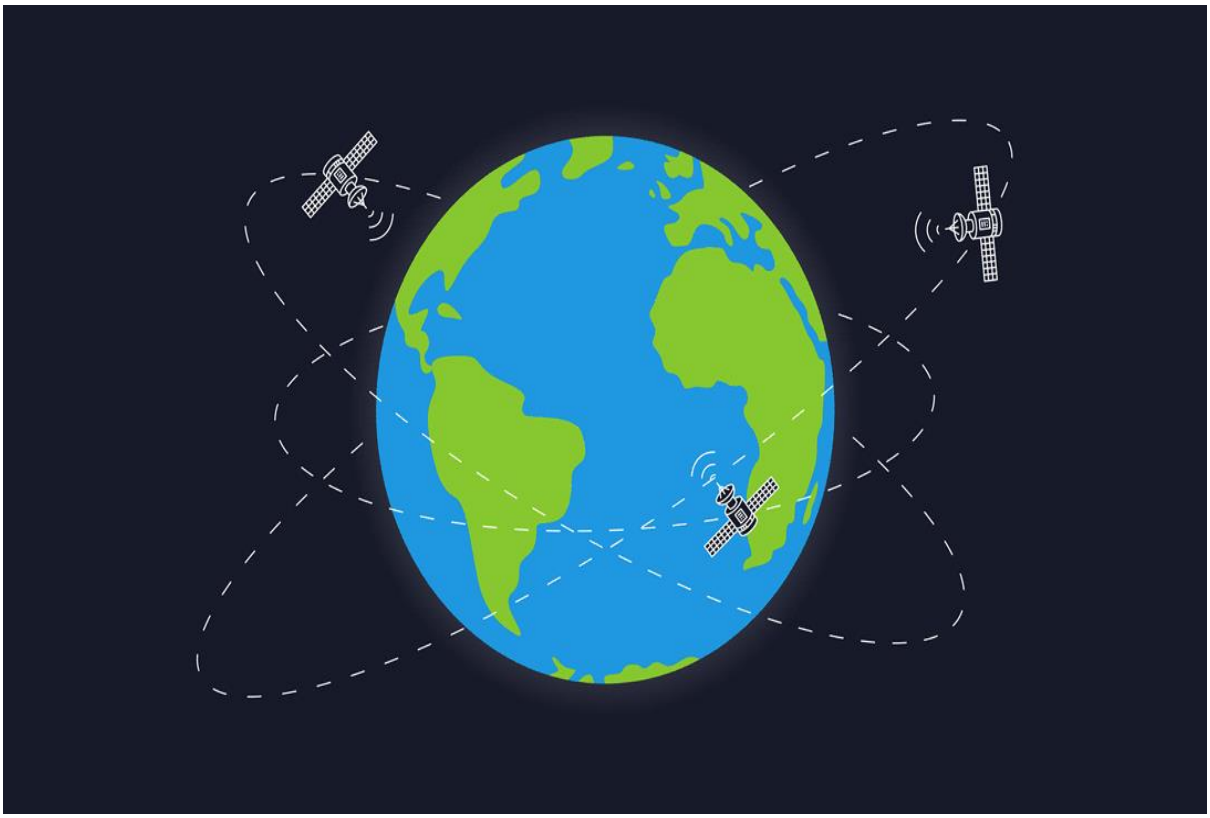
EECE 5554 Robotics Sensing and Navigation LAB 2

UTM Data Analysis by: Arvinder Singh



Description

Analysis of UTM X(Easting) and UTM Y(Northing) and Altitude vs Time, data collected and parsed for GNGGA string for 4 cases-

1) Base and rover are stationary and have no obstructions
2) Base is stationary and rover is moving but have no obstructions
3) Base and rover are stationary and have obstructions
4) Base is stationary and rover is moving but have obstructions.

The data without obstructions is collected on the soccer field and the data with obstructions is collected near ISEC.

Stationary Data without Obstructions

The stationary data obtained is plotted for UTM X(Easting) and UTM Y(Northing) & for Time vs Altitude using matplotlib, pandas is used to convert the rosbag data into a data frame. To calculate the horizontal error bounds we can find the maximum distance between the mean and other UTM coordinates. This is also how google maps works, it basically has a larger light blue circular area around dark blue circle (Measured latitude and longitude). The light blue circle depicts the horizontal accuracy of google maps. Similarly, I have calculated the maximum distance between average and UTM coordinate of the data. This maximum distance comes out

to be around 0.041382m. Hence the horizontal accuracy of my stationary data is 0.041382m. The error is a non-linear distribution curve.

