GPS RTK Data Analysis

1. Clear Unobstructed Position Stationary Data

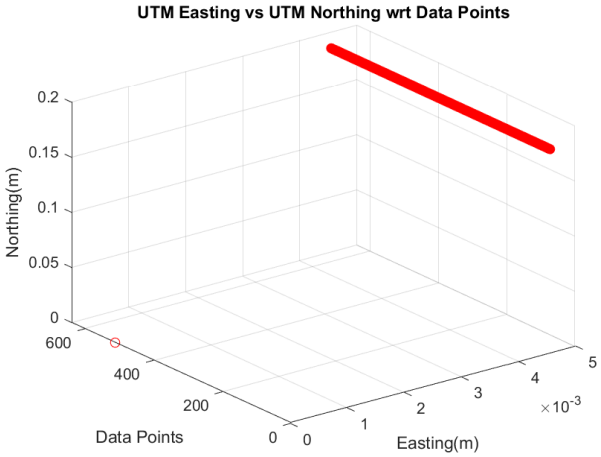

Figure 1

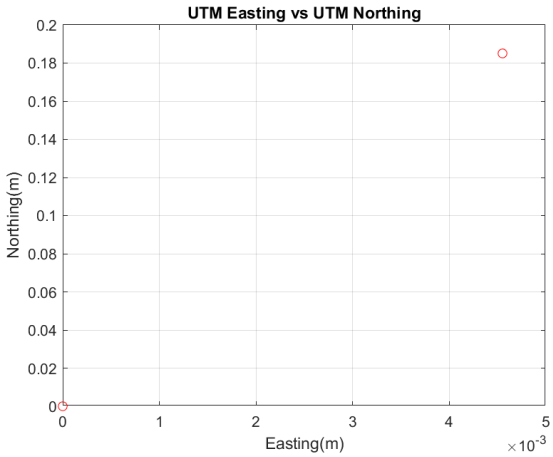

Figure 2

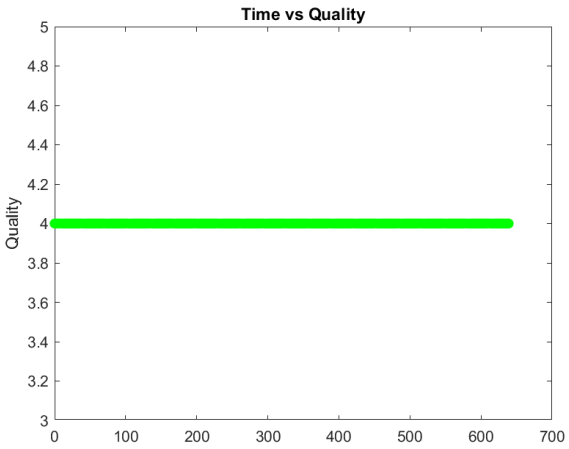

Figure 3

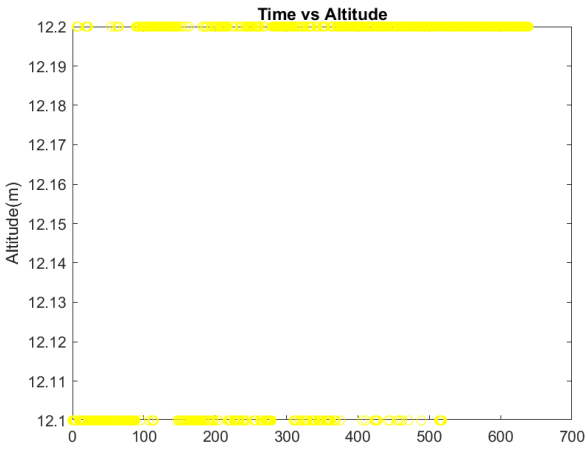

Figure 4

	Northing(m)	Easting(m)	Altitude(m)
Min	4689324.583522462	327774.6079719197	12.10
Mean	4689324.768303935	327774.6125148215	12.16671875
Max	4689324.768593111	327774.6125219299	12.1999
Mean – min	0.1847814	0.004542	0.0667
Mean – max	-0.000289	-0.000007	-0.0331
Std	0.007315	0.000179	0.047158

Table 1

From the graph and the table, we can see that for **Northing** the **max variance from the mean is of 18cm** and the **min variance from the mean is of 0.02mm**. from Fig1 it can be seen that the max data points lie

at the point 4689324.76859311 and there is one stray point that is 18 cm away from the data set. For **Easting**, the **max variance from the mean is of 0.45mm** and the **min variance from the mean is of negligible.** This can be attributed as a very clean data set without much error sources and this observation is in collation with how RTK GPS is supposed to work and hence can be concluded that the error estimates for this method are in the cm level accuracy.

