GPS Lab1 Report

UTM-Easting and UTM-Northing:

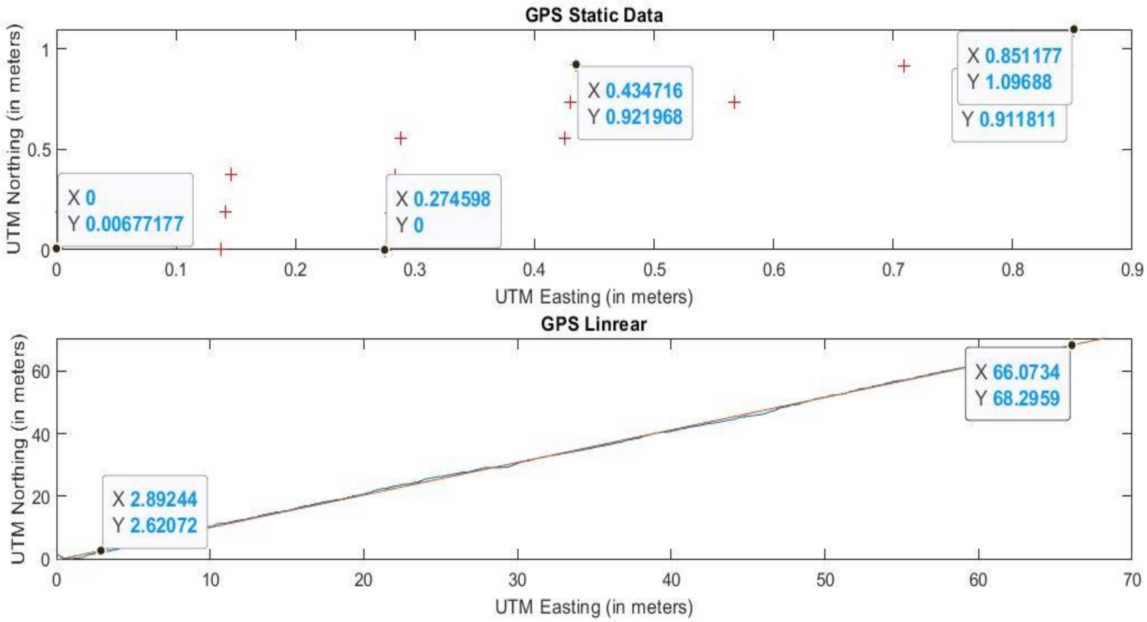


Figure1

The easting determines the east-west position w.r.t. central median. Northing is the distance of a point located in the Northern Hemisphere from the equator. Accordingly, the graph of UTM-Easting vs UTM-Northing is plotted on x-y axis which specifies the location of the point on the Earth.

We are observing fluctuations in the UTM Easting and Northing of Static data collected, it is evident from the points marked on the graph.

UTM Easting and Northing for linear motion does have some error but is following a linear path, we are comparing it with a best fit line, to observe the error.

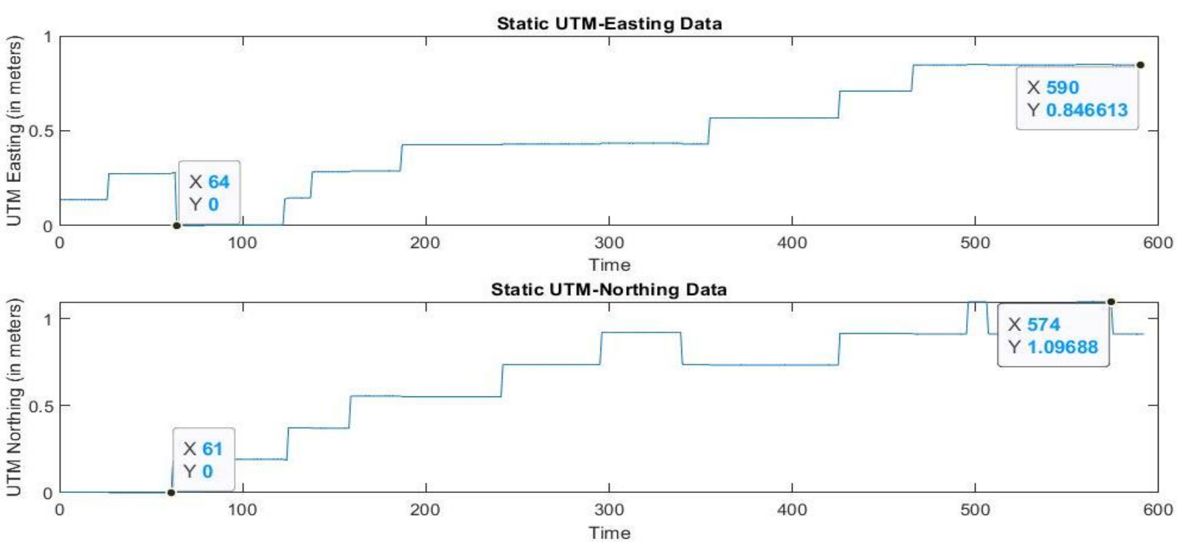


Figure2

Ideally, the UTM easting and UTM northing for static data should be constant. But with the collected reading we are observing some variations, error is being observed.

