

EECE 5554 Robotics Sensing and Navigation

LAB 2 Report

Introduction:

The (RTK) Real-Time Kinematic is a satellite navigation technique. It offers centimeter-level accuracy in real-time positioning. The Real-Time Kinematic uses a mobile rover receiver and a stationary base station, which is very high precision GPS receiver installed at known location and used to receive GPS satellite signals. By monitoring the phase difference between the signals from the satellites and the base station, the base station and the rover receiver interact with one another to pinpoint the exact location of the rover receiver. The

Differences between the RTN GNSS and GNSS:

Both the RTN GNSS and GNSS are two different techniques used for satellite navigation. To determine the location of receiver the Global Navigation Satellite Systems (GNSS) use satellite signals. A particular kind of GNSS technology known as the Real-Time Network (RTN) GNSS uses a network of continually functioning reference stations to rectify the GPS signals that a rover receiver receives in real time. The major distinction between GNSS and RTN GNSS is that GNSS offers accurate positioning, but it lacks real-time corrections, where as RTN GNSS offers more robust and dependable corrections.

Sources of errors in RTK GNSS:

- 1) Interference: radio signals or other electronic devices can cause errors in the position calculation.
- 2) Clock errors: The position calculation may be inaccurate if the receiver clock and GPS time are not exactly in sync.
- 3) User errors: These errors occurs when there is incorrect setup or mechanism of the RTK GNSS equipment which leads to cause errors in the positioning.
- 4) Atmospheric Errors: positioning problems may come from the satellite's signal being delayed or refracted as it travels through the atmosphere.
- 5) Multipath Errors: occurs when there is GPS signal reflection of surfaces such as trees, buildings and other obstructs before reaching the receiver.

Data Collection:

We attempted to extract data from our laptops but were unable, so we had a chat with the TA about the situation. He said that there was issue with the device's USB cable, which was not working, Consequently, Ronan McNally, a classmate, offered to provide data from their group. We are very thankful to him. We collected the data from our classmate with the TA'S consent only. Although we tried in 4 different laptops, but we couldn't succeed.

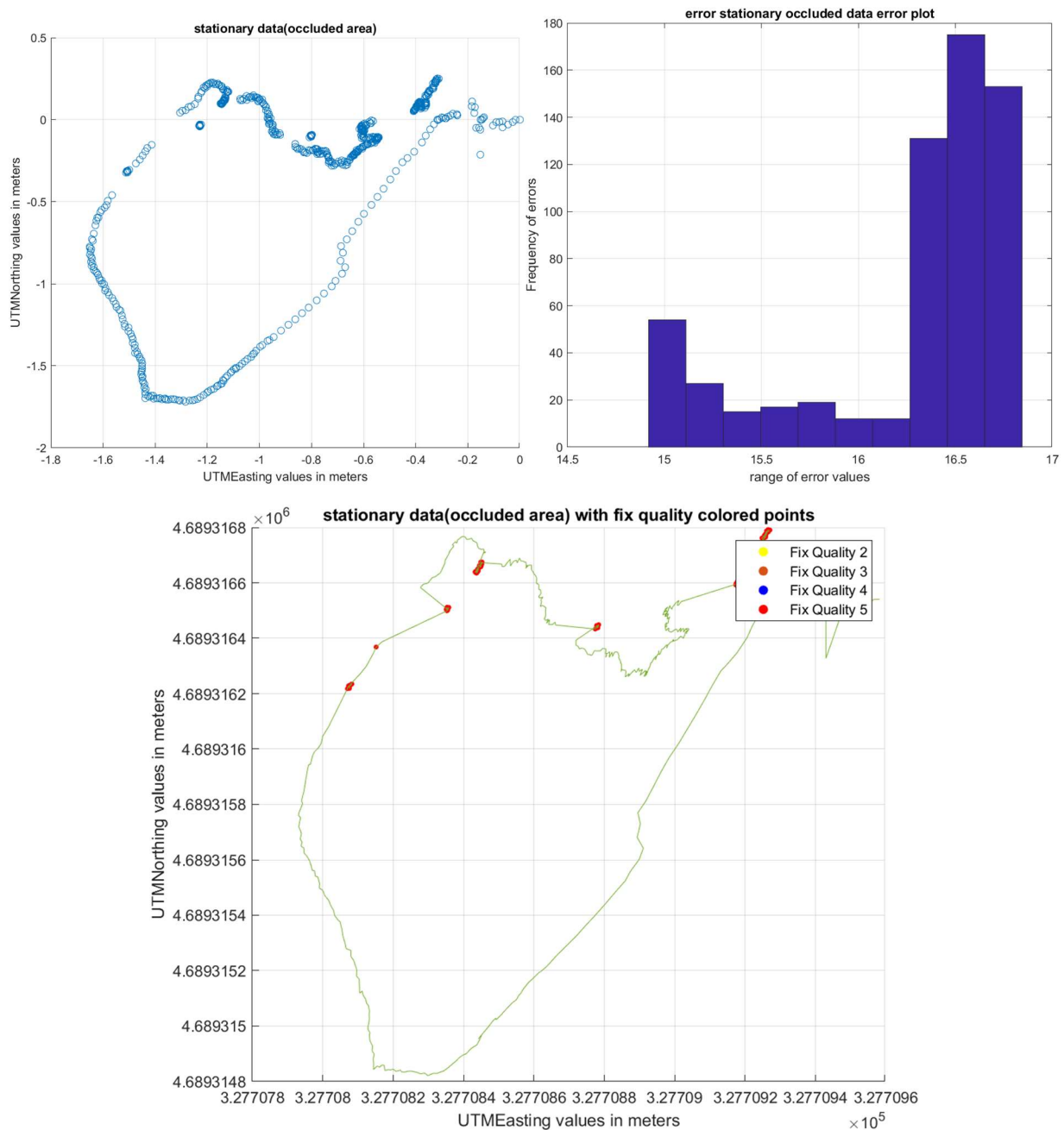
There are 4 sets of data collected totally:

- 1) Data set collected at a stationary point (clear environment space)
- 2) Data set collected while moving (clear environment space)
- 3) Data set collected at a stationary point (occluded environment space)
- 4) Data set collected while moving (occluded environment space)

Data Analysis:

Data set collected at a stationary point (occluded environment space)

Stationary data- (occluded environment space) scatter plot is shown below:

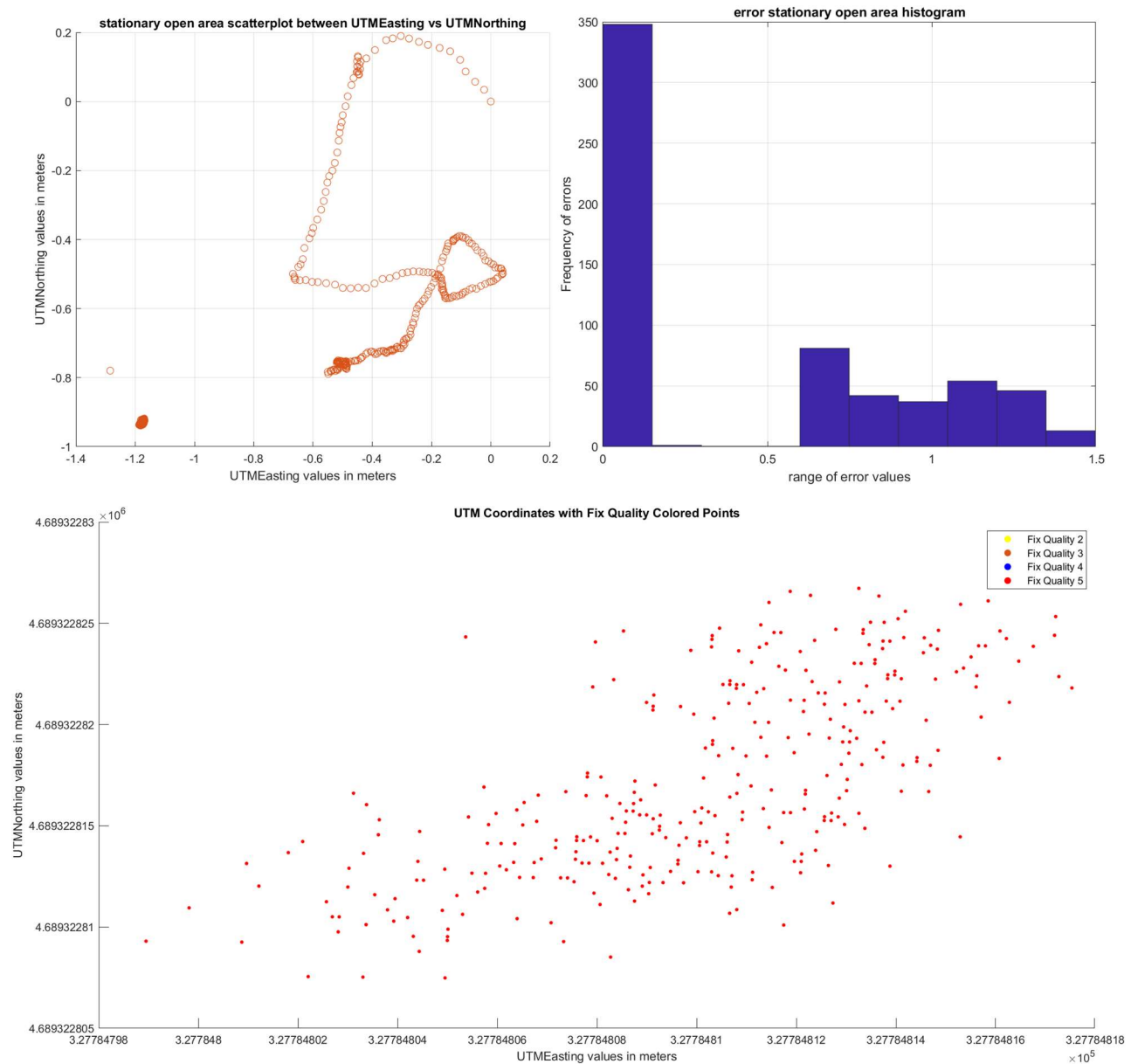


Coming to the errors I made a histogram for the above data as show in fig 2 below. Although I got **Fix Quality value as 5** indicates that RTK solution is based on the carrier phase measurement from at least five different satellites. This is known as fixed solution. This data is taken at behrakis center which is an occluded environment place. The data showed **mean error value as 16meters and median error value as 16.2 meters**.

