LAB-2
RTK GNSS

Introduction

Real-Time Kinematic (RTK) is a positioning system that utilizes satellite technology to provide real-time centimetre-level accuracy for various critical applications. The system heavily depends on Global Navigation Satellite System (GNSS) technology to determine precise positioning information and is commonly utilized in fields where high-precision positioning is of utmost importance.

Differences between GNSS and RTN GNSS.

GNSS and RTN GNSS are two different positioning systems with some notable distinctions. RTN GNSS refers to a network of permanently installed GNSS receivers that are maintained and monitored by a service provider, and are capable of providing high-precision real-time positioning data to users. This technology is particularly useful in areas where traditional GNSS measurements can be affected by obstructions.

In contrast, GNSS is a satellite-based positioning system that offers global coverage and does not rely on any ground-based infrastructure. The fundamental difference between RTN GNSS and GNSS is that while RTN GNSS is based on a network of ground-based receivers, GNSS is solely reliant on satellite signals. Due to this reliance on different technologies, RTN GNSS can offer higher positioning accuracy in locations where GNSS signals are obstructed or weak.

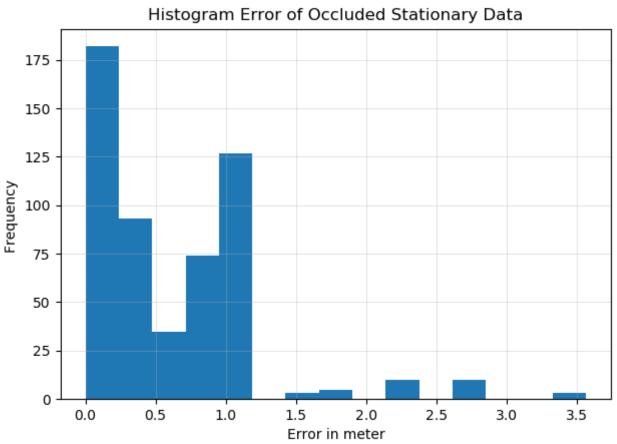
Error sources of RTK GNSS

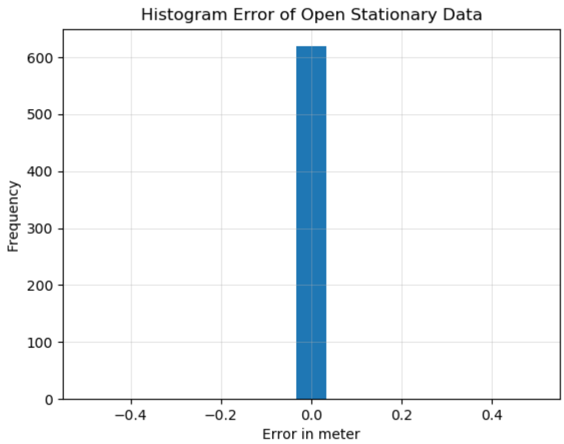
There are a few factors that can cause errors when using RTK GNSS which are:

1) **Atmospheric conditions:** Variations in atmospheric conditions, like ionospheric delays, can negatively affect the GNSS signal, leading to inaccuracies in positioning data.
2) **No. of satellites connected to:** The number and placement of GNSS satellites in view can impact the quality of positioning data obtained. Generally, the more satellites that are within view, the more accurate the measurements will be.
3) **Receiver noise:** The quality of the GNSS receiver used can also affect the accuracy of positioning data. If a low-quality receiver is used, it can introduce noise into the signal and reduce the accuracy of measurements.
4) **Multi-path interference:** When the GNSS signal bounces off surfaces such as buildings or trees, it can cause multi-path interference and produce incorrect positioning information.
5) **Improper configuration:** When the base and rover are not properly configured and are not communicating with each other properly, this results in the reading not having a fixed quality.

Questions:

a) What does the error (if you used a “true” position) or deviation (if you didn’t) tell you about RTK GNSS navigation, as compared to GNSS without RTK?





