ECE 5554 (RSN) LAB 2

INTRODUCTION:

The Lab focussed mainly on the analysis of the data obtained from GNSS/ RTK Processing boards. One GPS module is set up as the base and the second module is set as a rover. The base and the rover operate in a specific range because of which the base calculates the errors and sends the error to the rover in real-time, making it “Real-time Kinetic”. In this Lab-2 we have written a code to get the GNGGA format data/string, from which required GPS coordinates, utm data are acquired to publish onto the gps topic. In the initial sections utm data i.e utm_northing vs utm_easting was plotted for the following 4 data sets.

DATA COLLECTION

- The analysis report is based on four sets of data collected under different conditions. the first set of stationary data [both base and rover kept stationary at some distance apart] was collected on the rooftop of the Columbus Avenue Parking Lot. (42.33821198352815, -71.08641989071687)
- The walking-free data was collected in the middle of carter ground while walking 70 steps in the x direction and then turning and walking 7 steps in the y direction, again turning and walking 70 steps in the -x direction, followed by turning and walking 7 steps in the -y direction making a rectangle. (42.33906446180222, -71.08430427820721)
- The remaining two sets of data include the same procedure carried out outside the intramural office building in the same way as for the above conditions
- The data recording was done in a rosbag file with the help of the driver code generated in LAB1. The addition done in the driver code includes obtaining the GPS fix value from the GNGGA stream.

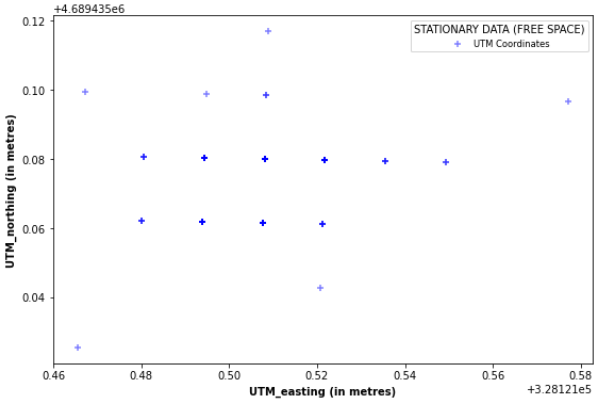
The GPS fix value determines the procedure of correction performed on the GPS signal received. In the case of LAB 1, the GPS receiver had a fix value of ‘0’ - means no correction / ‘1’ (which means an Autonomous GPS fix.)

- In the case of the Ublox ZED-F9P module, this value can take states of different numbers but we needed RTK to fix or RTK float for this lab which is the base station correction from the RTK module

‘4’ - RTK fix, high accuracy correction obtained from base station RTK module **‘5’** - RTK float, better than DGPS, but less accurate than RTK fix

DATA ANALYSIS

The collected UTM data will be plotted (UTM_northing vs UTM_easting) for all 4 data sets of data and inferences will be made on the plotted graphs



This graph is a plot between UTM_northing and UTM_easting for GPS data collected at a stationary point. The main inference that can be

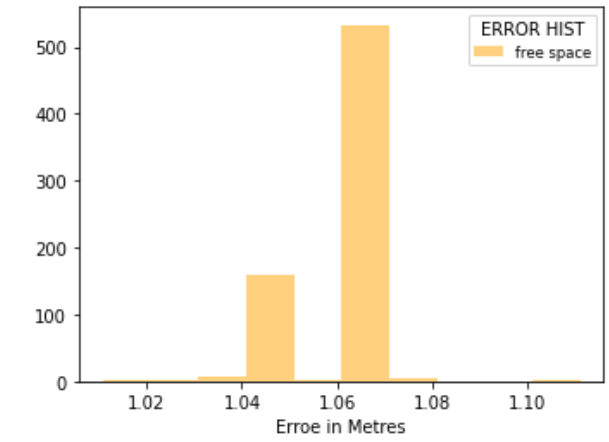
made from this graph is the range in which the scattered points are observed is in “cm”. As seen in the graph for the stationary point gps data, it seems to be scattered in a range of 0.46 to 0.58 meters which is basically in the range of 10cm deviation, I also collected the exact latitude and longitude at that point using the google maps and compared the UTM coordinates of the actual point with the data. UTM coordinates I got from the phone after converting the latitude and longitude

UTM Easting - 328169.06582452566, UTM Northing - 4689413.228256881

The RMSE error was calculated for this act from the given

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (Predicted_i - Actual_i)^2}{N}}$$