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Maximum distance from mean(Error):0.041382m
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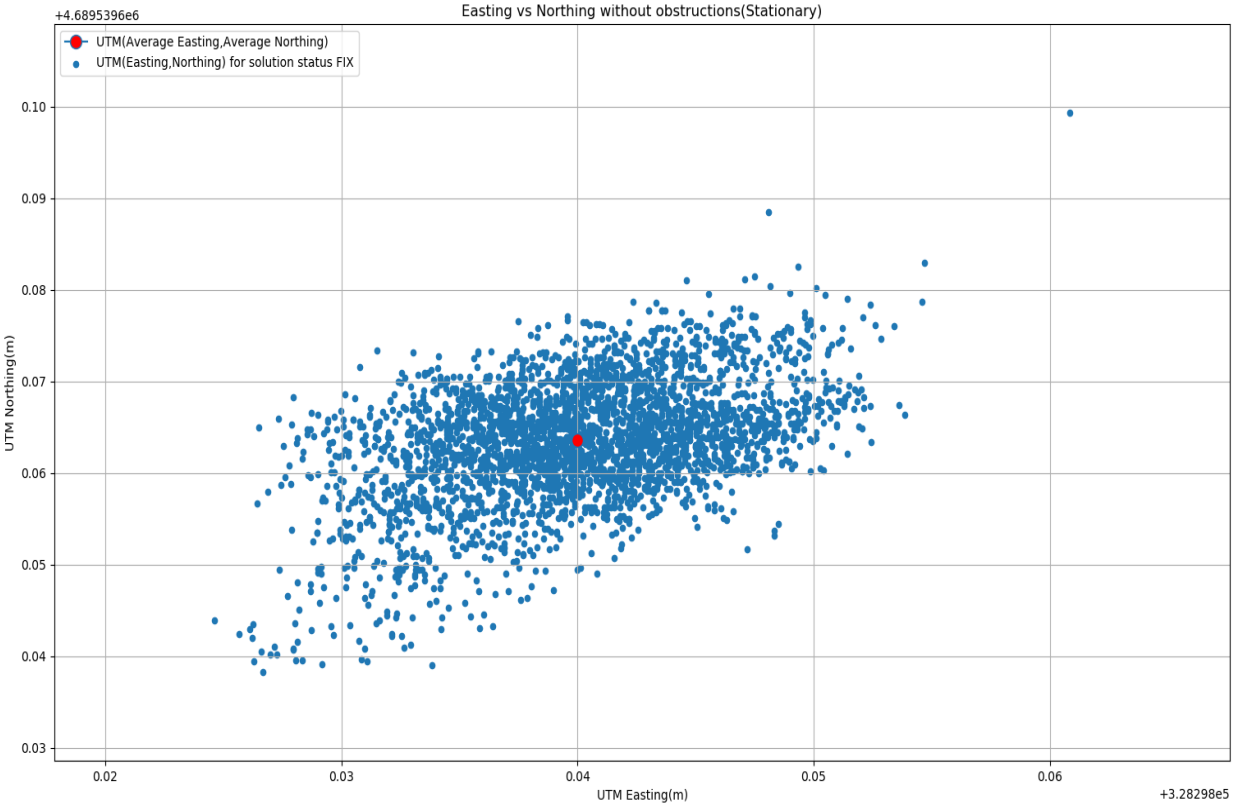
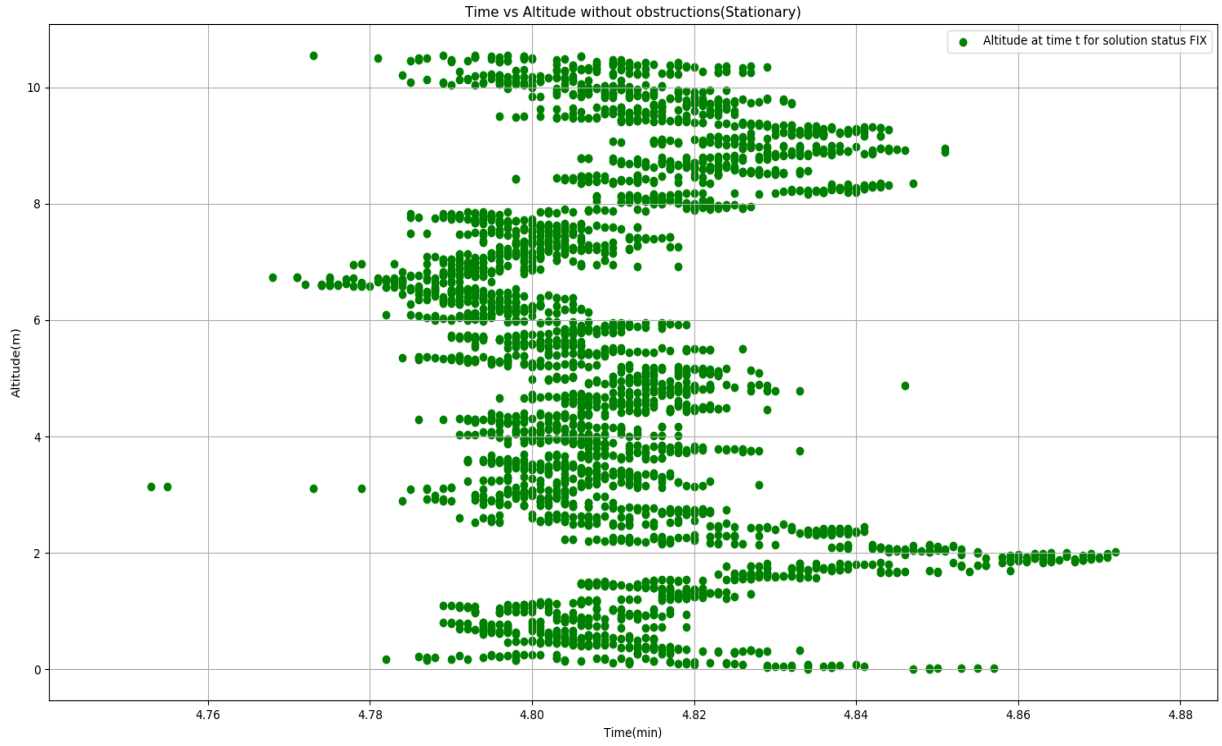
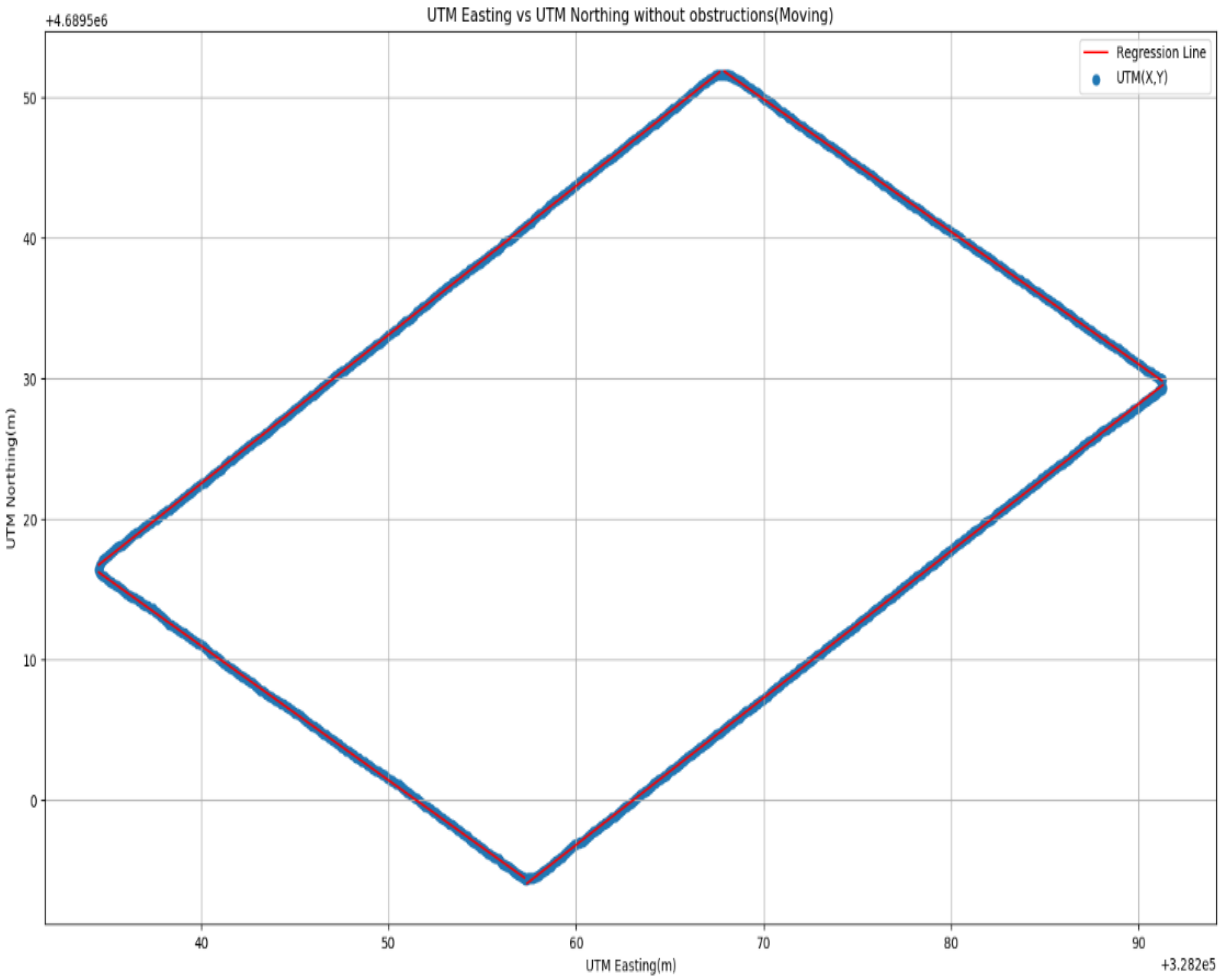




