LAB 2 – RTK GPS Report **Rahul Sha Pathepur Shankar**

A. Introduction

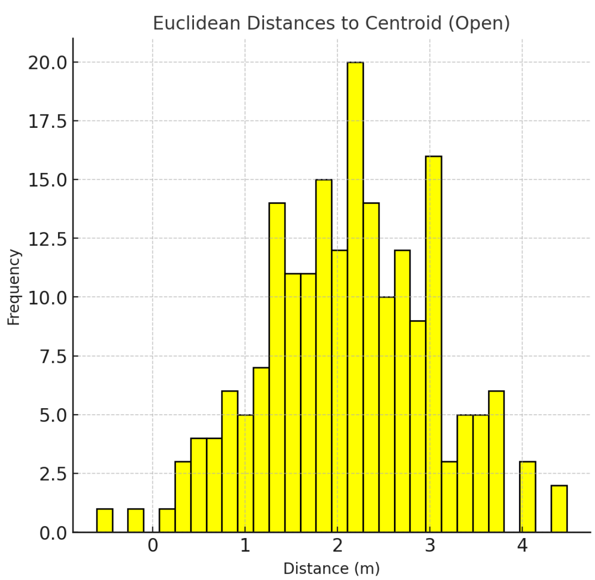
The RTK GPS is a sophisticated add-on of the global position system that uses real-time corrections to offer more precise location estimates compared to traditional GPS. This system consists of two primary components: a stationary base station and a rover.

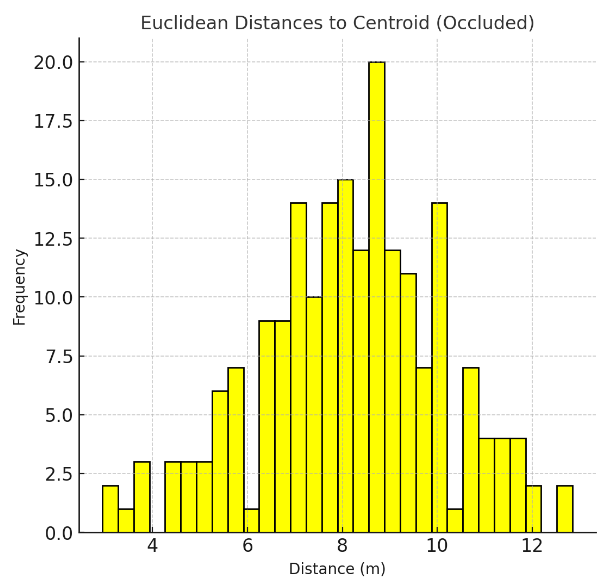
RTK determines its position by using carrier phase measurement, while the base station transmits differential GPS corrections to the rover. Once these corrections are applied, the rover can achieve accuracy within a 0.1m radius. Despite its precision, GPS GNSS systems, including multipath errors caused by GNSS signals reflecting off surfaces in obstructed areas, clock inaccuracies, atmospheric interference, and unfavorable satellite geometry, all of which are also common in standard navigation systems.

B. Data Acquisition and Analysis

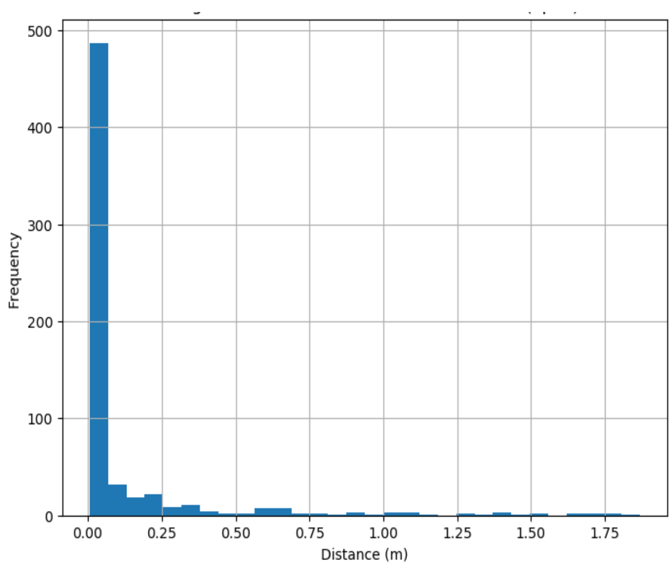
A total of four datasets were gathered to complete this lab, all using the u-center app after configuring GPS corrections from MACORS station network. The first two datasets involved 10-mintue stationary collections. The first set, referred to as the stationary open dataset, was recorded on near EXP. For the second stationary dataset, the location was moved to an occluded area in the open space of ISCE entrance. The final two datasets were collected while moving the RTK rover in a rectangular pattern. One of these collections was done in a partially occluded environment with reflections, while the other was near the open space.

