EECE 5554 Robotics Sensing and Navigation
Lab-2 Report

Introduction

The Lab focussed 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.

Data Collection

The Noise-free and clear environment data was collected on the terrace of the columbus parking garage building. Here two data-sets were collected: stationary data and moving data.

The occluded data was collected in front of the isec building which has a lot of obstacles (Buildings, Tress, Reflections etc.) which makes it an occluded environment. Two data sets while stationary and while moving were collected.

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.

- **Plot-1**

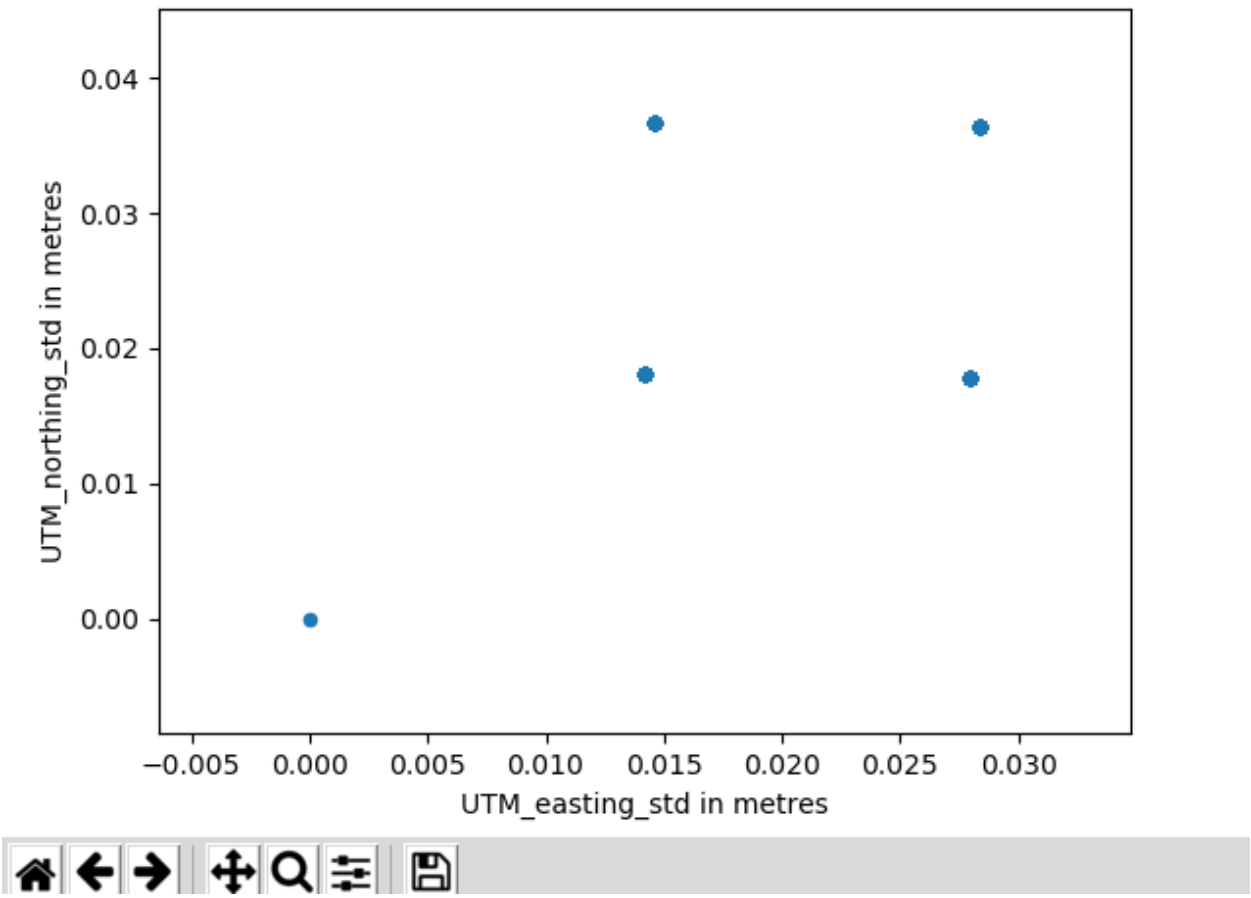

Fig-1 UTM_northing vs UTM_easting for stationary data in a clear environment.

