EECE: 5554 Robot Sensing and Navigation

Lab 2: RTK GPS

Introduction:

RTK GPS is a type of GPS, where RTK means "Real-Time Kinematic" which provides us with highly accurate data in real-time and the error is in within a centimetres range whereas for a normal GPS is in meters.

RTK GPS has two components ***"Base"*** and ***"Rover".*** The base is held stationary and receives signals continuously from the satellites. Rover is like a moving component that moves around the base and receives signals from the satellite. The rover communicates with the base to get the corrected signal, which helps the rover calculate its position accurately.

Difference between RTK GPS and GPS:

The major difference relies on the accuracy between RTK GPS and a GPS. If we estimate the error of a position given by RTK GPS and a GPS. The error is in centimetres when it comes to RTK GPS and for GPS it is in meters. RTK GPS has receivers on the ground that are maintained by a service provider which helps the RTK GPS to achieve high-level precision in real-time. In the case of a GPS, it solely relies on satellite signals and there is a high chance of the signal being manipulated by external factors, which produces a high error.

Source of error in RTK GPS:

There are several factors that influence the signals and are a major cause of the error:

- **Weather:** Atmospheric factors including ionospheric and tropospheric delays can have an impact on GPS transmissions. The positional data may be inaccurate as a result of these delays.
- **Multipath Interference:** Multipath effects happen when GPS signals scatter off structures like trees or buildings before, they reach the GPS receiver. This may result in positional data problems.
- **Base station location errors:** If the position of the base station is not precisely known, RTK GPS data may contain errors.
- **Obstruction of Signal:** If the signals are blocked by buildings and trees, where the signals may not reach the receiver and the GPS could not estimate the signal.

Questions:

1) **What do 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?**

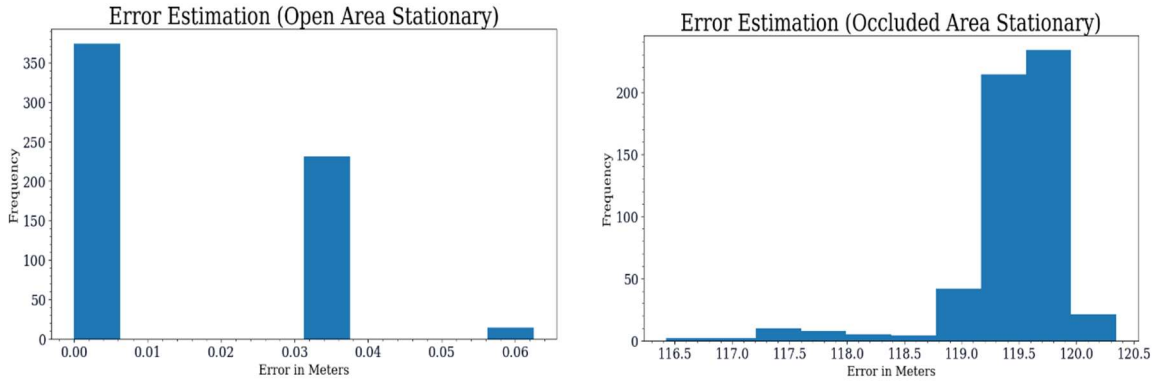

Fig.1 Error estimation between open and occluded area.

Explanation:

If we recall the plots for error estimates for the GPS puck and this RTK GPS, the deviation in error in this for the open area is less than a meter but for a normal GPS it was ranging to 5 meters. As RTK GPS is highly reliable on receivers that are on the ground, the accuracy is high as its values are corrected in real-time, compared to normal GPS which relies majorly on the satellites which can only provide a mere estimate of the location. The accuracy is also consistent in occluded areas as well, where a GPS puck has varying deviations in error based on the scenarios like open and occluded.

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

Explanation:

Open Area:

Mean: 1.3 cms
Std. deviation: 1.68 cms

Occluded Area:

Mean: 0.647 meters
Std. deviation: 0.534 meters

Mean and Std. deviations have been the standards that are most widely followed to measure errors. These standards change from data to data due to external factors that are called ***"noise"***, which can be anything that manipulates and intercepts the signal.