Histograms of the deviations in both Easting and Northing were created to compare the accuracy of RTK GNSS navigation with standalone GNSS without RTK.

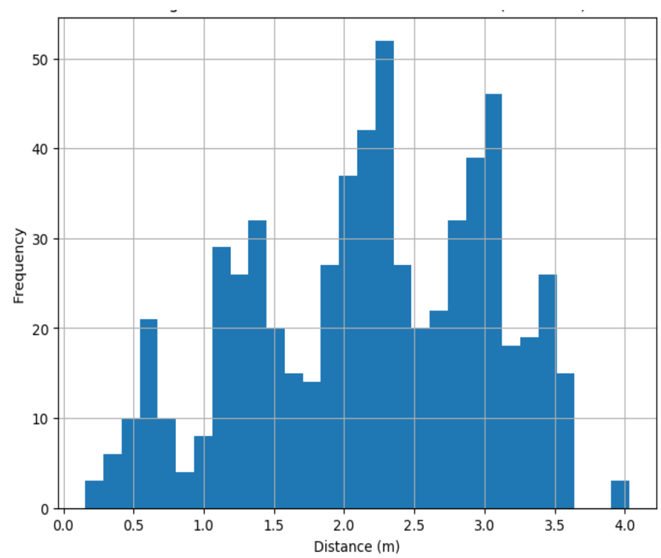




The blue histograms represent the datasets with error correction applied, while the yellow ones were generated in the previous lab. The blue plots show the deviations recorded in open spaces, whereas the orange plots reflect data collected in occluded areas. One key observation is that the RTK system collected significantly more points than in Lab 1, indicating higher accuracy in the readings. Beyond the corrections made using RTK, I also noticed that over 15 satellites were consistently in use during these recordings.

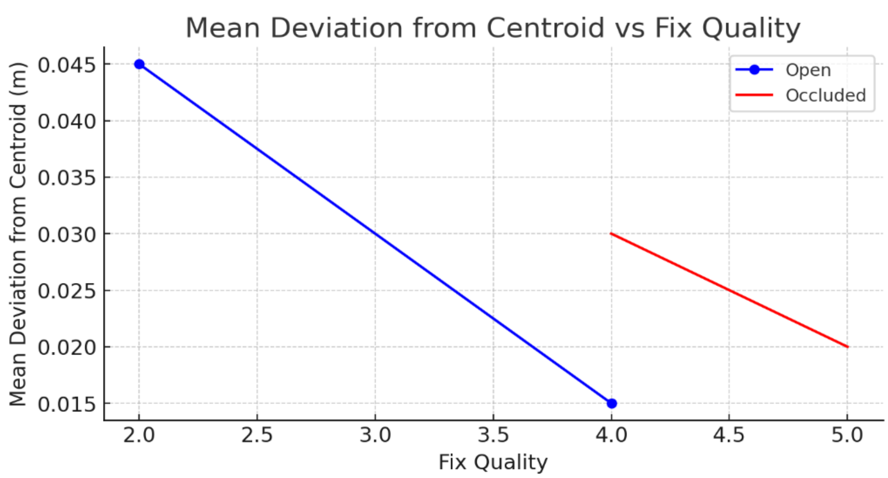


Histogram of Euclidean Distance to Centroid



Histogram of Euclidean Distance to Centroid (Occluded)

