<u>Lab 3 Analysis - Kyle Coelho</u>

Location: Outside ISEC

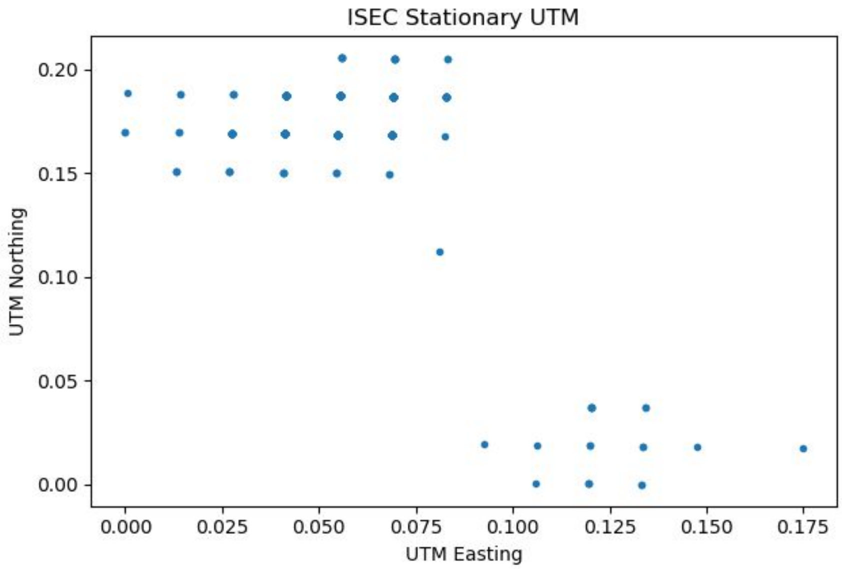

Fig. 1

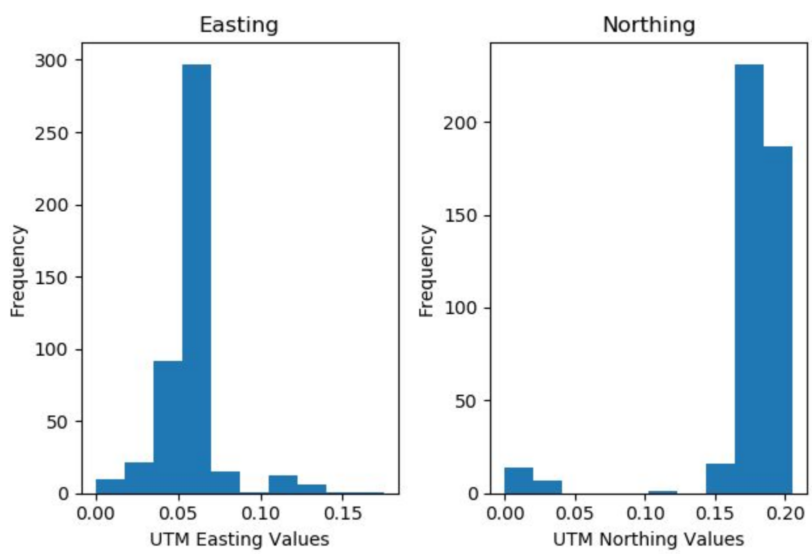

Fig. 2

Data was taken while sitting outside ISEC. Figure 1 above shows corrected UTM Easting and Northing values. There is a cluster of outlier points that represent multipath from reflections due to nearby buildings. There are higher than expected easting values and lower than expected northing values. The variance in the Easting values is 0.00043m and 0.0012m for the Northing values. This is much lower than the variance in the stationary data from Lab 1. While I was unable to compare it with my data, the variance in stationary data for several of my group members was approximately 1.5m. In Figure 2, The histogram for the data shows that the Easting values are normally distributed but the Northing values have a bimodal distribution or another indiscernible distribution.

When considering noise, the lower right point cluster in Fig 1 seems to be the largest contributor to the overall noise profile. A histogram of this point distribution is shown in Fig 3 below.