In the above plots we can see stationary data(occluded area) with fix quality , the plot includes the RTK fix quality 5 because mostly the data was collected at RTK float to RTK fix. Both the stationary datas show changes in the RTK fix quality values when compared to each other.

Data set collected at a stationary point(clear environment space)

The data is collected at an open area near the Centennial common in Northeastern University. Duration of the data collected is 10 minutes. Scatter plot between the UTM Easting vs UTM Northing is shown below



For the clear environment stationary data, the errors were quite very small as comparing to the stationary occluded data. I got **Fix Quality value as 5** indicates that RTK solution is based on the carrier phase measurement from at least five different satellites. This is known as fixed solution. The data

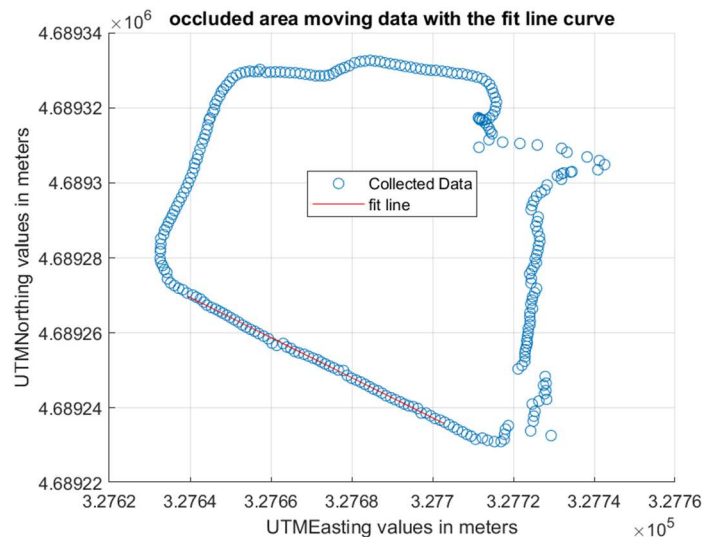
showed **mean error of 0.4268 meters and median error of 0.0129 meters**. The position has a very high level of accuracy and precision, typically within a few centimeters or better.

