Lab2 Report

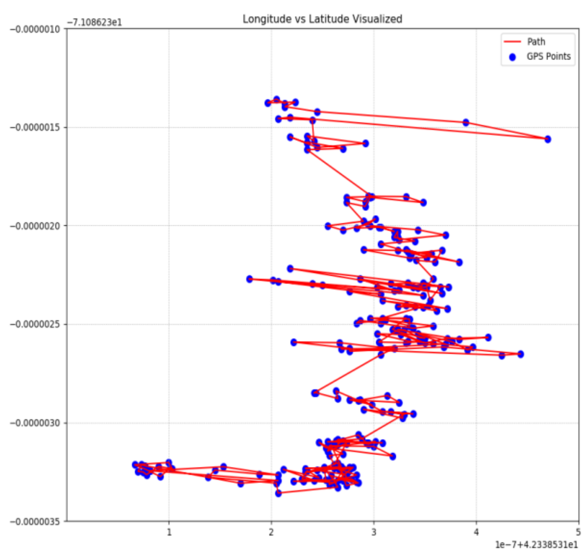
Real-Time Kinematic GNSS: Analysis and Implications

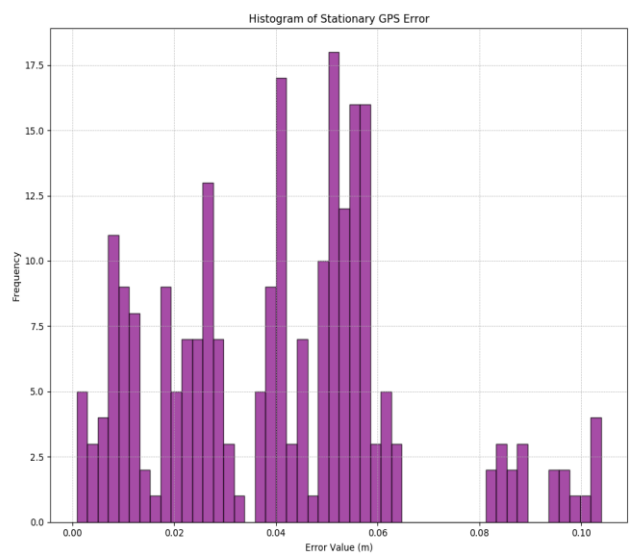
Introduction:

Real-Time Kinematic (RTK) is an advanced technique used in satellite-based navigation systems like Global Navigation Satellite System (GNSS). It improves the accuracy of positioning data by using a stationary base station and a roving mobile receiver. The base station sends real-time corrections to the mobile receiver, which then computes and refines its position. In this lab, locations were chosen to devoid of any significant obstructions, the roof of the Columbus parking garage and ISCE building.

Analysis

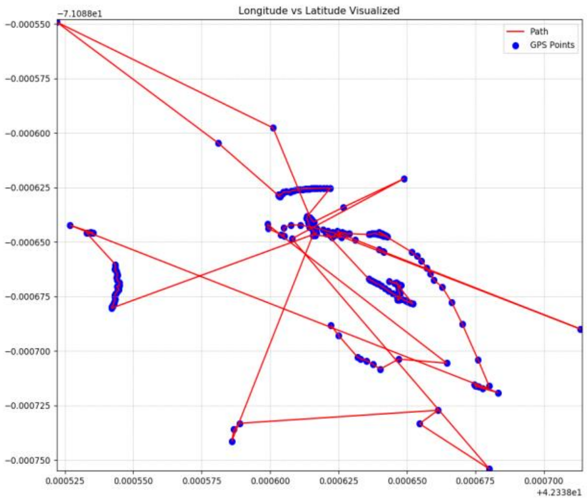
Stationary:

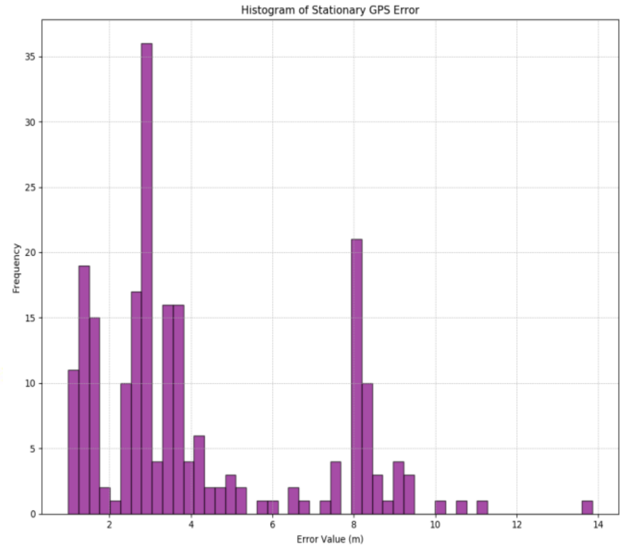




The provided histogram and scatter plot offer insights into the accuracy and movement pattern of a GPS system. The histogram reveals that the bulk of GPS error values predominantly fall within the 0.04 to 0.06 meters range, suggesting a commendable degree of precision in the readings. While instances of extremely low errors (around 0.00 to 0.02 meters) or notably high errors (0.08 to 0.10 meters) are less frequent, they highlight the system's overall reliability and the occasional outliers. In the scatter plot, the blue dots capture specific GPS data points. Notable concentrations of these blue dots indicate either pauses in movement or zones with dense GPS readings.

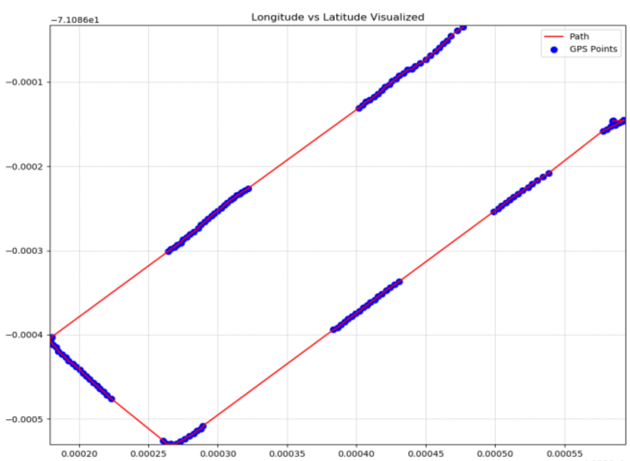
Stationary occultation:

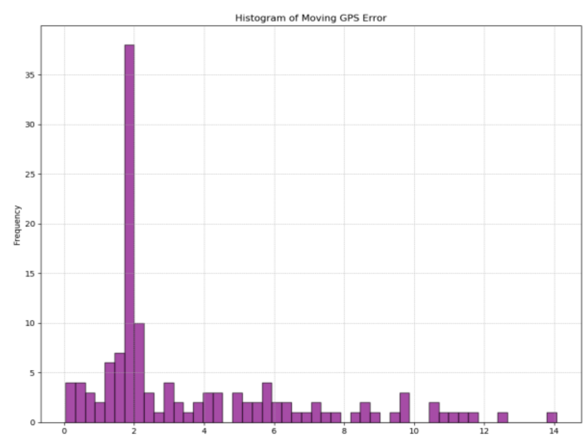




The histogram displays the error margins of a stationary GPS device, with the majority of errors falling between 2 and 3 meters, evidenced by over 30 instances in this range. There are two significant error peaks: a primary one between 2-3 meters and a secondary, less frequent one around 8-9 meters. In the Longitude vs Latitude graph, the blue dots represent the GPS's actual readings. There are noticeable zigzags in the blue dots, hinting at GPS inaccuracies. Clusters of these dots suggest periods where the device either remained still or faced signal issues.

