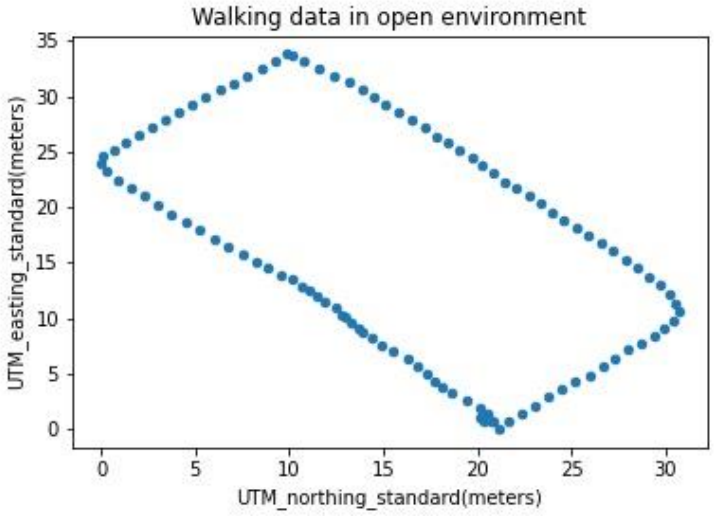

Figure 7: Walking data in open region

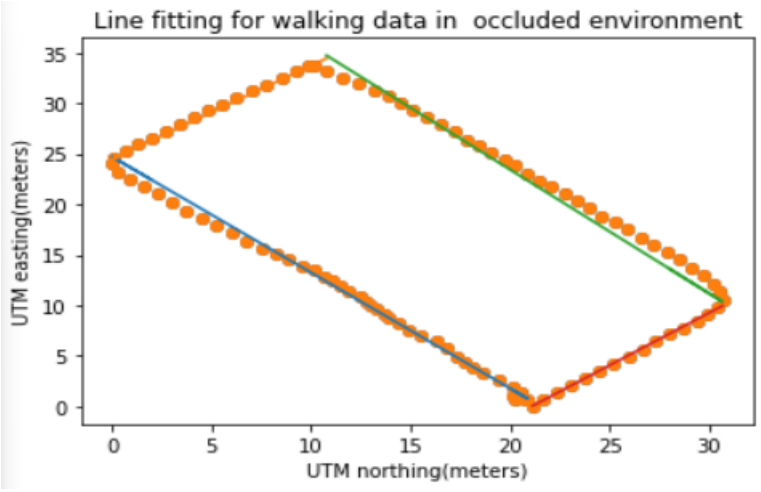

Figure 8: Line fitting for Walking data in open region

RMSE Values of each side after line of best fit

Blue line = 0.9168226677170697

Orange line = 0.514654008174409

Green line = 0.7510549658812091

Red line = 0.21799981295059043

Conclusion:

It is clear from my analysis that RTK GPS data collection is significantly superior to conventional GPS data collection for greater precession. However, in areas with dense construction and vegetation even RTK data needs be calibrated by employing filtering techniques like the Kalman filter and velocity estimation for better results.

References:

1. https://c3.ai/glossary/data-science/root-mean-square-error-rmse/
2. https://youtu.be/257WX_agvtg
3. https://en.wikipedia.org/wiki/Real-time_kinematic_positioning#:~:text=RTK%20follows%20the%20same%20general,correction%20data%20to%20the%20rover.