EECE 5554 - Robot Sensing and Navigation
Lab 1 Report

Introduction:

The primary focus of the lab is to analyze the data collected from the GPS sensor. The GPS puck was first conencted to a laptop to receive the corrected GPGGA string. In Lab-1 we write a driver code to collect the data in GPGGA format and convert it to the required format like GPS coordinates, UTM data etc to be published on to the GPS topic. The data for the analysis was collected from 4 different locations.

- Data collected at a stationary point in a clear environment.
- Data collected while moving in a clear environment.
- Data collected at a stationary point in an occluded environment.

Data Collection:

The first set of data was collected from the noise free and clear environment . The device was kept stationary while collecting the data. This was followed by a moving data collection at the nearby location. The next set of data was collected at the occluded area which had a lot of trees, building and shadows. The stationary data was collected for about 5 minutes and the walking data was collected while walking in a straight line for about 200 – 300 m.

Data Analyses:

In this section the scatter plot of UTM_northing and UTM_easting data, scatter plot of Altitude and time data, histograms will be plotted for all the 3 data sets collected and error calculations will be made from the plotted graphs.

1.Stationary Data in Open Space:

a. Scatter Plot of UTM_easting vs UTM_northing

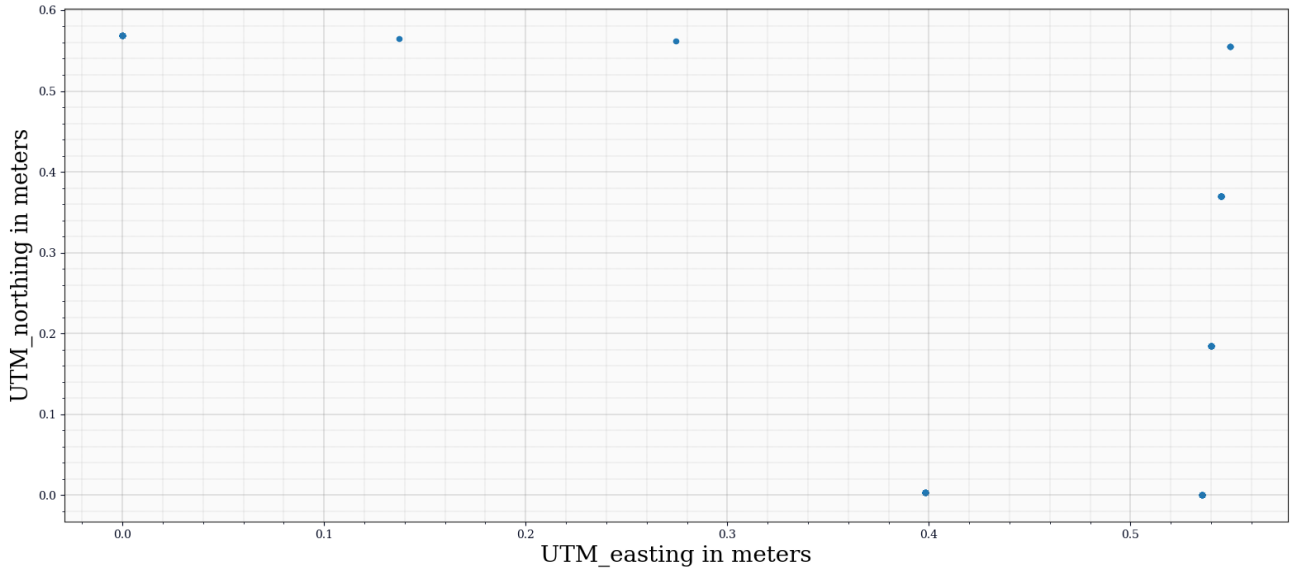

Fig 1: Scatter Plot of UTM_easting and UTM_northing

The above graph shows the plot between the UTM_easting and UTM_northing for GPS data collected from the stationary point at the clear environment in Centennial Common. We could clearly see from the graph that the GPS data is scattered in the range of 327799.20 to 327799.74 in terms of UTM_easting coordinates and varied from 4689318.59 to 4689319.16 in terms of UTM_northing coordinates. To find the exact UTM coordinates of the location, I had taken the latitude and longitude from google maps and converted it into UTM. The UTM_easting was found to be 327799.50 and the UTM_northing was found to be 4689328.86 .

