EECE 5554 Lab 1 Report

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I. Introduction

For this lab. I travelled to Cambridge Common park and collected both 10 minutes of stationary gps data and few hundred meters of walking data from a straight path.

II. Stationary Data Discussion

My stationary data is plotted on a map along with my actual location (figure 1, 2) and it's altitude data was plotted along with my actual altitude (figure 3) and error was calculated in terms of the difference between the collected points and actual location (figure 4). Through this data. it is immediately evident that stationary GPS, unassisted, has an accuracy of approximately 6-8 meters.

Interestingly, as time progressed, the plotted values would converge on different points, yielding 8 total convergence points over the course of a 10 minute sampling period. There are several sources of both the steady error of each point cluster as well as the difference between each cluster value. My best prediction is that the origin of the error at each point is due to multipath effects from nearby buildings and cars combined with minor clocking errors due to the cheapness of the gnss puck's internal clock. HDOP, I do not believe, was a major factor as the average value for the data set was between 1 (ideal) and 1.3.

The random appearing distribution of points is likely due to the changing of satellites coming into view of the puck and their individual differential errors. As satellites change, the location estimation over a period of time will shift due to minor differences between satellite bearings and timings. For altitude, error is around 5-6 meters, this is in part, due to the fact that satellite orientation that is geometrically favorable to find latitude and longitude is unfavorable for altitude. interestingly, this error should be greater than the horizontal error because because satellites in a favorable geometric position for horizontal accuracy are positioned unfavorably for altitude accuracy.

Additionally, even though WAAS (Wide Area Augmentation System) is used for GPS augmentation in the US, my gnss puck did not lock an augmentation signal and thus ionospheric (high energy layer at the top of the Earth's atmosphere due to solar radiation) and tropospheric (weather) error can also play into reducing GPS accuracy, given the spherical shape of the signals as they enter the atmosphere, this error is based on the inverse square of their radius and is non-linear, adding to the other environmental variables that make GPS error non-Gaussian.

Fig. 1. captured GPS points (red) mapped alongside actual location (blue) superimposed onto street map

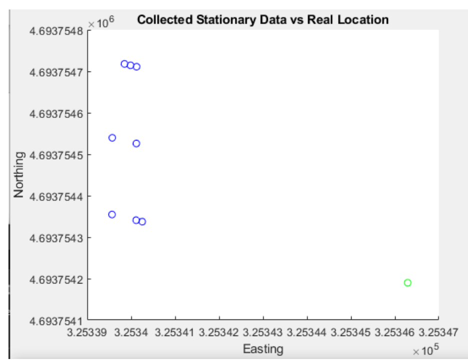

Fig. 2. captured GPS points (red) mapped alongside actual location (blue)

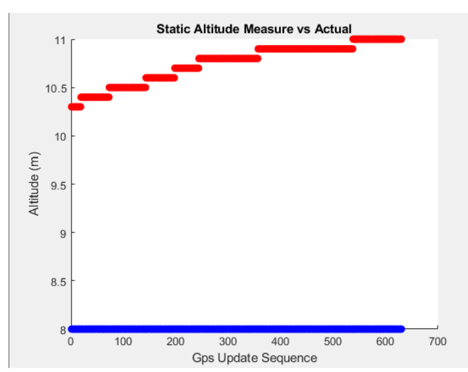

Fig. 3. captured GPS altitude points (red) mapped alongside actual altitude (blue)

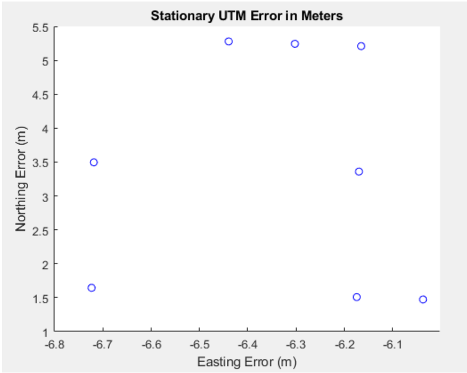

Fig. 4. calculated northing and easting error of GPS point convergences with respect to actual location

III. Moving Data

For moving data collection, The collected GPS data was significantly more accurate than the stationary samples. throughout most of the data range, the average error experienced was between 0-2 meters (figure 5, 6), a seemingly ideal case scenario. Altitude during this set had an average error of around 6 meters (figure 7). Upon inspection of the beginning and end of the captured GPS values, the points diverge from the actual walking path, at these points, I was standing still to start and stop my data collection.

The distribution of noise along the trajectory shows random-appearing peaks and valleys as the data veers off from my actual location and then returns back in. These trends may be due to walking past trees and statues in the park causing some disturbance to line of site with satellites and some multipathing to occur.

I suspect the higher accuracy of the moving data versus the stationary data is primarily due to the reduced time of the trial (thus less satellites coming in and leaving view and less differential errors) as well as less time spent in the same region with slightly adjusting circular error of probability (CEP). Overall, this exercise shows that GPS is best used for location estimation for a moving target versus a stationary one, which is great because that seems way more useful.

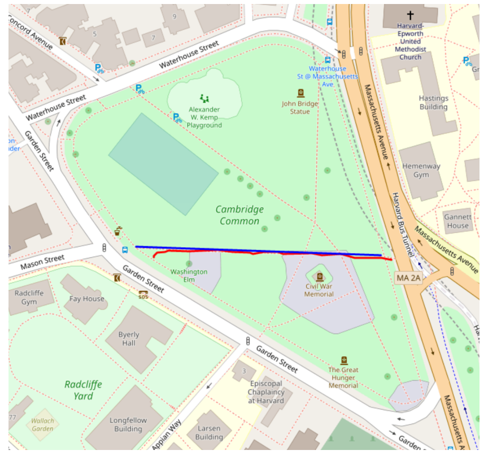

Fig. 5. captured GPS points (red) mapped alongside actual location (blue) superimposed onto street map

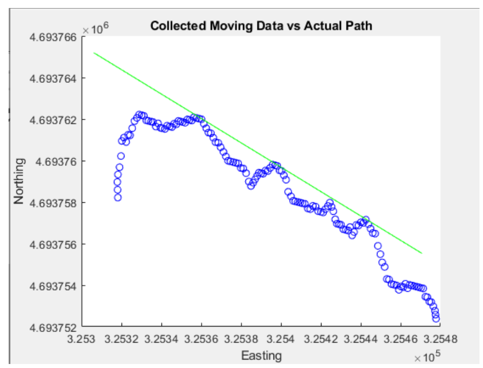

Fig. 6. captured GPS points (red) mapped alongside actual location (blue)

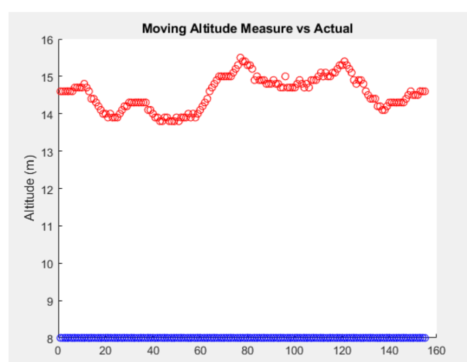

Fig. 7. captured GPS altitude points (red) mapped alongside actual altitude (blue)

References

[1] https://www.gpsworld.com/gps-accuracy-lies-damn-lies-and-statistics/"
[2] https://en.wikipedia.org/wiki/Dilution_of_precision_(navigation)
[3] https://gisgeography.com/gps-accuracy-hdop-pdop-gdop-multipath/
[4] https://www.intechopen.com/books/multifunctional-operation-and-application-of-gps/gnss-error-sources