NORTHEASTERN UNIVERSITY

LAB2- RTK GPS

EECE-5554

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ACKNOWLEDGEMENT

This Report Analysis is based on the data collected by Group-8.

INTRODUCTION

Real Time Kinematics (RTK) or differential GPS uses a reference station (BASE) and a mobile GPS (ROVER). The BASE is fixed and stationary. Initial surveying and computation help in determining a precise known location for the BASE, which it uses to calculate the error in the GPS signals it receives from the satellite and transmits this correction to the ROVER. The ROVER receives this correction and applies it to the GPS signal it receives from the satellite to eliminate the errors and achieving accuracy level within centimetres instead of meters as seen for GPS without RTK.

Results and Discussion

STATIONARY DATA

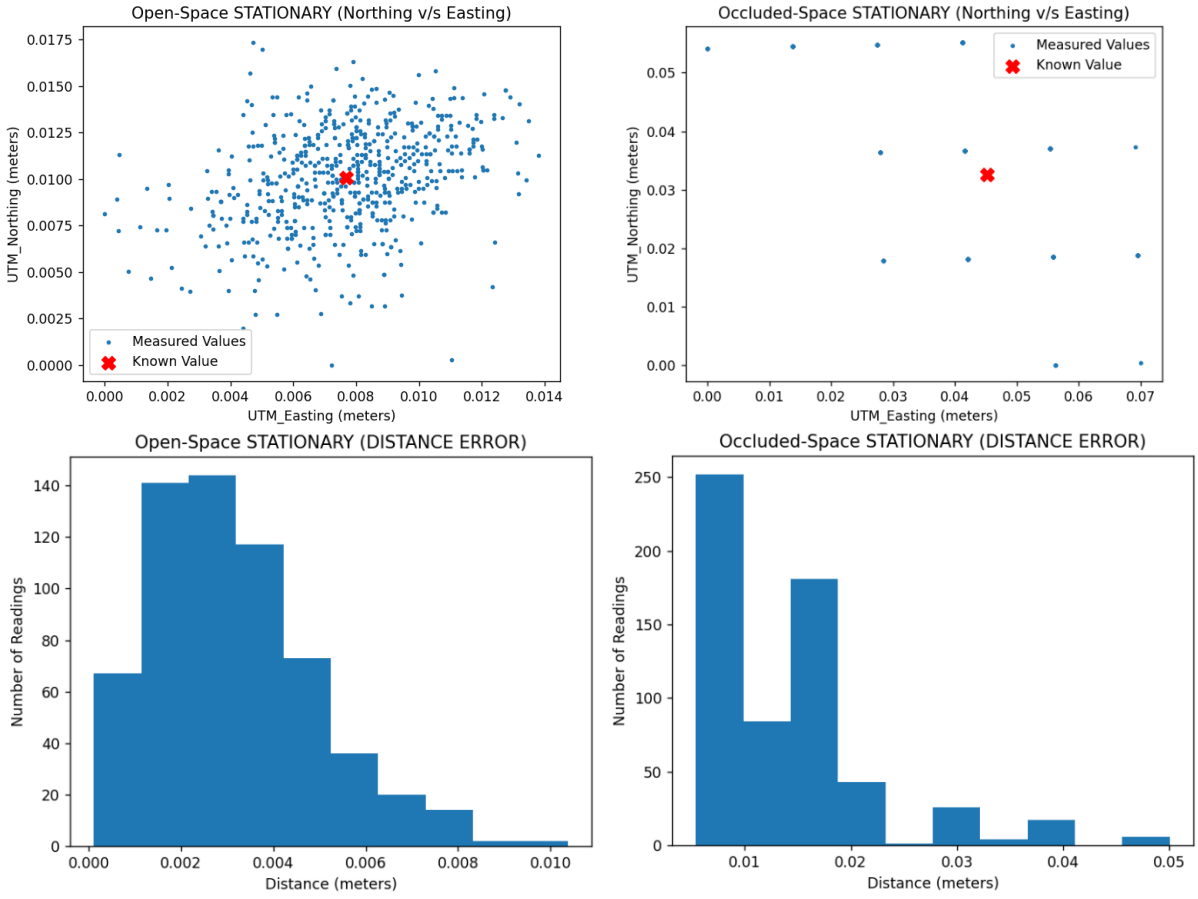

Figure 1: Stationary Data (Northing vs Easting). Open Space(left) vs Occluded Space(right)

