EECE5554 – ROBOTIC SENSING AND NAVIGATION

LAB -2 REPORT

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Stationary Data

The stationary data was collected while the RTK rover and the base station was left completely static. The below figures shows the UTM easting and UTM northing data for the stationary scenarios as a scatter plot and line graph respectively. The locations chosen for clear and obscure environments to collect data where the Parking lot of ISEC building and ground floor of an open area behind ISEC respectively. It was seen that in an obstructed environment the RTK GPS system was more likely to stay in quality 5 than the more accurate quality of 4. In the case of the clear environment we can see a clear straight line with a fixed quality of 4.

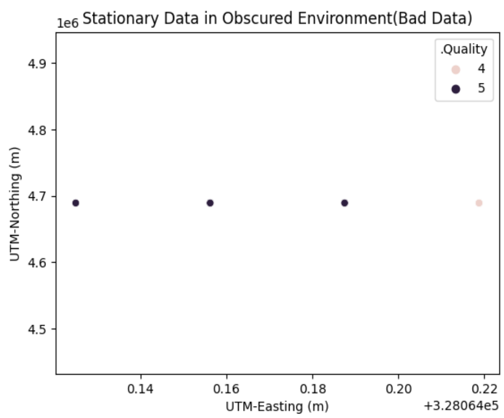

Figure 1. Northing vs Easting for Bad Static Data

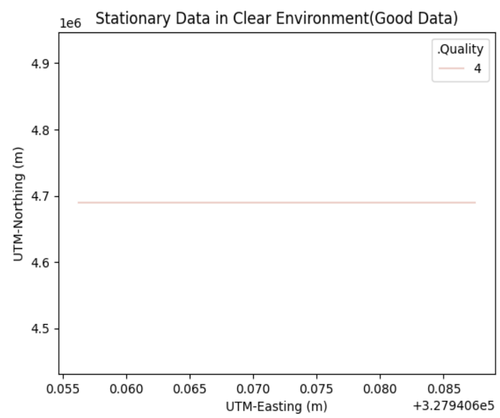

Figure 2.Northing vs Easting for Good Static Data

Stationary Data Statistics					
Obscured Environment			Clear Environment		
	Mean	Std Dev		Mean	Std Dev
Northing(m)	0.000000	0.000000	Northing(m)	0.000000	0.000000
Easting(m)	-0.029131	0.023755	Easting(m)	-0.025510	0.012101

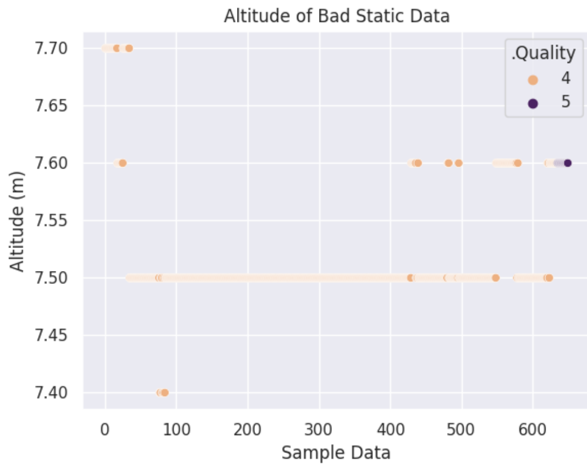

Figure 3. Altitude vs Sample Data for Bad Static

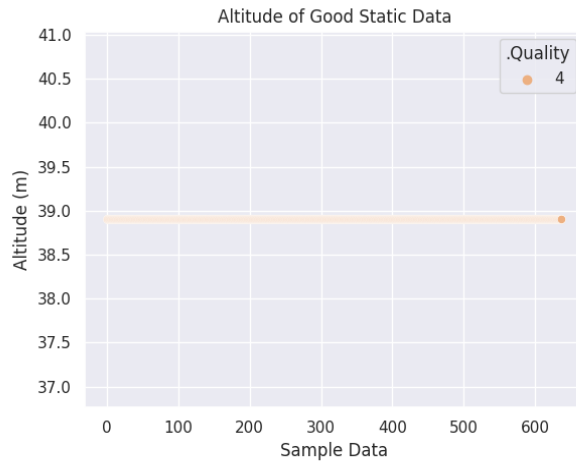

Figure 4. Altitude vs Sample Data for Good Static

The above figures show the altitudes for the stationary data. We can see in the clear environment data(good data) we can get the rtk gps in the fixed mode and it maintains the same altitude during the experiment. We can consider there is zero error in the case of altitude taken in the clear environment due to the fact thar there is a straight line plotted in the graph and with time there is no change in the altitude. While in the case of static data there is an error of about 0.15m due to that fact there is a fluctuation in the data obtained during this experiment.

Stationary Error Statistics		
	Mean Error	Root Mean Square Error
Obscure Environment	0.000932	0.037589
Clear Environment	0.000479	0.028235

When comparing stationary data in the two different locations we can see the clear environment data is much more accurate than the obscure one. The clear data mean error is 64% lower. The root mean square error is 28% higher for the obscure data.The distortions maybe caused by multipath effects, the signal of gps is reflected by the tall building for multiple times. Reflecting off ISEC and nearby building to be the largest factor in degrading GPS signals. These error margins at stationary data collection reveal one of the huge advantages of using RTK GPS as compared to the results from Lab1. Lab1 stationary data was highly unreliable for any real sort of GPS related navigation. The Rtk Gps has centimeter level accuracy. This is because the base station is at a fixed location and the sensor can rule out any variations in rover measurements as noise when the rover is completely stationary and remove them from the measured data.

