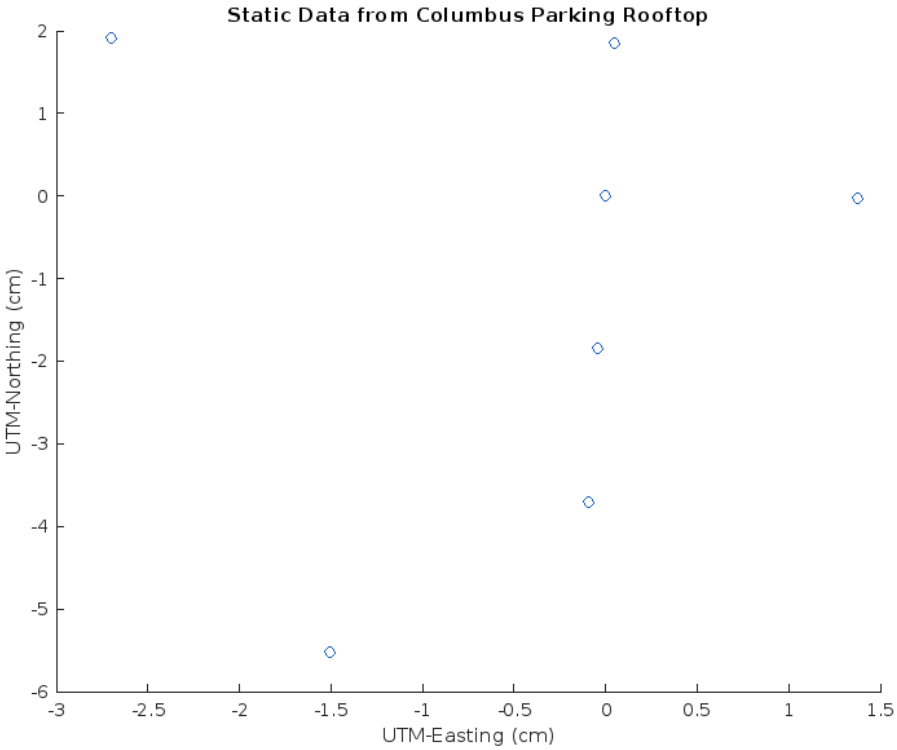
Kaushal Sorte

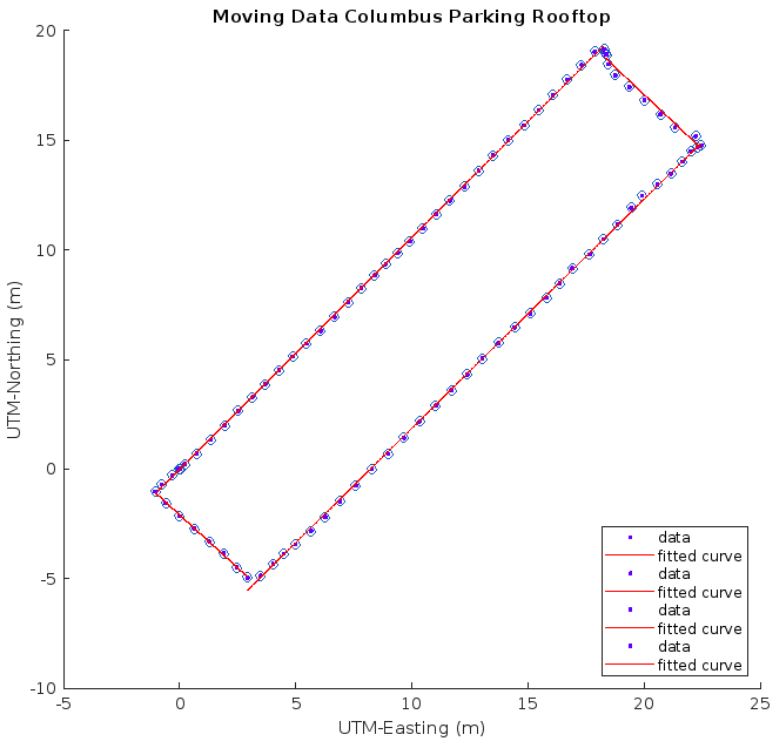
LAB2 : RTK GPS



OPEN DATA : COLUMBUS ROOFTOP

The error bound of the static data collected from the parking rooftop is found out to be 4.07 cm compared to the 1.6475 m from the lab1 gps. The error bound was calculated as the norm of the maximum easting variation and maximum northing variation vector. This approach was taken to get a hold of the gps error because the true location is not known in this exercise.
The data was collected with positioning status “fix” and hence the values vary within ~4 cm.