b. Scatter plot of Altitude vs Time

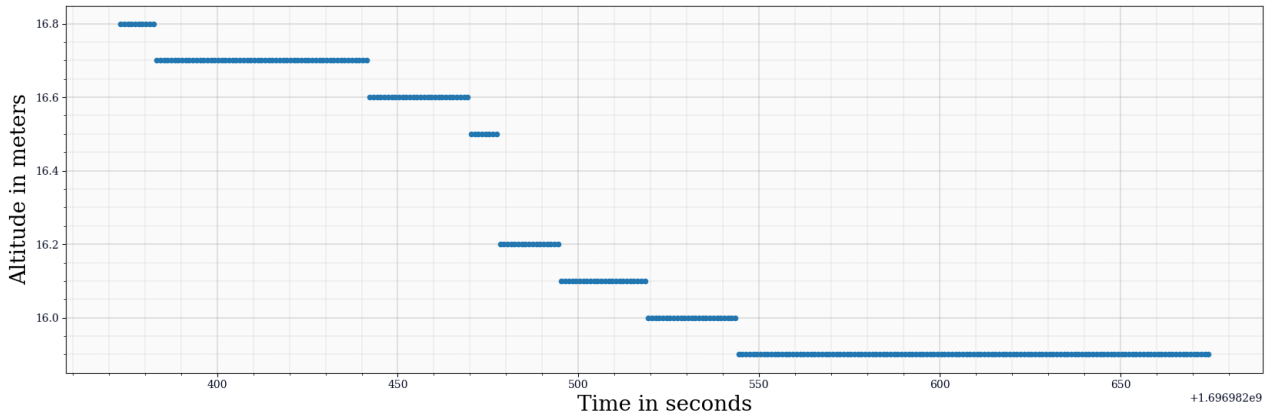

Fig 2: Scatter Plot of Altitude and Time

c. Histogram Plot

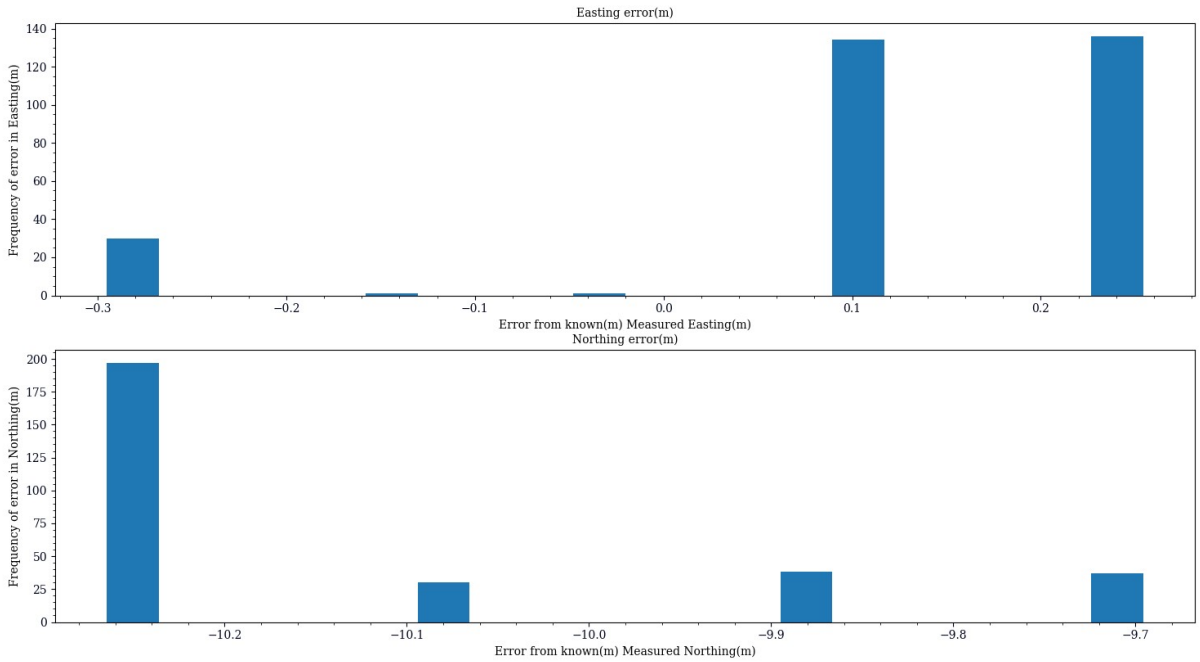

Fig 3: Histogram Plot

We calculated the mean, variance and standard deviation of the UTM_easting and UTM_northing data. We also got an mean and median of the error estimate of the utm values.

It was found that the easting data had the following results:

- Mean: 327799.62605
- Variance: 0.02451886
- Standard Deviation: 0.15658500

It was found that the northing data had the following results:

- Mean: 4689318.7312
- Variance: 0.0415211
- Standard Deviation: 0.20376728

Further the error estimates was found to be:

- Mean of error for easting: 0.12605055
- Mean of error for northing: -10.1287389
- Median of error for easting: 0.1032312
- Median of error for northing: -10.2612396

2.Stationary Data in Occluded Space:

a. Scatter Plot of UTM_easting vs UTM_northing

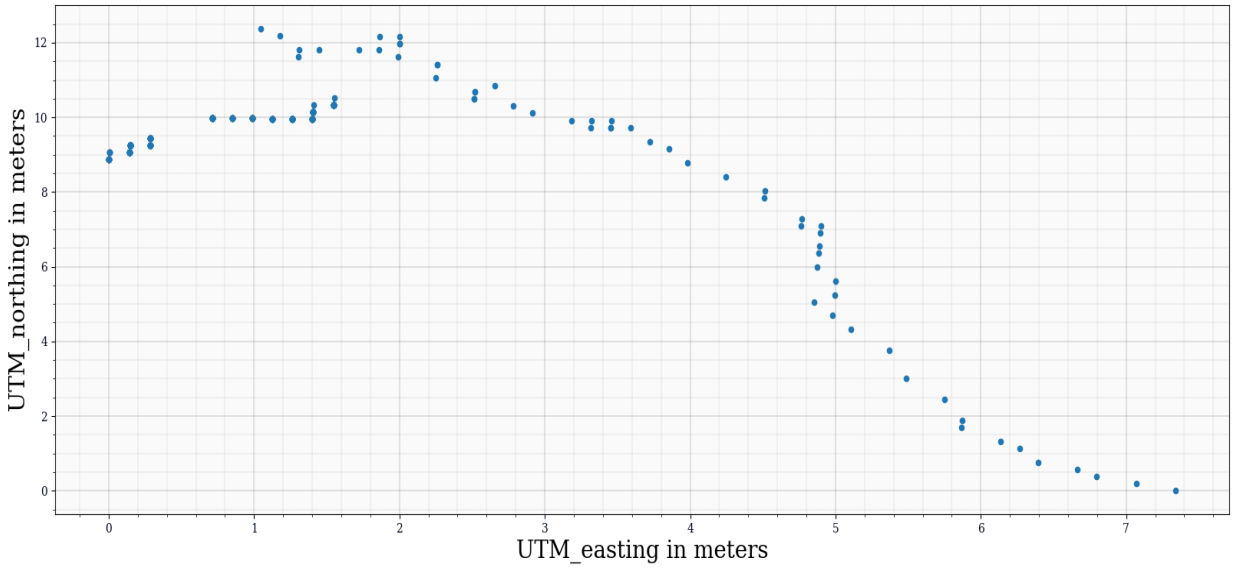

Fig 4: Scatter Plot of UTM_easting and UTM_northing

The above graph shows the plot between the UTM_easting and UTM_northing for GPS data collected from the stationary point at the occluded environment in Centennial Common. We could clearly see from the graph that the GPS data is scattered in the range of 327919.95 to 327927.29 in terms of UTM_easting coordinates and varied from 4689421.38 to 4689433.55 in terms of UTM_northing coordinates. To find the exact UTM coordinates of the location, I had taken the latitude and longitude from google maps and converted it into UTM. The UTM_easting was found to be 327924.54 and the UTM_northing was found to be 4689418.90 .