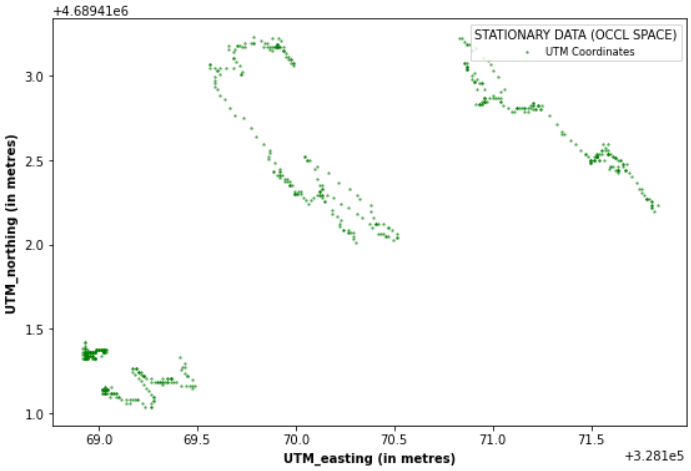
re RMSE is nula with the tual values.



Error histogram

The rmse calculated rmse error was **1.060530784341** (in meters) which is much better as compared to the RMSE error of the as compared of GNSS without RTK for the same conditions

RMSE error without RTK was 3.27099913509 meters



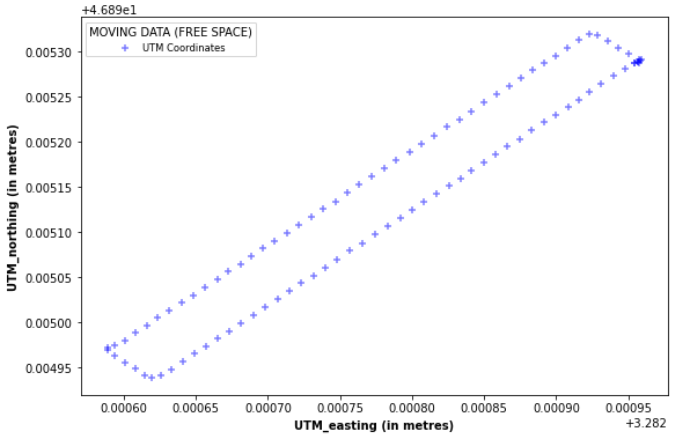
This graph is a plot between UTM_northing and UTM_easting for GPS data collected at a stationary point in occluded space. We can see from the graph the points are much more scattered as compared to free space because it was occluded space and also the major noise in the data was due to a change in fix the quality of RTK of GNSS module the change in fix quality from rtk float to gps fixed added much noise in the data we got 3 fix quality 2,4,5

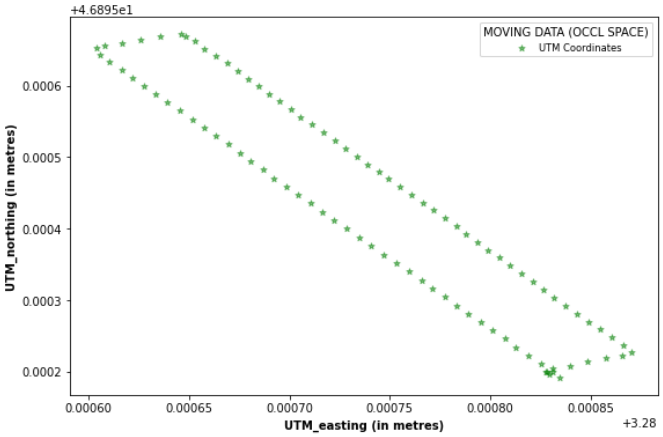
The actual UTM coordinates was also calculated for the latitude and longitude for the actual point from the google maps and compared the UTM coordinates of the actual point with the data. UTM coordinates got from the phone after converting the latitude and longitude

UTM Easting-328121.79105274694, UTM Northing - 4689436.087683276

The RMSE error calculated for the actual position, and the plotted data was **1.9075890168 (m)**

