RSN Lab-2 Report

Location of data-collection: On-Campus

Location of unobstructed stationary and moving data-collection: Centennial Common

Location of obstructed stationary and moving data-collection: West Village Quad

Data Courtesy: Team 2

Overview:

The system comprises of two GNSS receivers; a base and a rover. The base is setup at a particular place and is completely stationary from the start of the process till the end of the process. The other GNSS receiver is the rover which is moved around or held stationary as per the data that is being collected.

The base station is allowed to calibrate itself in a particular position. Now, it is held stationary. The rover then sends its location data to the base station which then sends back the corrected data. As the base station is stationary, it can make correction for the errors that disrupts the incoming GPS data and makes the necessary correction. It then sends the corrected data back to the rover which is far more accurate. This way, we get the precise location of the rover.

There are 4 sets of collected data:

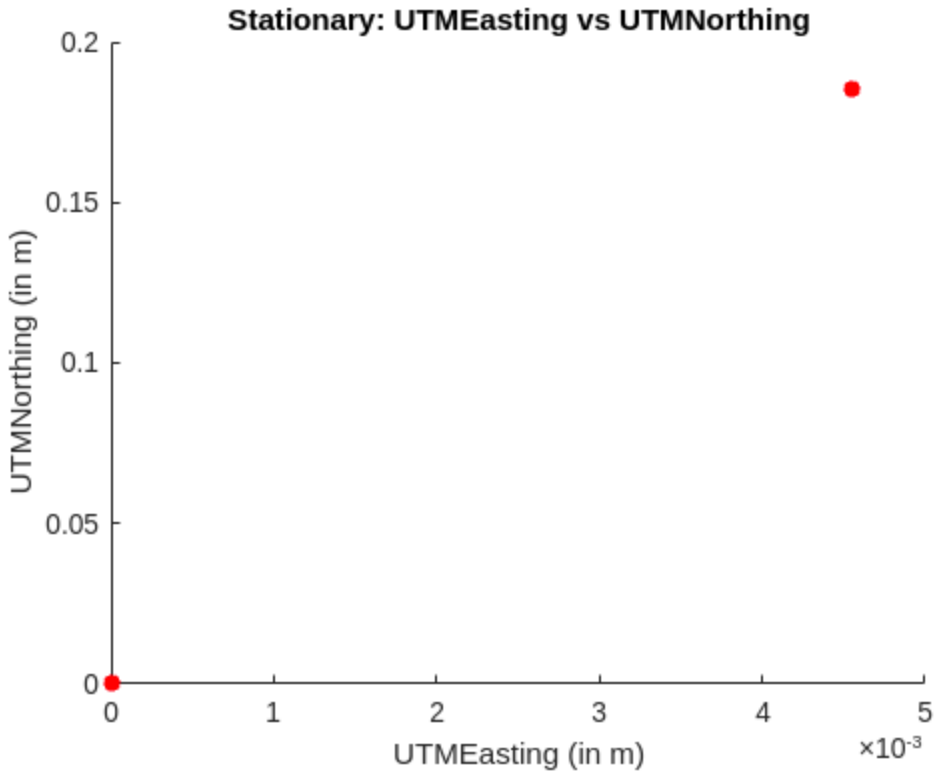
1) The data is collected in an open environment with minimum disturbance and reflection from the nearby resources.
2) The data is collected in an obstructed environment where the reflection of signals from nearby buildings interferes with the data.

For both the scenarios, both the stationary and moving data has been collected.

The data collected for all the 3 except for the Building side moving data is in the RTK fix format while the Building side moving data is in the RTK float format.