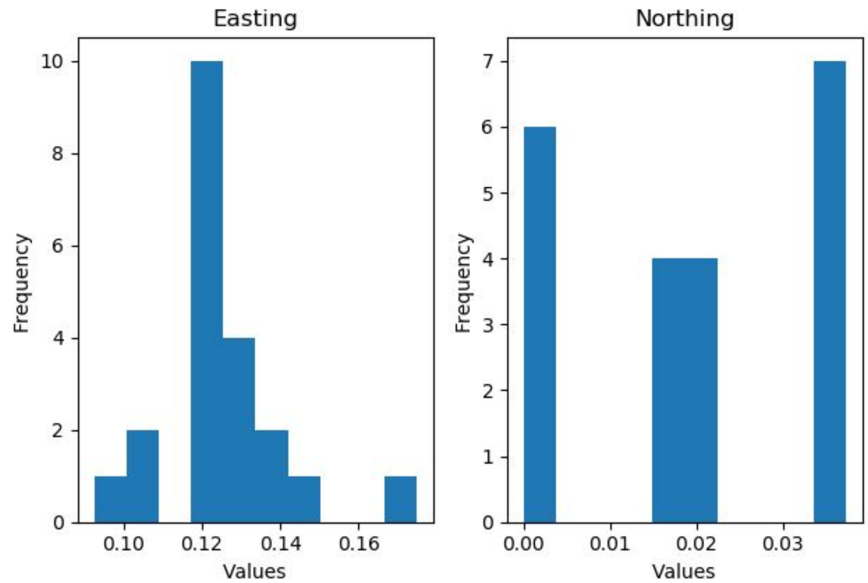

Fig. 3

The noise distributions for the Easting values seem to be normally distributed but for the Northing values, they take on a different kind of multimodal distribution. This noise, if removed from the dataset makes the data distribution look Gaussian for the Northing, similar to the Easting. This is shown in Fig 4 below.

