Robot Sensing and Navigation - EECE5554

Lab 1 Analysis Report

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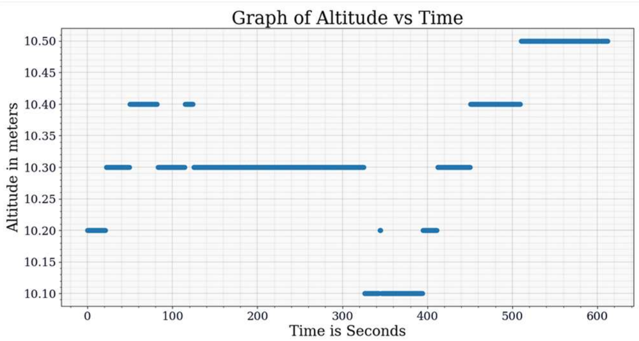
The data collected from the GPS puck provides us with information on the altitude latitude and longitude with respect to the time after which the values are converted to UTM nothing and UTM easting standards we get all the information about the position of the GPS Puck in terms of distance in meters with respect to time.

Now the information can be used for analysis as we have the position versus the time data.

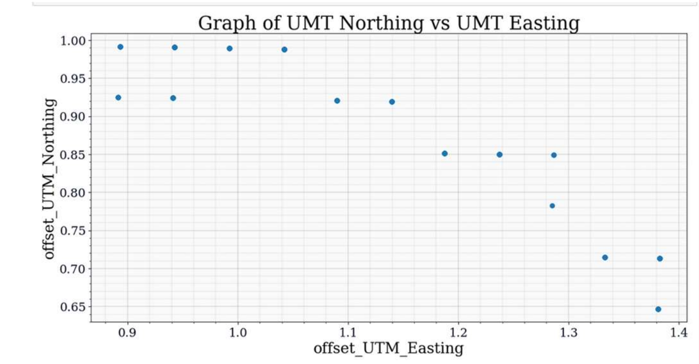
Stationary GPS Data Analysis

Firstly, the altitude versus time graph (Fig 1) provides us with information about the change in altitude of the puck with respect to time. The time has been offset to provide us with a graph having an x-axis from 0 to 600 seconds of data collection information. The graph shows the initial data that was collected to have an attitude of 10.2 meters. Eventually, the data collected shows that the altitude of the position increased by 0.2 meters, and then the attitude decreases by 0.1 meters. The graph stabilizes at 10.3 m for nearly 250 seconds. Which was the right altitude for the position. It can be observed that eventually the altitude decreases to 10.1 meters and gradually increases altitude position to 10.5 meters.



(Fig 1)

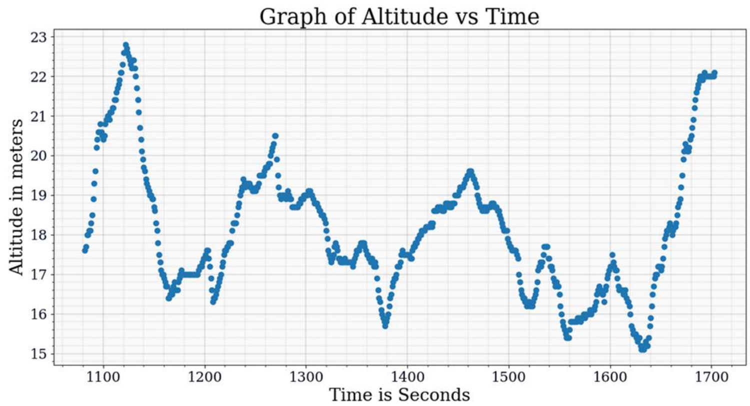
This graph (Fig 2) provides the offset UTM Easting versus offset UTM Northing. We can derive the position of the GPS puck on the ground with accuracy in meters. We can conclude from the graph that the position of the GPS was at (0.9,1.0) initially and eventually we can observe that the UTM nothing is going to a lower value of (1.4,0.65) which means the position of the GPS is slightly being moved towards the South and the UTM easting is increasing in value from the position of (0.9,1.0) which means that the position of the GPS is slightly moving to the east of the initially recorded point to (1.4,0.65). It can be inferred that the collection of data was from a stationary position on the Earth but the data provided by the GPS puck shows that the GPS Puck has been moving in the south-east direction. This shows that there is a small value of error that is recorded by the puck