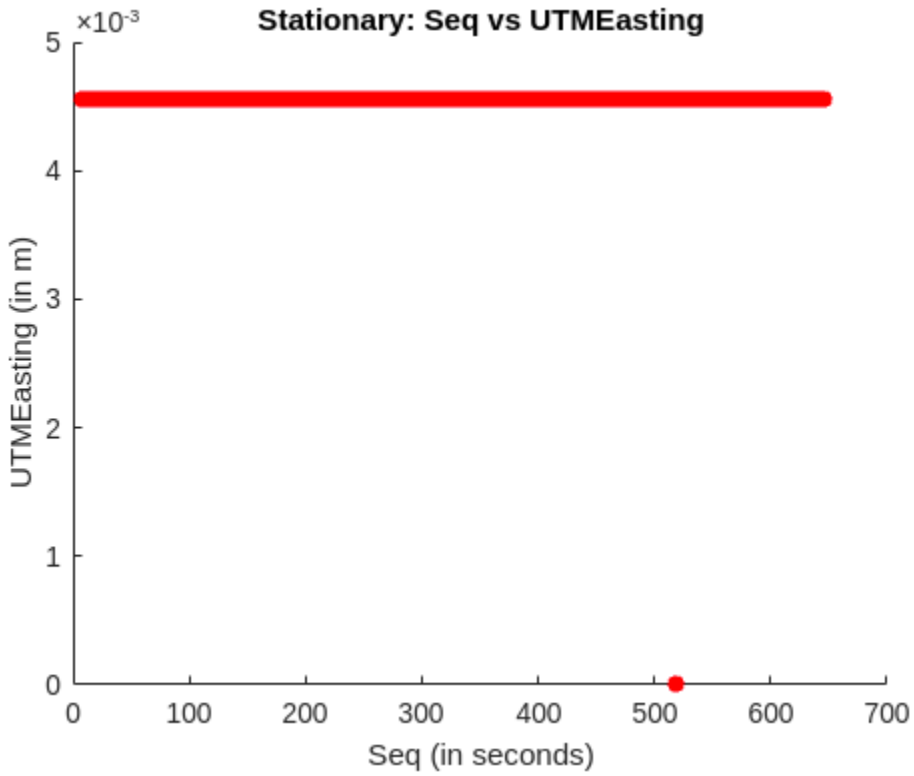
Open field Data: Stationary

Fix Quality = 4 (RTK Fix)

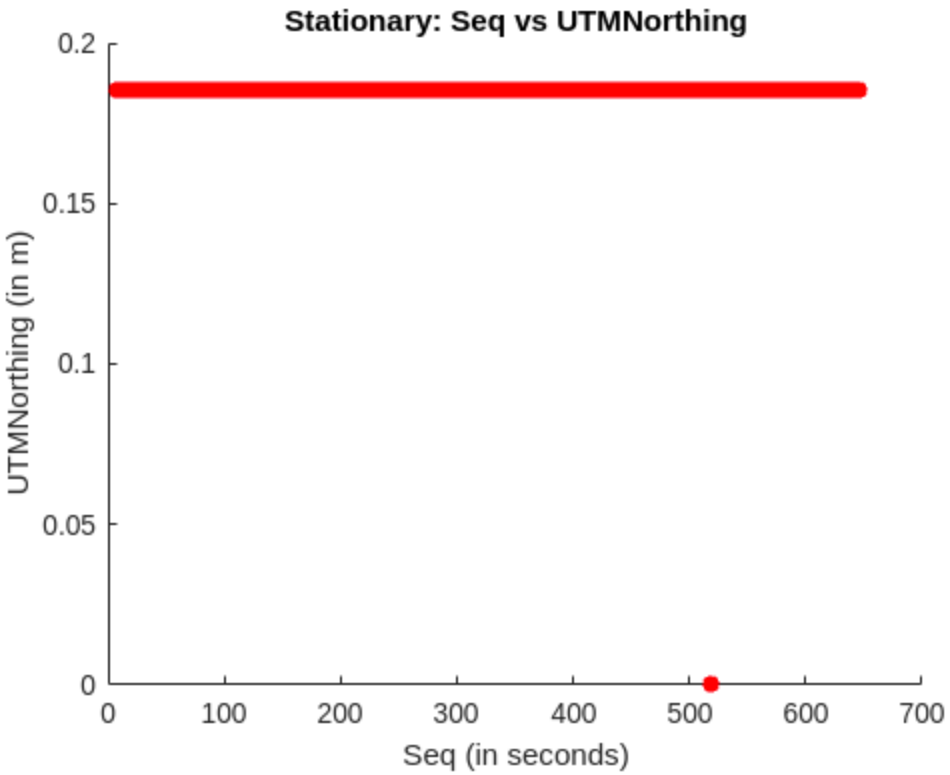


The above graph represents the UTMEasting vs UTMNorthing values for the stationary data collected in an open field. We can observe that the data is precise and plotting it on the real map will determine it's accurate as well.

The precision of this data can be attributed to the corrections made by the base station. The UTMEasting value varies in the range of approximately 0.0045 m while the UTMNorthing value varies in the range of approximately 0.18 m.



The above graph represents the plot between time and UTMEasting data. We can observe that the data is constant for whole of the duration except for a particular point which could be because of a bad signal or a bird flying or because of wind or other such factors.