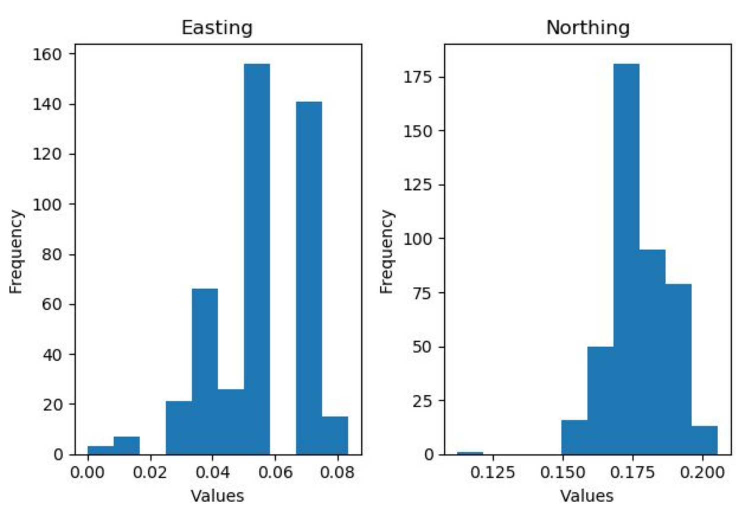

Fig. 4

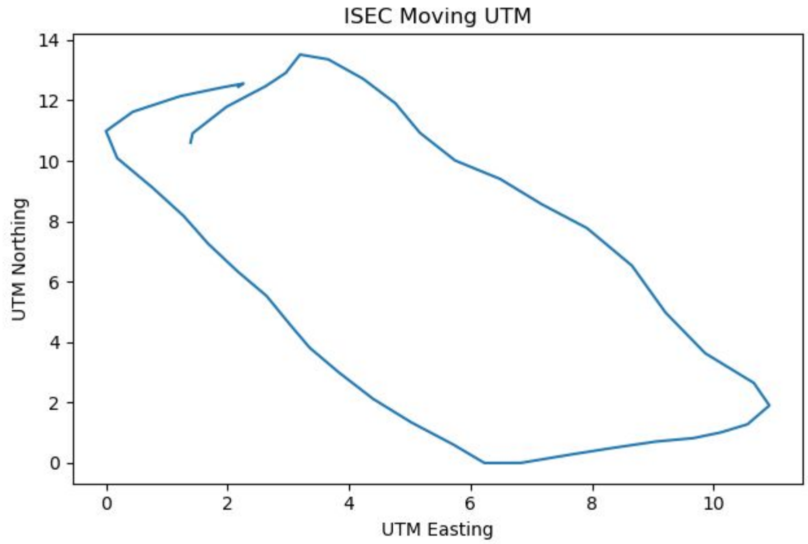

Fig. 5

The path taken is quite accurate from initial observation. However, the start and end points do not match up as we expect. The distance between the start and end position shows up as 2.01 metres even though it should be much less since we stopped around the same spot where we started. Additionally, the areas where we walked in a straight line do not appear to be very straight. The 3 straight line walking segments were analysed separately and trend lines were drawn for each so that the RMSE could be calculated. The average value for this is 0.040m. This is surprisingly slightly higher than the RMSE from LAB 1, which was approximately 0.0039m. It is unclear why this could be the case but it might be due to either signal blockage or the multipath, which was not the case in LAB1 where I walked in a straight line in an open area.

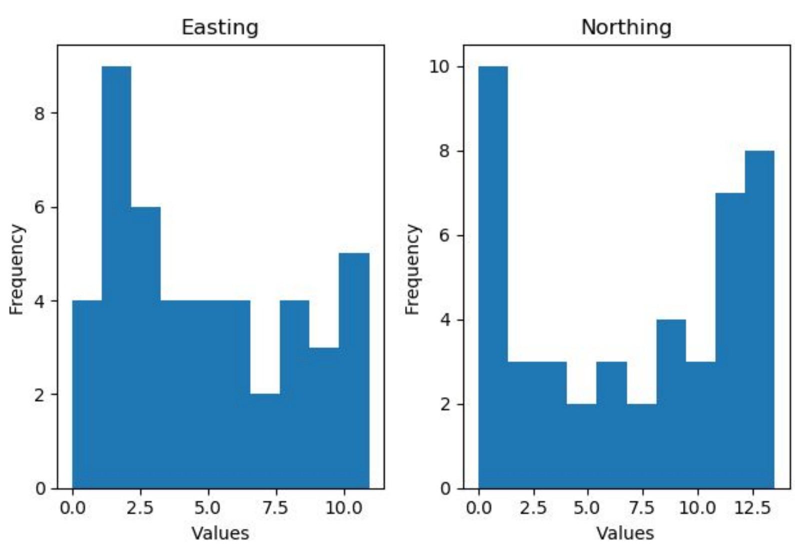

Fig. 6

The data distribution in Fig 6 for the moving data seems uniform for Easting and Northing data and is similar in distribution to the walking data from LAB1.

