Robot Sensing and Navigation – EECE5554

Lab 2 Analysis Report

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Stationary data in Open space

The data was collected from a stationary position in an open space in Carter ground, with very low possibility for multi-path error as there was building or structure in the area surrounding the data collection zone. 99.16% of the points have a data quality of 4(RTK fix). Which proves that the data is highly accurate.

Quality	No. of collected
4	591
2	5

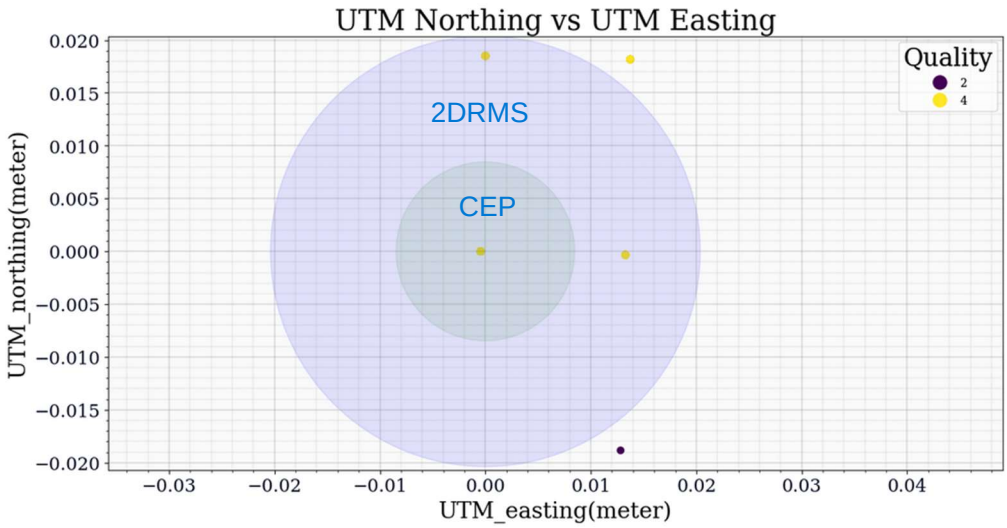

Fig 1: plot of CEP and 2DRMS to find the error bounds

CEP = 0.62 sigmaX + 0.56 sigmaY

Calculated CEP=0.008466930 m

A circle drawn with CEP radius from the x,y will capture 50% of the distribution values[2]

For our data 50% of the data points will lie within a radius of 0.008466930 m

sigmaX and sigmaY are the standard deviations of the X and Y components of the GPS signal

2DRMS = $2*\sqrt{\text{sigmaX}^2 + \text{sigmaY}^2}$

Calculated 2DRMS=0.020376276 m

A circle drawn with 2DRMS radius from the x,y will capture 95% of the distribution values[3]

For our data 95% of the data points will lie within a radius of 0.020376276 m

Stationary data in obstructed space

The data was collected from a stationary position in an obstructed space in Columbus Ave, with a possibility for multi-path error as there was a building or structure in the area surrounding the data collection zone. The position of the GPS happens to be spread across a given area. 99.66% of the points have a data quality of 4. Which proves that the data is highly accurate.

Quality	No. of collected
4	595
5	1
2	1

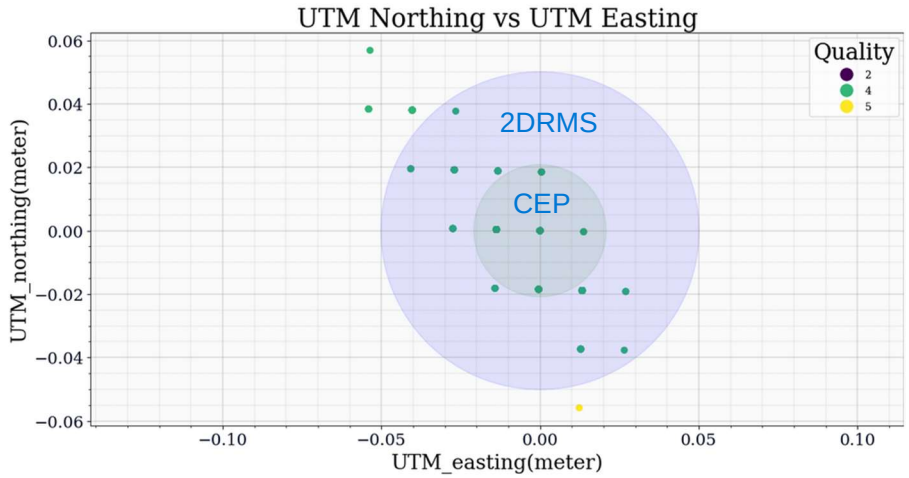

Fig 4:: plot of CEP and 2DRMS to find the error bounds

CEP = 0.62 sigmaX + 0.56 sigmaY

Calculated CEP=0.020860743 m

A circle drawn with CEP radius from the x,y will capture 50% of the distribution values[2]

