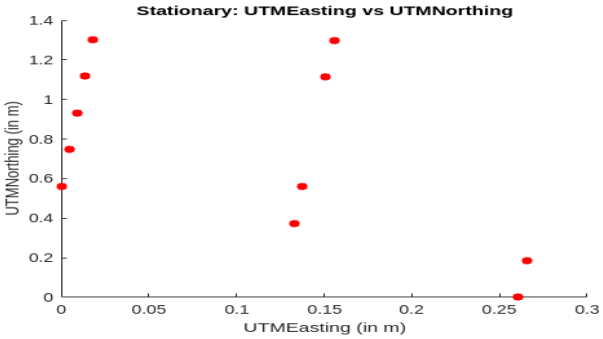
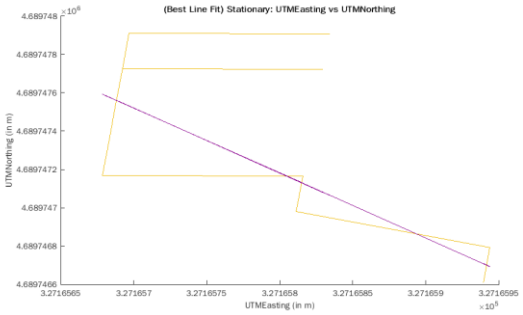
EECE 5554: Robot Sensing and Navigation (Report Lab1)

The stationary data as well as the straight line walk data was collected at Clemente Field, Boston. The report aims to analyze the collected data by examining various relationships between the collected data.

Analysis of Stationary Data:

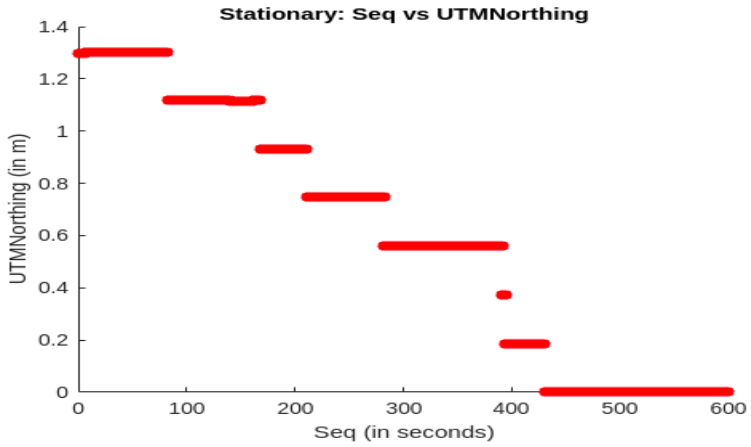


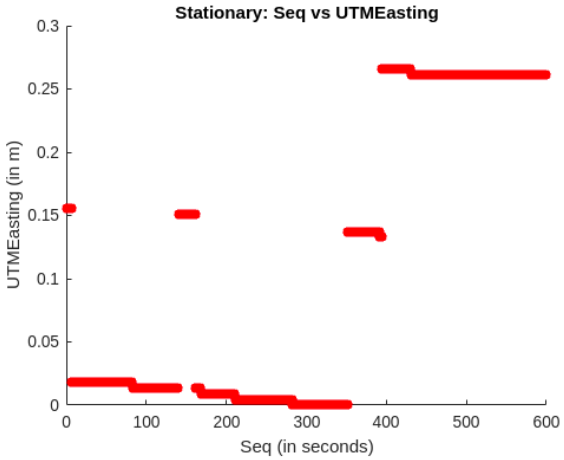


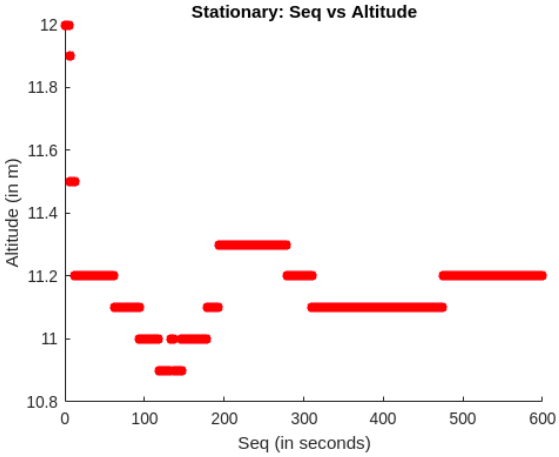
Shown above are two images showing the data of UTM-Easting plotted against UTM-Northing. As the sensor is stationary, we can observe that the sensor transmits the data in a set of points that coincide on each other. The scatter chart shown in the first image is a collection of 600 data-points coinciding with each other as the sensor was stationary. Ideally, the chart should have shown only a single point but because of various atmospheric disturbances, the data is corrupted a little. It can be because of the disturbances caused by the ionosphere, the shape of the earth, error in satellite clock, because of the satellite orbit, multipath r or the interference of EM waves by the surrounding environment. Efforts have been made to minimize multipath error and the disturbance due to the surroundings by collecting data in an open field. In the second chart, regression is used to create a best-fit line for the data and minimum and maximum error is calculated based on the distance of original data points from the regression line which is: s_error_min = 0 m, s_error_max = 0.8405 m.

