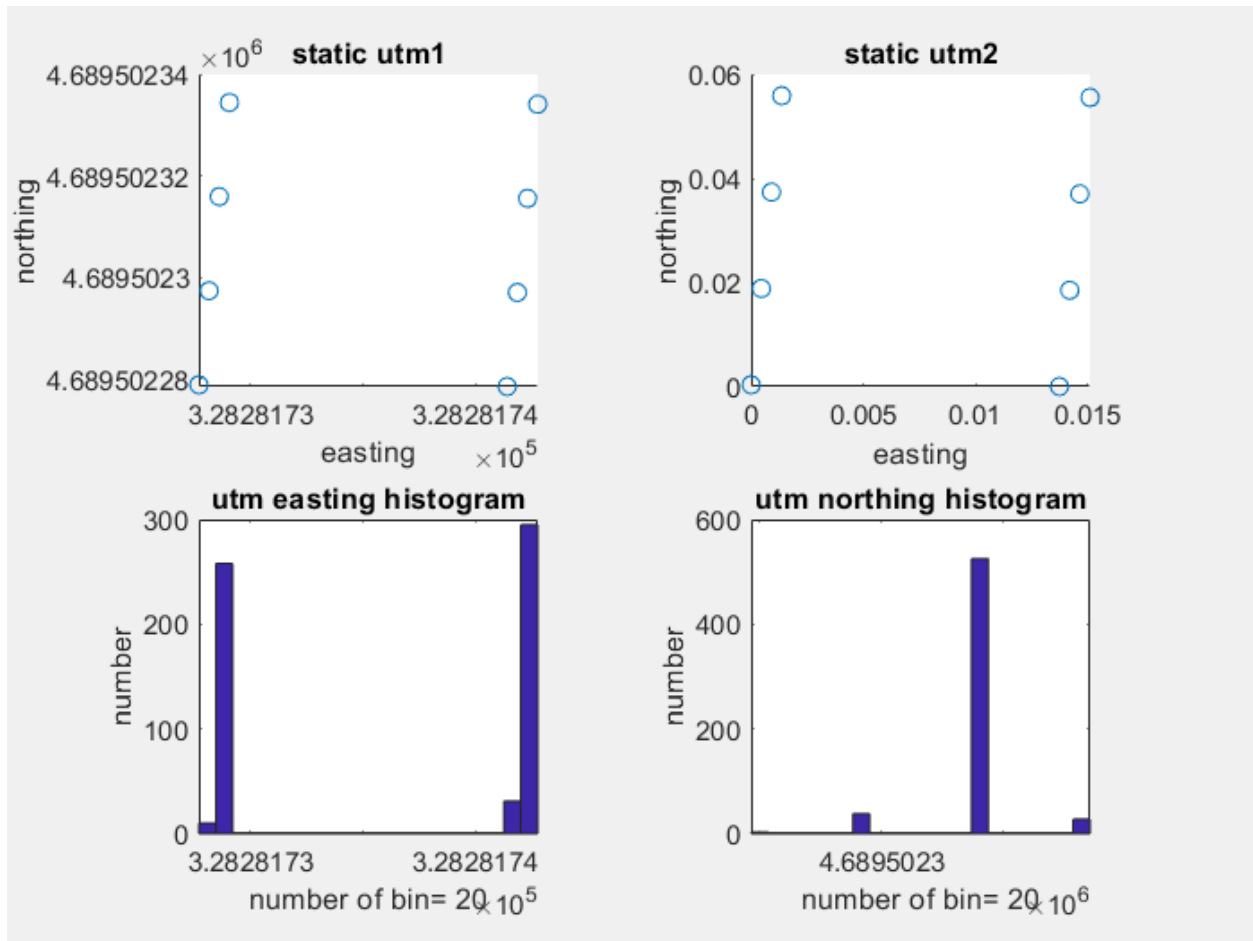Report for lab2

EECE 5554: Robotic sensor and Navigation

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Static data analysis

Static data in the playground:

Statistics Table

	average	max	min	STDEV	max variance
Longitude (deg)	-71.0845	-71.0845	-71.0845	8.3E-08	7.52122E-08
Latitude (deg)	42.33884	42.33884	42.33884	6.03E-08	1.71095E-07
Altitude (m)	8.999327	9	8.9	0.008185	0.000673401
UTM_Easting (m)	328281.7	328281.7	328281.7	0.006815	0.006660355
UTM_Northing (m)	4689502	4689502	4689502	0.006721	0.019185591

Static data outside the ISEC:
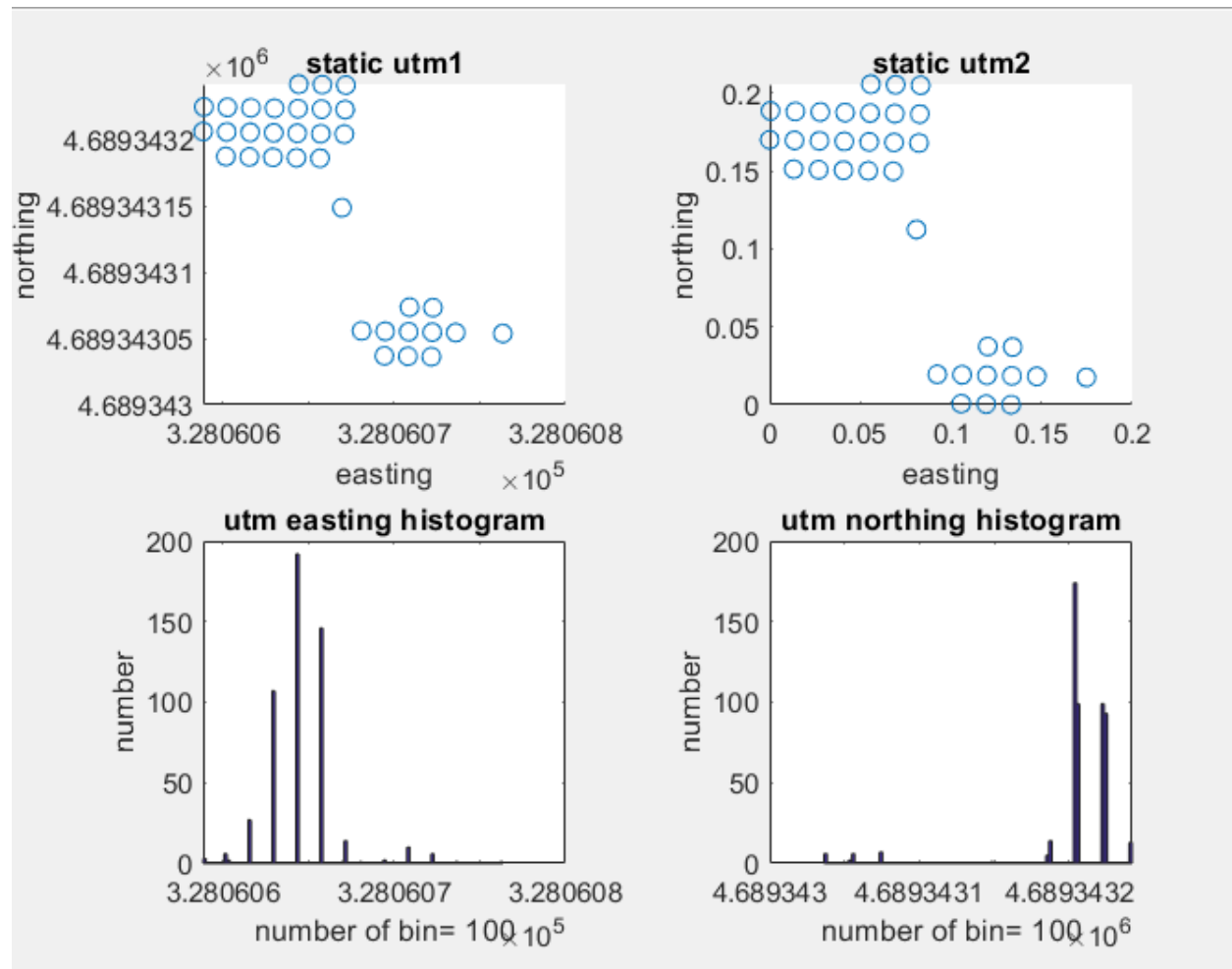
Statistics Table