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 “cm”. As seen in the graph for the stationary point gps data, it seems to be scattered in a range of 0 to 0.030 meter which is “ 0 to 3 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 328121.11m east and UTM-northing as 4689434.40m north. So to get an error estimate we can use these

utm values and get the RMSE (root mean square error) of the plotted data. As shown in below figure RMSE is calculated using the below formula with the measured/predicted values and actual values.

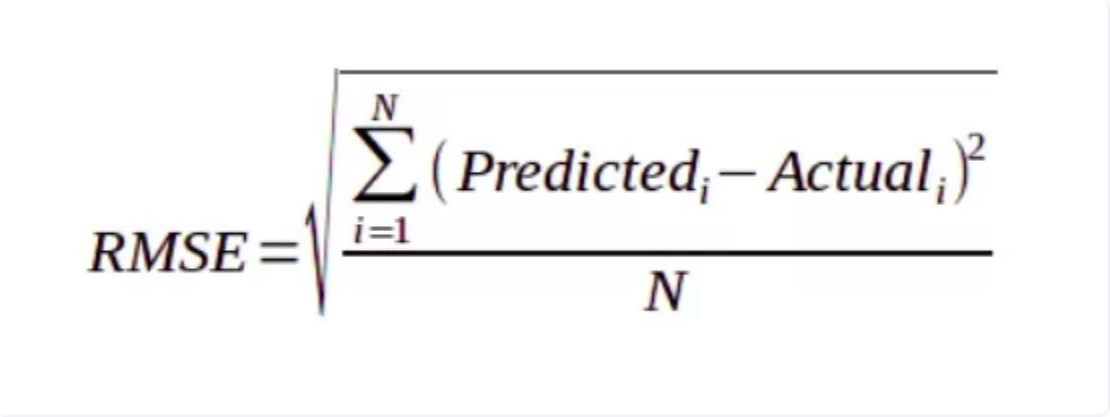

Fig-2 Formula to calculate RMSE

The RMSE for the UTM_northing was found to be 8.383377525717552 and the RMSE for the UTM_easting was 6.315027890169317