The results of the analysis show that RTK GNSS yields significantly lower error values than GNSS without RTK, i.e., values collected in LAB1. This indicates that RTK GNSS offers greater precision and accuracy in situations where the GNSS signal is weak or obstructed. RTK GNSS achieves this by utilizing a network of ground-based receivers that continually monitor and correct the GNSS signal, reducing the impact of potential sources of error, which are more likely to occur in urban and suburban environments.

On the other hand, GNSS without RTK relies solely on satellite signals, which are susceptible to various sources of error, resulting in higher deviation values. While GNSS provides global coverage, it may not deliver the same level of accuracy, especially in areas where obstructions or interference exist.

b) What can you say about the distribution of noise in the signal?

The mean and standard deviation values for the open and occluded areas are as follows: Mean – 3.59 cm and Standard deviation – 4.45 cm for the open area, and Mean - 0.604 m and Standard deviation - 0.621 m for the occluded area.

When using RTK GNSS, it is crucial to take into account the mean and standard deviation of the measurements as various sources of error can impact the accuracy and precision of the readings. These sources of error, as previously mentioned, include atmospheric conditions, signal blockage, and receiver errors.

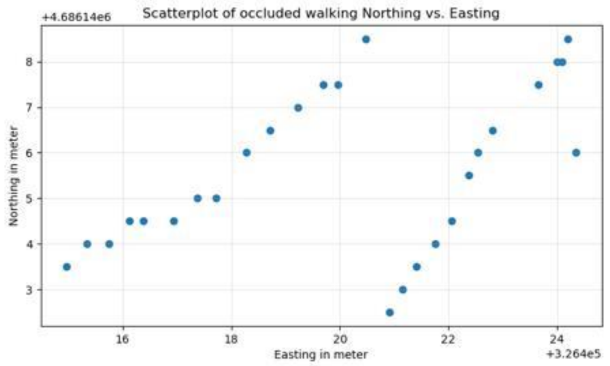
The mean of the errors helps estimate the bias in the measurements that results from errors in the reference station. Meanwhile, the standard deviation of the errors provides an indication of the level of noise or random error in the measurements.

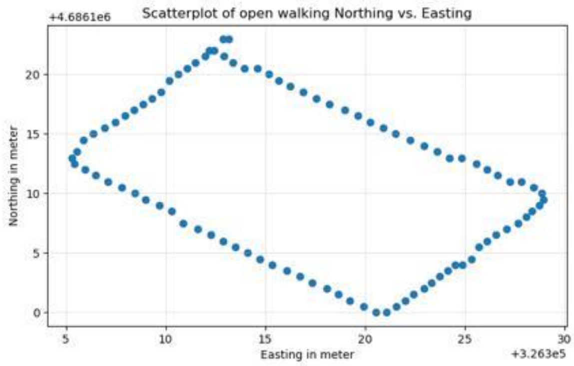
C) Why is this distribution different from GNSS data collected in Lab 1?

To estimate the accuracy of GNSS data measurements, the commonly used approach is to calculate the median value instead of the mean value. This is because the errors in GNSS measurements typically exhibit a non-normal distribution. The median represents the central tendency of the data, which is not influenced by extreme values, making it a more representative measure of error for GNSS measurements.

Also, we can notice that the errors obtained are higher towards the initial readings and tend to decrease as we go further away or give more time. This is because over time the rover and base communicate with each other and the corrections received are closer and more accurate resulting in lesser errors as time increases.

D) How are your moving data different in the open and occluded cases? Does this have anything to do with GNSS fix quality?