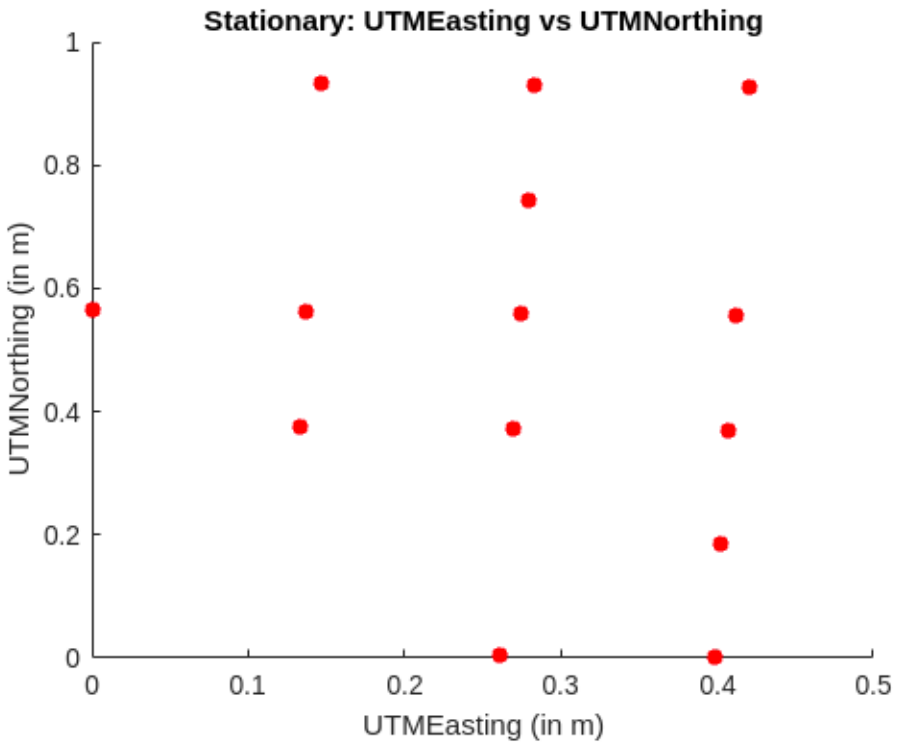
The above graph represents the plot between time and UTMNorthing data. Similar conclusions can be made as done in the time and UTMEasting graph.

```
s_mean_utme = 3.2777e+05
s_mean_utmn = 4.6893e+06
s_mean_alt = 12.1667
s_std_utme = 1.7985e-04
s_std_utmn = 0.0073
s_std_alt = 0.0472
s_var_utme = 3.2348e-08
s_var_utmn = 5.3517e-05
s_var_alt = 0.0022
```

The above image shows the statistics calculated from the collected data. It displays the information about mean, standard deviation and altitude of UTMEasting, UTMNorthing and Altitude data.

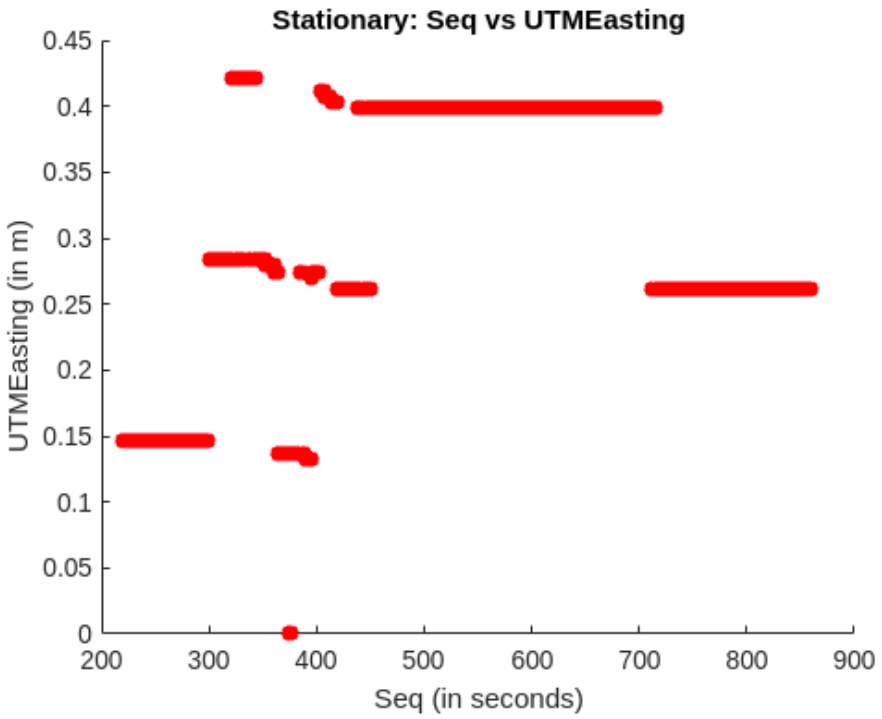
Building side Data: Stationary

Fix Quality = 4 (RTK Fix)