Location: Middle of Carter Playground

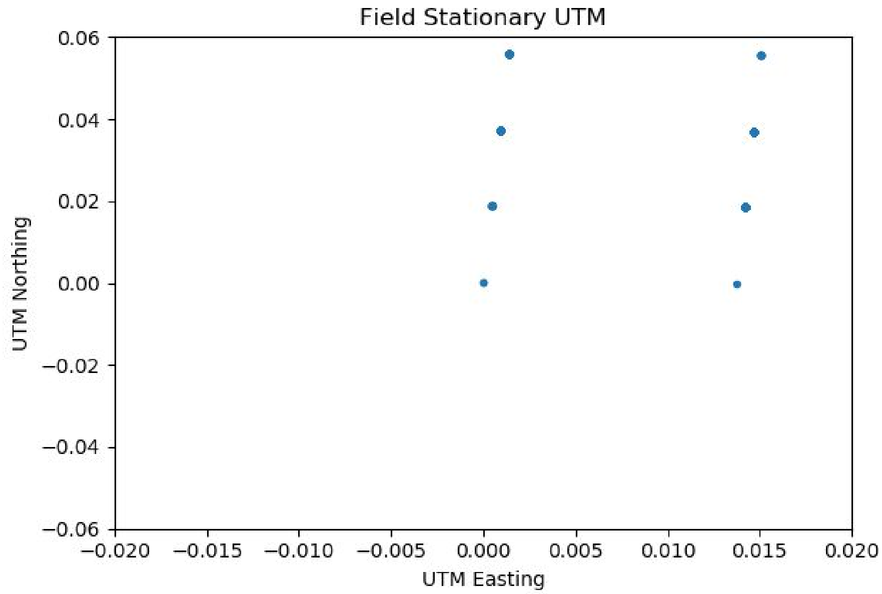

Fig. 7

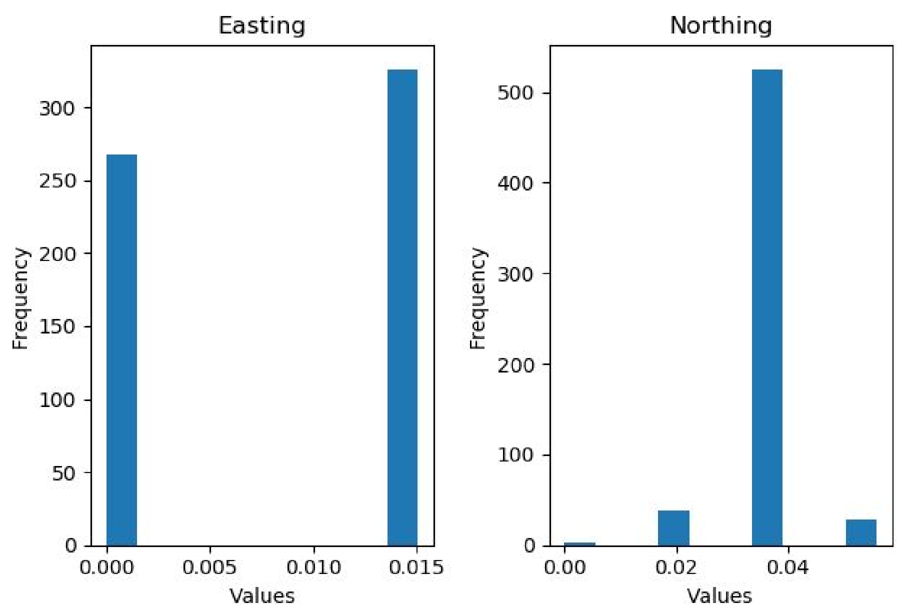

Fig. 8

The field data was collected on a cloudy day but the RTK fix was always maintained at either 4 or 5 throughout all the data collecting. Figure 7 shows that the data is very accurate as the easting values take either one of two values and the northing values take either one of four values. It does not seem like there are any outliers and the variance for this data set is 4.64e-05m for Easting values and 4.51e-05m for Northing values. This, compared to the data outside ISEC, makes it 10 times less noisy for Easting values and approximately 25 times better for Northing data. When comparing altitude data for stationary datasets, there does not seem to be any clear difference between the ISEC and Carter datasets, so the UTM data should be the best way of comparing these two stationary datasets. In Figure 8, the distribution of points shows this as both show a multimodal distribution for the data points, with Easting values being bimodal. Considering that the ideal data should have only a single peak, this seems very accurate. It is difficult to determine error estimates for this dataset since there are no visible outlier points and the thresholds for determining error points would be too small.