Now, let us look at some more statistics calculated based on the collected data:

```
s_mean_utme = 3.2717e+05
s_mean_utmn = 4.6897e+06
s_mean_alt = 11.1575
s_std_utme = 0.1165
s_std_utmn = 0.4786
s_std_alt = 0.1337
s_var_utme = 0.0136
s_var_utmn = 0.2291
s_var_alt = 0.0179
```



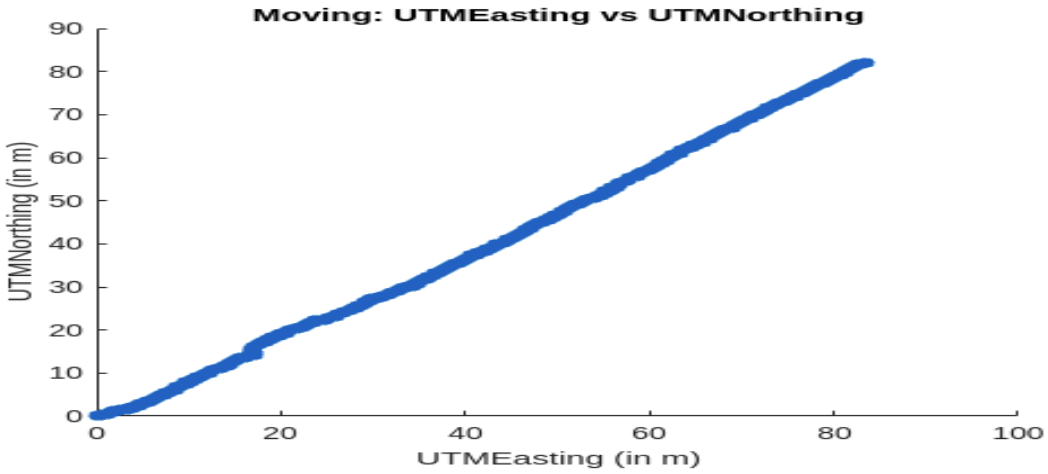


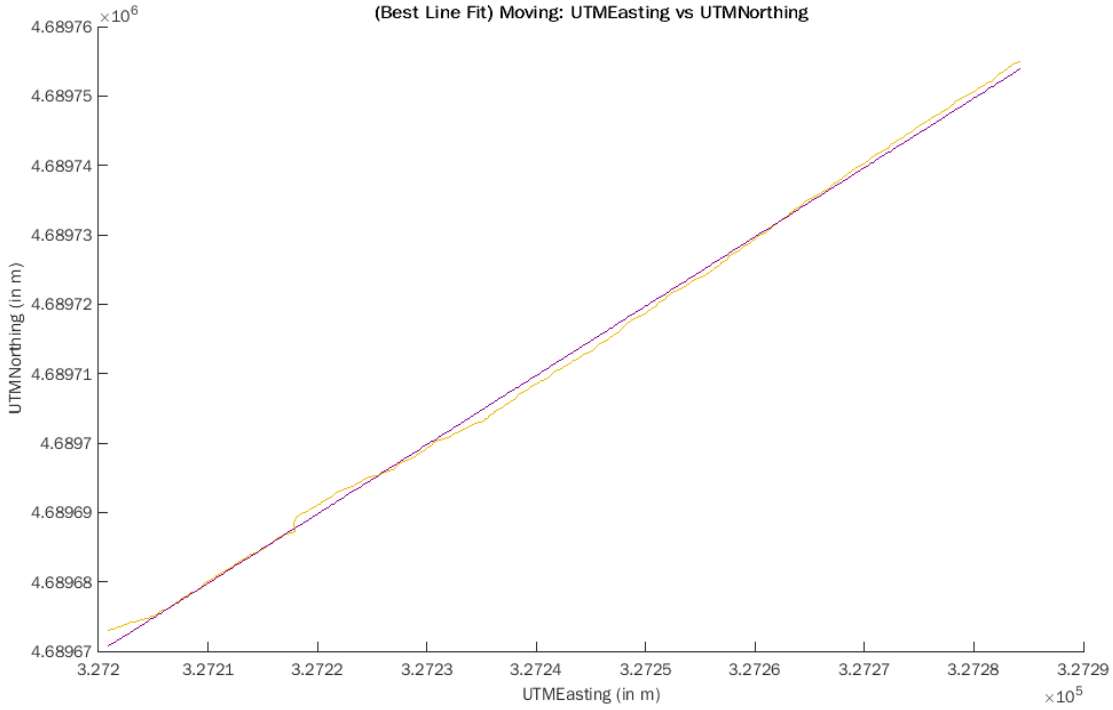


The image on top left shows the mean, standard deviation and variation of UTM-Easting, UTM-Northing and Altitude components respectively (all the data is in meters). We can conclude that the data is densely distributed from the values of standard deviation and variance. The image on the top right goes on to describe the relation of UTM-Northing with respect to time. The image on the bottom left shows the relationship of UTM-Easting with respect to time. Ideally these values should not change but because of the reasons listed above, tends to deviate from the actual data.

Similar conclusions can be drawn for the bottom right chart which shows the relation of altitude with respect to time. Even though the sensor is at the same place, the chart shows variation because of various environmental disturbances as stated above. We can also observe some steady state error in altitude which may have been affected during initialization and results in a little over 3 meters of elevation more than required. It could possibly be because the sensor was not able to calibrate itself with respect to the surroundings and we will observe in the straight line data analysis how the value of altitude is more natural than that in the stationary data.

Analysis of Straight Line Walk Data:

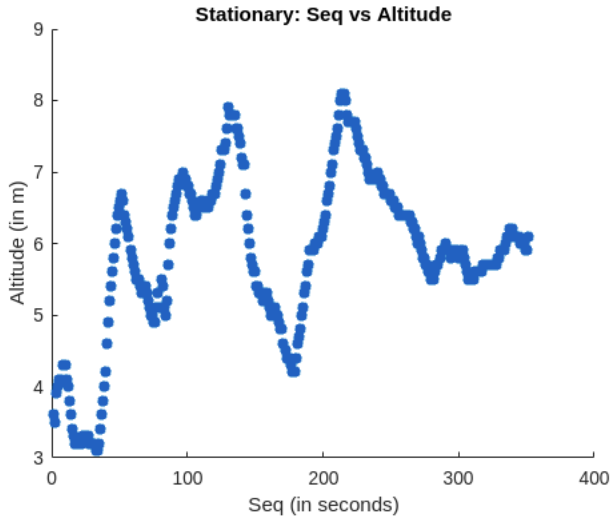




The above images show the UTM-Easting vs ETM-Northing data. The first one is the scatter chart showing all the data-points through which the sensor was walked. The second image shows two lines. The yellow line is the actual data and the red line shows the regression line which best fits the curve. We can observe that the line almost coincides and our data plots a straight line as the easting and northing values varied linearly