	average	max	min	STDEV	max variance
Longitude (deg)	-71.0871	-71.0871	-71.0871	2.4959E-07	1.4705E-06
Latitude (deg)	42.33736	42.33736	42.33735	2.9396E-07	3.2407E-07
Altitude (m)	6.463776	6.7	6.4	0.06054766	0.23622351
UTM_Easting (m)	328060.6	328060.8	328060.6	0.02010671	0.1174829
UTM_Northing (m)	4689343	4689343	4689343	0.0329378	0.0360355

1.For static data, the error can be represented as standard deviation. In the field, it is 0.06815 meters for easting and 0.06721 m for northing. Outside the ISEC, it is 0.02 meters for easting and 0.03 m for northing. The error outside the ISEC is bigger than that in the field.

2. the sources of the error and the distribution of the noise:

The data is composed of three parts with different fix quality(1,5,4) and each part of the data contributes to the total error.
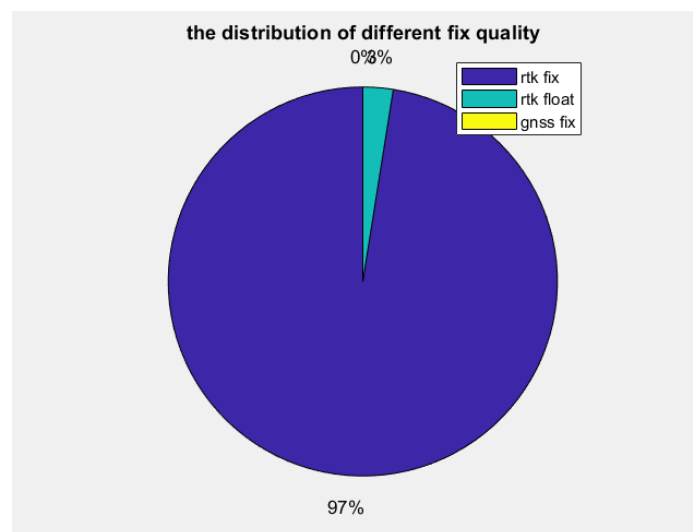
Error_ Total = Gnss fix error + rtk float error + rtk fix error

The following figure is the distribution of the data with different fix quality.

Pie graph for Static data in the field

the distribution of different fix quality
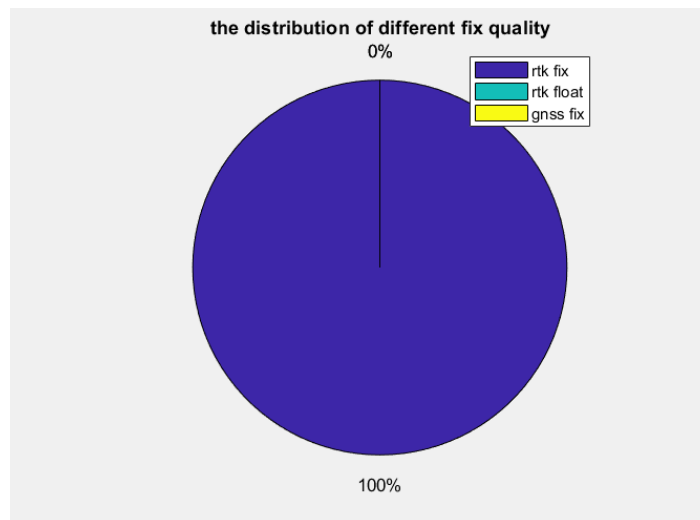
Pie graph for Static data outside of the ISEC

the distribution of different fix quality

The data collected on the field is all RTK fixed.