We can also see above the graph for Time vs Altitude without obstructions for the stationary data. The error in the vertical accuracy is around 11m which is very less as compared to the normal GPS puck from LAB1.

Moving Data without Obstructions

The Moving data obtained is plotted for UTM X(Easting) and UTM Y(Northing) & for Time vs Altitude using matplotlib, pandas is used to convert the rosbag data into a data frame. The program also returns coefficient of determination and the maximum distance from the best fit line(error).

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Maximum Distance(error) from best fit line on corners: 0.341841m
Maximum Distance(error) from best fit line while moving straight: 0.064216m
Coefficient of determination: 0.999884
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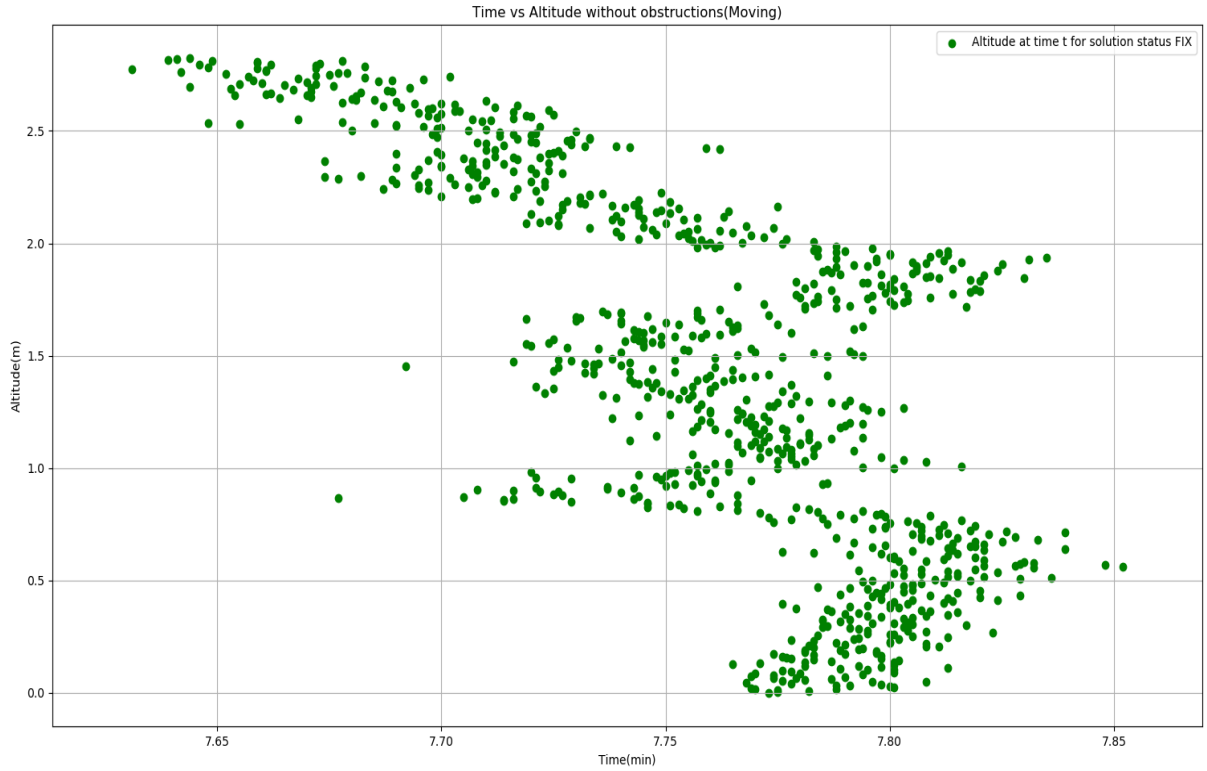
