EECE 5554 Robotics Sensing and Navigation
Lab-2 Report

Introduction:

The Lab focused mainly on analysis of the data obtained from GNSS/ RTK Processing boards. Where one GPS module is set-up as base and the second module is set as a rover. The base and the rover operate in a specific range because of which the base calculates the errors and sends the error to the rover in real time which makes it "Real-time Kinetic". In this Lab-2 we have written a code to get the GNGGA format data/string, from which required GPS coordinates, UTM data are acquired to publish on to the GPS topic. In the initial sections UTM data i.e utm_northing vs utm_easting was plotted for the following 4 data sets.

- Data collected at a stationary point in a clear environment.
- Data collected while moving in a clear environment.
- Data collected at a stationary point in an occluded environment.
- Data collected while moving in an occluded environment.

Difference between RTN GNSS and GNSS:

RTN GNSS and GNSS are used for positioning and navigation, although they have certain distinctions. GNSS stands for a worldwide network of satellites that gives users on the ground location data. RTN GNSS, on the other hand, uses a network of fixed base stations to receive signals from GNSS satellites and then send correction data in real-time to roving receivers. As the base station correction data can increase the accuracy of the GNSS signals, RTN GNSS often offers higher positioning accuracy than independent GNSS. As long as the receiver has a clear view of the sky, GNSS has worldwide coverage. RTN GNSS coverage is frequently restricted to the region where the base stations are situated.

Here are a few of the most typical reasons of error:

Conditions in the atmosphere: The atmosphere can cause GNSS signal delays that lead to mistakes in computed positions. This is especially accurate for the GPS signal, which is impacted by the ionosphere and troposphere. Obstacles like terrain, trees, or buildings can interfere with or block the GNSS signal. As a result, there may be fewer satellites visible, which could result in less precise location. Defects in the receiver and antenna, such as phase center change, clock drift, and antenna misalignment, can also reduce the precision of RTK GNSS measurements. Position of the base station: The accuracy of RTK GNSS positioning depends heavily on the base station position. The calculated positions will take into account any errors in the base station position.

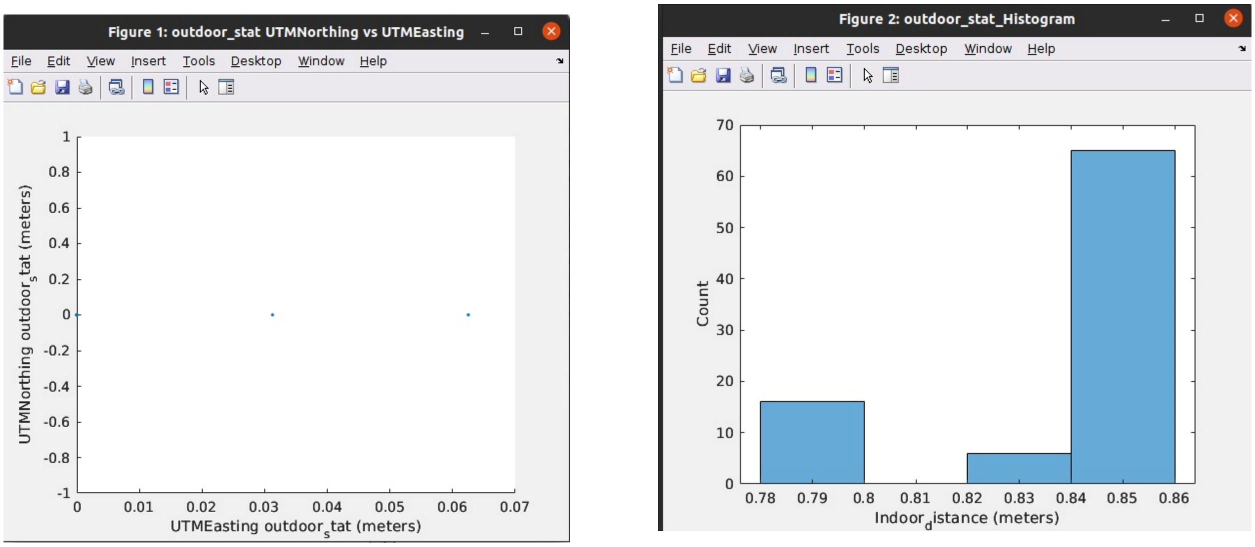
Error or deviation in RTK GNSS as compared to RTK GNSS without RTK:

The error or deviation in RTK GNSS gives an indication of the greater precision that can be attained through the usage of RTK when compared to regular GNSS without RTK. Without RTK, the number and position of visible satellites, atmospheric conditions, and other sources of error can all have a significant impact on how accurate GNSS positioning is. Depending on the circumstance, this can lead to errors of a few meters to tens of meters or more.