For the Moving Data of the graphs are plotted below

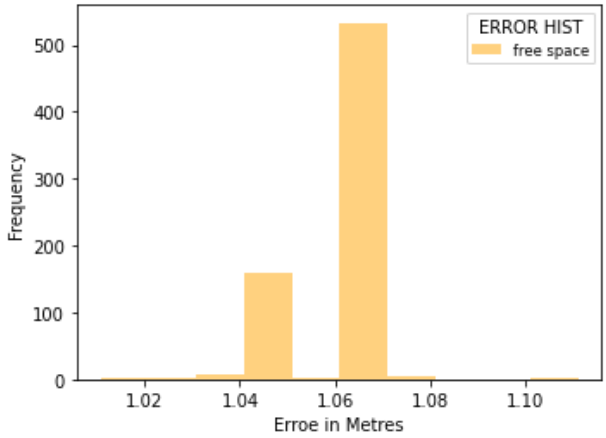


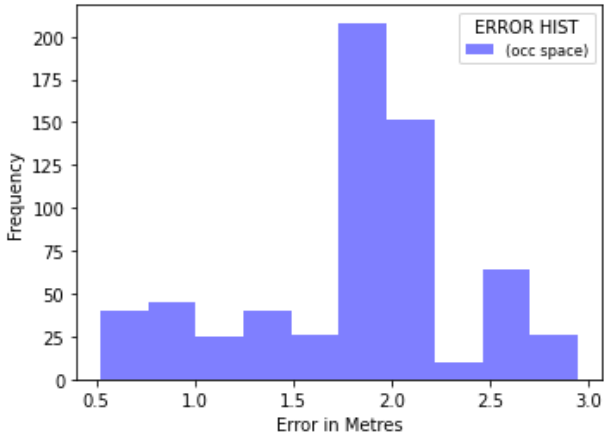


As we can see from the above graphs of the UTM north vs UTM east for both free and occluded space in the as we can see from graph we got the desired shape that we walked in but the free space walking is more accurate as compared to Occluded walking as while walking in free space we had a guideline to walk in a straight line but for the occluded case we had to that on our own so we didn't get an exact line to match the closed loop

ERROR ANALYSIS

HISTOGRAM OF ERROR IN STATIONARY CONDITION

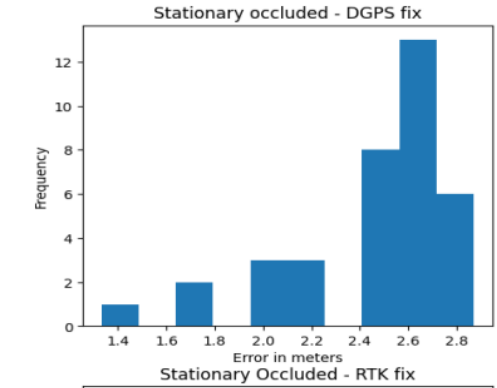


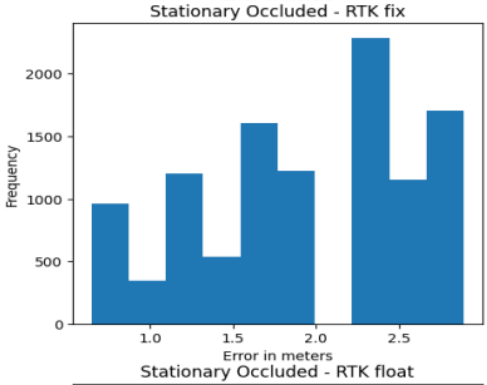


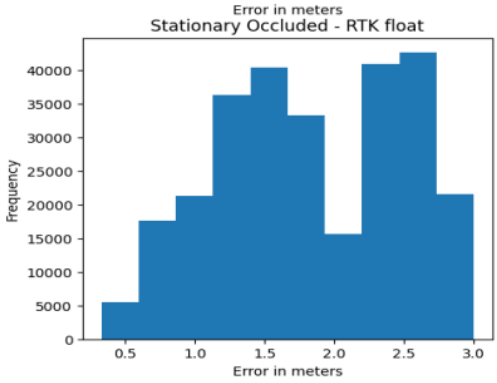
From the above graph, we can analyse see that for the

- Stationary Free space - The root means square error for this case is **1.060530784341** meters, even though we can see that the error is very high but GPS is not a major contributor to this error as we can see the deviation is around 10 cm so the data is quite precise the error is this because the true location that we got from google maps is faulty.

- Stationary Occlude space - The root means square error for this case is **1.9075890168** meters, in this case, we can see that the error is highly distributed and also the deviation is around 2.5 meters. As mentioned earlier this is due to the fact that we have different fixed quality values in this data and further analysis on that is given below







Comparison of different Fix quality on the Data

Comment - DGPS fix - The root means square error for this case is 2.508698879418221 meters, with only six data points, in this case, we can see in the scatterplot that the points are quite scattered and thus we can see from the errors also that this is the worse than
RTK fix and float. RTK fix - The root means square error for this case is 2.017194334436641 meters, we can see that the range between errors is just 1.5 meters and also the points are cluttered in one place three places precisely because of multipath thus showing this is the best fix available between the three.
RTK float -The root means square error for this case is 1.9491136829462967 meters, we can see that the range in error is 2.5 meters also we can see that the points are scattered all over the place, thus this is better than the DGPS fix but worse than he RTK fix