EECE5554 LAB 2 Report

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1 Lab Report and Analysis

1.1 RTK GPS

The Real Time Kinematics GPS, or the RTK-GPS, is the modified version of the previous puck used in LAB1 in that it uses corrections from a base station (usually a known location) to correct it's error. This enables the GPS to be more accurate. But as I did notice, this does not remove the precision problems that comes with the sensors, which are usually caused by the hardware and external factors that have nothing to do with the satellite data or calibrations.

The RTK GPS was setup following a multi process setup. This included creating an account with The Massachusetts Continuously Operating Reference Station Network (MaCORS), which was used to get the corrections from the nearest base station on Earth.

The python module "**utm**" was used to convert true coordinates to UTM format in LAB1, which was later found to be very innacurate, I have fixed that for this report. Using a more reliable source on the internet, as it is for just the true values.

1.2 Datasets

The dataset required for this report, were pretty straight forward. A rosbag collected for 10 minutes standing stationary in an open space, rid of any occlusions. And one more, in open space while walking in a loop, preferably a square.

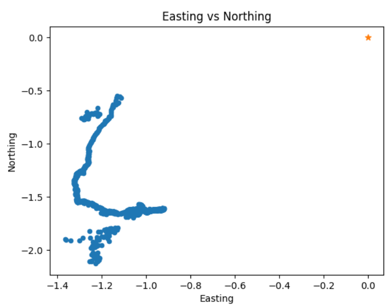
This was repeated in an occluded position (with buildings and trees to check the accuracy of the RTK in these situations). The module given was setup properly, but we had problems getting the data values printed on the screen using **minicom -D**. Multiple attempts at debugging the problem were in vain, so we borrowed the data collected by another RTK GPS by another group for this LAB report as last resort.

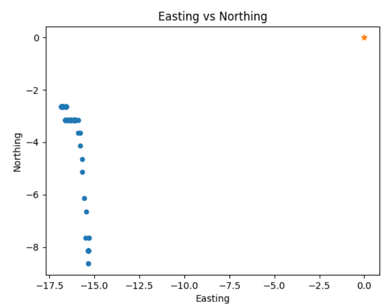
1.3 Analysis - Open space

The 10 minute dataset collected in an open space was used to do the analysis. True longitudes and latitudes were collected from Google Earth and converted to UTM using online tools.

1.3.1 Easting vs Northing plot

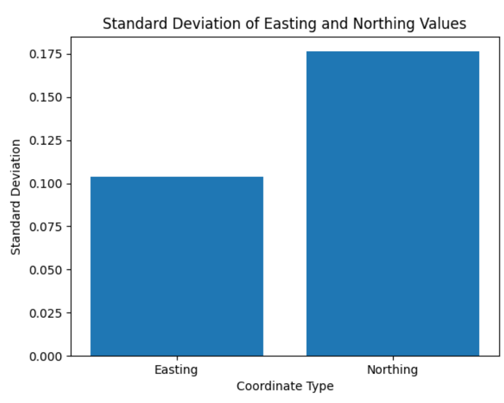
The plots use the data collected by the RTK GPS and show the difference between the datapoint and the true point, it is plotted along with the True Northing and Easting values (0,0).





The plot is much better compared to the plots we got for LAB1, the readings are a lot more accurate, landing on a closer zone near the true values. Attaching the plot for LAB1 data below.

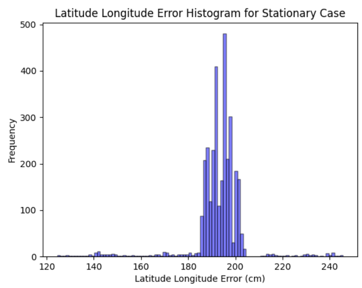
I also plotted the standard deviations for the easting and northing values, to check the variations in the values. The idea here is that if the std deviations are small, for both the axes it means that the data is very tightly packed near the mean of the distribution.