For the Moving data, I have also calculated the Coefficient of determination for our regression model to measure the scatter of data points around the fitted regression line which is a good way to calculate error in our GPS data. I plotted 4 regression lines for all the sides. The error was most at the corners while making a turn, this can be due to me not moving exactly in a rectangle while cornering and hence the error at corners is 34.1cm. Whereas if you compare

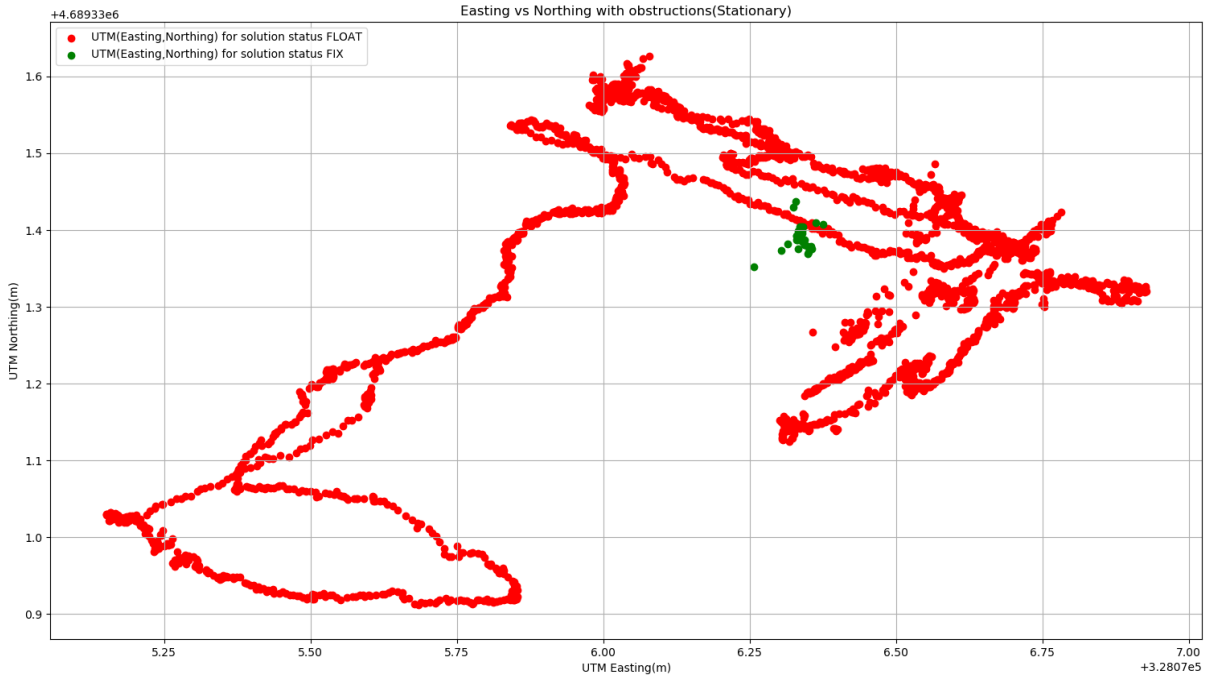
this to the error while moving in a straight line, the error while moving straight is very less and is around 6.42cms. Coefficient of determination comes out to be 0.999884 which is very good and this means 99.9884% of our UTM coordinates fit the regression model of our system