RTK GNSS systems, in contrast, use a network of fixed base stations to deliver real-time correction data to the wandering receiver, enabling far improved positioning accuracy. The positional precision of RTK GNSS is typically limited to a few millimeters or less.

Data analyses:

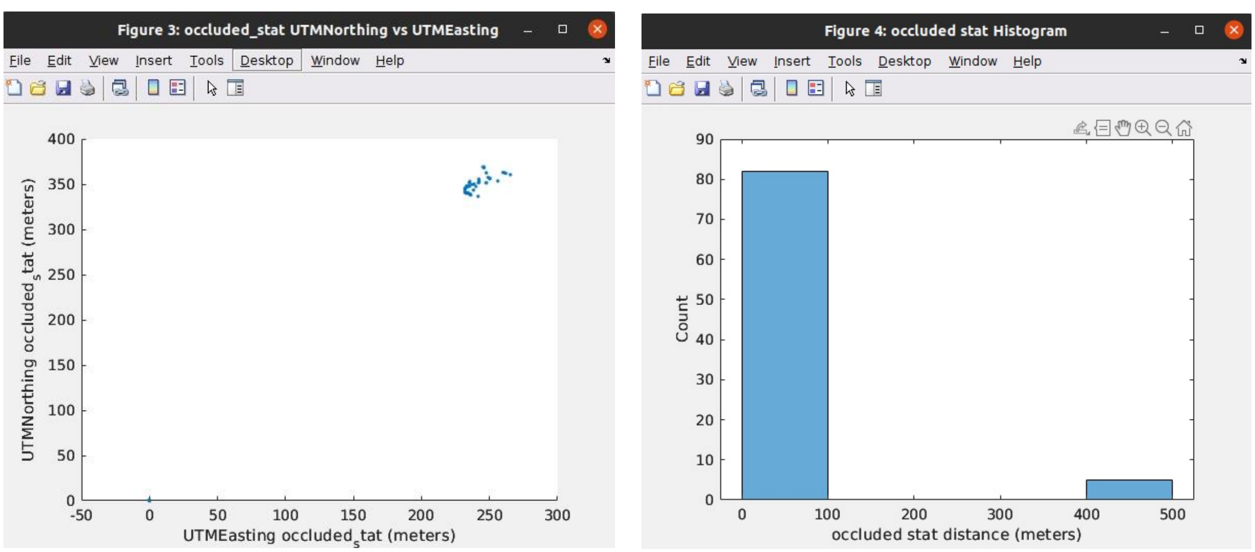
In this section the collected UTM data will be plotted (UTM_northing vs UTM_easting) for all the 4 data sets and inferences will be made on the plotted graphs.



(a) (b)

Fig-1 (a)UTM_northing vs UTM_easting for stationary data in a clear environment. (b)Histogram plots for error in clear environment.

The above graph is a plot between UTM_northing and UTM_easting for GPS data collected at a stationary point. The main inferences that can be made from this graph is the range in which the scattered points are observed is in "meters". As seen in the graph for the stationary point GPS data, it seems to be scattered in a range of 0 to 0.060 meter which is " 0 to 6 cm" range. In order to get the exact data I have taken the latitude and longitude coordinates from google maps and converted them to UTM which gave us the UTM-easting as 328140.65m east and UTM-northing as 4689478.37 m north. So to get an error estimate we can use these



(a) (b)

Fig-2 (a)UTM_northing vs UTM_easting for stationary data in an occluded environment. (b) Histogram plots for error in clear environment.

The stationary data for the occluded environment has been collected in front of isec building. The range of error and region of stationary data has been described in later sections. But one important inference that can be made from the data is that even after the error corrections are made using rtk gps the obstacles, buildings etc cause significant error in the position which could be in meters unlike the stationary data in clear environment which is in “cm”.
The accuracy and precision of the position solution offered by an RTK GNSS system are measured by the RTK GNSS fix quality. The moving data in open and occluded cases are different, the data from open area is more accurate when compared to occluded case because of the buildings and trees. We got fix quality for open environment as “5” whereas for the occluded environment is “1” which shows that the accuracy of the GPS positions are much higher in clear environment.