The data collected outside of the ISEC has 97% rtk fixed and 3% rtk float.

The rtk float data will have more error than rtk fix.

data outside the ISEC	percentage	STDEV (easting, northing)	
RTK fixed	97%	0.0114	0.0165
RTK float	3%	0.0176	0.0230

For gnss error, it is the same as the GPS error which is a random distribution due to several reasons such as the multipath error, the ionosphere error, the satellite orbits and so on. It occupied a small part of the amount of the data, but will give us a big error (it contributes zero error in this case because of ZERO weight)

For the mechanism of RTK is similar to gps except that it has a base as a reference and a complicated calculation method. Its measurement could be affected by the ionosphere, troposphere and imperfections related to ephemerides, clocks and multipath.

(ref: https://www.lantmateriet.se/globalassets/kartor-och-geografisk-information/gps-och-geodetisk-matning/publikationer/measurement-accuracy-in-network-rtk.pdf)

For rtk float error and rtk fix error, it is also a random distribution due to several reasons such as such as the ionosphere, the troposphere, the local effects (the rover and the reference sites) ….

It took up a big part of the amount of the data, but gave us a smaller error.

So the error/noise distribution = the weight 1 * the gnss error distribution (a random distribution with large variation) + the weight 2 * the rtk float error distribution (a random distribution with smaller variation) + the weight 3 * the rtk fix error distribution (a random distribution with smallest variation)

In the playground: the wights and variations are [0, 0, 1]

Outside the ISEC: the wights and variations are [0, 0.03, 0.97]

Some inference: For the weather's reason, the ionosphere and the troposphere error would be main sources. The data collected outside the ISCE has a big error than that in the field due to the blocking of the building(multipath error).
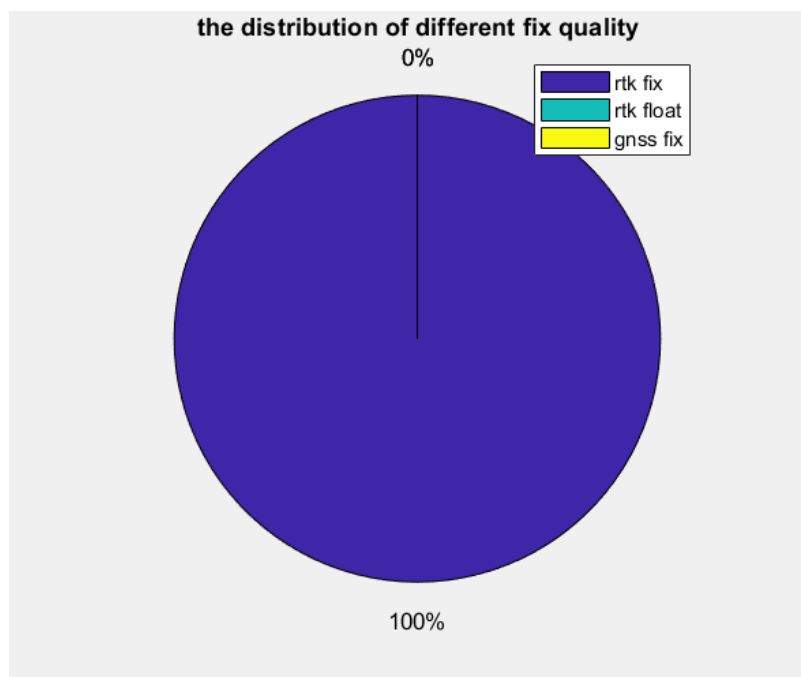
The moving data

After the analysis of the static data, the moving data is easy to analyze.

