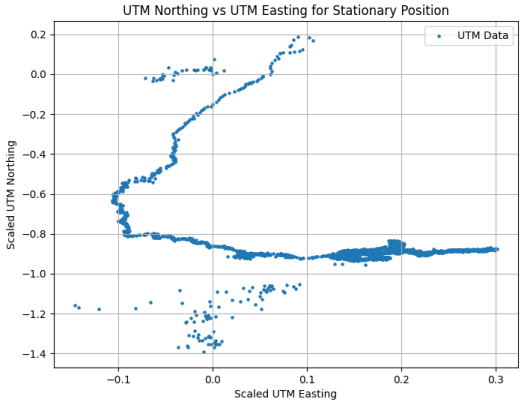
LAB#2

Introduction to RTK GPS

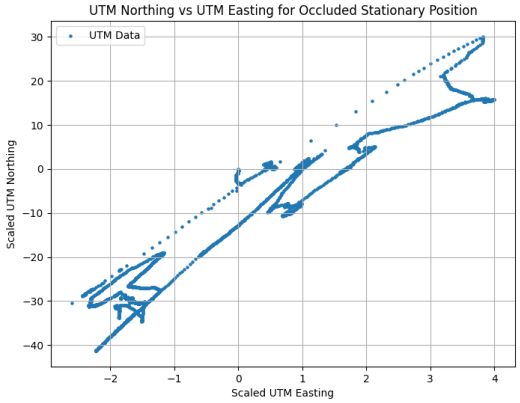
To eradicate the errors incurred in the usage of standard GPS that involved changes in speed of light, atmospheric refraction, clock errors, and satellite position (Dilution of Precision), the technique of using a Differential GPS was established wherein a fixed GPS station with accurately known position is used to send error fixes (through radio transmission) to the moving GPS stations (with unknown location) in a certain proximity to it. The pseudorange correction factors for each satellite is calculated and then radio transmitted to the moving GPS, which the moving GPS can then use for calculating its accurate location. The fixed station GPS in a DGPS calculates the correction factors based on travel time to each satellite and the observed accuracy of a DGPS is 1m.

To enhance the accuracy of the moving GPS, the technique of Real-Time Kinematic GPS (RTK GPS) was established which had a few modifications over the DGPS system and gave an error estimate of just 1-3 cm. The RTK GPS system repeatedly determines its position through Carrier Phase Measurements, instead of using Travel Time. The system then applies statistics over the timely data to produce the pseudorange corrections of each satellite. The RTK GPS, then, like the DGPS, also transmits the pseudorange corrections as radio signals to the moving GPS station, whose accurate position is to be determined.

Analysis of Stationary Data

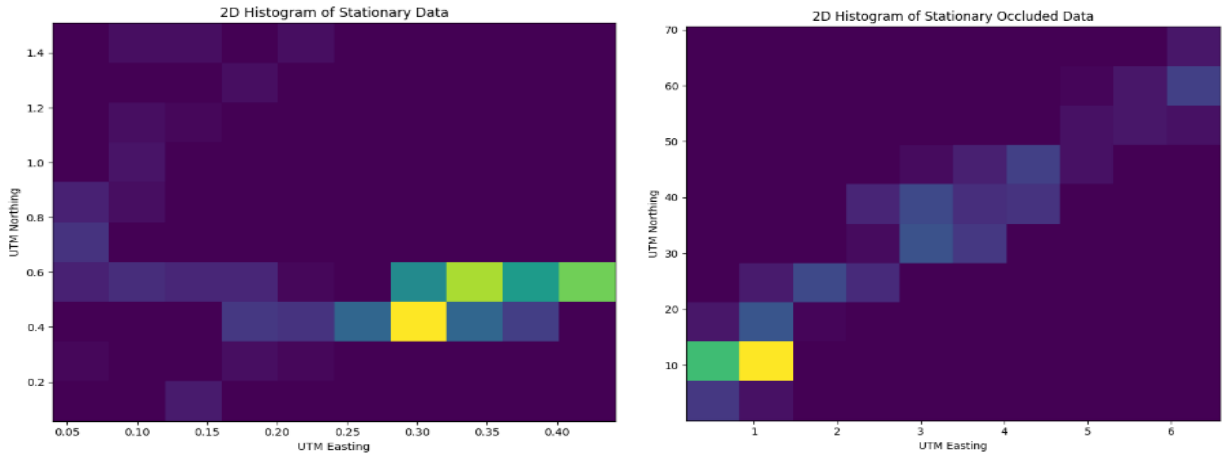


True Location = (42.33862, -71.08575)