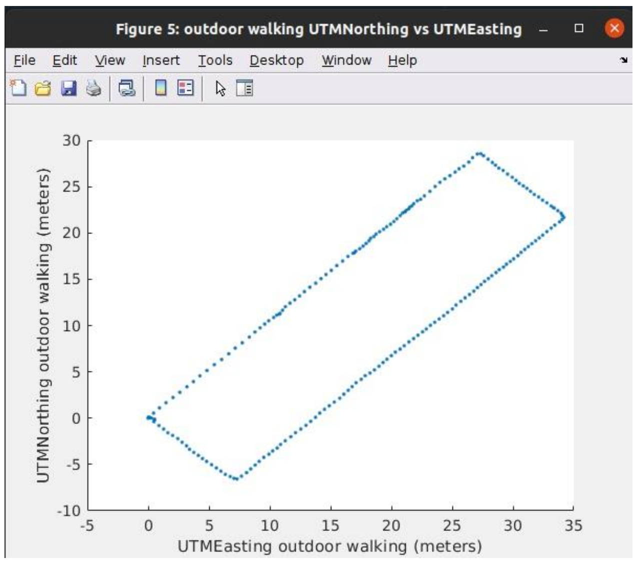


Fig-3 UTM_northing vs UTM_easting for moving data in a clear environment.

The walking data in clear area is collected on top of the columbus parking garage and the utm northing to easting data is plotted as shown in figure-3. The data is so precise and seems to have minimal error.

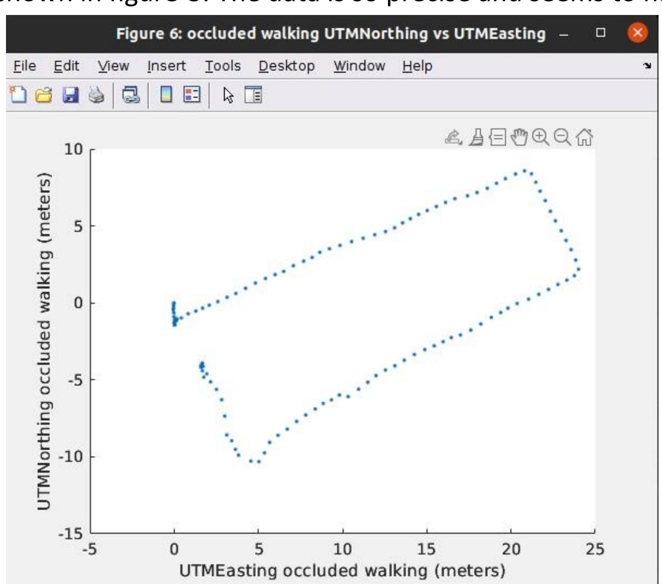


Fig-4 UTM_northing vs UTM_easting for moving data in occluded environment.

The occluded walking data was collected in front of snell library which is surrounded by multiple buildings. The accuracy and precision of the position solution offered by an RTK GNSS system are measured by the RTK GNSS fix quality. The moving data in open and occluded cases are different, the data from open area is more accurate when compared to occluded case because of the buildings and trees. The fix quality for the open case is more than the occluded case because of the more accurate correction values. We got fix quality for clear environment as “5” and for the occluded environment is “4”

The measured positions using RTK GNSS are more accurate and distributed over less area, this is due to the corrections from the RTK GNSS and the distributions of measured positions using GNSS without RTK is less accurate.

Conclusion:

In conclusion, RTK GNSS is a high-precision positioning technique that uses a network of fixed base stations to provide real-time correction data to a roving receiver. Compared to standard GNSS without RTK, RTK GNSS can achieve much higher accuracy positioning, typically in the range of a few centimeters or less. However, RTK GNSS is still subject to various sources of error, such as atmospheric conditions, multipath, signal blockage, and receiver and antenna errors. While these errors can be mitigated to some extent through the use of correction methods and advanced algorithms, they can still affect the accuracy of RTK GNSS measurements. Overall, RTK GNSS is a valuable tool for applications that require high-precision positioning, such as surveying, construction, and machine control.