From the Fig 3 we see that the quality of the **RTK GPS doesn't drop from the fixed mode** which again shows that the data is very accurate.

The **Altitude of the data set varies in the range of 4cm**. This is also very accurate. One hypothesis for the noisy altitude can be due to the difference at which the Base and the Rover GPS were kept at. The Base can only cancel out the noisy altitude data which it calculates according to the position it is kept at, but the same errors may not propagate for the Rover being kept at a different altitude. Hence, we see that the Base does try to RTK the errors and hence we see a variation.

2. Unclear Obstructed Position Stationary Data

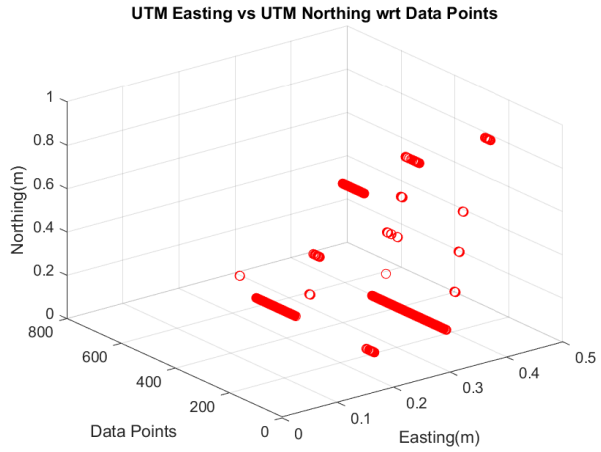

Figure 5

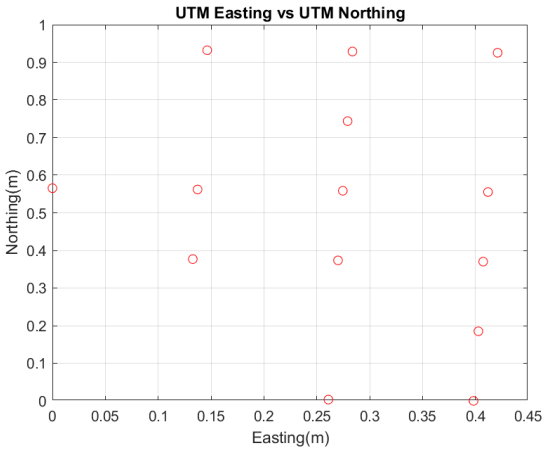

Figure 6

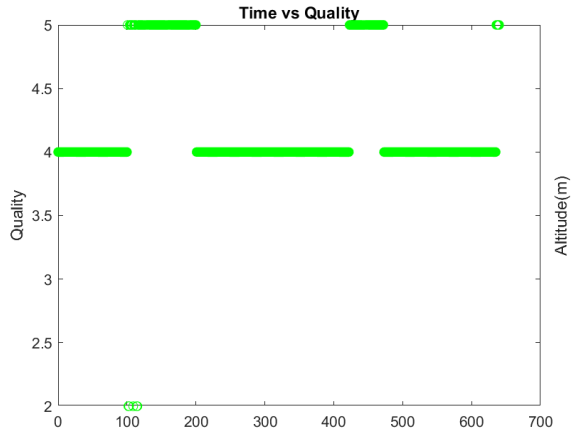

Figure 7

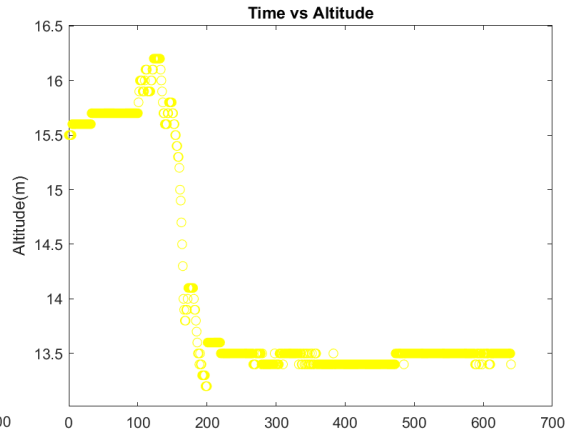

Figure 8

	Northing(m)	Easting(m)	Altitude(m)
Min	4689340.763149868	327613.3118078022	13.199999999999999
Mean	4689341.012079809	327613.6201682191	14.059438377535121
Max	4689341.695261024	327613.7328368218	16.199999999999999
Mean – min	0.2489	0.3083	0.85941
Mean – max	-0.6831	-0.1126	-2.14056
Std	0.38581	0.098005	0.987852

Table 2

From the graph and the table, we can see that for **Northing** the **max variance from the mean is of 68cm** and the **min variance from the mean is of 25cm** For **Easting**, the **max variance from the mean is of 30cm** and the **min variance from the mean is 11cm.** From the data we can see that the standard deviation for Northing and Easting is 38cm and 11cm respectively. This can be considered as a good data set as in the unclear obstructed scenario error can be associated with the reflections from buildings, trees, and multiple sources of reflection and hence the error can be justified. The noise in the data is seen to be more than the clear situation and that too is an expected result.

From the Fig 3 we see that the quality of the **RTK GPS does fluctuate between float and fixed mode** which again shows that the data is not stable and hence RTK processing cannot be as accurate as it could have been at a fixed mode

The **Altitude of the data set varies in the range of 98cm**. This is very noisy data, and we can see from the graph, as the time increases, the altitude drops down to the altitude as we saw in the clear dataset, this shows that by eliminating the error sources the base is doing multiple calculations to try and narrow down the error. From the graph of quality, we can relate that the altitude bumped up when the quality went to float and then again fixed mode was achieved and then altitude correction started to work.