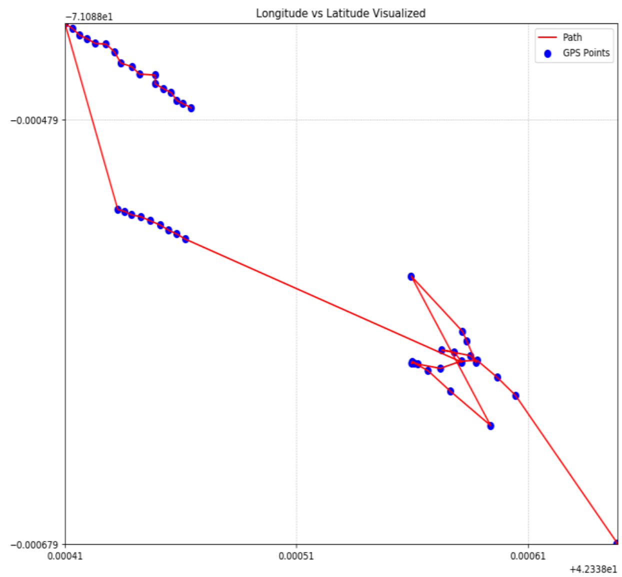
Moving:

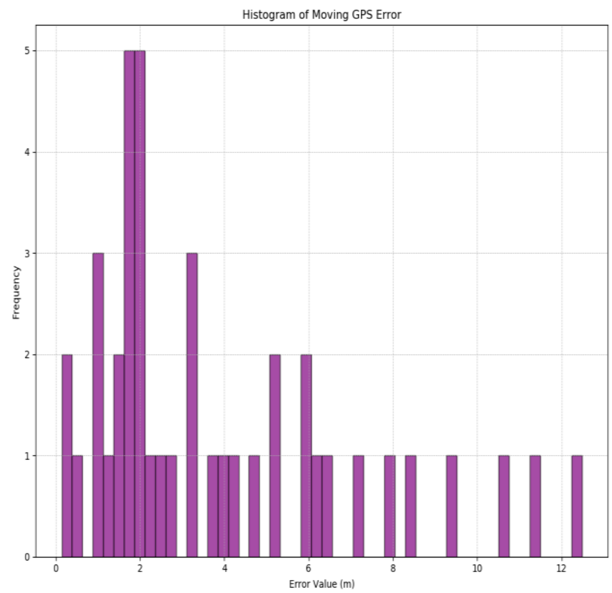




The graphical representation depicts the trajectory of a device, presumably following a rectangular route designated by the red lines. The blue dots, representing GPS data points, largely align with this predetermined path, but there are some disparities, most notably in the bottom-left corner, which mean possible inaccuracies or interferences affecting the GPS readings in that zone. A pronounced peak near the 2-meter mark on the error value axis suggests that many of the data points were clustered around this error magnitude. However, the distribution also has a noticeable tail, extending towards the 14-meter mark, indicating sporadic larger errors during the collecting. The spread of these errors, especially around the 2-meter and up to 14-meter marks, indicates variations in the accuracy of the GPS readings while the device was moving.

moving occultation:



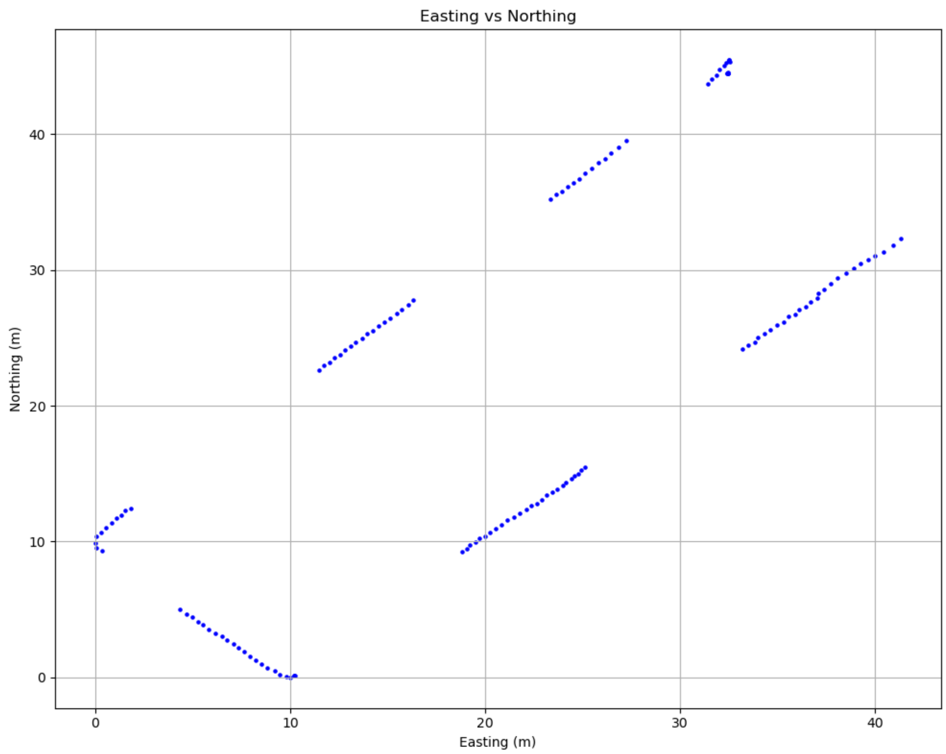


The data reveals a prominent concentration of error values around the 2-meter mark, with a frequency peaking at 5 occurrences. This diverse range of errors during movement, especially the primary concentration around 2 meters and the secondary peaks at 4 and 6 meters, indicates the varied influences and challenges faced by the GPS system under occultation conditions. In the graph, the path appears to have been planned in a linear fashion with some deviations, especially in the top-left and bottom-right regions. But in the actual collection, we followed a rectangular path around ISEC. This error may have been caused by the fact ISEC is not a fully rectangular structure and got influenced by the train railway. These deviations indicate potential errors or disturbances in the GPS signal.

GNSS navigation vs. standalone GNSS without RTK:

The histogram of stationary GPS error provides insights into the error or deviation when comparing to a "true" position. The concentration of error values suggests that RTK GNSS navigation might be more accurate than standalone GNSS without RTK, as the errors are relatively constrained within a narrow range. The presence of distinct peaks might imply systematic errors that can be accounted for or corrected in an RTK setup.

Ranges and shapes of Easting and Northing from RTK GPS:



Based on the above graph for easting vs northing , it appears to have traversed multiple distinct linear paths across a range of approximately 0 to 40 meters in both directions. These paths indicate specific routes or predefined maneuvers. The density variations within these paths suggest different movement speeds, with denser clusters possibly indicating slower movement.the range seems to be more precise alignments in some areas than others. The data clusters suggest the device's stationary period or areas with more substantial deviations. The shapes of easting and northing are more likely to be same as ideally.

Comparison with Lab 1 data:

In comparison, LAB1's GNSS without RTK might exhibit a broader error distribution. The scale used for the graphs is much bigger since the errors are larger. But for the walking data, the shape is better than Lab2 because Emlid Reach itself has some technical issue for the corrections during walking.

Moving data in open vs. occluded cases:

The data and graphs suggested minimal interruption in open areas. In contrast, the deviations and clustering might signify occluded cases where the GPS signal was disrupted. The error/deviation estimates in occluded regions might be higher due to obstructions affecting the GNSS signals. GNSS fix quality could be a factor, as lower quality fixes might result from weaker or reflected signals, common in occluded environments.

Stationary data in open vs. occluded cases:

The histogram of stationary GPS error presents a clear view of the device's performance when stationary. The concentration of error values and distinct peaks might be a result of GNSS fix quality. In open cases, the errors might be lower and more consistent, while in occluded cases, there might be increased deviations due to obstructions or reflections affecting the signal. GNSS fix quality is intrinsically tied to the error/deviation estimates, as a higher quality fix would ideally result in lower errors.

Conclusion

RTK GNSS provides superior accuracy when compared to standalone GNSS. However, its performance can be hindered by obstructions, reflected in the GNSS fix quality. A clear line of sight, minimal multipath interference, and robust communication between the base and rover are essential for optimal RTK GNSS operation.