LAB2- Report

Collection of data

During the recording of all of the following data base station was set on the top of Columbus garage.

1) The stationary free data was collected at the top of the Columbus garage. (42.33821198352815, -71.08641989071687)
2) The stationary occluded data was collected in front of the Intramurals club office below the shed. (42.33801329029123, -71.08582505429443)
3) The walking-free data was collected in the middle of carter ground while walking 70 steps in the x direction and then turning and walking 7 steps in the y direction, again turning and walking 70 steps in the -x direction, followed by turning and walking 7 steps in the -y direction making a rectangle. (42.33906446180222, -71.08430427820721)
4) The walking-occluded data was collected at the back of Snell library on the street while walking 70 steps in the x direction and then turning and walking 7 steps in the y direction, again turning and walking 70 steps in the -x direction, followed by turning and walking 7 steps in the -y direction making a rectangle. (42.33893599222485, -71.08698440213239)

RTK GNSS Introduction

We were given the following hardware and sensors :

- 2 x GNSS/RTK processing boards
- 2 x GNSS antennas
- 2 x 915 MHz telemetry radios
- 2 x microB USB to USB A cables
- 2 x Cables to connect telemetry radios to GNSS/RTK processing boards

The GNSS/RTK processing boards are the main brain of the sensor in which the GPS signal is converted into meaningful data.
The GNSS antennas help us to capture the GPS signal from the satellite.
The 915 MHz telemetry radios help us to communicate between the base station and rover.

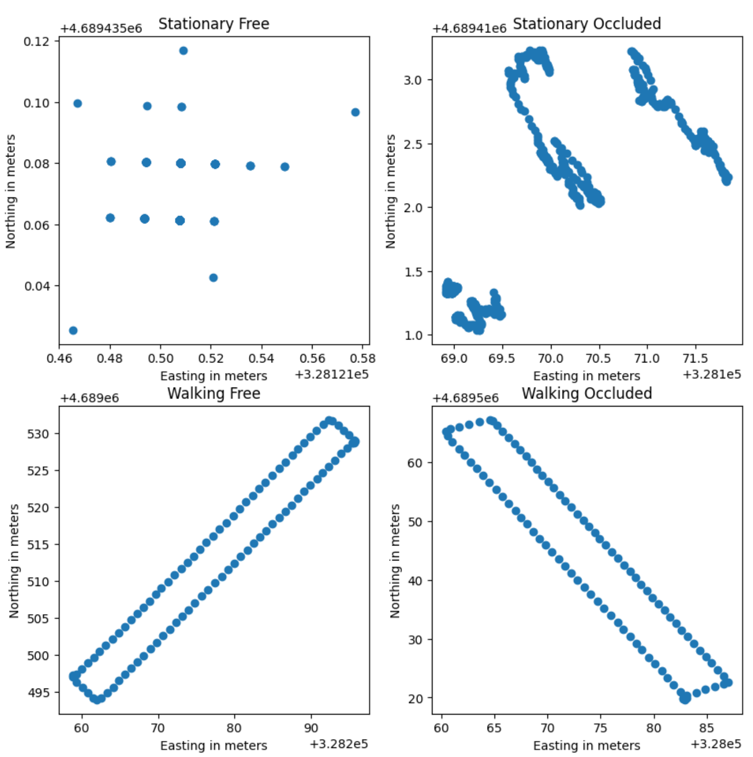
Difference between RTK GNSS and GNSS

GNSS stands for Global Navigation Satellite System, which is a constellation of satellites in space that transmit signals to receivers on the ground, enabling users to determine their location, velocity, and time. Examples of GNSS systems include GPS (Global Positioning System), GLONASS (Global Navigation Satellite System), Galileo, and Beidou.
RTK (Real-Time Kinematic) GNSS is a technique that uses a GNSS receiver with a highly accurate clock and specialized algorithms to improve the accuracy of position determination in real-time. RTK GNSS uses a fixed base station and a mobile rover to calculate highly accurate positions in real-time by calculating the difference between the phase of the satellite signal received at the base station and the phase of the same signal received at the rover. This technique can provide highly accurate positions, with centimeter-level accuracy, which is especially useful for applications that require very precise positioning, such as surveying, construction, and precision agriculture.