(Fig 2)

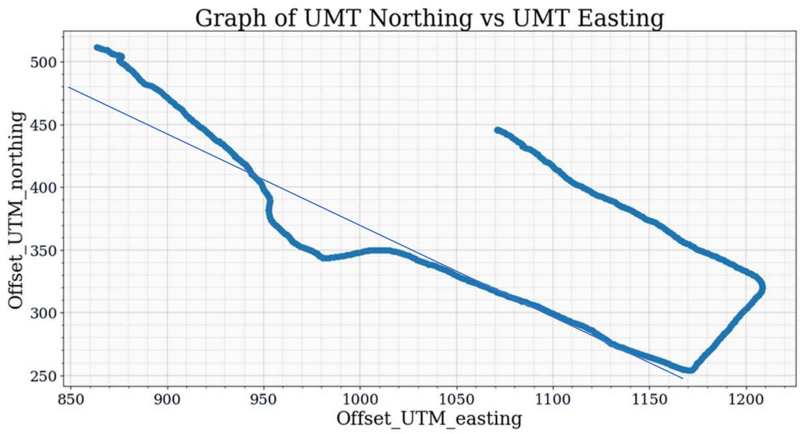
Moving GPS Data Analysis

This graph (Fig 3) provides data about the variation of altitude with respect to time as we collected data as we walked down the streets of Boston. The graph shows there was a frequent fluctuation in altitude throughout the entire duration. The highest elevation is 23 meters and the lowest elevation is 15 meters. The fluctuation of altitude can be observed because the walking path itself had a variation of altitude but not as much as what is observed in the graph. The reason for constant fluctuation is the error in data collected by the GPS in motion.



(Fig 3)

The following graph (Fig 4) provides the plotting of the offset UTM Nothing versus offset UTM Easting on the data off moving GPS puck. The graph shows that the walk starts from a point (870,510). The graph shows the straight-line plotting from the initial point towards the southeast direction. Deflection is noticed on the path. This is due to the presence of certain buildings and trees on the path. Once the stretch buildings and trees come to the end the graph correctly shows the straight-line path I took. Additionally, after a certain distance as the road comes to an end, I have taken two left turns which can be very precisely observed in the graph. As this data had been collected in a street which minimum disturbance it can be observed that the path has been correctly captured by the GPS puck.



(Fig 4)

Out of all the statistical estimation methods, I find that **Mean** is the most appropriate method to estimate the position from the graph. Mean provides the average value of the dataset. Mean is the best method to describe the centre of the data set when the distribution is symmetrical in nature and has very few outliers.
Median is used, if you get skewed distributions to either side. The **Median** does the best job of capturing data that has a huge number of entries on either side of the centre, where the median pulls the value towards that side.

But of all the probability theories, the **Central Limit Theorem** is the best and the smartest use of data to estimate the error. As we have a large dataset, we can obtain sample means of a small number of samples and then obtain the normal distribution of these samples. This can give us a highly accurate value compared to any other probability methods of error estimation.

Yes, we can put bounds to these errors by using **Kalman Filter algorithm** on the surface of the plotted graph by assuming that it is a **gaussian surface**, in this method data from different sources are collected and an estimation is made and this can be done on a data that has large amount of noise. But beyond this a huge margin of error can be reduced by collecting data in a place where there are less structures around so that the signals are not deflected which in turn provides erratic data.

Because the Extended Kalman Filter is implemented in the GPS Puck, the noise in reduced when the data is collected in motion. As noise is linearizes about an estimate of the current mean and covariance

We could also use the method of drawing a fitted line on the UTM Northing vs URT Easting graph. Then draw a graph **mapping the errors from the fitted line to the actual line**. Then find the **Root Mean Square** of the error variance to determine the error.

The sources of these errors in a GPS puck are caused due interference in GPS signal that the puck receives are because of the following reasons

- **Multi-path effects**- where the radio signals reflect off surrounding terrain, buildings, canyon walls, hard ground, etc
- **Atmospheric Interference** - thick clouds and precipitation will cause marginal error in the collected of data