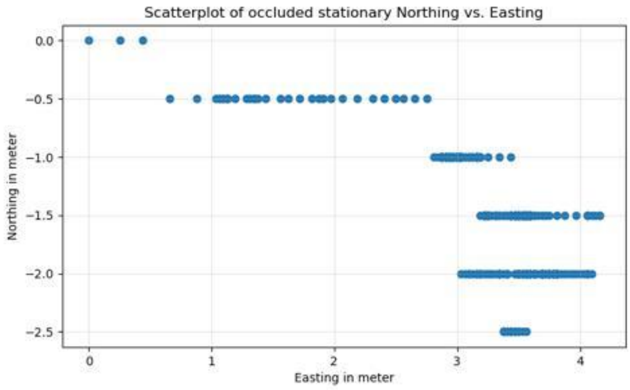


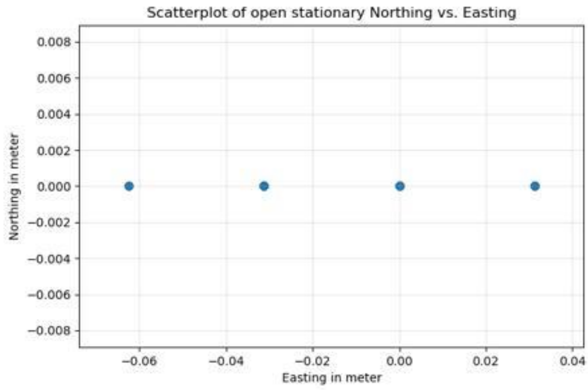
RTK GPS measurements are typically more accurate and precise in open spaces, while in occluded areas, the measurements tend to be less accurate and precise. The reason for this is that in open spaces, GPS signals encounter fewer obstructions, leading to a higher number of satellites being tracked and a more accurate fix. In contrast, occluded areas are more likely to experience signal blockage or reflection, resulting in a less accurate fix.

The GNSS fix quality, also known as "RTK Fixed", is an indicator of the quality of the satellites being tracked and can impact the accuracy of the measurements. However, it's important to note that other factors such as atmospheric conditions and receiver errors can also affect the quality of the measurements.

It is also important to note that the value of Quality obtained at Open locations is 4 meaning RTK fixed whereas value of quality obtained at occluded spaces is 5 meaning RTK float which although is an excellent reading still is subpar with respect to RTK fixed which in itself states that the accuracy in open conditions is higher than occluded spaces. We can thus note that the data with most deviation is the occluded and walking data because of continuous movement and simultaneous obstructions. This is not the case with open condition and the signal received is stronger and without a lot of interruptions resulting in lesser deviation from travelled path and we can also notice that the start and stop point of open condition is the same unlike the start and stop position of occluded space.

E) How are your stationary data different in the open and occluded cases? Does this have anything to do with GNSS fix quality?





The quality of the GNSS fix is a crucial factor that can significantly impact the accuracy of stationary RTK GPS measurements, regardless of whether the measurements are taken in open or occluded areas. Typically, in open spaces, the quality of the GNSS fix is higher, resulting in more precise and accurate measurements. On the other hand, in occluded areas, the quality of the GNSS fix tends to be lower due to signal blockage, leading to less precise measurements.

However, it's essential to note that the quality of the GNSS fix is not the sole factor that affects the accuracy of stationary RTK GPS measurements. Other sources of error such as multipath interference, receiver noise, and atmospheric conditions can also impact the accuracy of the data, even in open spaces with a high-quality GNSS fix.

It is also important to note that the value of Quality obtained at Open locations is 4 meaning RTK fixed whereas value of quality obtained at occluded spaces is 5 meaning RTK float which although is an excellent reading still is subpar with respect to RTK fixed which in itself states that the accuracy in open conditions is higher than occluded spaces. We can also note that since the rover is both stationary and in an open environment, we obtain an almost negligible error in this case relative to occluded and stationary where there are some obstructions to the signals.

Note: Despite reviewing our firmware flashing process with the TA since the sensors weren't communicating with each other, we were at an impasse. Therefore, our group (Group no. 6) has collected data in collaboration with group 4, and has performed analysis individually.