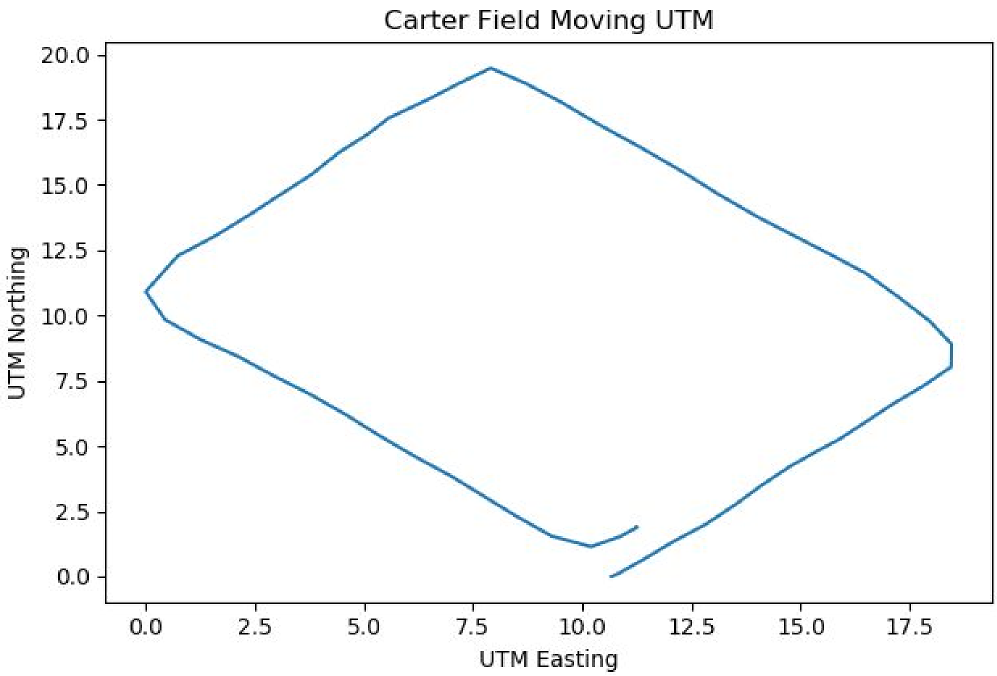

Fig. 9

Fig 9 shows the walking in straight lines dataset. Even when in an open field, the line does not end where it started even though our team mate stopped roughly in the same position. The difference in this distance is 1.98m, which is about a metre less than the ISEC dataset. While it might indicate less noisy data, it is difficult to quantify for comparisons since the start and end points were approximate. When taking the individual line segments and finding the RMSE, it came to an average value of 0.030m, which is approximately 36% less than when doing it on the ISEC dataset. This is therefore much more accurate and can also be easily seen visually since Fig 9 has much straighter lines than Fig 5, which shows some deviations.

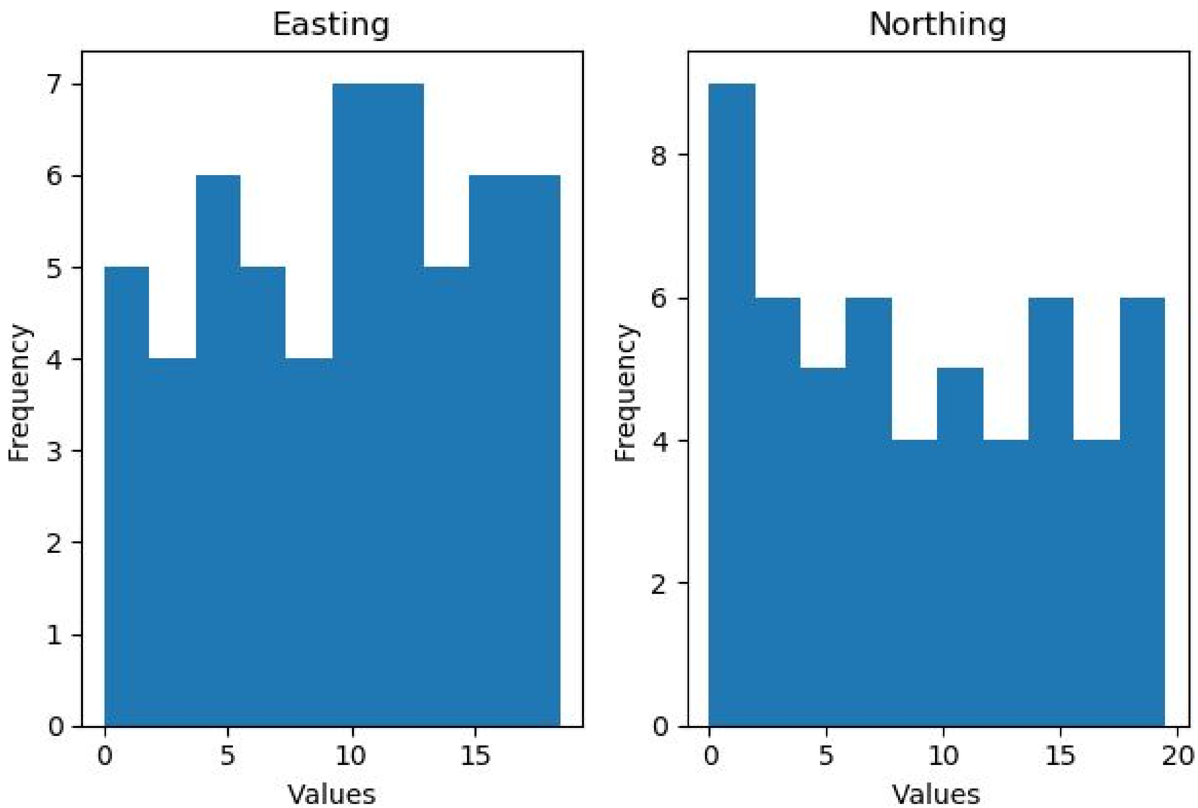

Fig. 10

The histogram for the spread of the Easting and Northing values again shows a somewhat uniform distribution similar to the ISEC dataset and the one from LAB1.