For our data 50% of the data points will lie within a radius of 0.020860743 m

sigmaX and sigmaY are the standard deviations of the X and Y components of the GPS signal

2DRMS = $2*\sqrt{\text{sigmaX}^2 + \text{sigmaY}^2}$

Calculated 2DRMS=0.05013825 m

A circle drawn with 2DRMS radius from the x,y will capture 95% of the distribution values[3]

0.05013825 m

To analyse the above data collected from open space and data collected from obstructed space it can be observed that the radius of the drawn circle for the data collected in open space is smaller than the radius of the drawn circle for the data collected in obstructed space. This proves that the error in the data collected in the open space is much lower compared to the error in the data collected in the Obstructed space. The reason for this might be due to the multipath error caused by the buildings in the surrounding. Another

reason could be because of the change in atmospheric interference as the data collected during a different timing.

This error distribution won't be a Gaussian but the central limit theorem can be used to say that if we collected a large amount of data then our distribution would tend to be a gaussian.

Moving data in Open space

The data was collected as the GPS was in continuous motion in an open space in Carter ground, with very less possibility for multi-path error as there was no building or structure in the area surrounding the data collection zone. It can be observed that the graph is able to capture the change in the magnitude of the Easting and Northing accurately as the data was collected by moving in a rectangular shape. 92.27% of the points have a data quality of 4 and 6.52% of the data has quality of 5. Which proves that the data is accurate to a good extent.

Quality	No. of collected
4	382
5	27
2	5

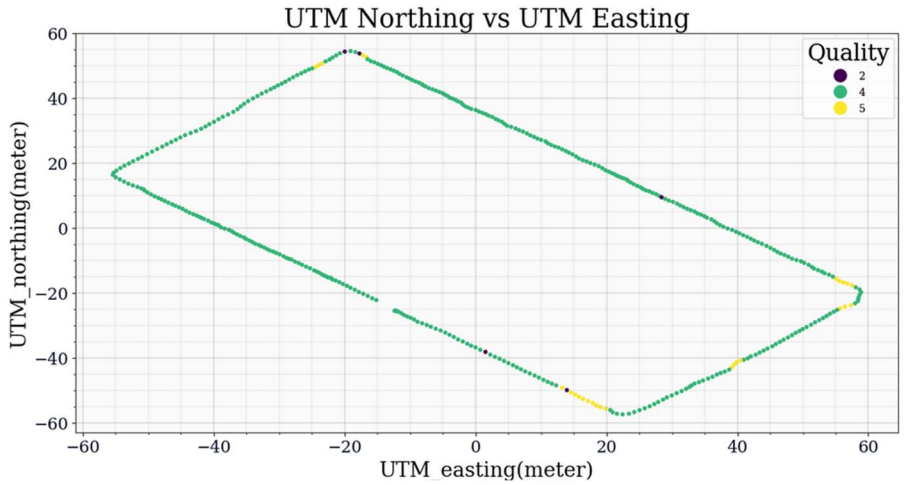

Fig 2: plot of the UTM easting and UTM Northing along with points coloured with quality shades from the Legend

Fitting a best fit line of the 4 straight line paths

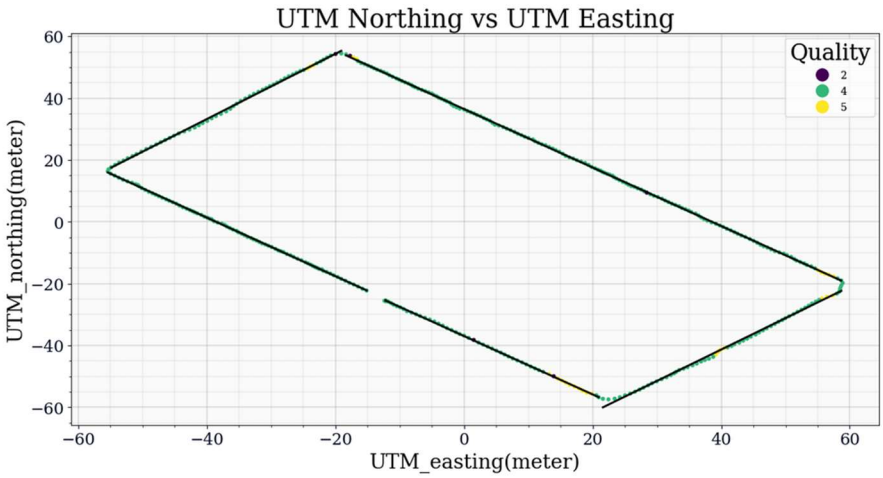

Fig 3: plot of fitting a best fit line on the points

Calculating the Residual sum of squares(RSS)=$\sum(\hat{Y}_i - Y_i)^2$

The RSS the sum of the squares of residuals (deviations predicted from actual empirical values of data) [1][4]

RMSE= $\sqrt{((1/N).RSS}$

The calculated value of RMSE is: 0.30813299 m

Moving data in obstructed space

The data was collected as the GPS was in continuous motion in an obstructed space in Columbus Ave, with a possibility for multi-path error as there was a building or structure in the area surrounding the data collection zone. 55.46% of the points have a data quality of 5 and 41.38% of the data has quality of 4. Which proves that the data is not very accurate.