As comparing the errors or deviation about the RTK GNSS to GNSS without RTK, the data collected using the RTK GNSS showed better accuracy by eliminating the errors in GNSS positioning.

From the plots we can see that RTK GNSS data has more tighter clustering of points and also we can that a more precise distribution but whereas for LAB1 using only GNSS we saw a wider distribution in positioning of points. In addition without the use of RTK GNSS we had presence of erros or noice in the GNSS data which lead to mispositioned of points which distorted the overall distribution of data in lab1.

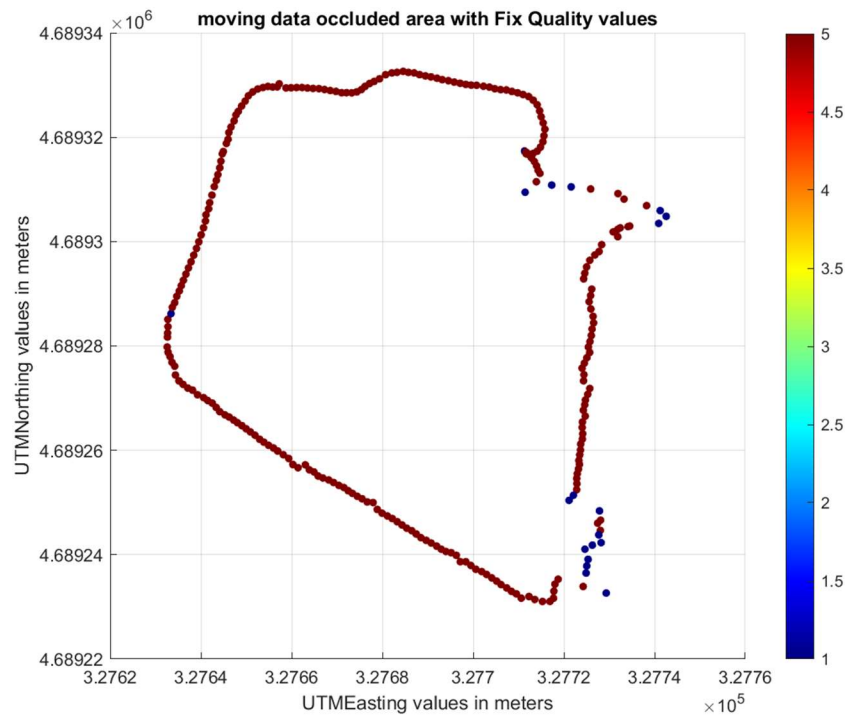
Data set collected while moving (occluded environment space)

The data is collected at Behrakis Center at Northeastern university. The data is collected with moving the rover in an partial occlusion area. The moving data plot is shown below with the linear regression line . I used the best scatter points to find the errors of the moving data ,the **Mean Squared Error of 0.4480 meters and Root Mean Squared Error of 0.2007 meters**.



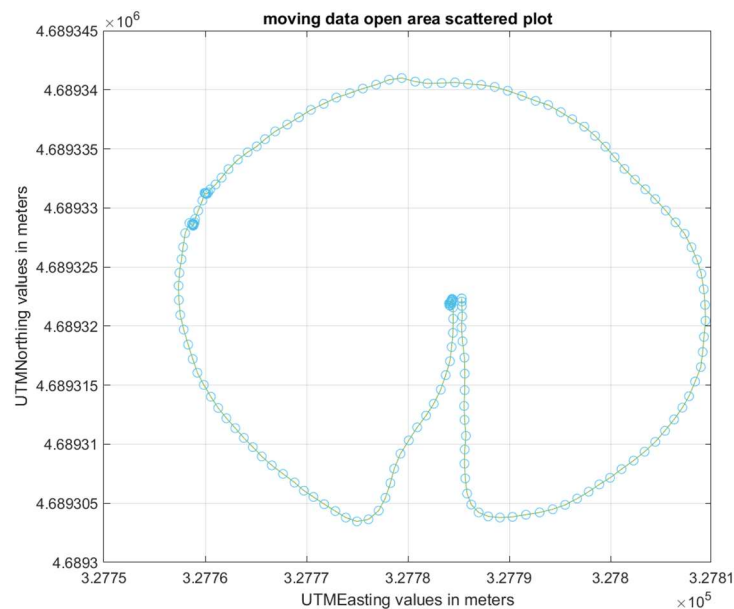
The below plot shows the moving data in occluded area with the fix quality values although it was covered with the buildings,trees and other obstctacles the RTK GNSS fix values were always near to value of 5.