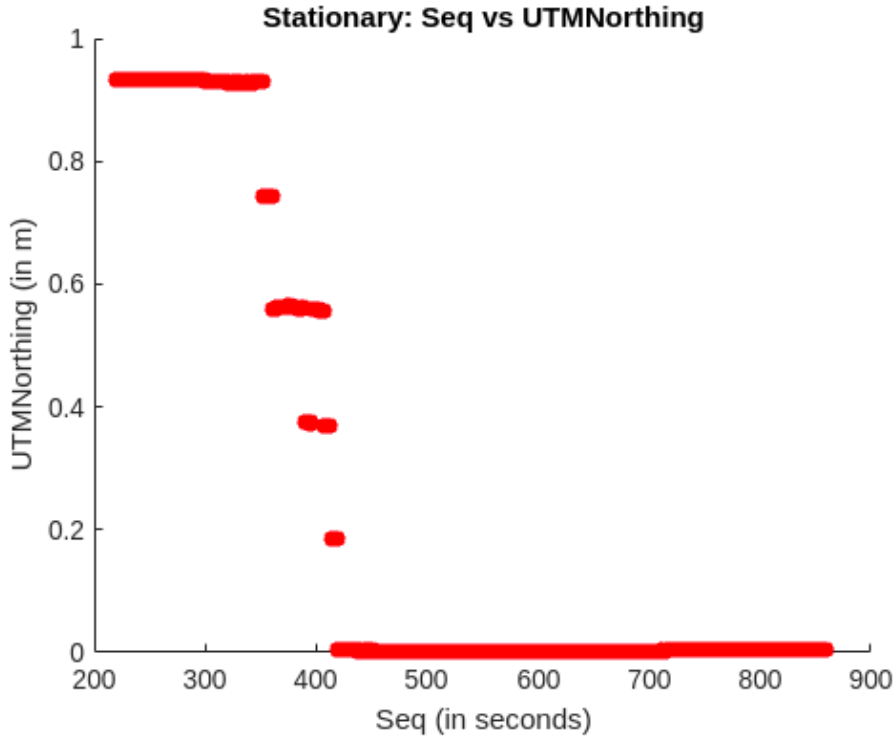


The above graph represents the plot between UTMEasting and UTMNorthing values for the stationary data collected in a building side area. We can observe that the data is a little more sparse and less precise than the data collected in an open field because of the interference of nearby objects and reflection of signals from the building.

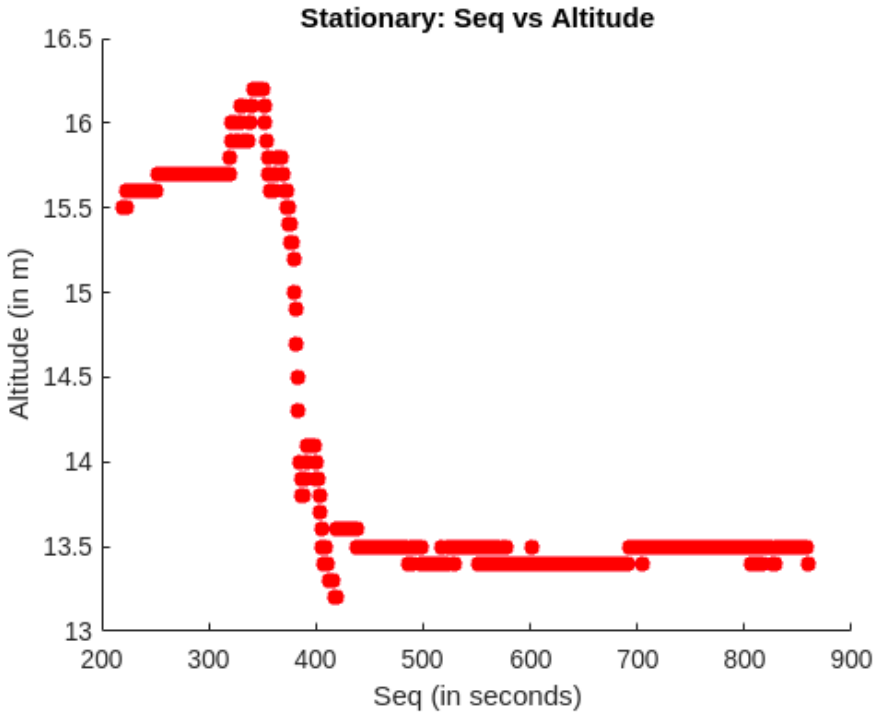
It can be observed that the UTMEasting data is in the range of 0 m to 0.45 m which is almost 100x of the data observed for the stationary values while the UTMNorthing data is in the range of 0 m to 0.95 m which is considerably greater than the previously observed data in an open field.



The above plot represents the changing values of UTMEasting with that of time. We have more values than compared to the open-field data and the data is more distributed as well. This is caused by the interference from nearby objects and the signals reflecting from the building.



The above plot represents the changing values of UTMNorthing with that of time. We have more values than compared to the open-field data and the data is more distributed as well. This is caused by the interference from nearby objects and the signals reflecting from the building.