The field utm_northing and utm_easting plot:
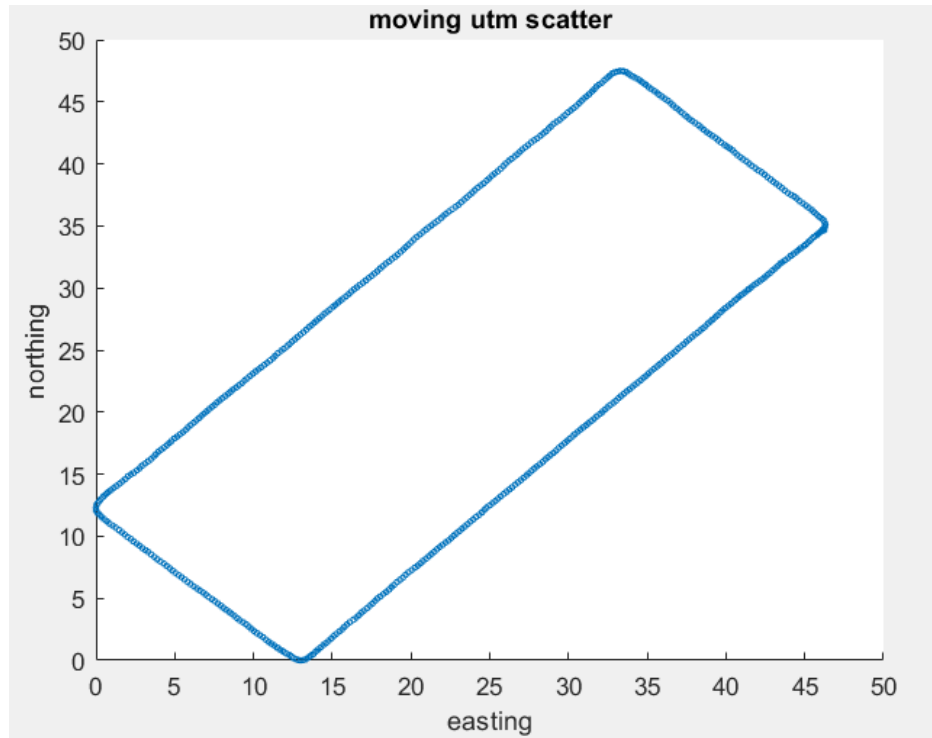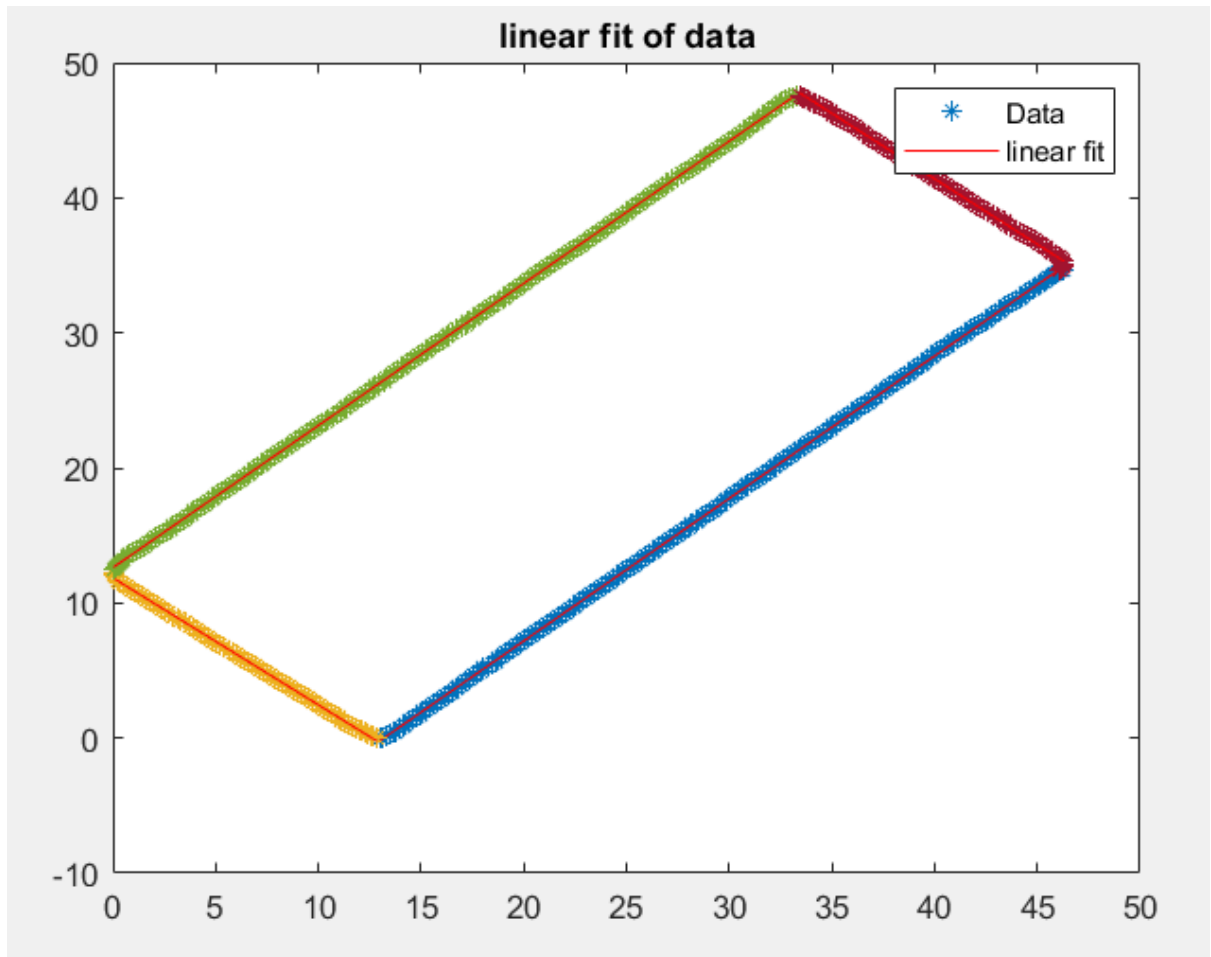