Altitude Statics/Walking:

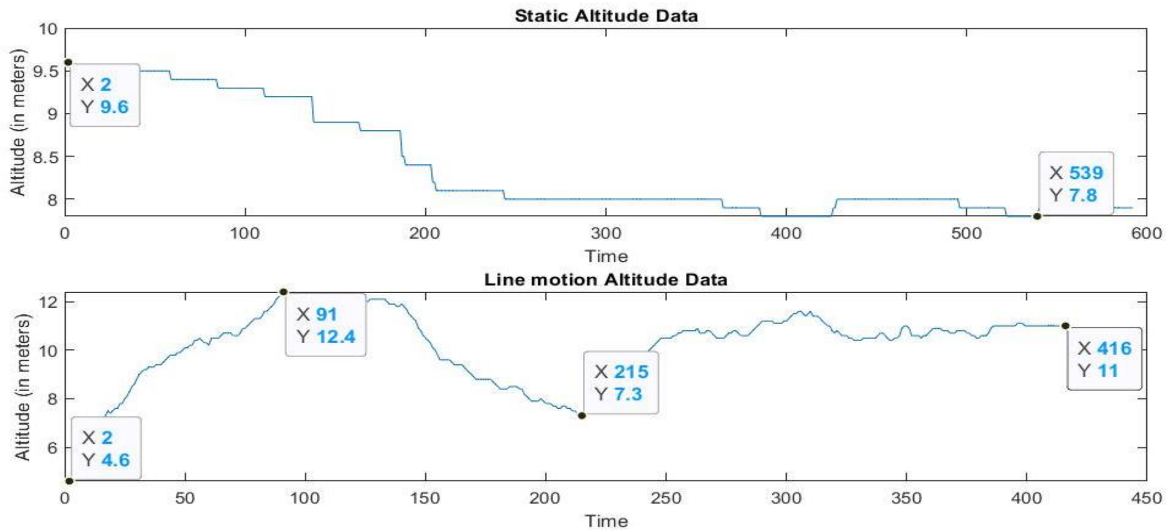


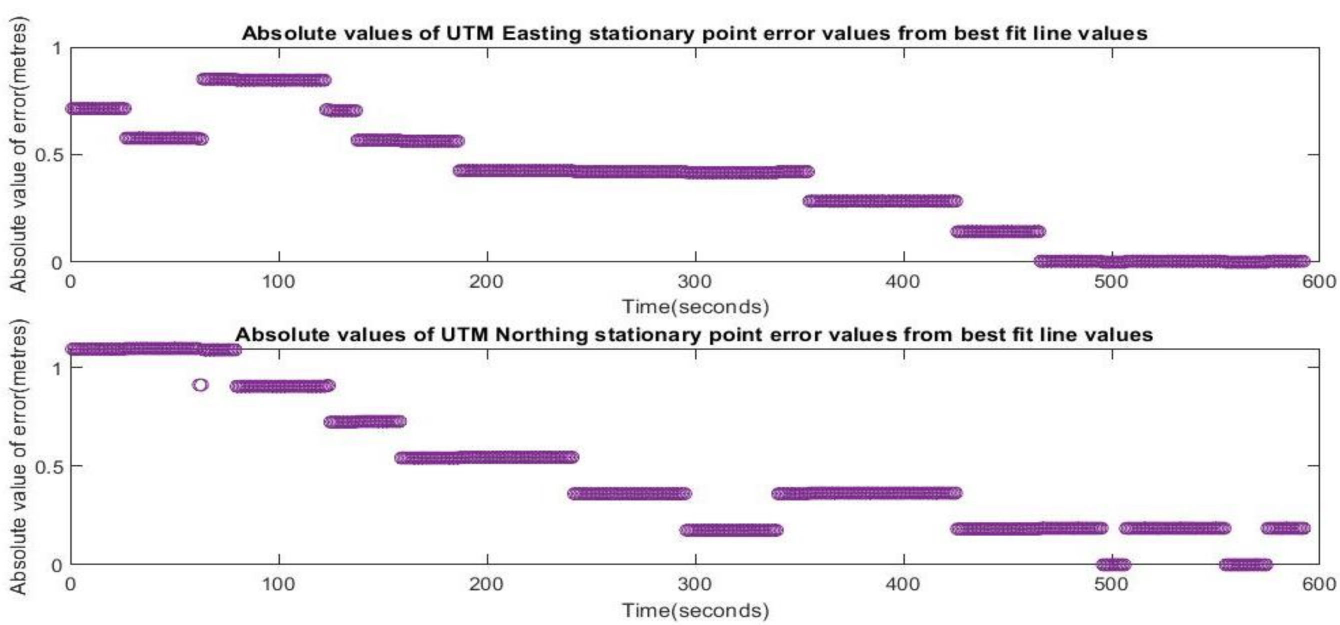
Figure3

A GPS receiver needs to receive signals from minimum four satellites to calculate the position. Several factors affect the accuracy of the reading. As per the general thumb rule, 'The vertical error is three times the horizontal error' error in the altitude readings were observed.