The above plot represents the changing values of Altitude with that of time. We can observe that the value of altitude ranges between 13 m to 16.5 m approximately.

```
s_mean_utme = 3.2761e+05
s_mean_utmn = 4.6893e+06
s_mean_alt = 14.0594
s_std_utme = 0.0980
s_std_utmn = 0.3858
s_std_alt = 0.9879
s_var_utme = 0.0096
s_var_utmn = 0.1489
s_var_alt = 0.9759
```

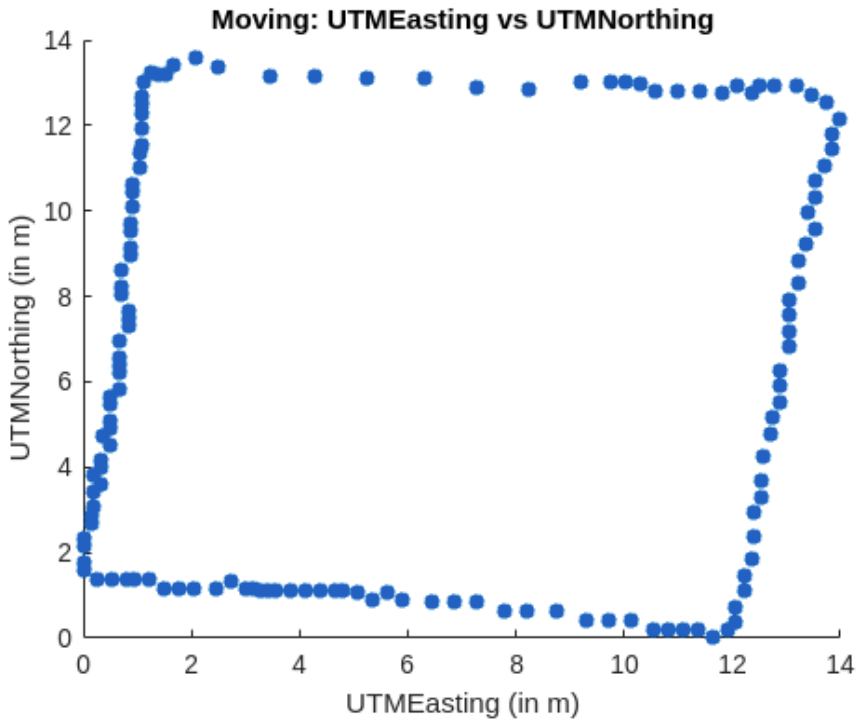
The above image shows the statistics calculated from the collected data. It displays the information about mean, standard deviation and altitude of UTMEasting, UTMNorthing and Altitude data.

One important thing to note from comparing the above two datasets is that while the base station can take care of the errors like changes in environment, errors in satellite vehicles, errors caused by the time clock and other such anticipated errors but the correction is a little off when it comes to disturbances from the surroundings like the data being reflected from the building or other electromagnetic interferences.

The possible reason for this could be that the base station is able to rectify the errors and accurately correct the data for which errors in both the base and rover are of similar kind. As the base location is known, it is corrected for the rover.

Open field Data: Moving

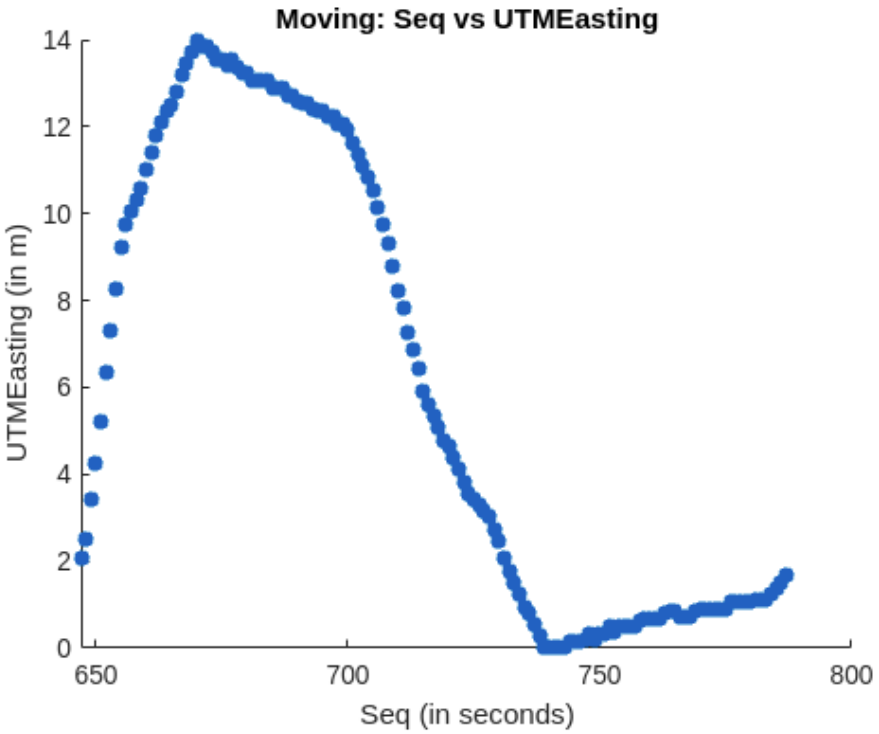
Fix Quality = 4 (RTK Fix)