Pie distribution graph

Get the fit line:

The fit line was composed by four linear lines which is computed by linear regression.
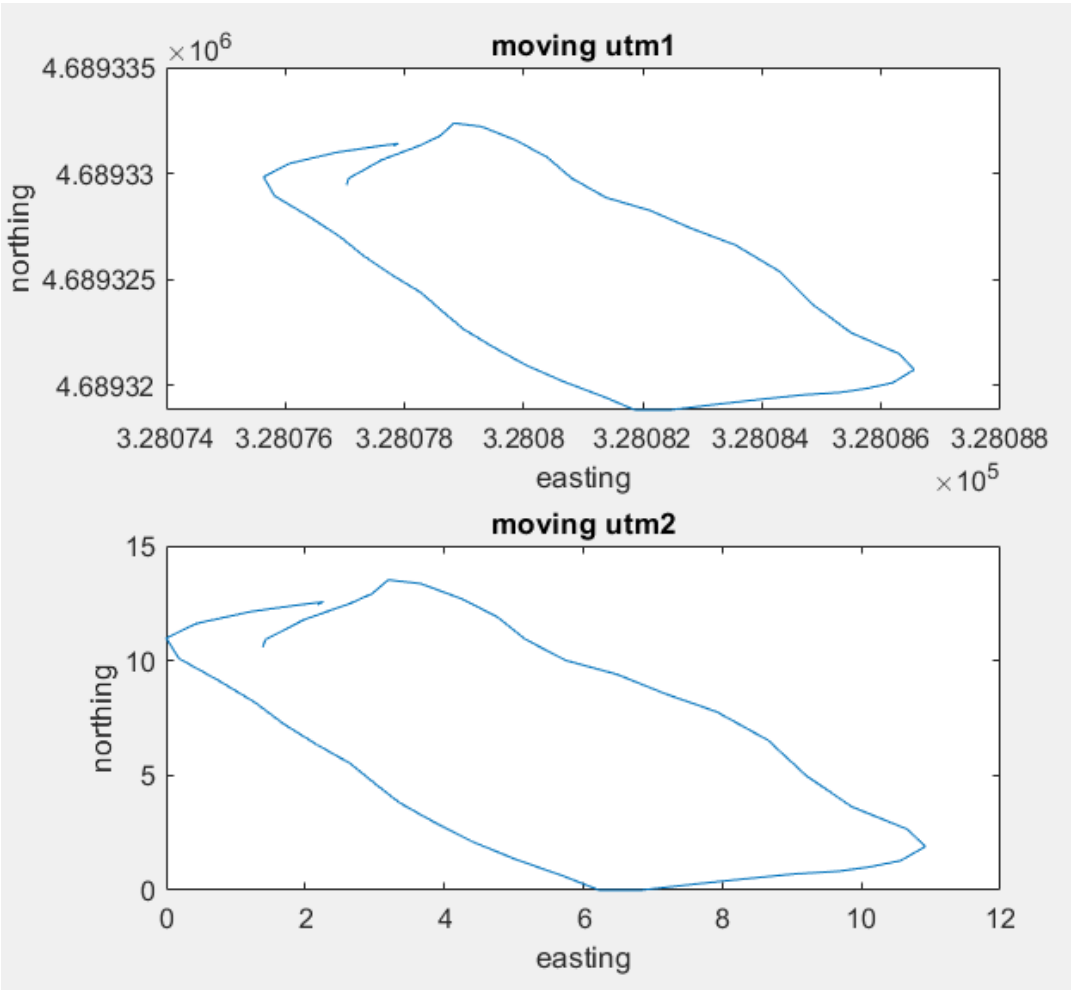
1. Get the start point and end point in the first straight line of the utm graph
2. Use the polyfit and polyval to get the linear line for this segment
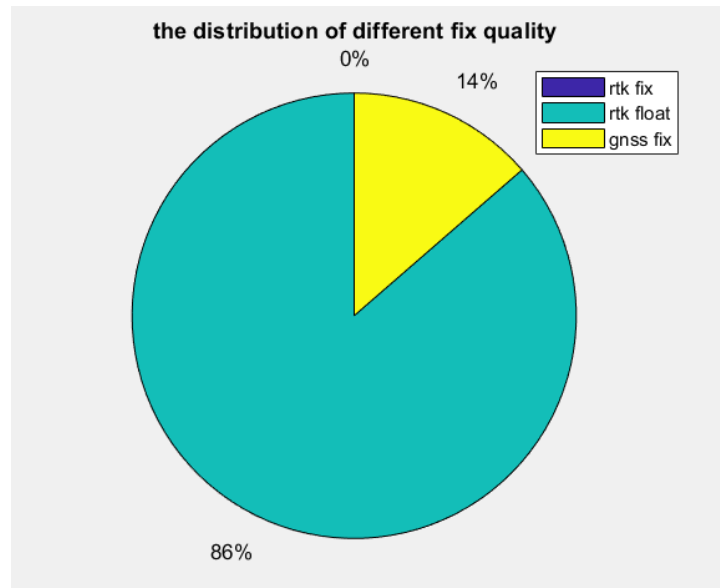3. Repeat 1 and 2 for the four segments to get the whole fit line

(ref: https://www.mathworks.com/help/matlab/ref/polyfit.html)