Quality	No. of collected
5	264
4	197
2	15

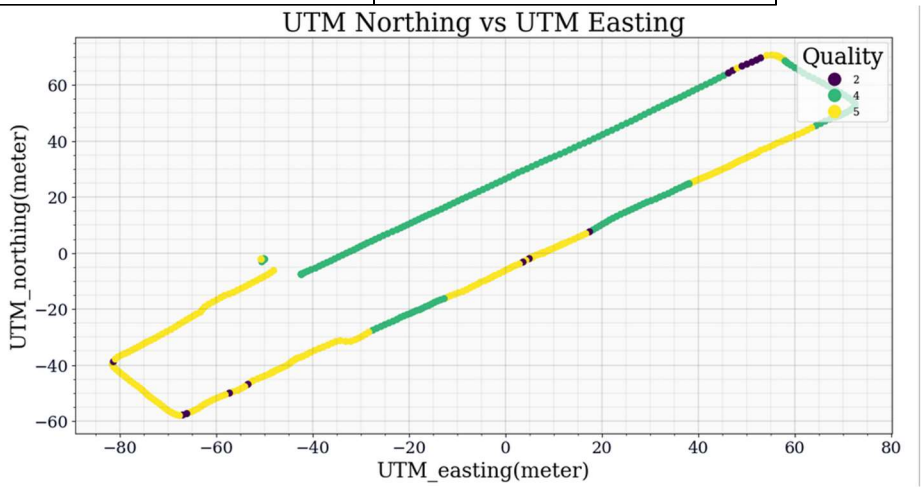

Fig 5: plot of the UTM easting and UTM Northing along with points coloured with quality shades from the Legend

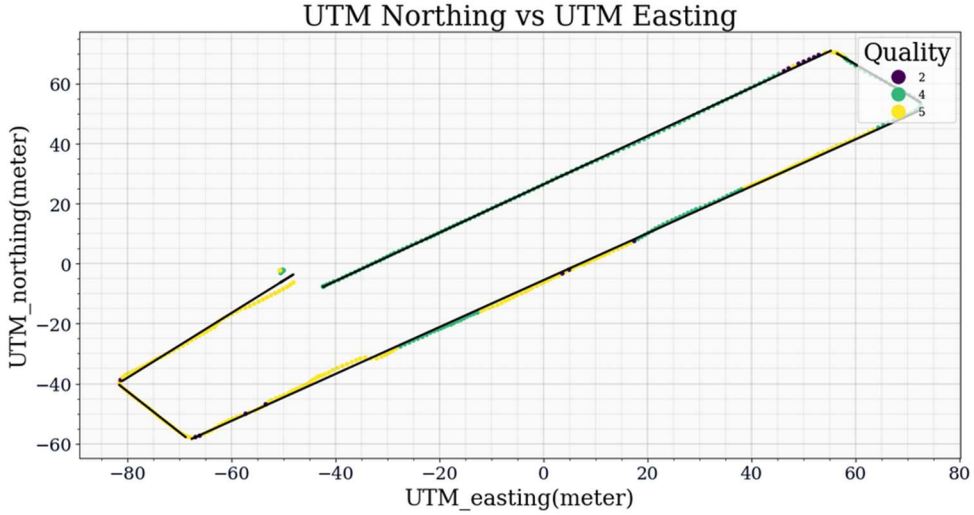

Fig 6: plot of fitting a best fit line on the points

Calculating the $RSS=\sum(\hat{Y}_i - Y_i)^2$

the sum of the squares of residuals (deviations predicted from actual empirical values of data) [1][4]

$RMSE= \sqrt{((1/N).RSS}$

The calculated value of RMSE is: 0.82421817 m

From the above data an analysis can be drawn that the RMSE value (0.30813299 m) of the data collected in an open space is much lesser that the RMSE value (0.82421817 m) of the data collected in an obstructed space. Hence the data collected in open space is more accurate. This is because there is very low chance of multi-path error in open space compared to a space that is obstructed with building and structures. Atmospheric interference could also be another reason of the error as the data was not collected during the same time

REFERENCES:

1) https://stats.stackexchange.com/questions/206274/relationship-between-rmse-and-rss
2) https://blog.oplopanax.ca/2012/11/calculating-gps-accuracy/
3) https://blog.oplopanax.ca/2012/11/your-gps-is-lying/
4) https://en.wikipedia.org/wiki/Residual_sum_of_squares