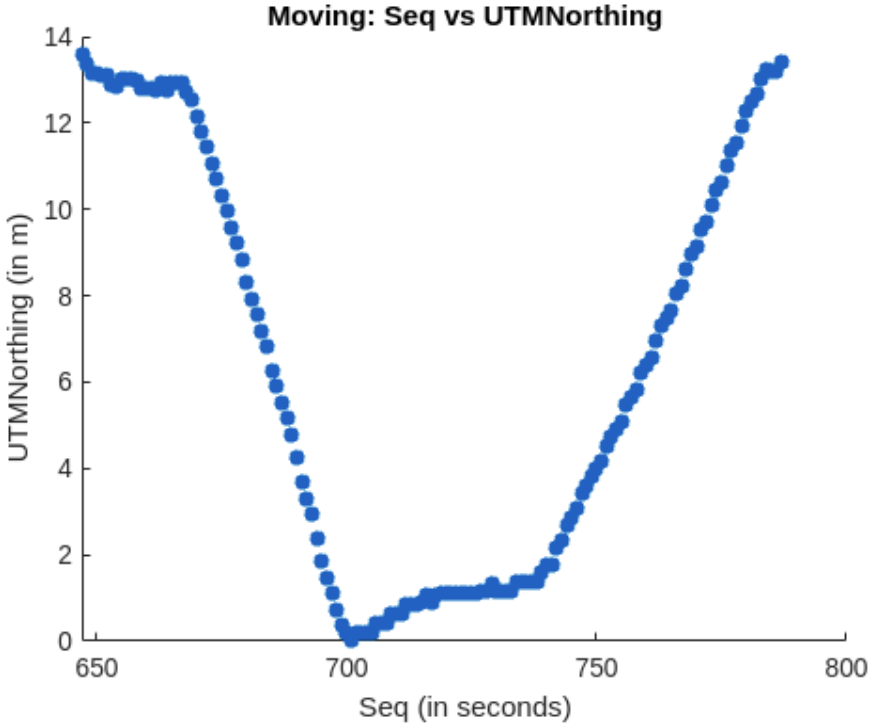
The above graph shows the plot between UTMEasting vs UTMNorthing data values collected in an open field while moving in a square shape. As the field is open, we can observe that the lines are nearly straight. The data we received was in the fix format though it did fluctuate to float format sometimes which could have been the source of error.

The little deviation that can be seen could also be because of human error as the person had to walk in a straight line while carrying the laptop and holding the GNSS receiver in hand.

The deviation of UTMNorthing data from its mean is determined to be approximately 0.85 m while the deviation of UTMEasting data from its mean is determined to be approximately 1 m.



The above graph shows the variation of UTMEasting with time. We can observe that the starting point and the ending point values of the graph for UTMEasting are similar which is because the rover returned to the initial point after moving in a rectangular manner.



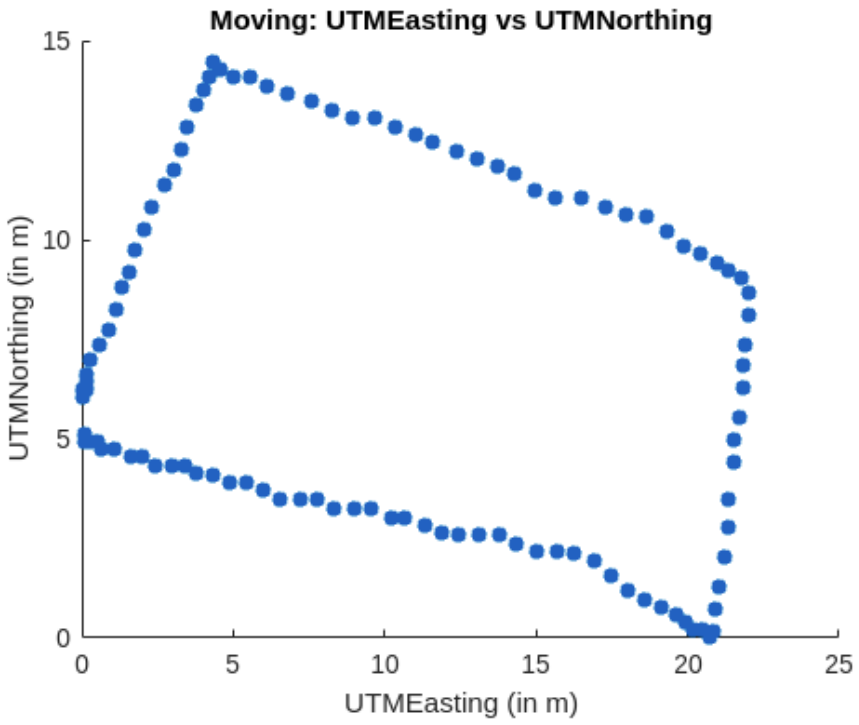
The above graph shows the variation of UTMNorthing with time. We can observe that the starting point and the ending point values of the graph for UTMNorthing are similar which is because the rover returned to the initial point after moving in a rectangular manner.

```
mean_utme = 3.2778e+05
mean_utmn = 4.6893e+06
mean_alt = 13.1738
std_utme = 5.2759
std_utmn = 4.8509
std_alt = 0.1026
var_utme = 27.8351
var_utmn = 23.5313
var_alt = 0.0105
```