True Location = (42.33879, -71.0883)

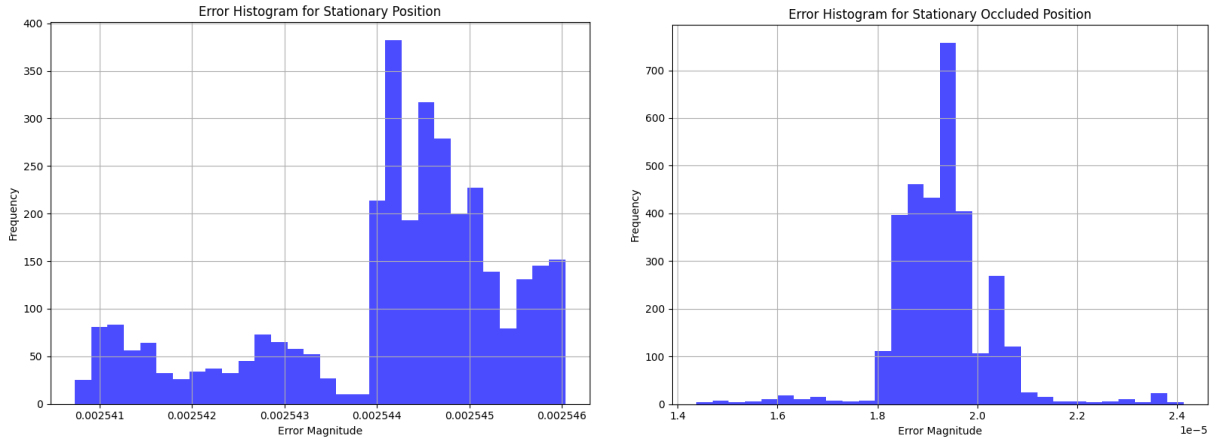
Note:
The datasets were collected and given by Yijian Huang.



The calculated deviations of Easting and Northing are as follows –

Median Absolute Deviation for Easting of Stationary Position – 0.046283
Median Absolute Deviation for Northing of Stationary Position – 0.013006
Median Absolute Deviation for Easting of Stationary Occluded Position – 0.95686
Median Absolute Deviation for Northing of Stationary Occluded Position – 11.1733

As can be observed, the deviations in the northing and easting datasets recorded while being at an open space are comparatively higher than those recorded at an occluded Position. This clearly indicates the amount of randomized errors in the collection of the former.



The shapes of the error histograms have a huge difference to the ones associated with the data collected using a standard GPS. Here, the shape is much more evenly distributed and has a much lower magnitude.

The error in RTK GPS as compared to the standard GPS, was found to be very low, for both occluded and non-occluded data. The error (in position) from the data calculated using RTK GPS are as follows –

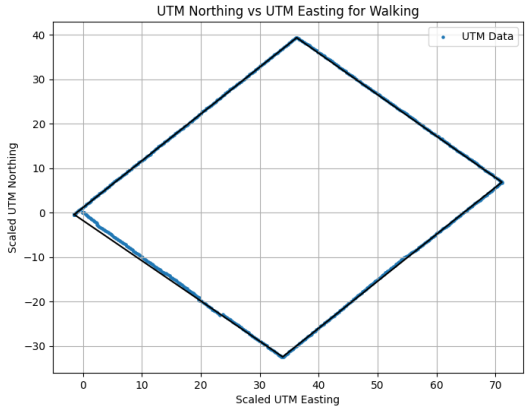
Root Mean Square Error (RMSE) for Stationary Position – 0.2544 cm