The RSME error between the fit line and the collected data is: **0.0853**
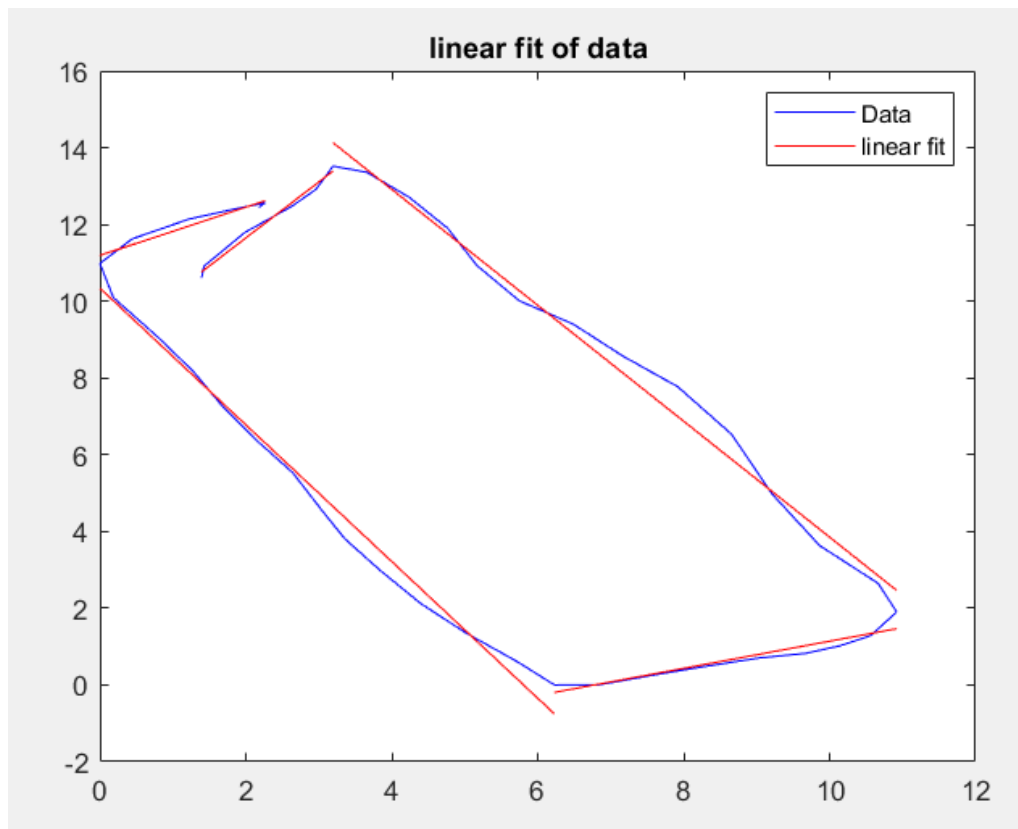
The moving data outside the ISEC:

Pie distribution graph

Get the fit line:

The process is the same as the previous part, but I have to segment it into 5 pieces(it give us the best fit line).

The RSME error between the fit line and the collected data is: **0.291**

The error/noise distribution = **the weight 1 * the gnss error distribution (a random distribution with large variation) + the weight 2 * the rtk float error distribution (a random distribution with smaller variation) + the weight 3 * the rtk fix error distribution (a random distribution with smallest variation)**

> Outside of the ISEC: the wights are [0, 0, 1]

> In the field: the wights are [0.14, 0.86, 1]

However, there still existed some error when we introduced the fit line since it could not represent the real walking path.

Error source:

> **The total error** = **the bias error + variation**, where the bias error is difference between the fit line and the real path, the variation is the RSME between the fit line and the collected data since the real line is not a critical linear.

> The ionosphere and the troposphere error would be main sources. The data collected outside the ISCE has a big error than that in the field due to the blocking of the building (multipath error).