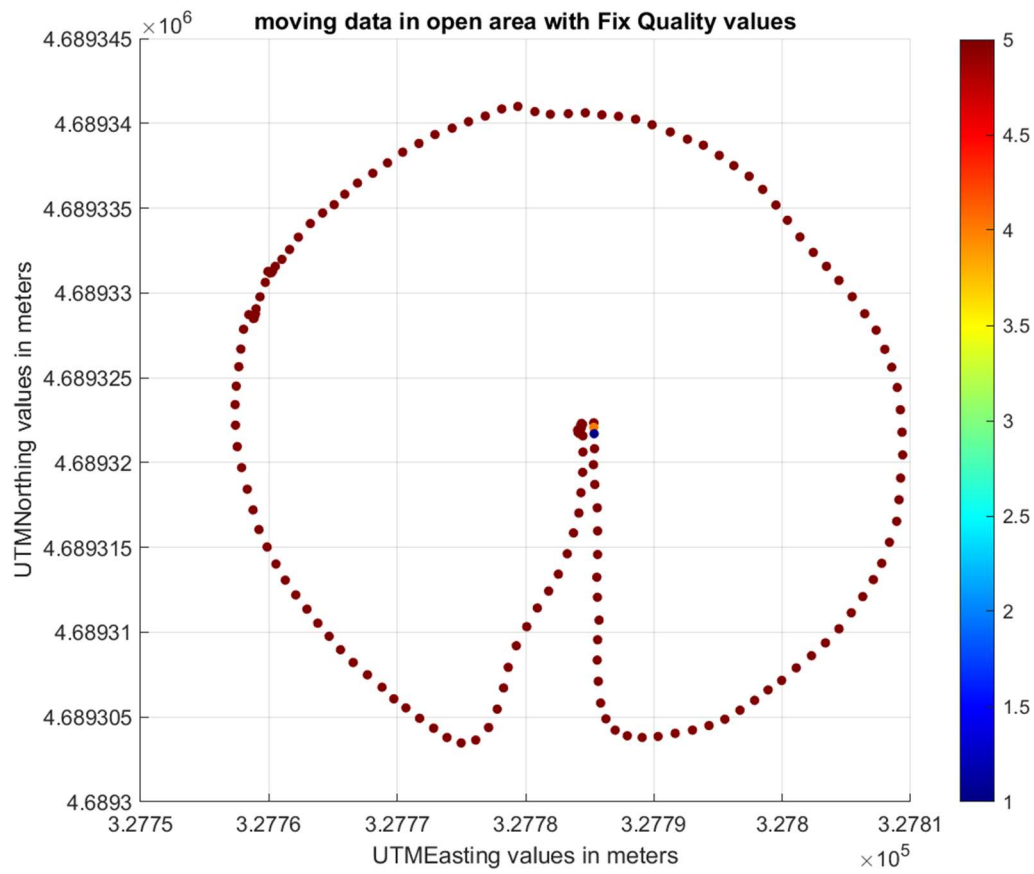
The moving data occluded area with Fix Quality values scatterd plot can be seen below , the data is collected at the Behrakis center while walking near the building with the rover.



Data set collected while moving (clear environment space):

The data set is collected near the Centennial common area , the collected moving data is different in the open and occluded cases as we can see the scattered plots , the occluded moving data showed more of the distribution of points with respect to the open area moving data. Also the values of the Fix Quality showed more accuracy as the errors decreased. The RTK float (5) and the RTK fixed(4) values were more in data collection as compared to the moving data of occluded area. The occluded moving data has even (1-1.5) RTK values with less accuracy and the scattering of the position can also be seen in the occluded data.





The distribution of the measured positions of the data is normally distributed. It means that the most of the measured positions are clustered near to the mean or the average value with fewer mispositions farther away from the mean.