The elevation of Boston is around 5.8m above Sea Level. The altitude was expected to be constant, but it is observed that it is fluctuating in a range of 7.8m-9.6m for the static data and in the range of 4.6m to 12.4m for linear motion data.

The inaccuracy could be because of the below reasons,

1. All the satellites (min. 4 for 3-D location – Longitude, Latitude, & Altitude) were right above the antenna, causing a geometric issue at the time of taking readings. Widely spread satellite constellations give better and accurate location coordinates.
2. There could be a possibility of GPS signal loss where in the pre-acquired data and the data acquired once the signal is re-established are treated as two points, without considering the time-laps in-between.
3. Delay in reception of the signal where in the receiver might be retaining the previous data received until the next data set is received can cause the retained reading to be published until next reading are received. Point 2 and 3 can be an explanation for the step wise fluctuation of the Altitude observed in the static data collected.
4. The position of the GPS antenna is not stable while walking, little deviations and jumpy steps are accounted for a connecting straight line, this could be one of the reasons for fluctuations in the linear motion Altitude readings.



Figuer4

The above graph is the difference between the best fit line and the recorded reading from figure1. Eliminating the above plotted error will give us the best fit line.

Below are some possible reasons for the observed error.

1. Clock error: Satellites have their own on-board clock and transmit this information to the receiver on the earth at the rate of 70milliseconds. The GPS receiver collects data from minimum 4 satellites, the time from each satellite is considered for triangulating the location. The difference in the satellites time calculation result in noticeable errors in the position.
2. Atmospheric conditions: Charged particles in the ionosphere and the water vapor in the troposphere cause the signals to slow down introducing an error in the readings. This could be one of the major reasons for the error observed since it was cloudy and raining on the day this lab experiment was conducted.
3. Environmental factors: High rise building, trees, infrastructure as well as human bodies result in erroneous readings by the GPS receiver. The satellite signals bounce off these surfaces giving a false reading.
4. Satellite geometry: 'The further apart the satellites, the better the position calculation.' Dilution of Precision (DOP) is the value which determines the quality of satellite constellation condition. The possible reason for the maximum and minimum value discrepancy record could be because of the satellites being clumped up together.
5. The GPS Receiver also introduces some noise which affects the performance of the system. The noise affecting the performance mainly is thermal noise, antenna noise, antenna temperature, and system noise. Receiver noise is majorly affected by thermal noise and dynamic stress more than the other factors. Receiver noise cannot be avoided, it adds up to the overall error.

Clock error, atmospheric conditions, environmental conditions, satellite geometry, noise – are the major sources of error which contribute to the overall additive error observed in the latitude, longitude, and altitude readings of this experiment.

The GPS receiver was successfully able to record the zone – 19 T

Parameters	UTM Northing (meters)	UTM Easting (meter)	Altitude (meter)
1. Static mean	4.6898e+06	3.2727e+05	8.3736
2. Linear mean	4.6897e+06	3.2723e+05	10.1621
1. Static Range	1.0969	0.8512	1.8000
2. Linear Range	70.3873	68.1876	7.8000
1. Static Std	0.3317	0.2657	0.6175
2. Linear Std	21.2707	20.4577	1.5695
1. Min Value	4.6898e+06	3.2727e+05	7.8000
2. Max value	4.6898e+06	3.2727e+05	9.6000
1. Min Value	4.6897e+06	3.2720e+05	4.6000
2. Max Value	4.6898e+06	3.2727e+05	12.4000

Table1

The above values were extrapolated by analyzing the readings.

Concluding Analysis for Stationary Data:

The readings of the static data are scattered as compared to Linear motion readings. The Kalman filter keeps seeking for velocities around at the stationary point and hence ends up taking scattered readings.

The error recorded is random error since the reading are repeated very few times and are changing. The random error is reported by standard deviation of the readings. More the sample set, more precise measurement of the random error.

The stationary GPS errors cannot be bounded, since approximation isn't good the error bound will be very high.

Concluding Analysis for Linear:

The GPS navigation while moving is approximately close to the expected coordinates. The recorded errors is random error type for linear motion as well.