The above image shows the statistics calculated from the collected data. It displays the information about mean, standard deviation and altitude of UTMEasting, UTMNorthing and Altitude data.

Building side Data: Moving

Fix Quality = 5 (RTK Float)

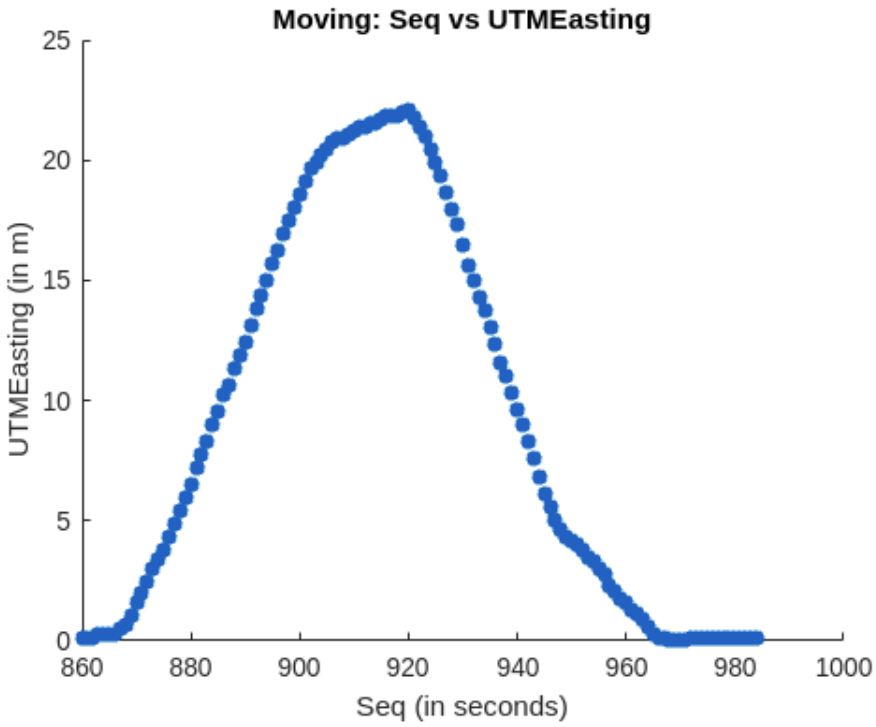


The above image shows the plot of UTMEasting vs UTMNorthing data collected by moving along the building side. It is important to note that for this particular dataset, we received the data

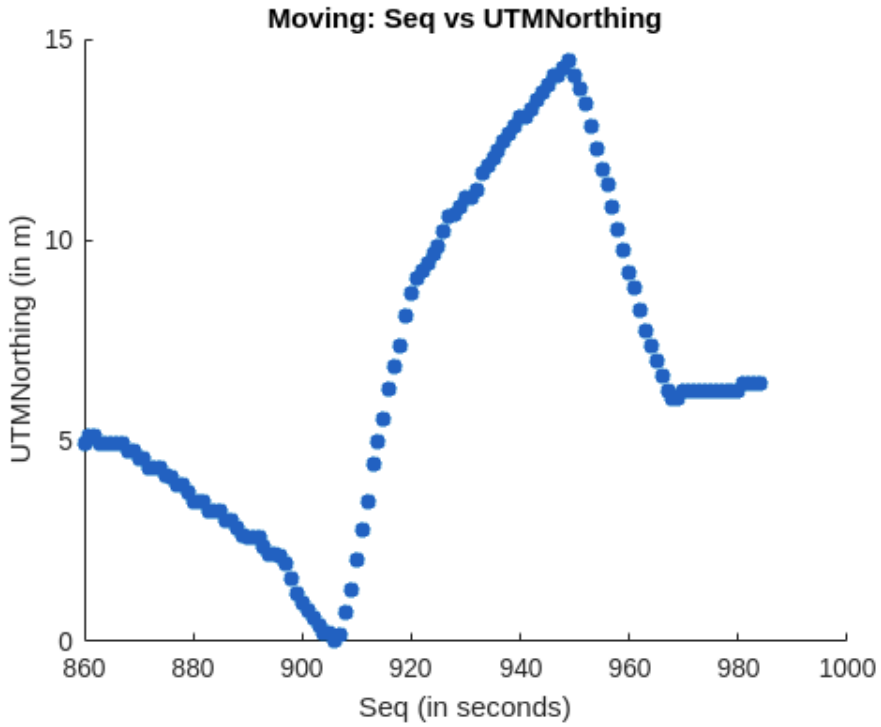
in RTK float format and hence the distribution is more as compared to the previous three while the error is maximum.