Multipath Contribution

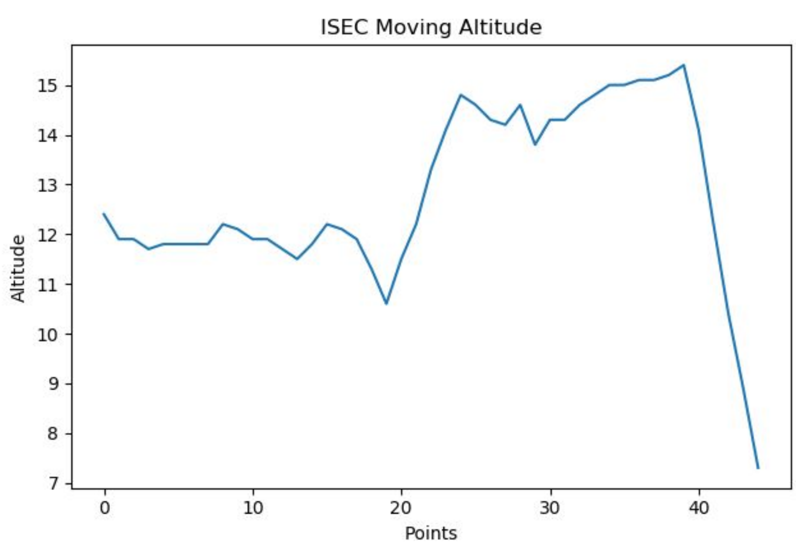

Fig. 11

While RMSE and other metrics were used to compare the ISEC and field data, the altitude was not very useful for the stationary data. However, it does become evident when we took our moving data that multipath was occuring when analyzing the altitude. Figure 11 clearly shows a spike in altitude from 12m to approximately 14.5m even though the laptop was held at waist level. The fall at the end could be bad data or some sort of other multipath effect, which could explain why the end of our path looks so misaligned with the start. However, as Fig 12 shows, there are no such jumps when in an open field. Therefore, in our moving data near ISEC multipath clearly plays in part in overestimating part of our data but It is unclear to what extent though.

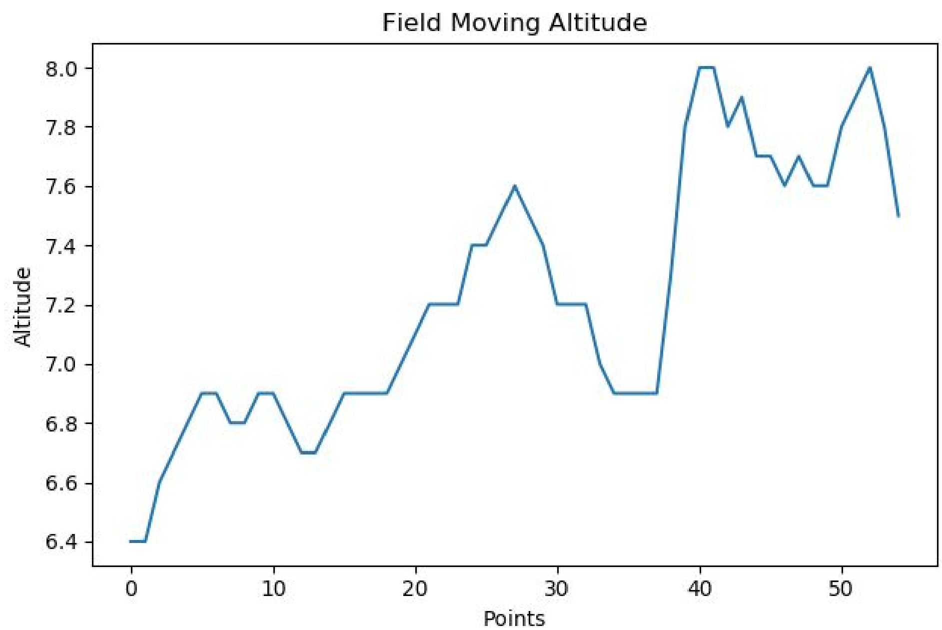

Fig. 12