EECE5554 Lab1 Report

1. Analysis of stationary data

a. Data overview

I sampled the stationary data on the west side of the Snell library at a location approximating the red point in Figure 3. In the following figures, Figure 1 shows the raw data I have collected using the sensor, the data noise and data offset is obvious; Figure 2 shows the results obtained after linear regression of the raw data, which shows that there is a continuous east-west bias of the GPS signal; Figure 3 shows the result obtained by averaging the raw data, which approximates the ground truth position. However, considering that the GPS signal may indeed have a continuous unidirectional offset, in the following data analysis I used the data processed by linear regression which shows in Figure2 as the ground truth.

Figure 1 Data From GPS

Figure 2 After Regression

Figure 3 Average of Data

b. Data analysis

The following figure shows the GPS position information, GPS latitude information and GPS longitude information respectively. We can easily notice a big bias in the latitude information around the 3500th message, the longitude signal was also lost during the same period. It can be inferred that the GPS lost the signal between about 3500th-4000th messages.

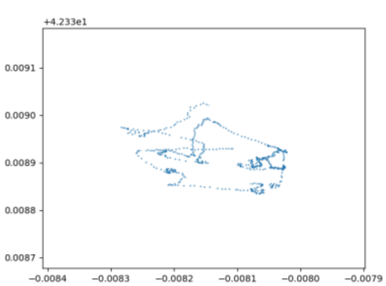

Figure 4 Position from GPS

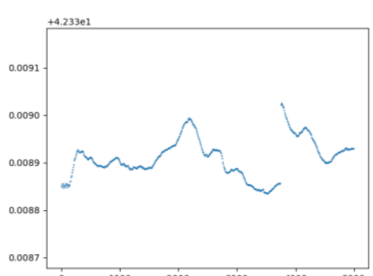

Figure 5 Latitude from GPS

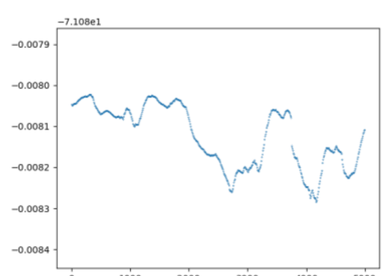

Figure 6 Longitude from GPS

After linear regression of the data, the following graphs can be obtained: GPS position, latitude and longitude after regression. We can easily see that the GPS signal shows a certain bias in both longitude and latitude, which is most likely caused by the GPS not being calibrated.

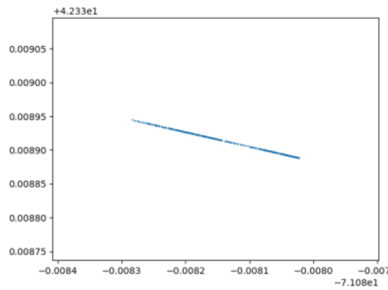

Figure 7 Position after regression

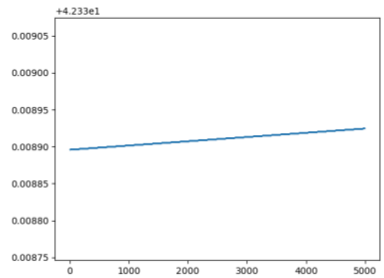

Figure 8 Latitude after regression

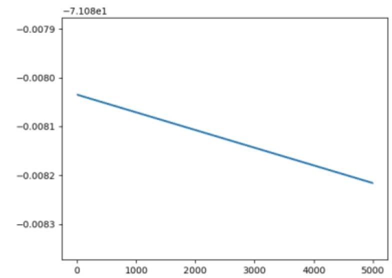

Figure 9 Longitude after regression

Using the data after linear regression as Ground Truth, the distribution of errors can be obtained after comparing with the raw data and GT. According to the following figure, we can find that the distribution of the stationary GPS signal error roughly approximates to a Gaussian distribution.