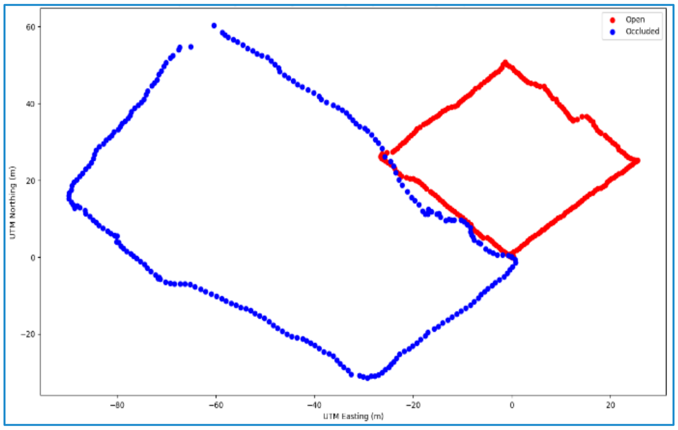
As a result, the largest deviation recorded in Lab 2 was less than 0.1 meters, while the standalone GNSS produced errors exceeding 2.5 meters. In contrast, the histograms from Lab 1 lack a clear shape, and the deviations appear to be more evenly distributed. Additionally, the range of deviation in the standalone GNSS is significantly broader compared to the RTK GPS data.



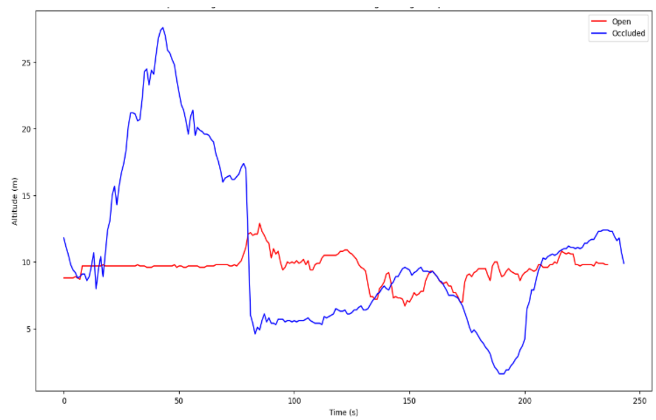
Mean Deviation from Centroid vs Fix

The GNSS fix quality is a key factor in these findings. A plot of the mean deviation from the centroid versus fix quality was created to demonstrate how fixed quality impacts the magnitude of errors in the datasets. During data collection in open spaces, we obtained fix quality values of 2 and 4, with the latter showing a noticeably higher precision. In contrast, for occluding areas, the fixed quality values were 4 and 5. Although the fix quality in occluded areas was higher, the average deviation remained larger than in open spaces. This outcome is consistent, as the environment surrounded by buildings and trees—introduced more signal interference, leading to greater errors despite the improved fix quality. For the datasets collected during movement, we also observe higher accuracy when using the RTK GPS, similar to the stationary datasets. The process was consistent, and the deviation remained minimal. However, there were significant errors in the altitude data.

The figures below illustrate the evolution of altitude over time during the moving data collections in occluded spaces, highlighting these altitude discrepancies. Despite the improved horizontal accuracy with RTK, the altitude readings were less reliable, especially in environments where buildings and other obstacles likely interfered with vertical measurements.



UTM Easting vs Northing for a Reading in open and Occluded Area



Graph showing time vs altitude for dynamic reading in open and occulted area

C. Results

This lab highlights the substantial benefits of using RTK GNSS navigation over standalone GNSS. The data analysis shows that RTK consistently delivers significantly higher accuracy, with deviations staying under 0.1 meters, while standalone GNSS produced errors exceeding 2.5 meters. These results underscore the impact of real-time corrections in enhancing positional precision, particularly in open environments.