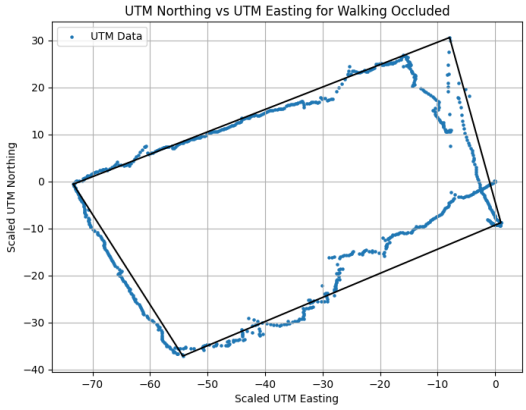
Root Mean Square Error (RMSE) for Stationary Occluded Position – 1.93 cm

The Occluded Position is associated with a higher error as was expected due to multipath effects.

This indicates that the inclusion of a reference base station sending pseudorange corrections measured through carrier phase measurements reduces the errors from meters to just centimeters.

Analysis of Moving Data



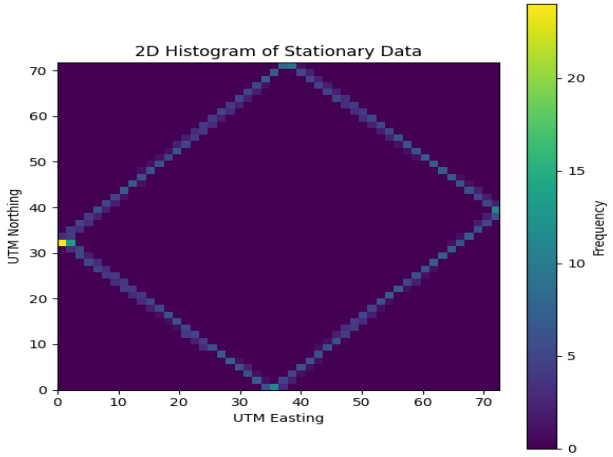


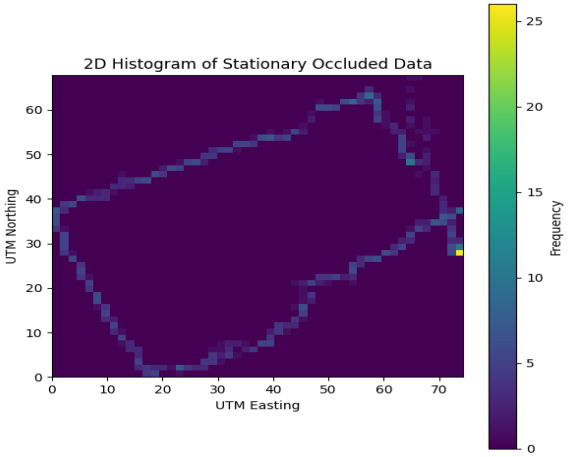
The above plots visualize the walking path with an overlapping best fit line. The higher deviation between the datapoints and the best fit line in the second (on the right) plot indicates the amount of deviation, which is higher than the one that was bserved when the area was an open space (on the left).

The error (in position) from the data calculated using RTK GPS are as follows –

Mean Error while Walking in an Open Space – 4.27698 m
Mean Error while Walking in an Occluded Space – 11.367 m

The Occluded Position is associated with a higher error as was expected due to multipath effects and signal interference.





The shape of these 2D histograms are different than the ones plotted in LAB1 as the former data was calculated while walking in a straight path.

The calculated deviations of Easting and Northing are as follows –

Median Absolute Deviation for Easting while Walking at Open Space – 0.000359
Median Absolute Deviation for Northing while Walking at Occluded Space – 27.739
Median Absolute Deviation for Easting while Walking at Open Space – 0.00194
Median Absolute Deviation for Northing while Walking at Occluded Space – 57.382

As can be observed, the deviations in the northing and easting datasets recorded while walking in an open space are comparatively higher than those recorded at an occluded Position. This indicates the timely intrusion of randomized errors in the data collection while walking in an occluded space. These errors may be attributed to sources like Multipath effects, Signal interference and GNSS fix quality. GNSS fix quality is an indication of accuracy of the pseudorange corrections sent out by the reference base statio in the form of radio signals to the moving (mobile) GPS receiver.