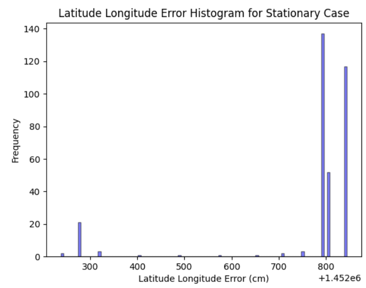


The easting std deviation come out to be 0.1, which is pretty small which means the easting values have a thin peak distribution curve. The northing has a wider distribution curve with std dev = 0.175, but it is still small in the general sense.

1.3.2 Error plots for the latitude and longitude

Similar to LAB1, I used Haversine formula for the errors. Histograms showing the error values are attached below, compared to the same from LAB1.

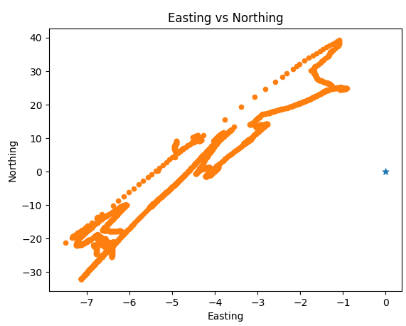


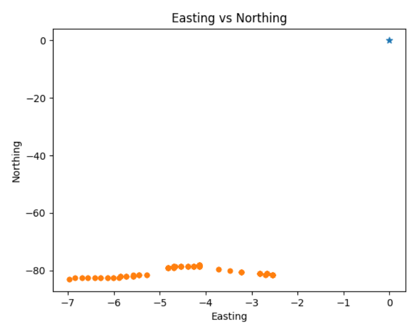


The errors are much more closer to true values in the RTK-GPS, peaking at around 200cms, which is closer compared to the results from LAB 1, which had a high frequency of 800 cms error.

1.4 Analysis - Occluded Spot

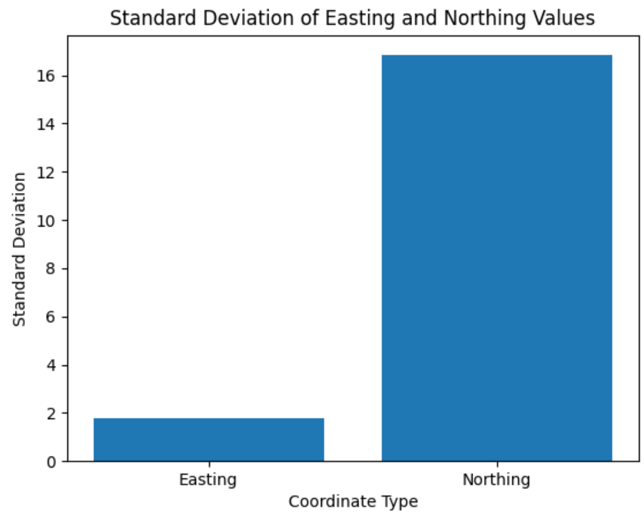
1.4.1 Easting vs Northing curves





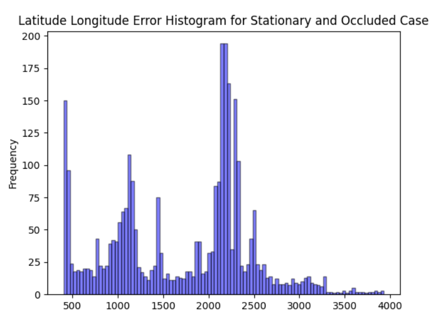
Easting Northing curves for RTK-GPS (left) and GPS(right)

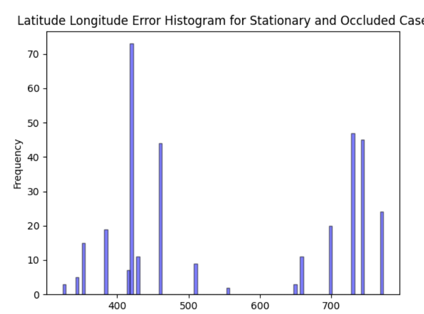
As we can see the RTK GPS has less error, and is a bit more spread near the true position, while the normal GPS module had a major shift in the northing values, which resulted in major accuracy issues. But the RTK-GPS has a little precision error, which can be better analysed with standard deviation estimates below.