b. Scatter plot of Altitude vs Time

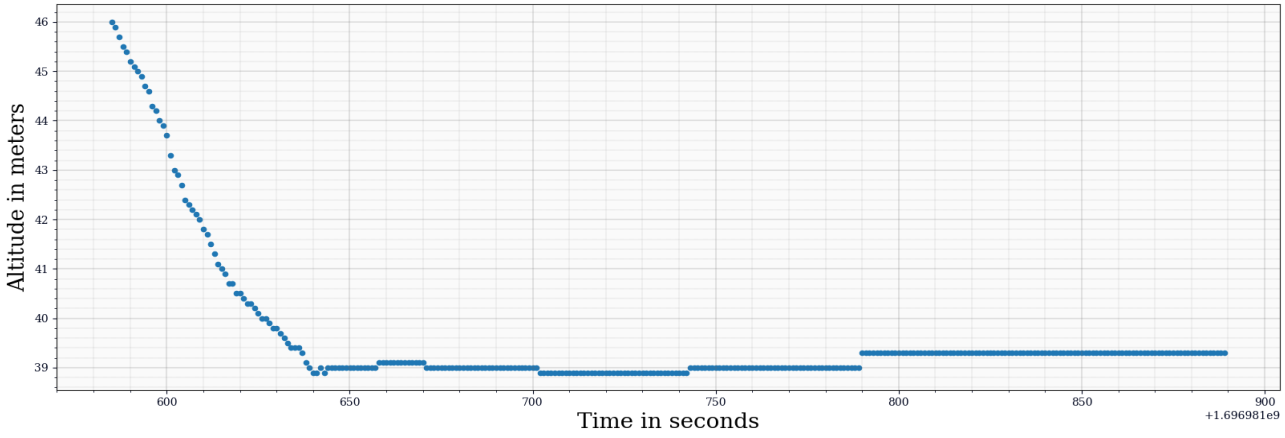

Fig 5: Scatter Plot of Altitude and Time

c. Histogram Plot

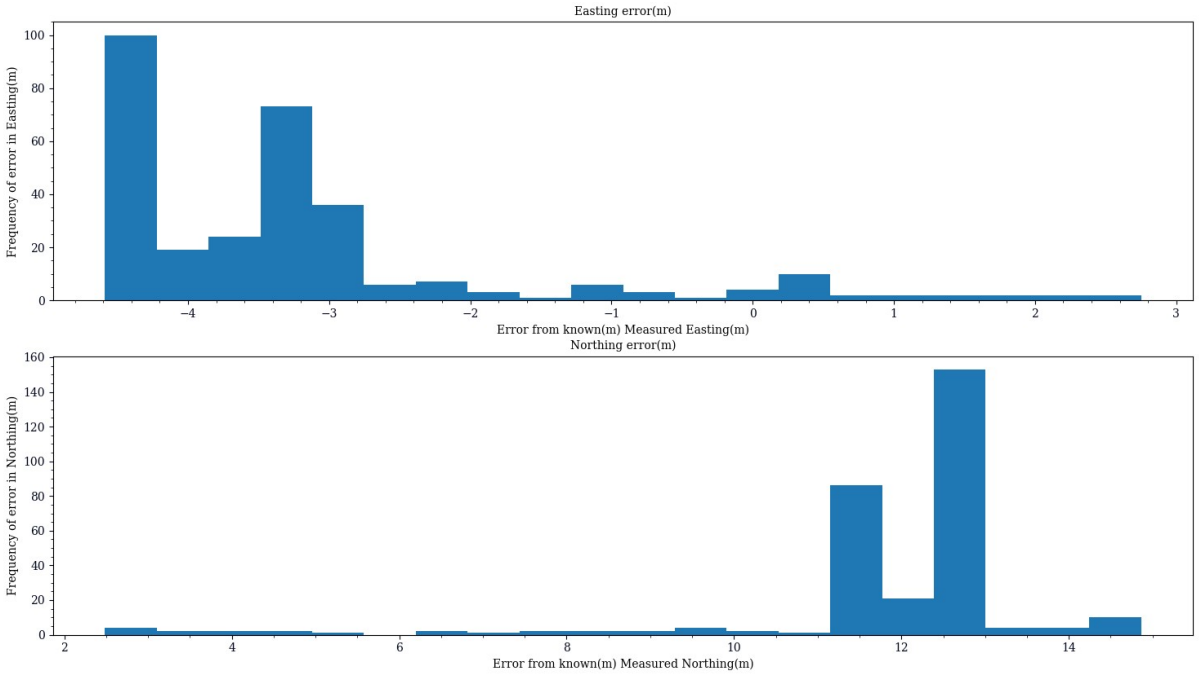

Fig 6: Histogram Plot

We calculated the mean, variance and standard deviation of the UTM_easting and UTM_northing data. We also got an mean and median of the error estimate of the utm values.

It was found that the easting data had the following results:

- Mean: 327721.339760
- Variance: 2.27527491
- Standard Deviation: 1.50840144

It was found that the northing data had the following results:

- Mean: 4689430.73062
- Variance: 3.6383334
- Standard Deviation: 1.90744159

Further the error estimates was found to be:

- Mean of error for easting: -3.2002392774
- Mean of error for northing: 11.8306277677
- Median of error for easting: -3.46198566
- Median of error for northing: 12.44596697

The data was collected in 2 different places where one was open and the other was in a occluded area covered by tress, buildings etc. The error was due to various reasons like the time of the day, weather, position of the sensor, receiver clock etc. The main source of the error in both the cases when using the GPS puck would be mutlipath effects.

3.Walking Data :