when the sensor was walked through a straight line. The drift that can be observed (more clearly in the first image) is caused because of an unexpected obstacle (lacrosse players warming up!!) causing me to drift a little from the straight line I was trying to walk on. The error can be calculated by taking the perpendicular distance of datapoints from the regression line and is found to be as follows:

error_min = 0.0032 m, error_max = 2.2243 m.

Now, let us look at some more statistics:




```
mean_utme = 3.2724e+05
mean_utmn = 4.6897e+06
mean_alt = 5.8450
std_utme = 24.6210
std_utmn = 24.5925
std_alt = 1.1508
var_utme = 606.1934
var_utmn = 604.7889
var_alt = 1.3243
```

The first figure shows the variation of altitude with respect to time when we were moving. Even though we see that the overall variance is more as compared to the stationary data (it should be obvious as I was carrying the sensor by hand), it is worth noting that the actual mean of altitude is closer to the original value that should be on the Clemente field. My guess is that it is because the sensor was able to calibrate it with the surroundings.

The second image shows the statistical analysis of the moving data. It calculates the mean, standard deviation and variance of UTM-Easting, UTM-Northing and Altitude respectively. As we are moving, the first two paramenters are bound to change but inference can be drawn from the data of altitude as we see an increase in deviation, but the accuracy is more. It is a case of accurate but not precise!

Conclusion:

Comparing the minimum and maximum error calculated with the help of best fit line generated with linear regression, we can say that the minimum error and the maximum error of stationary is lower than that of the moving data as the disturbance was relatively lower and as the data was collected on the Clemente field, other miscellaneous disturbances were minimized as well.

Although, we can observe that the sensor seems to be more calibrated when looking at the moving data and the values are more accurate but lack precision as can be clearly seen with the data of altitude.