Mean help us understand the weight in the error which manipulates the whole data whereas it shows the fluctuation clearly. Std. deviation shows the range or randomness of error in the measurement.

3) **Why is this distribution different than GNSS data collected in Lab 1?**

Explanation:

Mean helps us to calculate the outliers of the data, which is caused when a few of those external factors act on the signal. Mean is an average of the whole data set and helps us predict an accurate value from the whole data set and it also takes the larger value into consideration which helps us give an overall picture. But in terms of the median, it takes the centric value of the data and doesn't care about the spiking value in the set. The mean is generally considered to be a better measure of the average error in the measurements because it considers the magnitude of all the errors and is more sensitive to outliers than the median.

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

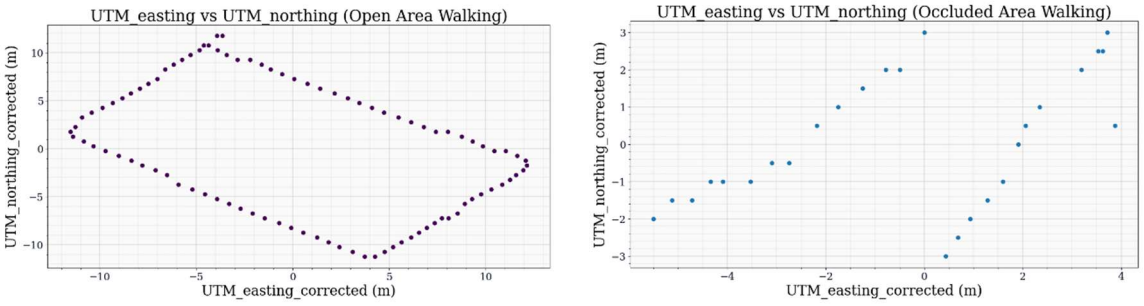

Fig.2 Open and Occluded walking data in a scatter plot

Explanation:

It is clearly visible from the plots when there is some disturbance caused to the signal or change in the GNSS fix quality. The GNSS fix quality can be estimated from the signal received by the receiver. If there are any obstacles or hindrances to the signal, then GNSS fix quality will reduce accordingly. The plot on the left shows the data collected in the open area, where there is no disturbance to the signal, which is why we can clearly see the structure in which direction we walked. But in the case of occluded it is not clearly visible as the GNSS fix quality is low and doesn't show any clear pattern like in the left plot, based on the walking direction.

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

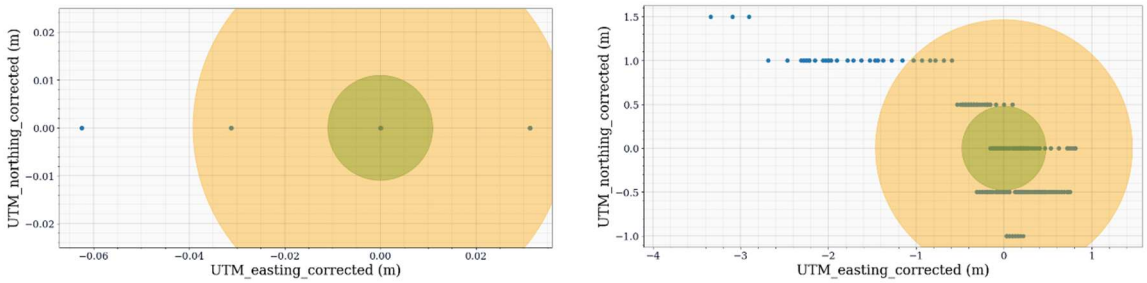

Fig.3 Open and Occluded data in a scatter plot.

Explanation:

As we already know that GNSS fix determines the quality of the signal received by the receiver. From the plot on the left, we can see that each point is evenly spaced with an interval in between which shows us that GNSS fix quality is high and the green circle show us the mean of the plotted data. The plot on the right shows us an unclear position and the values plotted are very random, which means the GNSS quality of the signal is very low.