The standard deviation, compared to the previous estimate in an open space, shows more deviation for both the axes. Easting values show ≈ 2 which means the curve is more spread out near the mean distribution. Northing values show a more diverse shift in the values, with a std dev of 16, which migth be due to the fact that the estimates were occluded by buildings and mirrors everywhere. This is still a small number as the graph above shows not much variance from the true position.

1.4.2 Latitude and Longitude errors - Occluded



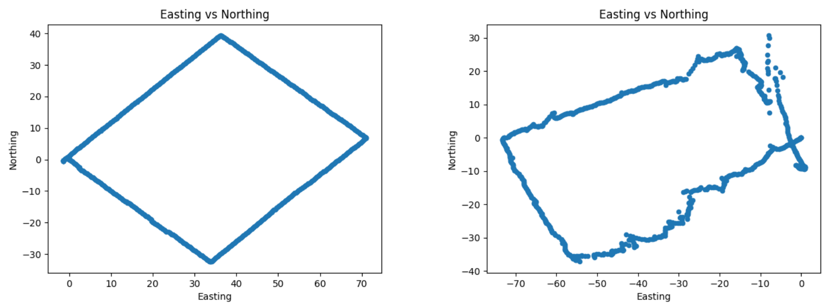


The errors on the RTK GPS (left) turned out to be more distributed, than the one collected for lab 1, this might be due to different locations chosen. The errors can be attributed to the occlusions, weather and other external factors. The errors peak at around 2200 cms, for the RTK which is quite a lot than expected. Different occlusions behave differently and this might be a case where the influence of errorneous data is majorly seen in these type of GPS systems.

1.5 Moving data

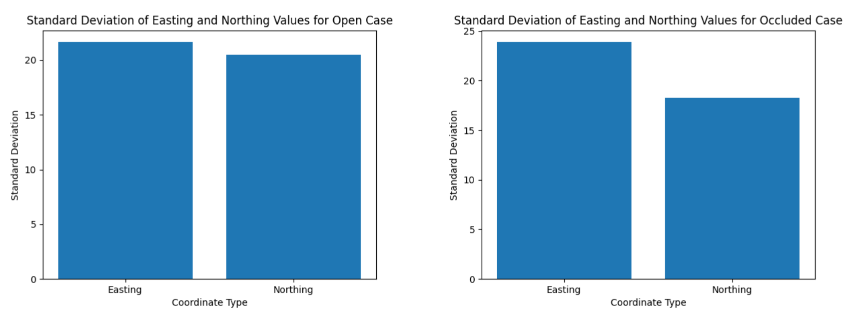
1.5.1 Easting Northing values

The easting northing values expected would look like a diamond, which was the path taken to move around in an **open space**. We can expect it to be pretty accurate as this was in an open space, rid of any sources of error in the environment excluding weather.



The Easting northing for **an occluded spot**, given on the right is expected to be a bit inaccurate, due to the conditions. And I got something similar to what was expected.

Comparing the std deviations for the easting and northing values, I expected to find a spike in dev values for the occluded data.



As seen from the analysis, there was no much difference between the cases for the moving dataset. Coming back to other hypothesis, this could be due to the different reasons. The connection with the satellites and communications could grow better as we move around in the occluded space, which might improve the data for the occluded case. And for the open space other error sources like vibration, module hardware issues and other unknown problems might be playing a part in tracking the signal.

The GPS fix values might also be an issue, but I could not explore that portion since the module I had was not responding at all, so it had to be done on whatver data was available with no alternate and also a time constraint.