- **Plot-2**

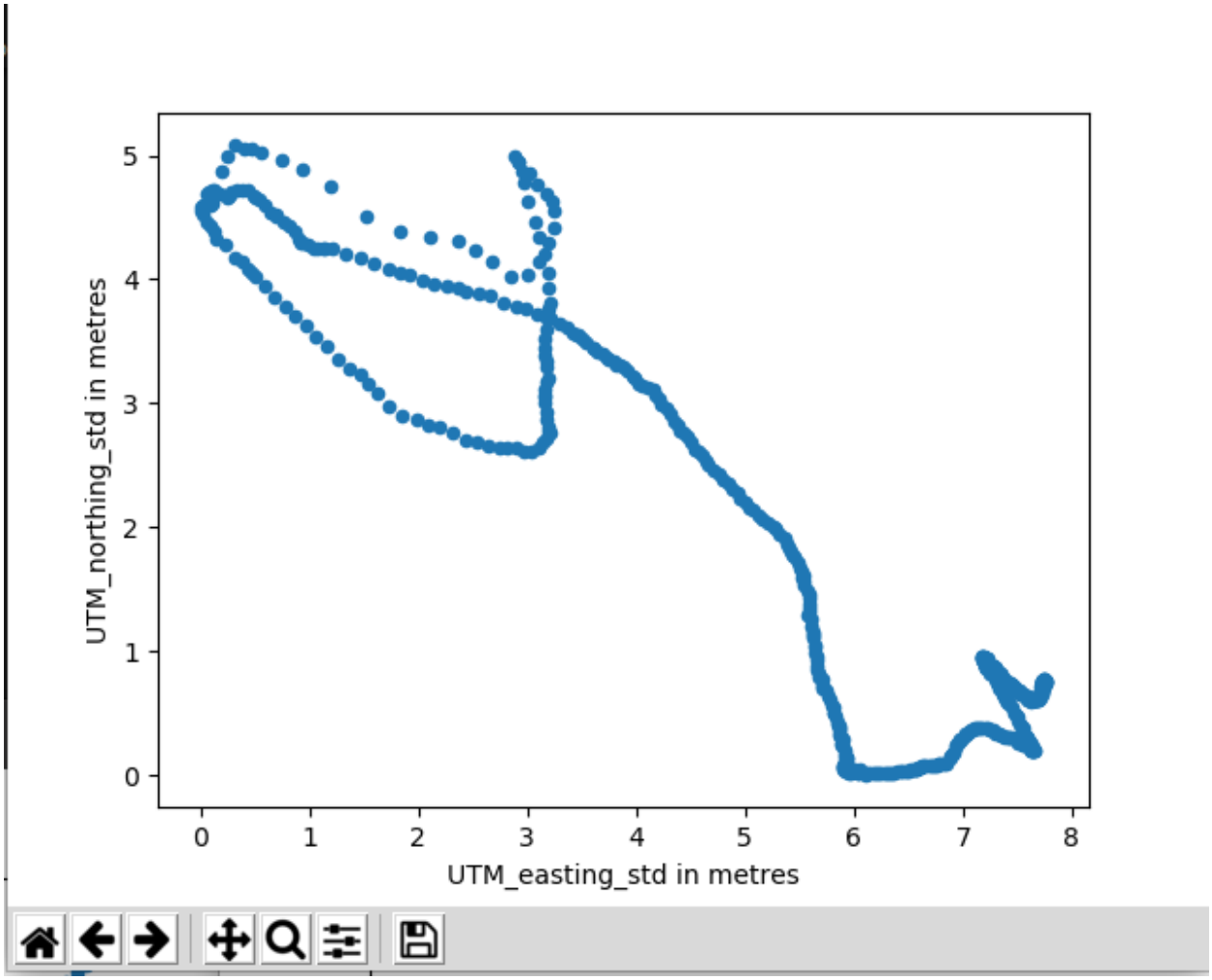

Fig-3 UTM_northing vs UTM_easting for stationary data in an occluded environment.

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”.