We can observe from the graph that the rectangle is not perfect, and the data is deviated, slanted along some points. Also, it does not capture accurately the initial and final positions and they are not coinciding as they should be. The deviation in data from the mean is approximately 5 m for the UTMEasting data and 2.5 m for the UTMNorthing data. This, when compared to the data collected in an open field with the data in RTK fix format, is considerably larger.

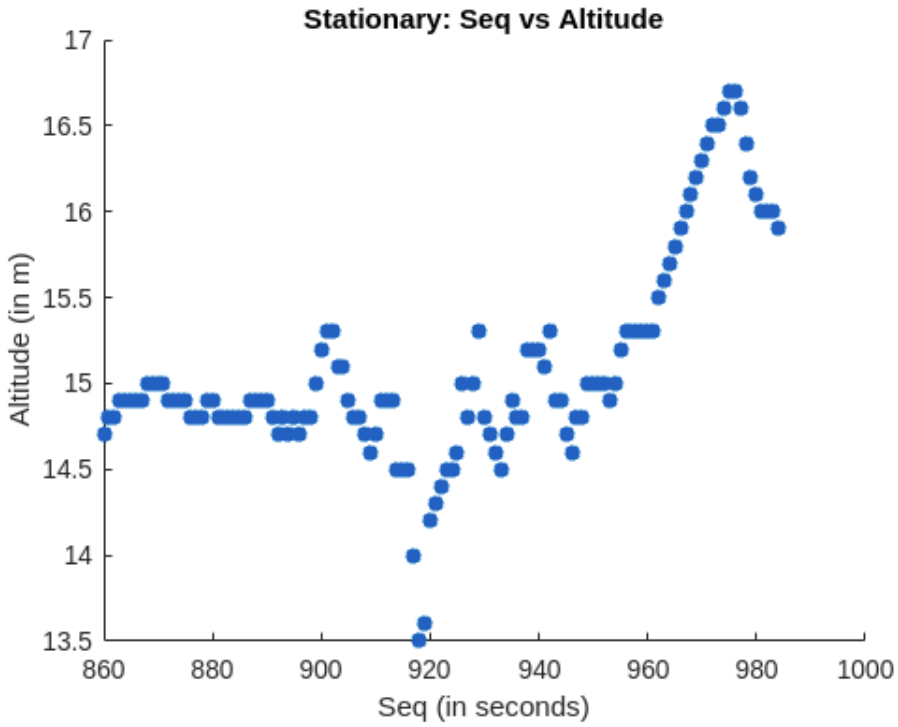
While a part of the error could also be because of human error, the maximum contribution according to my observation is because of the surrounding buildings which reflected the signals as well as interference from other electric and magnetic objects.



The above graph shows the variation of UTMEasting with time. We can observe that the starting point and the ending point values of the graph for UTMEasting while nearer to each other, does not exactly coincide even though the rover returned to the initial point after moving in a rectangular manner. The error can be attributed to the building side area.



The above graph shows the variation of UTMNorthing with time. We can observe that the starting point and the ending point values of the graph for UTMNorthing while nearer to each other, does not exactly coincide even though the rover returned to the initial point after moving in a rectangular manner. The error can be attributed to the building side area.



The above plot represents the changing values of Altitude with that of time. We can observe that the value of altitude ranges between 13.5 m to 17 m approximately.

```
mean_utme = 3.2763e+05
mean_utmn = 4.6893e+06
mean_alt = 15.0848
std_utme = 8.1010
std_utmn = 4.0838
std_alt = 0.6007
var_utme = 65.6269
var_utmn = 16.6773
var_alt = 0.3608
```

The above image shows the statistics calculated from the collected data. It displays the information about mean, standard deviation and altitude of UTMEasting, UTMNorthing and Altitude data.

Conclusion:

The error in the stationary data collected in an open field is the minimum.

The error in the stationary data collected near the building side and moving data collected in an open field is comparable, but the stationary data collected near the building side has a slightly less error.

The error calculated in the moving data collected near the building side is the highest.