Sources of error in RTK GNSS

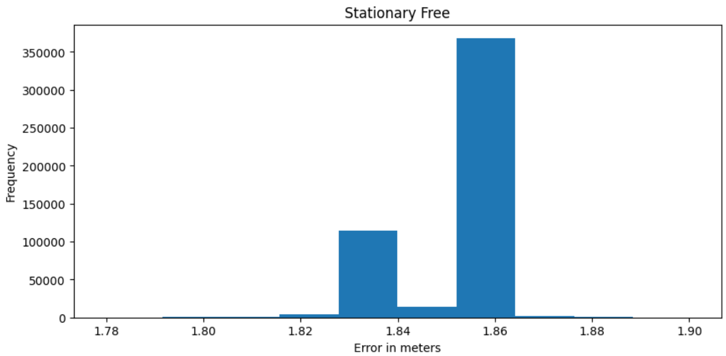
- Multipath: Multipath occurs when the GNSS signals bounce off surfaces, such as buildings or trees, before reaching the receiver. This can result in errors in the signal's arrival time, which can lead to inaccurate position measurements.
- Atmospheric effects: The ionosphere and troposphere can cause the GNSS signals to bend or slow down, leading to errors in the signal's arrival time. The amount of error can vary depending on factors such as time of day, season, and location.
- Satellite geometry: The accuracy of GNSS positioning can be affected by the arrangement of the satellites in the sky. Poor satellite geometry, where the satellites are clustered together or located low on the horizon, can lead to inaccurate position measurements.
- Receiver noise: Noise in the receiver can cause errors in the signal's arrival time, leading to inaccurate position measurements.
- Clock errors: The accuracy of the receiver's clock can also affect the accuracy of the GNSS positioning. Even small errors in the clock can lead to significant position errors over time.
- Signal obstructions: Objects such as buildings or terrain can block the GNSS signals, reducing the number of satellites visible to the receiver, and resulting in reduced positioning accuracy.
- Data processing errors: Errors can also occur during the processing of the GNSS data, such as incorrect baseline length calculation, antenna phase center variation correction, and ionospheric model errors.

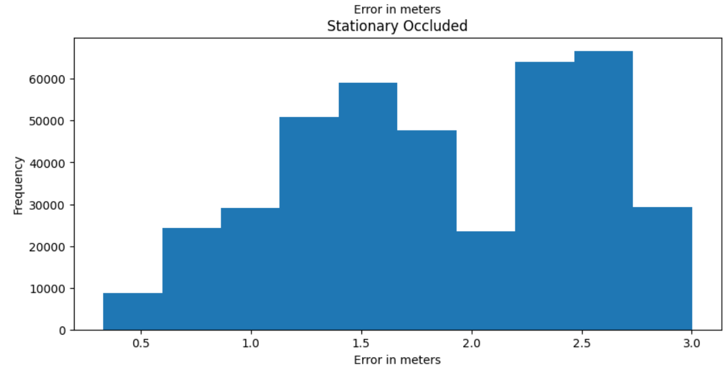
Scatterplot between Northing and Easting



Comment - As we can see in the plots we got highly precise stationary data for free space as almost all of the fix quality values were 4(RTK fix), thus giving this result whereas, for the case of stationary data in occluded space, we can see the data is cluttered in three spaces part of the reason for that is that we got fix quality values 2,4,5 and therefore different error values, these values maybe because we didn’t have a clear line of sight with the satellite and also due to multipath. In the case of walking data, we can see that we were able to make the shape that we desired but it is more accurate in free space, as while walking in free space we had a guideline to walk in a straight line but for the occluded case we had to that on our own.

