ANALYSIS OF GPS DATA

The following document aims to analysis the data collected from a GPS puck using a custom driver written in Python and ran using ROS.

Figure 1.

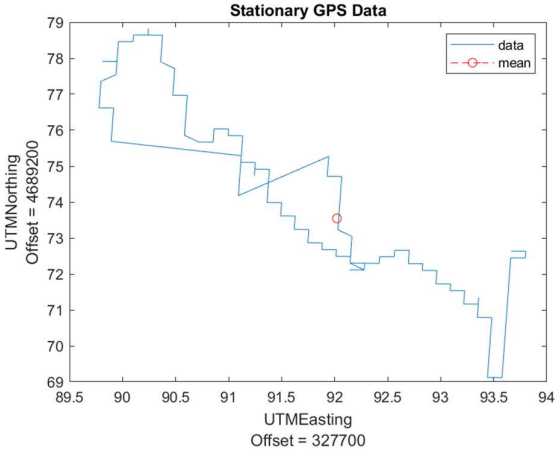
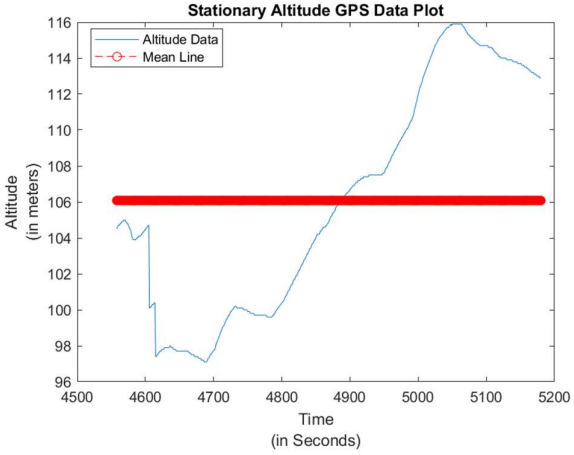


Figure 2.



The Figure 1 shows the GPS data collected by standing in one spot in an urban environment, surrounded by multiple buildings, but open to sky, and recording data for 10 minutes. The graph is drawn by using UTM data, using the Northing and Easting values. The mean has been calculate using the same values and shown as a point in red. The range of error in this case is 4.5 meters in UTM Easting and 10 meters in UTM Northing. The Mean value is (92.0216, 73.5462) (excluding Offsets).

The Figure 2 shows the Altitude data captured by the GPS puck during the same time as Figure 1. There is a variation of 20 meters. The Mean of this data is 106.08 meters and is indicated by the red line.

Q. What does this say about GPS navigation?

- According to the data collected in this test case, the GPS data collected is not very accurate and could be a limitation of the receiver puck and has a variation of 4.5 meters in UTM Easting, 10 meters in UTM Northing and a variation of 20 meters in the altitude.

Q. What can you say about the distribution of the error in GPS?

- The distribution of errors is random and cannot be formulated in a standard distribution.

Q. What is a good error estimate?

- A good error estimate would be around 8 to 10 meters in urban environment according to this data.

Q. Can we put bounds to these errors?

- A bound is very difficult to put to these errors as they are random and can be drastically different for different environments as seen in the data.

Q. What is/are the source(s) of these errors?

- The sources of these errors are due to multi path errors as there were multiple tall buildings surrounding the location of GPS data collection. This error is called Urban Canyon Effect.

Figure 3.

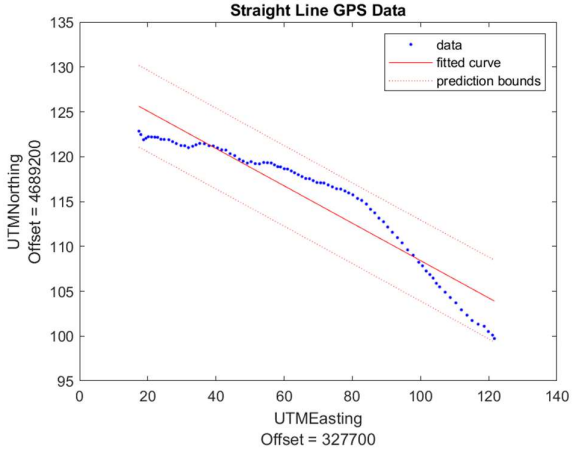
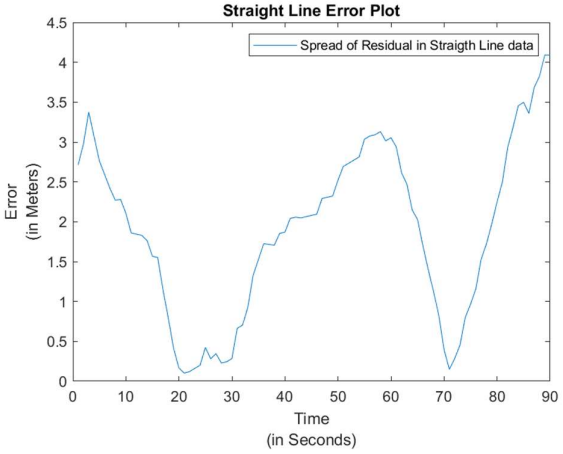


Figure 4.



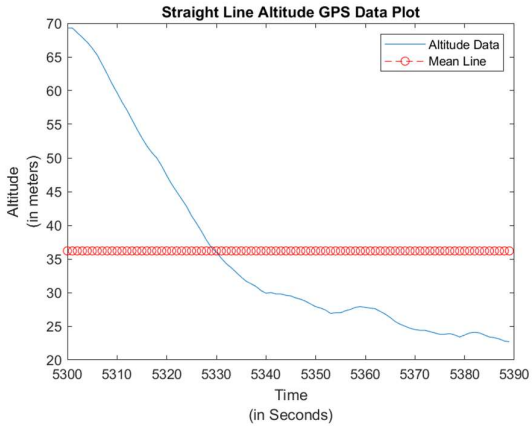
The Figure 3 shows the GPS data collected by a puck, while walking in a straight line. There is a fitted curve or best fit line drawn in red. The difference between the best fit line and GPS data is the error and is shown in Figure 4 with respect to time. It can clearly be seen in Figure 4, when the data reaches true value and when there is a larger deviation in the data collected.

Using the Residual spread, the Root Mean Square Error (RMSE) was calculated in MATLAB.

RMSE = 1.8967

The Figure 5 shows the Altitude data collected during the same test case. Here the red line shows the mean value, which is 36.19 meters. There is a variation of 50 meters. Although, the data was collected at a place where the terrain was not at the same height. The terrain starts with a downward slope and then flattens out, which can clearly be seen in the altitude data.

Figure 5.



Q. What does this say about GPS navigation when moving?

- While moving, the GPS data was not perfect, but we could clearly see a path that is close to the true path.

Q. How does the error estimate change as you move as opposed to stay in a spot? What can you say about the distribution of noise in this case?

- The maximum error measured in the UTM Easting is 5 meters and little less than 5 meters in UTM Northing. As compared to the Data collected in one spot, the error is lower. The distribution of noise is bound between two lines (as shown in the figure). The GPS data can be estimated to always be inside these bounds. The error in Straight line has a variation of less than 5 meters as seen in Figure 4