3. Clear Unobstructed Position Moving Data

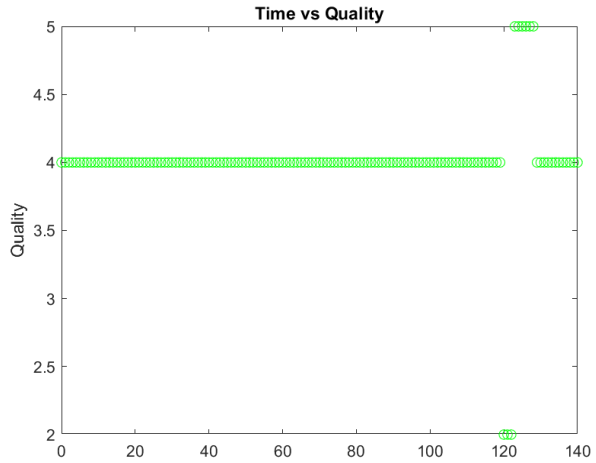

Figure 9

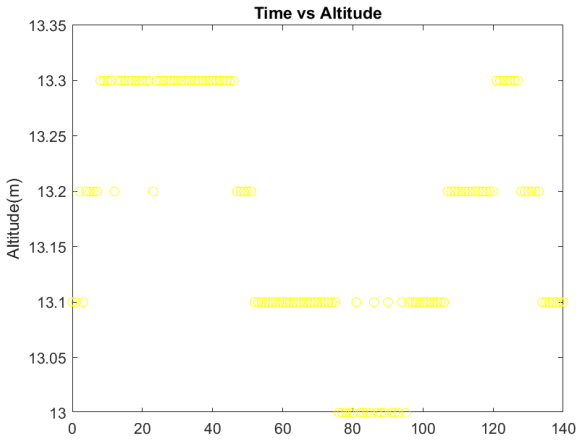

Figure 10

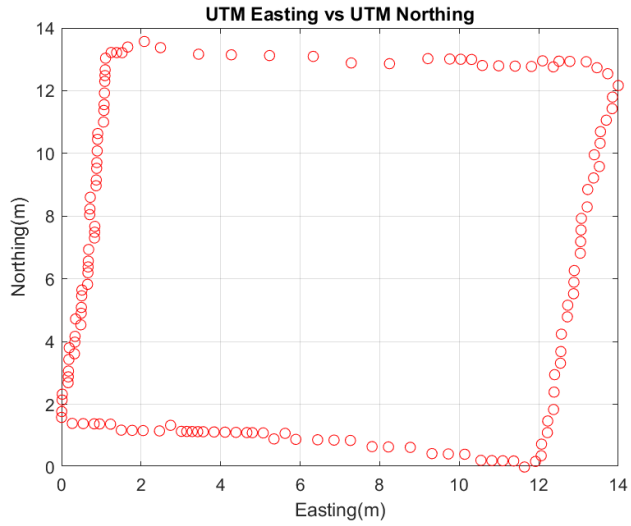

Figure 11

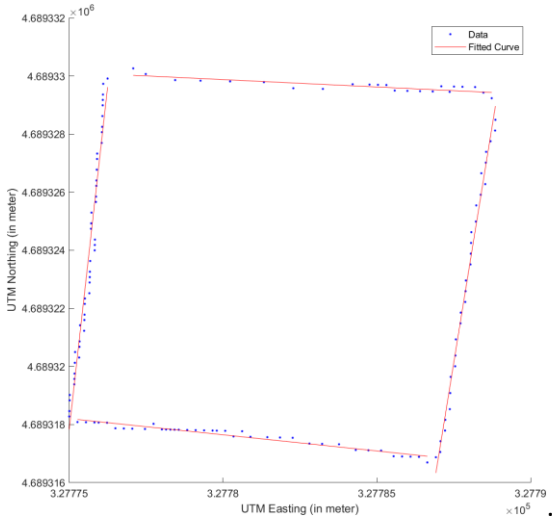

Figure 12

	Error (Point from Fit Line)	Altitude
Max	33cm	
Mean	10cm	13.17
Std	8cm	10cm

Table 3

From the Graphs and the Table above we can see that the dataset collected in the open clear unobstructed condition has a **mean altitude of 13.17m above mean sea level**. The altitude graph does jump about in quantized manner but the **standard deviation for the same is about 10cm**. This is a very good data set and the error can be accounted due to 1. Human Factors (As the data collection was done with the sensor in hand) 2. Variation in the Field as the field where the data was collected was not evenly flat. These two errors can be considered to be within the 10 cm bandwidth. **This verifies the working of the RTK GPS.**

Considering the moving data, we see from the Easting vs Northing graph that the lines are not exactly straight , this could be attributed to the uneven field as well as human error. If the person were to talk in a straight line then the error can be calculated. From the Figure 12 we can fit lines to the data set and then figure out the deviation from the line as the error (assuming the data collection was done in the straight line). **The max error from the line comes to be about 33cm** and the **mean error is about 10cm. The standard deviation** from the line when averaged over the rectangular path comes to be **about 8cm**. **This cm level accuracy can be attributed to the RTK GPS.**