Histogram of error in positions

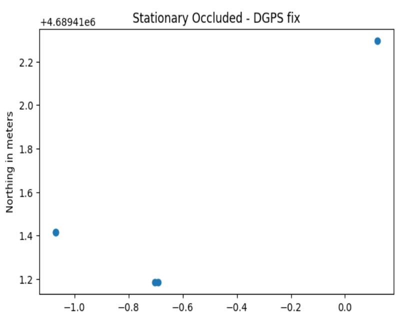


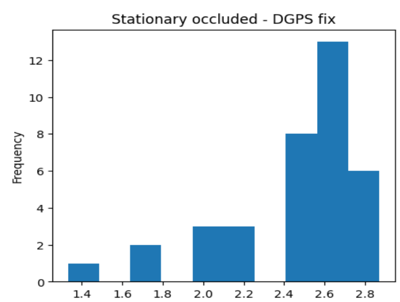


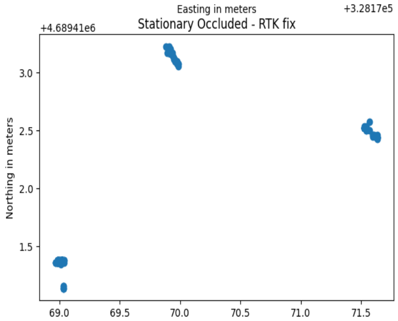
Comment -

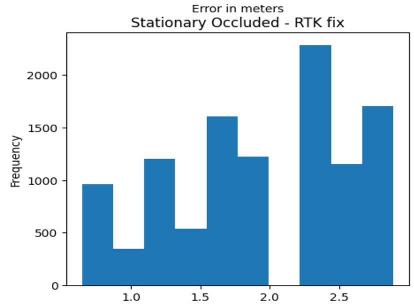
- Stationary Free space - The root means square error for this case is 1.84903930243698 meters, even though we can see that the error is very high but GPS is not a major contributor to this error as we can see the deviation is around 10 cm so the data is quite precise the error is this because the true location that we got from google maps is faulty.
- Stationary Occlude space - The root means square error for this case is 1.9665362721748307 meters, in this case, we can see that the error is highly distributed and also the deviation is around 2.5 meters. As mentioned earlier this is due to the fact that we have different fix quality values in this data and further analysis on that is given below

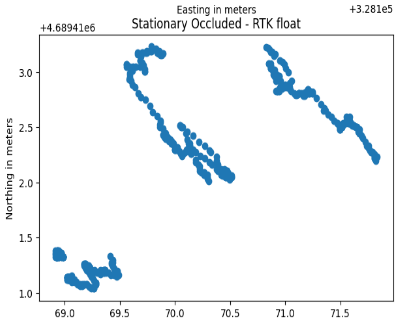
Comparison of different types of Fix Qualities

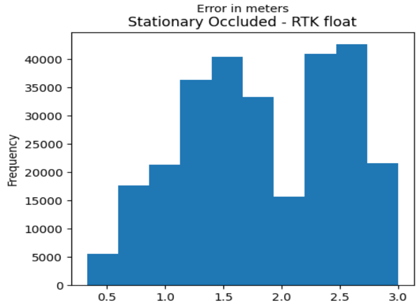












Comment -

DGPS fix - The root means square error for this case is 2.508698879418221 meters, with only six data points, in this case, we can see in the scatterplot that the points are quite scattered and thus we can see from the errors also that this is the worse than RTK fix and float.

RTK fix - The root means square error for this case is 2.017194334436641 meters, we can see that the range between errors is just 1.5 meters and also the points are cluttered in one place three places precisely because of multipath thus showing this is the best fix available between the three.

RTK float -The root means square error for this case is 1.9491136829462967 meters, we can see that the range in error is 2.5 meters also we can see that the points are scattered all over the place, thus this is better than the DGPS fix but worse than he RTK fix.