Table 1: Stationary Error Comparison. with RTK (green) and without RTK (orange)

Error Statistics	Open	Occluded	Open (NO RTK)	Occluded (NO RTK)
Mean	0.3 cm	1.32 cm	246.3 cm	1031 cm
Standard Deviation	0.18 cm	0.8 cm	222.6 cm	1070 cm

From the histograms above, we can confirm the values in (table 1) that for Open Space, the greatest number of readings are around 0.003 m (mean=0.3cm), and the majority of values fall before 0.005 m (std = 0.18cm from the mean). Similarly, with Occluded Space, we can confirm the mean and standard deviation as 1.32cm and 0.8cm, respectively. From this, we can say that Open Space is more accurate as it gets more view of the sky and thereby exposure to a larger number of satellites for more accurate corrections. Moreover, in Occluded Space, due to surrounding objects near the device, the signals between the device and surrounding satellites can bounce off the objects before directly reaching the device or can simply not reach the device at all; error is amplified in both scenarios. When the signal bounces off an object before reaching the device, the time it takes to communicate with that satellite increases, causing the calculation of a false value. When a signal is completely blocked, there are fewer reference points to get a precise position.

We cannot see a trend in the histogram to classify the noise distribution as gaussian; however, we can say that the noise in Occluded Space is approximately. 5 times the noise in the Open Space due to the errors discussed above.

MOVING DATA

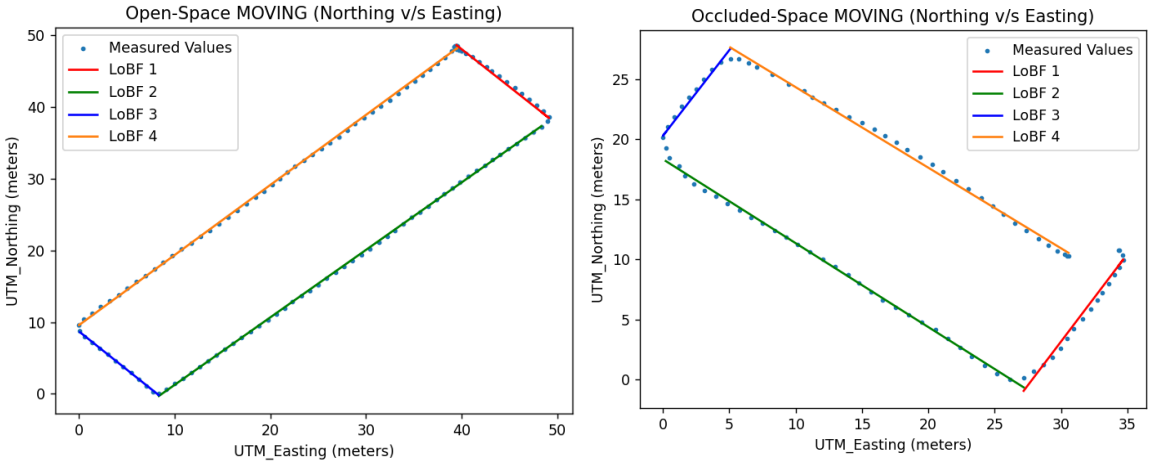

Figure 2: Moving Data (Northing vs Easting). Open Space(left) vs Occluded Space(right)

For moving data, the path is a square, and for error analysis it is divided into 4 lines of Best Fits (LoBF) for which the value of Root Mean Square Errors (RMSEs) is averaged, yielding an RMSE for the whole path as presented below:

Table 2: Moving Root Mean Squared Error Comparison. with RTK (green) and without RTK (orange)