The moving data was also collected on the Columbus rooftop and the rover was moved in a circle as shown. Four best fit lines were plotted for each of the 4 sides which can be approximated as the ground truth for the moving data because errors such as multipath must be negligible in the open space.



The error in the gps reading was calculated as the RMS of the deviation from the best fit straight lines. The overall RMS value was taken as the weighted mean of the 4 rms values. The overall RMS value for this is 5.42 cm. The same value for the Lab1 data was found out to be 3.894 m. Lab1 walking readings were taken in not-so-open environments. Even so,

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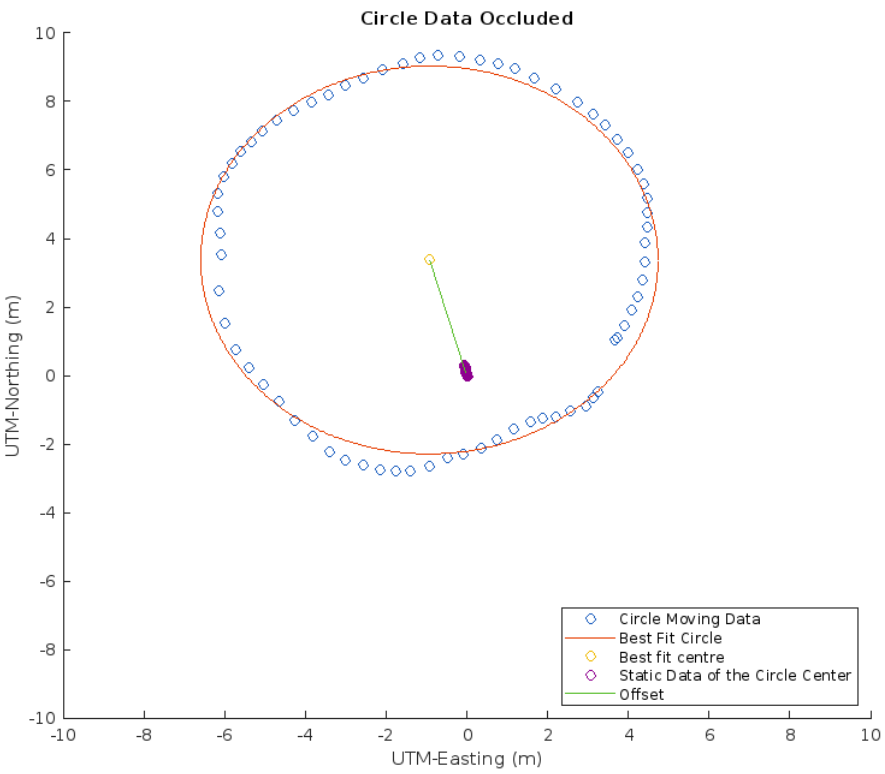
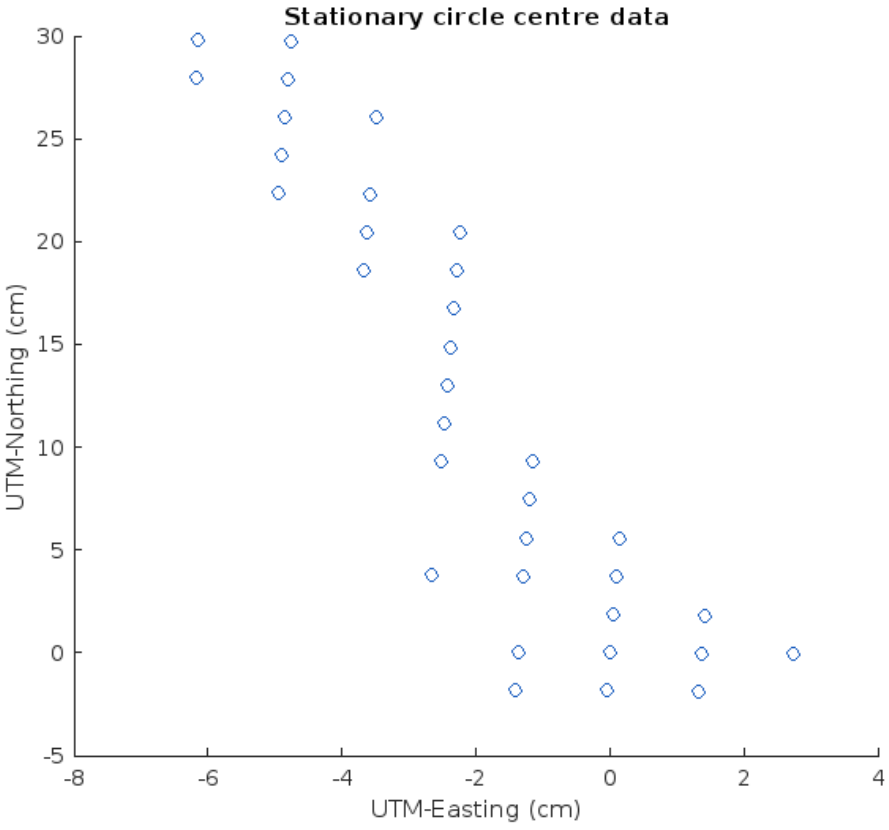
RTK GPS is orders of magnitude more accurate than simple GPS.