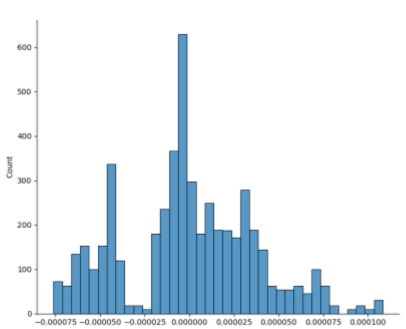

Figure 10 Error distribution of Position

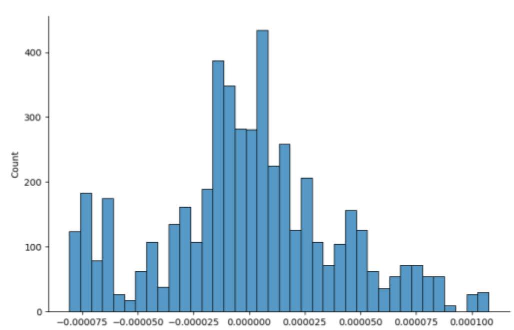

Figure 11 Error distribution of Latitude

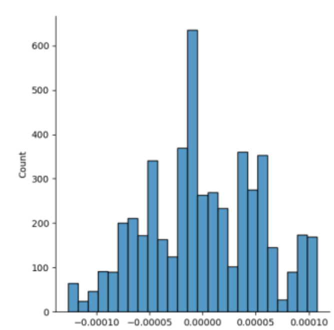

Figure 12 Error distribution of Longitude

c. Conclusion
As those data above demonstrate, the GPS signal is not just a fixed point, but some haphazard curve. So, we can infer that the GPS signal error is composed of systematic error and random error, which might be caused by random signal noises. Linear regression is used to remove the random error of the signal, so the data presented after regression is the systematic error. It is easy to notice that the signal is biased in both longitude and latitude, which may be caused by the GPS not being calibrated.

2. Analysis of moving data

a. Data overview

These data were collected on a straight street near MIT in Cambridge, Figure 1 shows the raw data and Figure 2 shows the regressed data. It is easy to notice that the raw data showed multiple GPS signal losses.

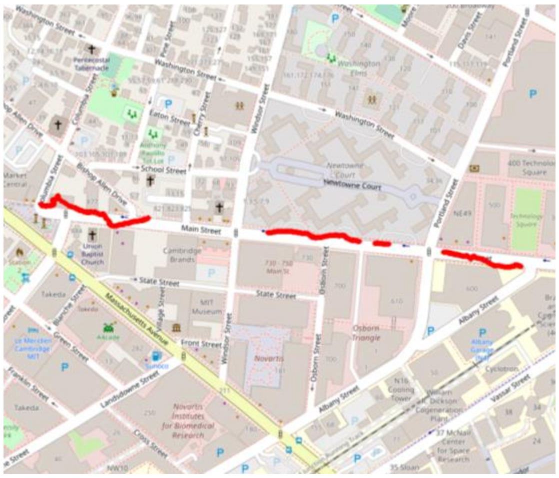

Figure 13 Data from GPS

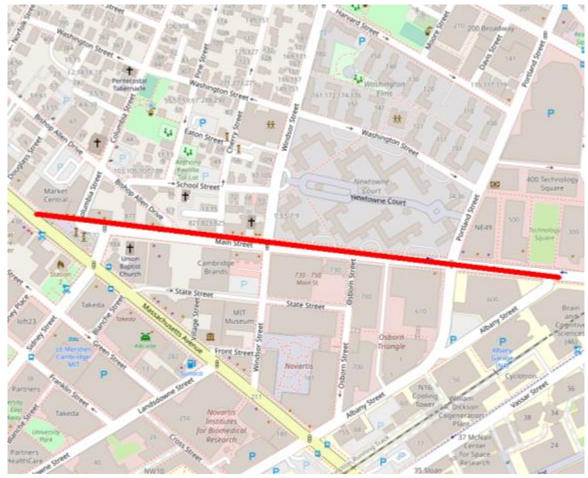

Figure 14 After regression

b. Data analysis

The following figure shows the GPS UTM information, UTM_E information and UTM_N information respectively. Multiple signal losses shows up in this moving process, and this situation is most likely due to the signal shielding of high buildings on that street.