- **Plot-3**

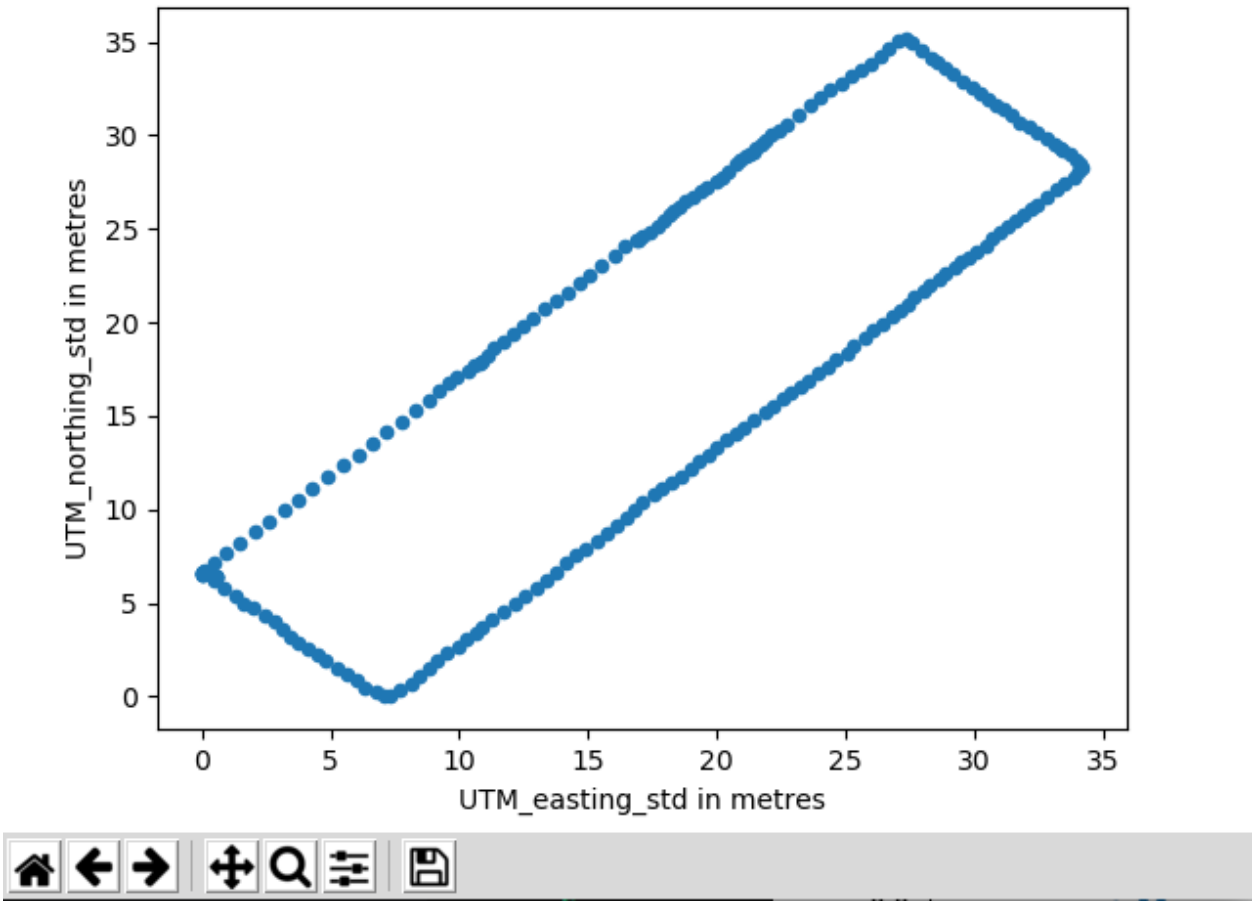

Fig-4 UTM_northing vs UTM_easting for moving data in a clear environment.

The walking data in clear environment is collected on top of the columbus parking garage and the utm northing to easting data is plotted as shown in figure-4. The data is so precise and seems to have minimal error which is evident from the rsme values calculated after applying linear regression to all the four sides of the rectangular path.

Fig-5 Google maps image of the path followed while collecting data

Fig-6 Linear regression applied on the occluded environment data and the relative data is plotted

The RMSE calculated for each path as depicted in fig-6 is as follows:

Green line- 0.18292114192604647

Orange line- 0.7806714699778871

Blue line- 0.07292256205756383

Red line- 0.1187548350024078

- **Plot-4**

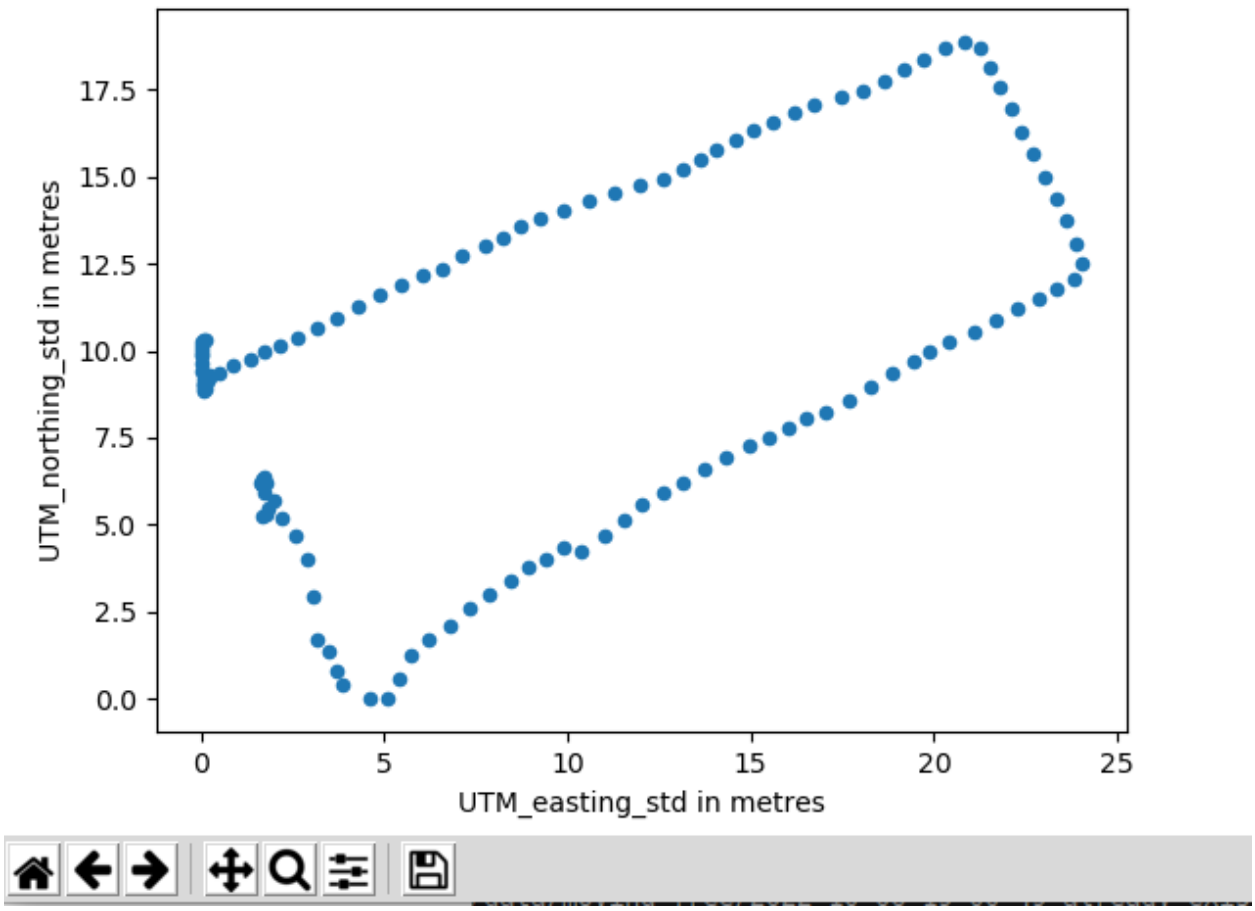

Fig-7 UTM_northing vs UTM_easting for moving data in occluded environment.

The occluded walking data was collected in front of snell library which is surrounded by multiple buildings. Linear regression was applied on the plotted data later the rsme is calculated. The regression plot is shown in fig-8.