a. Scatter Plot of UTM_easting vs UTM_northing with best fit

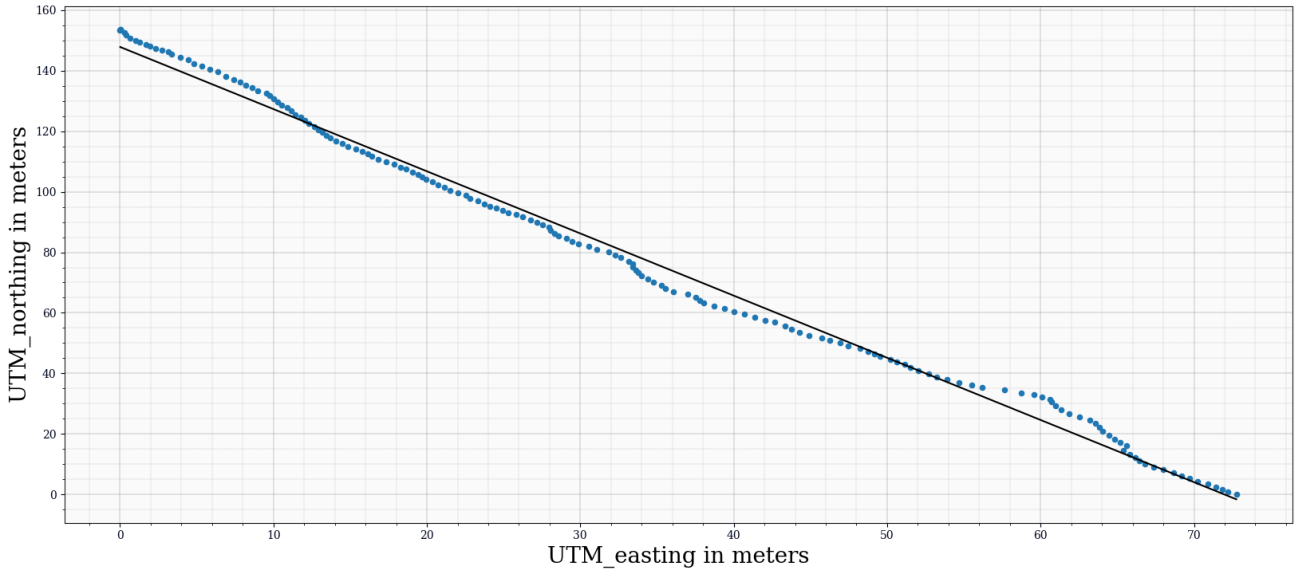

Fig 7: Scatter Plot of UTM_easting and UTM_northing

We can clearly see that the plot of the actual data is not coinciding with the best fit. This is due to the subtle movement of the hand when walking. Further it is very difficult to walk in a perfect straight line due to which the error could occur.

b. Scatter plot of Altitude vs Time

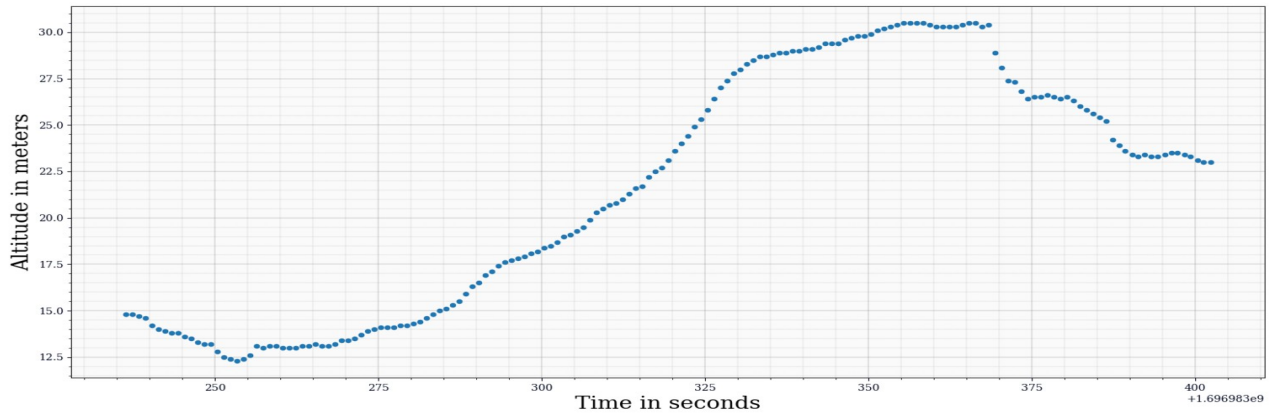

Fig 5: Scatter Plot of Altitude and Time

When a GPS device is stationary, meaning it's not moving, the error values associated with its measurements are relatively low and consistent. In these situations, the GPS signals encounter fewer disruptions, resulting in more stable and accurate location data. However, when the GPS device is in motion, such as during walking or driving, the error values tend to increase. Movement introduces various factors like buildings, trees, or atmospheric conditions, which can interfere with the GPS signals, causing the readings to be less accurate and more variable. This is visible in the scatter plot of the moving and stationary data.

GPS navigation while moving, especially in urban areas with tall buildings or area with dense trees the accuracy of the GPS receiver can be affected significantly. The movement introduces additional challenges, as the signals bounce off structures, creating multipath interference, and the receiver might momentarily lose connection due to signal blockages. These factors can lead to inaccuracies in the displayed position, potentially causing the navigation system to show the user slightly off-course or with delayed updates.