4. Unclear Obstructed Position Moving Data

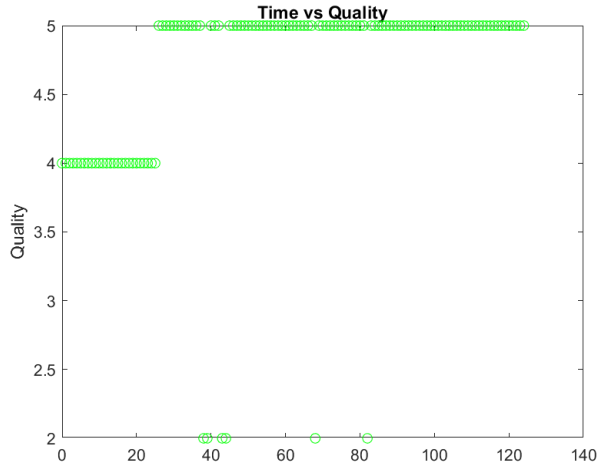

Figure 13

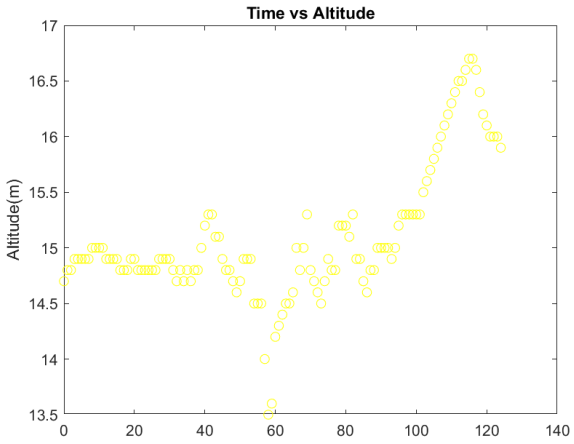

Figure 14

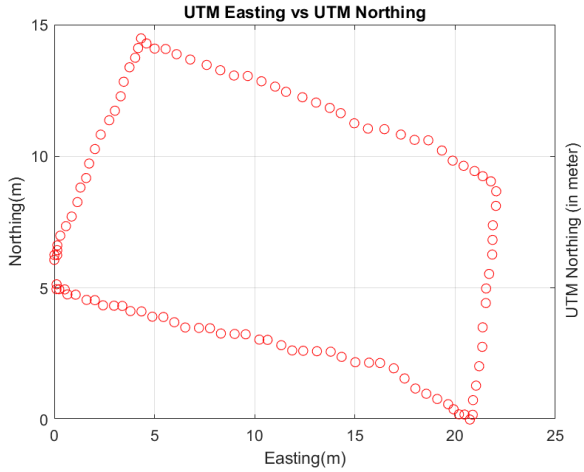

Figure 15

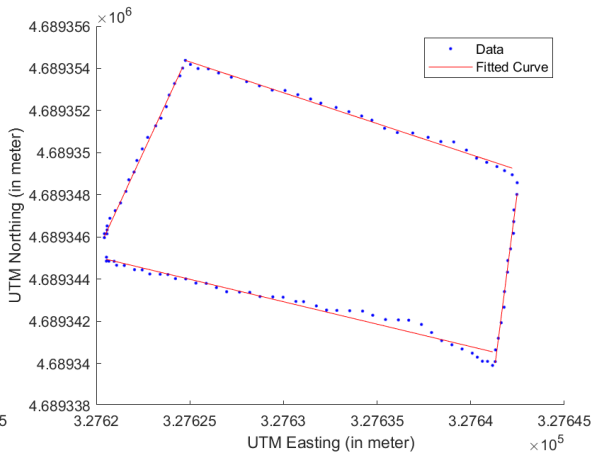

Figure 16

	Error (Point from Fit Line)	Altitude
Max	100cm	
Mean	18cm	15.08
Std	23cm	60cm

Table 3

From the Graphs and the Table above we can see that the dataset collected in the unclear obstructed condition has a **mean altitude of 15.08m above mean sea level**. The altitude graph does jump about in quantized manner but the **standard deviation for the same is about 60cm**. This is a not a good data set and the error can be accounted due to 1. Human Factors (As the data collection was done with the sensor in hand) 2. Variation in the Field as the field where the data was collected was not evenly flat 3. The reflections from buildings and trees. These errors can be considered to be within the 60 cm bandwidth. **This verifies the working of the RTK GPS.**

Considering the moving data, we see from the Easting vs Northing graph that the lines are not exactly straight , this could be attributed to the uneven field as well as human error. If the person were to talk in a straight line then the error can be calculated. From the Figure 12 we can fit lines to the data set and then figure out the deviation from the line as the error (assuming the data collection was done in the straight line). **The max error from the line comes to be about 100cm** and the **mean error is about 18cm. The standard deviation** from the line when averaged over the rectangular path comes to be **about 23cm**.This kind of data collected in an obstructed field with reflections from multiple buildings and trees can be attributed to this type of error. There could also be noise in the data and hence this leads to errors. We even see from the GPS quality graph that the RTK status keeps fluctuating a lot from fixed and float mode and hence the error in the Base may not always be RTKed over the Rover. These sources of errors were expected and the dataset verifies it.