I have also calculated the maximum distance of a UTM coordinate from the best fit line which is the horizontal error of our moving GPS. The distance comes out to be: 6.42cm.



Above we can see the Time vs Altitude plot for moving data without obstructions.

Stationary Data with Obstructions



The stationary data obtained is plotted for UTM X(Easting) and UTM Y(Northing) & for Time vs Altitude using matplotlib, pandas is used to convert the rosbag data into a data frame. To calculate the horizontal error bounds we can find the maximum distance between the mean and other UTM coordinates. Since in the data with obstructions around GPS we had both float and fix solution status. I have calculated error for both the cases. Below is the error for Solution status Fix and Float. It can be clearly seen that the error is more for solution status float which is around 1.1m whereas for float it is 0.08m

```
Maximum distance from mean for solution status fix(Error):0.087633m
Maximum distance from mean for solution status float(Error):1.106053m
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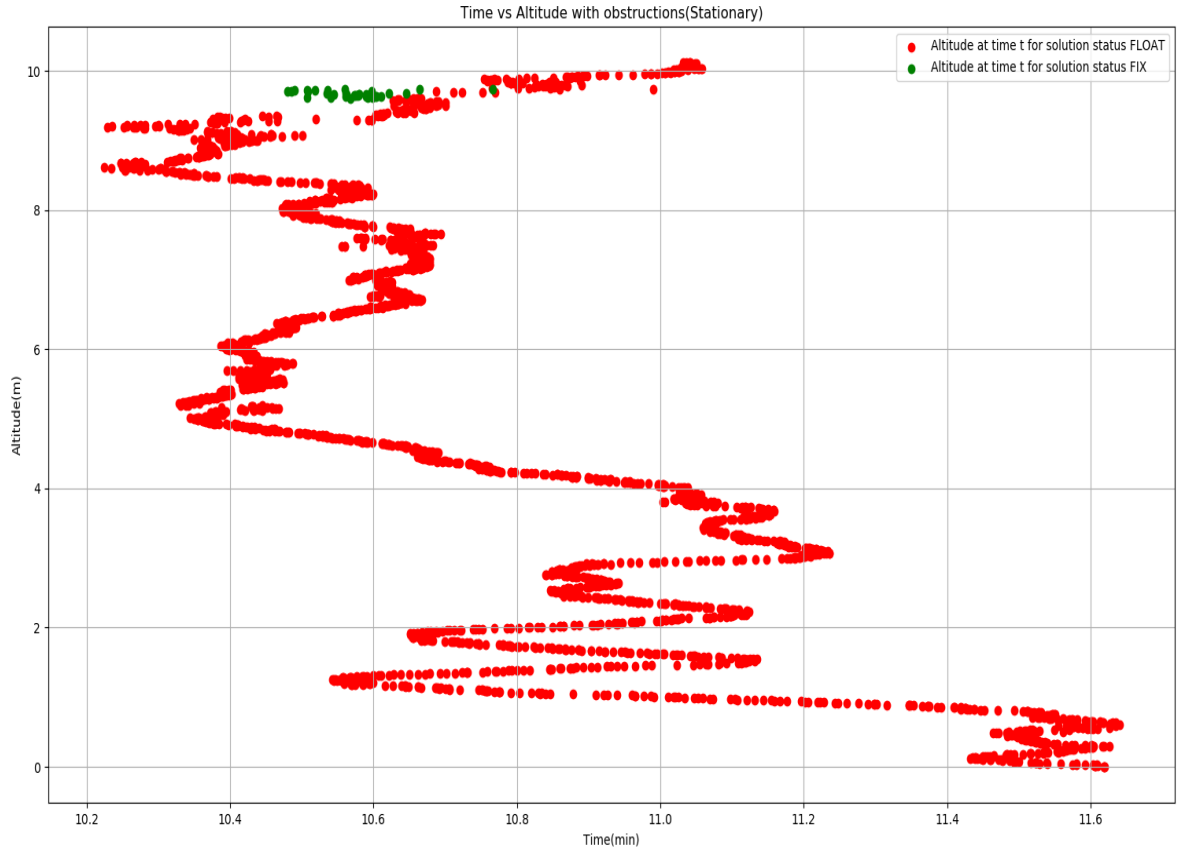
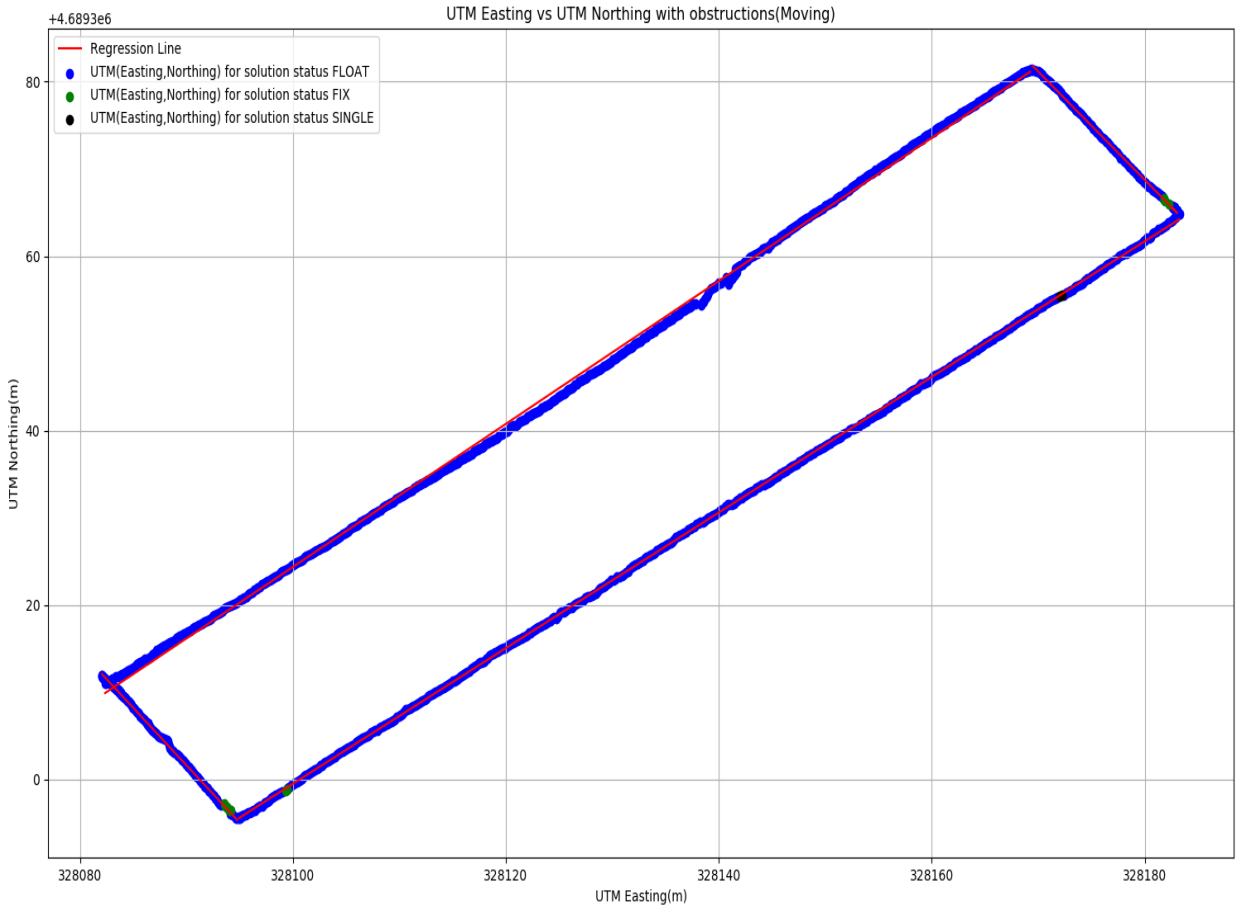
Below we can see the Time vs Altitude graph for stationary data with obstructions:



Moving Data with Obstructions

The Moving data obtained is plotted for UTM X(Easting) and UTM Y(Northing) & for Time vs Altitude using matplotlib, pandas is used to convert the rosbag data into a data frame. The program also returns coefficient of determination and the maximum distance from the best fit line(error) for both FIX and Solution status Float.



We can clearly see the error is more when there are obstructions around the RTK GPS. Coefficient of determination comes out to be 0.998956 which is very good and this means 99.8956% of our UTM coordinates fit the regression model of our system. But when compared with the case where there were no obstructions the error is more and there are lesser UTM points that fit our best fit line.