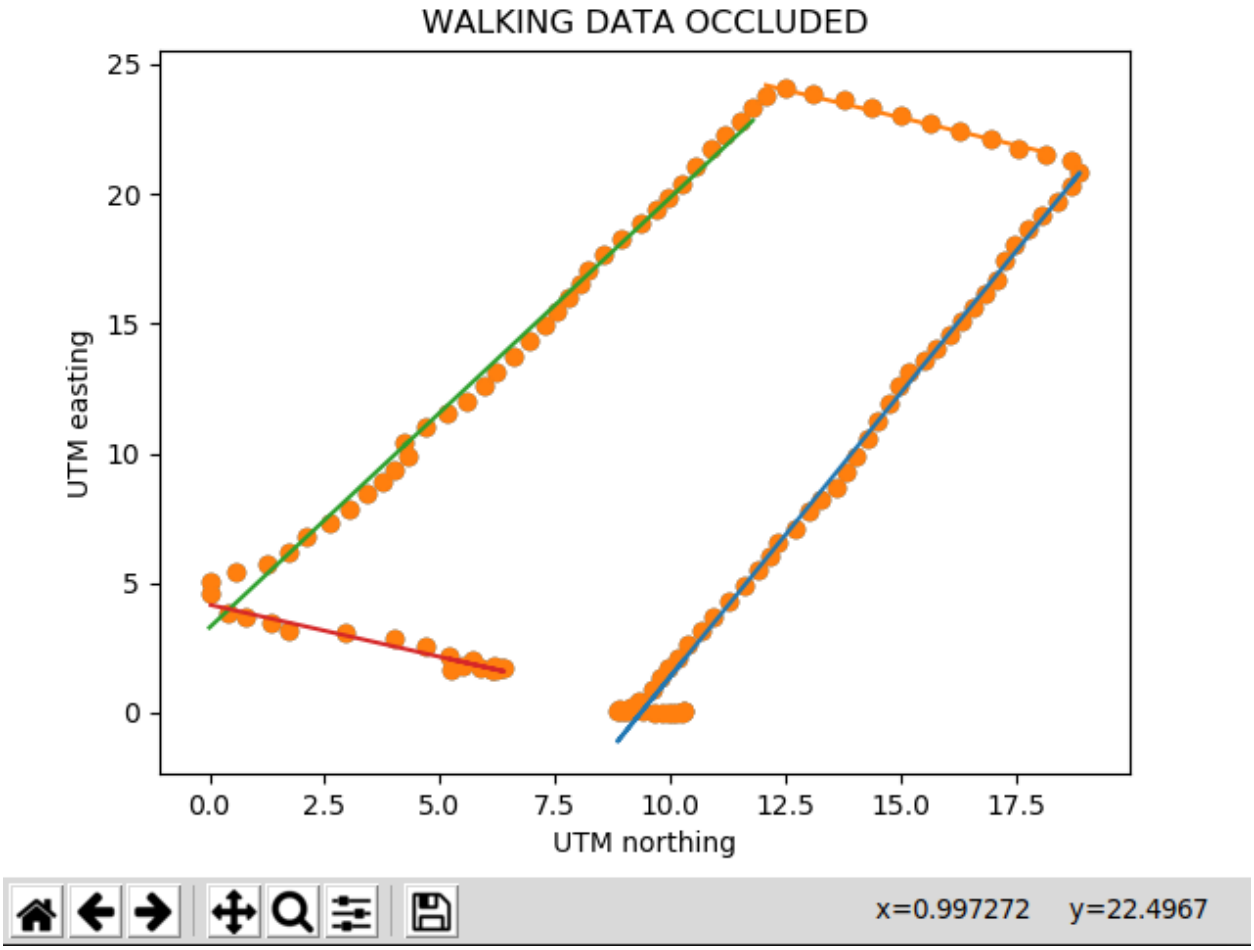

Fig-8 Linear regression applied on the occluded environment data and the relative data is plotted

The RMSE calculated for each path as depicted in fig-8 is as follows:

Green line- 0.7122680827544607

Orange line- 0.14015638817749723

Blue line- 0.5105568734872659

Red line- 0.2078530196770425

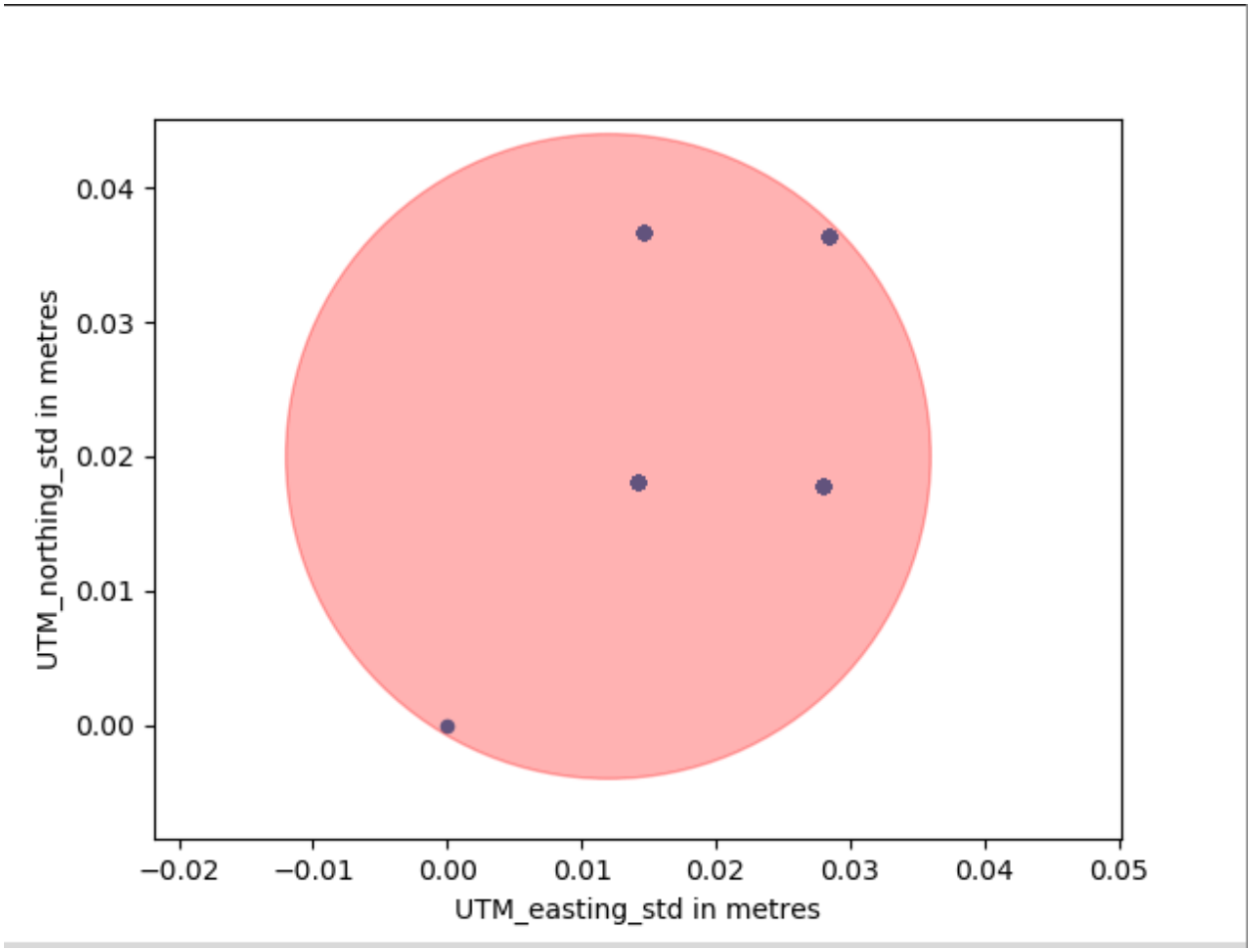

Fig-9 Circular region comprising the scattered data points in stationary data of clear environment , indicating possible error range using the radius of the circle

One important observation that can be made from all the stationary data plot (Fig-9) is that the range in which the data scattered is in radius of 0.024m which gives us an important inference about the data, that the point is in scattered over a range of 2.4cm which would be the possible error. It is very precise and something which wasn't seen when the gps data was collected and plotted without RTK. Hence the error correction sent by the base and used by the rover is crucial for better precision.