RMSE	Open Space	Occluded Space	Open Space (No RTK)
x-direction	5.5 cm	9.8 cm	20.5cm
y-direction	5.7 cm	10.8 cm	22.9cm

From the above figure2 and table2, we can see that. Again, as discussed previously, the Open Space provides more accurate data than Occluded Space. It is due to Occluded Space resulting in a multiple path effect and a smaller view of the sky, leading to exposure to fewer satellites. These two reasons contribute to error which is twice as compared to Open Space. Furthermore, we can see that due to the larger error, the starting and end points, which are supposed to be the same, are off by a greater value for Occluded Space. However, for Open Space, they are almost the same.

FIX QUALITY

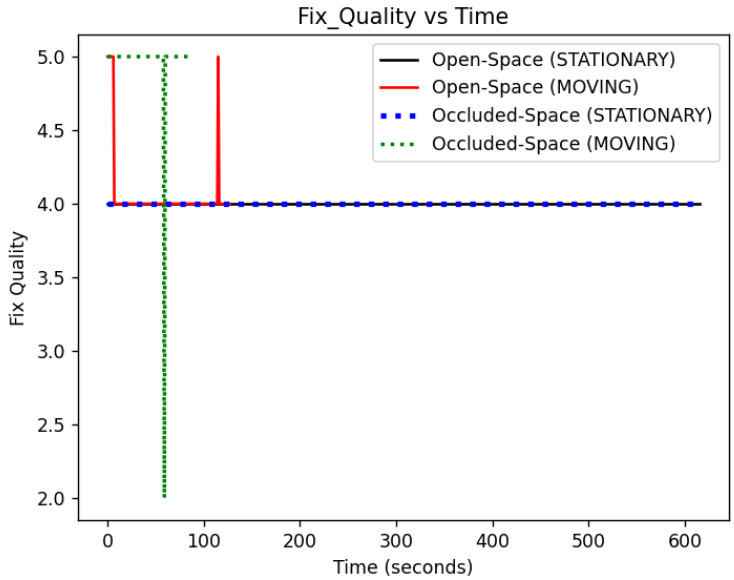

Figure 3: Fix value vs Time for different Data Sets

A Higher Fix Value determines larger accuracy in estimates. More visible sky leads to more satellites interacting with the GPS device and better corrections to the rover, resulting in higher accuracy. Based on this, we were supposed to have a larger value for the fix in Open Space (more view of the sky) than Occluded Space. However, from the above figure, we see that for stationary data, the fix is always 4, regardless of the environment. Moreover, we can achieve a fix of 5 during moving, indicating better accuracy. Lab-1 follows the same trend, where walking data was more accurate than stationary spot.

Furthermore, in Moving Data, the Occluded-Space shows fix = 5 for more time than Open-Space. This inconsistency could be due to an error in the Data Collection Process or Initial Surveying of the base. It is hard to explain the primary cause of it. Another Group was responsible for Data Collection. Moreover, one feasible thing we notice is that during Occluded-Space, the Fix value instantaneously drops to 2 and then goes back to 5 indicating the Data Collection Error discussed before.

CONCLUTIONS

RTK system helps to minimize the errors such as Atmospheric Refraction, Satellite position, Clock Errors, etc. We can see this with data comparison with LAB 1 (table 1&2 orange columns). For, stationary data the error is almost 1000 times in GPS without RTK as it estimates without any corrections, similar trend can be seen in altitude measurements. Moreover, looking at the noise trend between both the variants of GPS there isn't a clear trend except that for GPS without RTK the errors are larger, this can be confirmed by looking at the DOP (dilution of Precision) values which are lower for the GPS with RTK.

However, errors caused due to reflective surfaces (multipath) and identification/communication with a more satellites, as seen with data comparison between Open and Occluded space (table 1&2 green columns), cannot be resolved effectively using the RTK system.

Moreover, as the fix value increases, the accuracy increases. However, there is an inconsistency in explaining this trend through the data collected due to an error in the collection process, as discussed earlier.