OCCLUDED DATA : CIRCLE IN FRONT OF CURRY STUDENT CENTER



The moving data was taken by walking on the cobbled circle in front of the Snell Library and Curry Student Center. A best fit circle (red) was plotted for this data with radius 5.6626 m and center at (-0.9271 m, 3.3727 m) (yellow).
The static data was taken by placing the rover at the center of the circle (purple).



The center data is precise within 8.93 cm which is the second norm of easting variation and northing variation. However, the center data cluster has an offset from the center of the best fit circle by around 1 meter (green). There are several possible reasons for this offset.

1) Multipath - Multipath can result in highly precise data which is inaccurate. The occluded space can result in reflections that keep giving offsetted readings.

2) We were unable to get a fix for the circle and the readings were taken in

a float condition. So it might be possible that the satellites in communication with the rover and the base changed for the two data sets. For different constellations, we might be getting different but consistent multipath errors. **Thus, there is a possibility that the moving data and stationary data BOTH were subject to multipath and the offset we see is the combination of both these offsets giving a net offset following vector addition.**

The RMS deviation of the walking data from the best fit circle is found to be 28.27 cm. This value can be taken to be the accuracy of the module IF the multipath errors in the moving data were negligible in which case the best fit circle can be taken as the ground truth. But, there is no way to be sure if the multipath errors were zero in the walking data. **Hence, the ground truth of the circle in the occluded data cannot be known or reliably estimated from this dataset owing to occlusion and multipath.**
In any case, this value is huge, possibly because it is difficult to walk in a perfect circle along with the fact that the readings were taken in a float state, which further degraded the performance of the module.

The center value is precise within 8.93 cm which is acceptable considering the occlusion and the resulting lack of fix. As it is evident, the precision in the occluded environments drops substantially. Also, multipath can cause offset in meters. Thus, self-driving cars using RTK GPS, that are unable to get a fix, are not in an ideal condition, since offsets in meters can be dangerous.

Overall it may be noted that the precision of RTK GPS even in occluded environments is far better than the normal GPS (as can be seen from the RMS values). This is because even in float conditions, the rover does get corrections from the base albeit not enough to get centimeter accuracy.

NOTE : 1)The code used for plotting the above figures also used two functions for getting the best fit circle and getting perpendicular distances from the best fit line respectively. Thus, three analysis Matlab scripts are included in the submission.
2) The mean of the center of circle data was only used to visualize the offset vector in the figure and get a rough approximation of the offset.