Moving Data

The moving data was collected from the same locations as the stationary data. The walking experiment was conducted by walking in a measured rectangular path. The rover traveled along the path once and returned to the original starting point. For bad moving data the rtk was in float mode because the quality of the data was 5 during most of the experiment. While in the case of the Clear Environment we have a fixed quality of 4. The rtk is almost all in the fixed mode for the whole experiment.

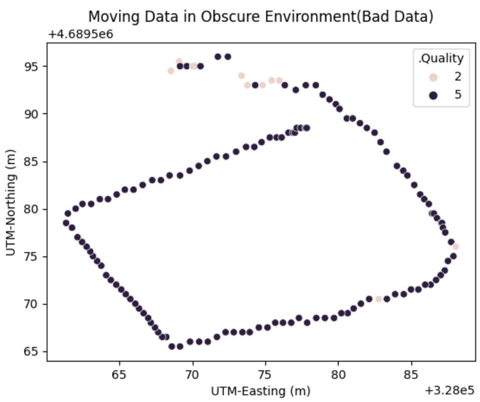

Figure 4. Northing vs Easting for Bad Moving Data

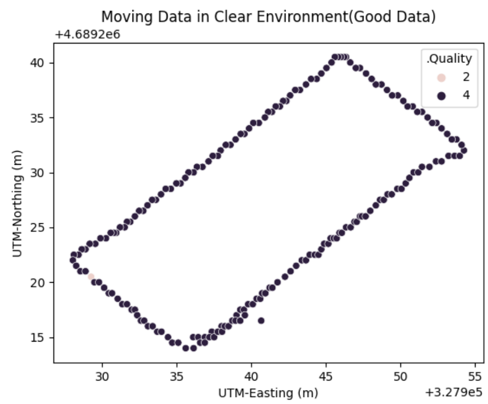

Figure 5.Northing vs Easting for Good Moving Data

Moving Data Statistics					
Obscured Environment			**Clear Environment**		
	Mean	**Std Dev**		**Mean**	**Std Dev**
Northing(m)	-14.860140	9.424786	Northing(m)	9.842105	7.887453
Easting(m)	6.302448	7.857512	Easting(m)	0.104934	7.299691

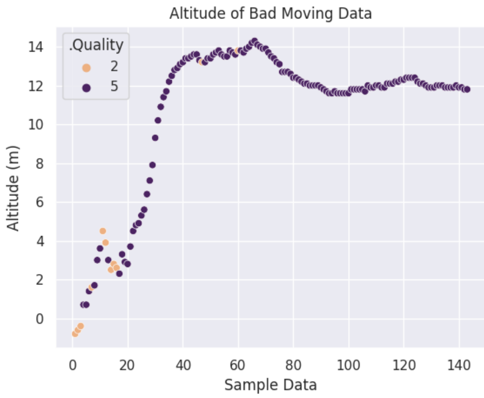

Figure 7. Altitude vs Sample Data for Bad Moving

Figure 8. Altitude vs Sample Data for Good Moving

Altitude data was also collected for the walking scenario in both locations. These inaccuracies are due to the fact that the benefits of RTK is less effective on vertical measurements than that of horizontal position measurements. Similar to the case of altitude in the walking data here also due to the obstruction of signals the gps is not in a fixed position in the case of the obstructed environment. While in the case of the clear environment you can see the gps is almost throughout in a fixed position. Similar to that of the stationary data the clear environment data is show to be more accurate. In the case of vertical measurements the obscure data the gps is shown to be accurate of 9.2m as there is no fixed mode and therefore proper analysis can't be done. While for the clear data we can see that the gps is accurate up to 0.8m . This may be due to the walking patterns of the humans during the experiment during which there may have been a shift in the height of the receiver of the rover.

Moving Error Statistics		
	Mean Error	Root Mean Square Error
Obscure Environment	0.657078	10.072802
Clear Environment	0.529575	7.300445

We can see that the clear environment has a 21% lower mean error rate. Also, the root mean square error is 32% higher for the data taken in the obscure environment. While the moving RMS errors are higher most of this can be attributed to human walking patterns. The common factor here with the stationary data is that in both cases the clear environmental data is much more accurate. We can see there is no fixed case for the obscure environmental data due to the presence of other buildings and structures

Conclusion and Analysis

As demonstrated in the analysis above, RTK GPS navigation is highly accurate compared to conventional GPS. However, RTK GPS precision is affected by the environment where the data is taken. Obstruction will degrade the quality of the signal. RTK-GPS provides better accuracy than normal GPS. The accuracy level of stationary data is 0.028m when there's no occlusion and 0.037m when near high building. The accuracy level of moving data is 7.3m when there's no occlusion and about 10m when near high building. Comparing with the result of LAB1 the data obtained in this lab is highly accurate. We can see that if there's no occlusion then RTK-GPS can provide high accuracy at centimeter level when it's stationary, and at meter level when its moving. As in the previous lab, the major source of error is multipath error, caused when GPS satellite signals deflect off environmental obstructions. This is reduced by the base, which computes its own location as a reference point, and compares it to the value obtained from GPS satellite data. If there are sudden fluctuations in the value being obtained from satellites, the base can send correcting data to the rover to offset these changes in data. There is also another source of error called Ephemeris error. The ephemeris errors are the differences between the true satellite position and the position computed using the GNSS navigation message.