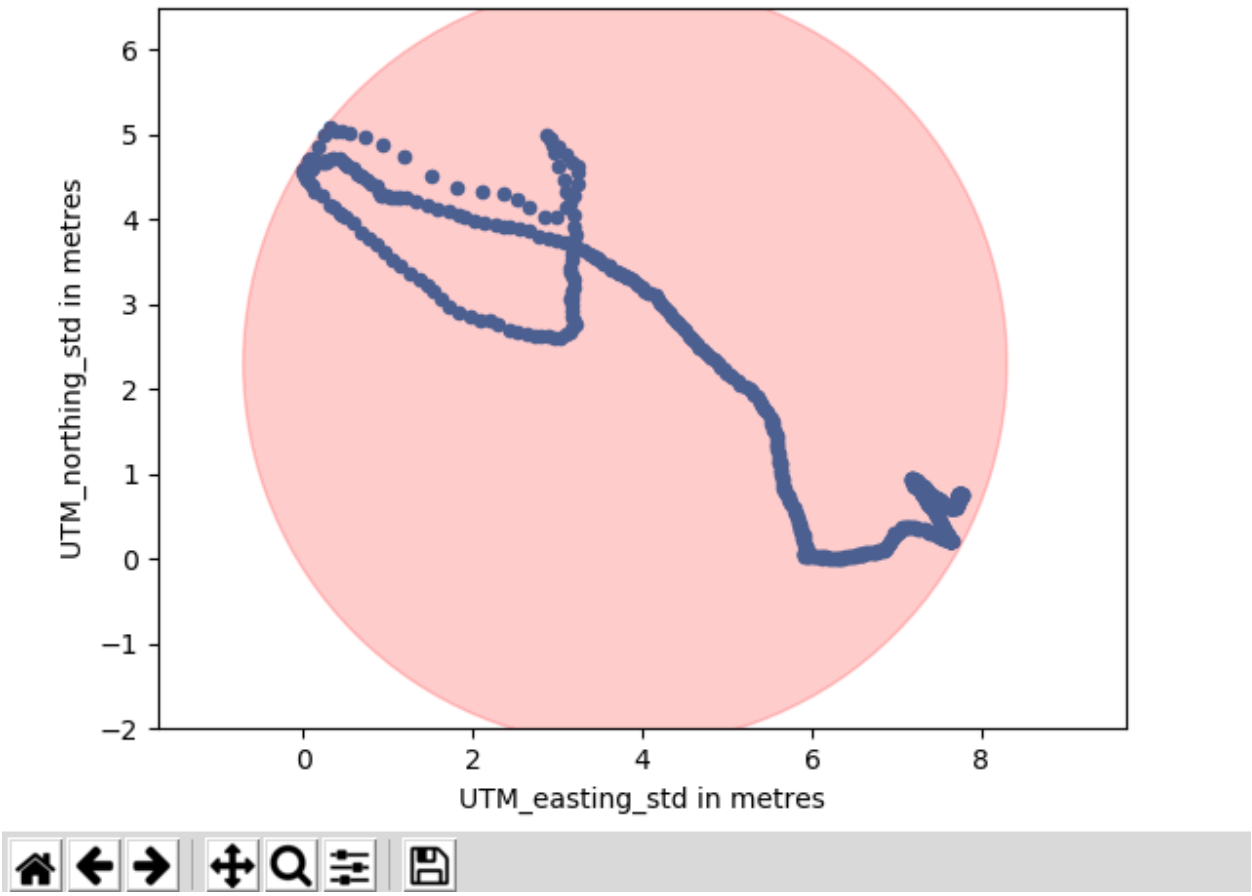

Fig-10 Circular region comprising the scattered data points of stationary data of occluded environment, indicating possible error range using the radius of the circle

Observing the Fig-10, In case of stationary data in an occluded environment the points are scattered over a range of 4.5m which gives us the possible error range and we can infer that the obstacles, trees, reflections, buildings cause a lot of error even after correcting the errors with RTK.

In case of waking related data in both free and occluded environments as discussed in previous sections the rmse values gives us an understanding on the precision obtained by using RTK GPS.