```
Maximum Distance(error) from best fit line for solution status FIX: 0.102277m
Maximum Distance(error) from best fit line for solution status FLOAT: 1.411147m
Coefficient of determination: 0.998956
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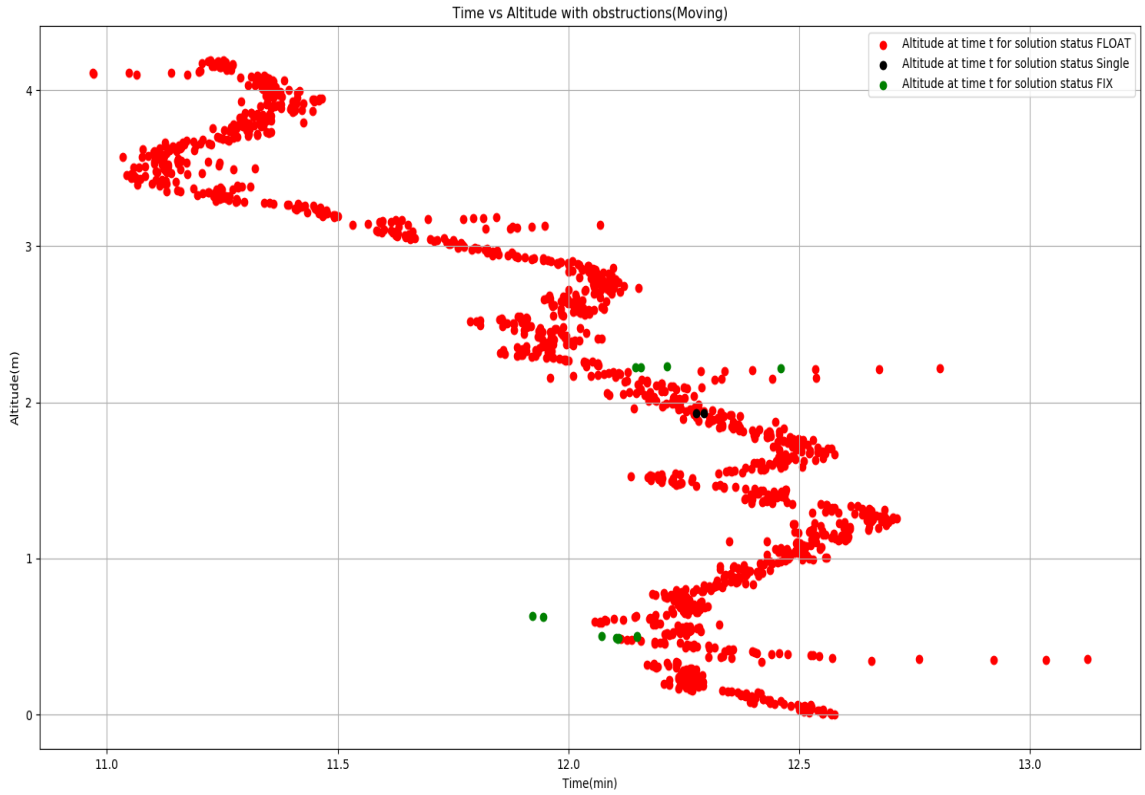
Below we can see the Time vs Altitude graph for moving data with obstructions



Overall, RTK GPS is very accurate and can be sometimes have an accuracy of 0.1cms. The distribution of noise is non uniform/non-gaussian for all the cases.