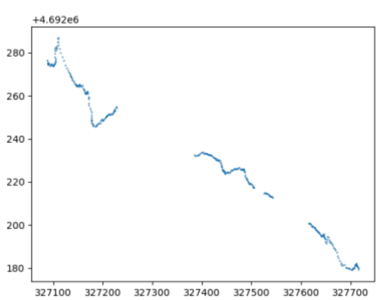

Figure 15 UTM position

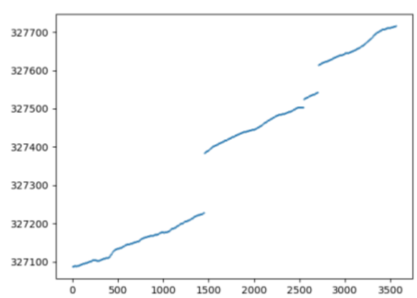

Figure 16 UTM_E data

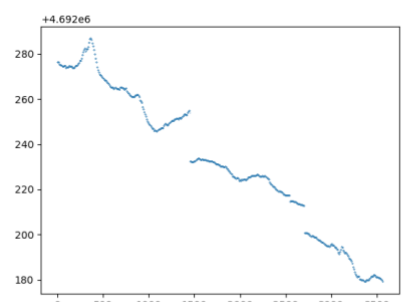

Figure 17 UTM_N data

Using the data after linear regression as Ground Truth, the distribution of errors can be obtained after comparing with the raw data and GT. According to the following figure, we can find that the distribution of the moving GPS signal error roughly approximates to a Gaussian distribution, but the data of UTM_E seems to be more accurate because there are more counts distributed around 0.

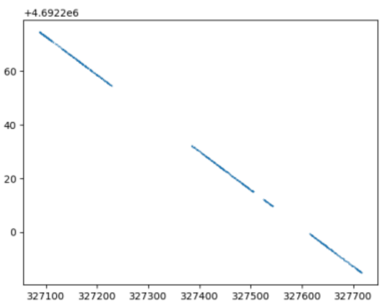

Figure 18 UTM after regression

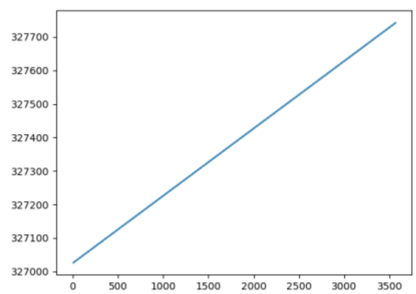

Figure 19 UTM_E after regression

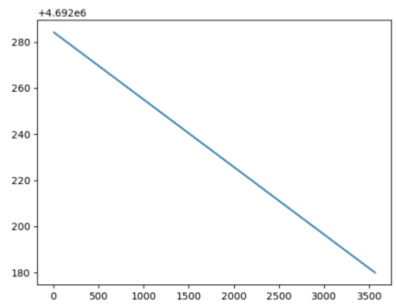

Figure 20 UTM_N after regression

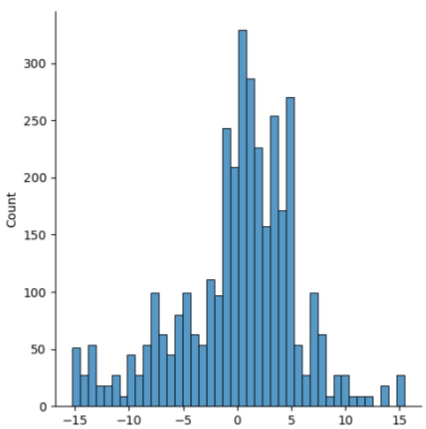

Figure 21 Error distribution of UTM

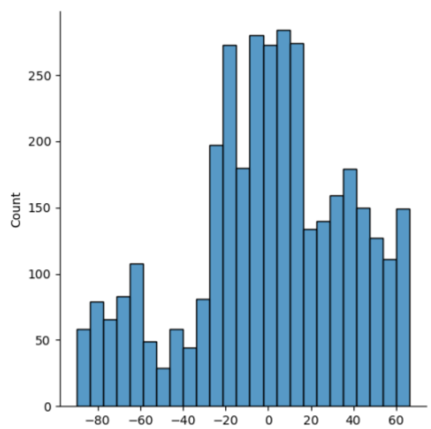

Figure 22 Error distribution of UTM_E

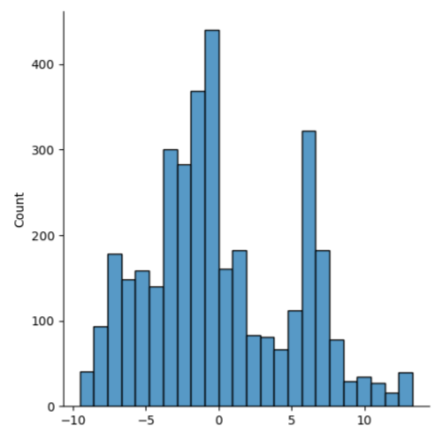

Figure 23 Error distribution of UTM_N

c. Conclusion
The data error while moving is mainly reflected in the data breakpoint, because there are many tall buildings on that road where the data is measured, so it is reasonable to infer that the reason is the signal shielding of these tall buildings. In addition, there is a small amount of random error caused by GPS noise. Finally, compared to stationary data, the single directional bias error of moving data is negligible.