Exercises, module 5 week 41

UAS positioning & navigation

Thor Rørdal throe16@student.sdu.dk
Søren Emil Hansen soeha16@student.sdu.dk
Shubham Kumar shkum20@student.sdu.dk

3 Exercises

3.1 Remove outliers

The original map is sampled by walking through the Eastern entrance of building U43, clockwise around the building and back inside the Northern entrance.

All figure plots have the mean Eastings and mean Northings subtracted to center the map around 0. The calculations are done in 3 dimensions.

In figure 1, the original map with randomly inserted deviating points can be seen as well as the map without outliers. The outliers have been removed with the following approach:

The mean μ and standard deviation σ of the speed between points is initially calculated. Whenever the distance between two consecutive points is larger than $\mu + \sigma$, the point is removed from the mission.

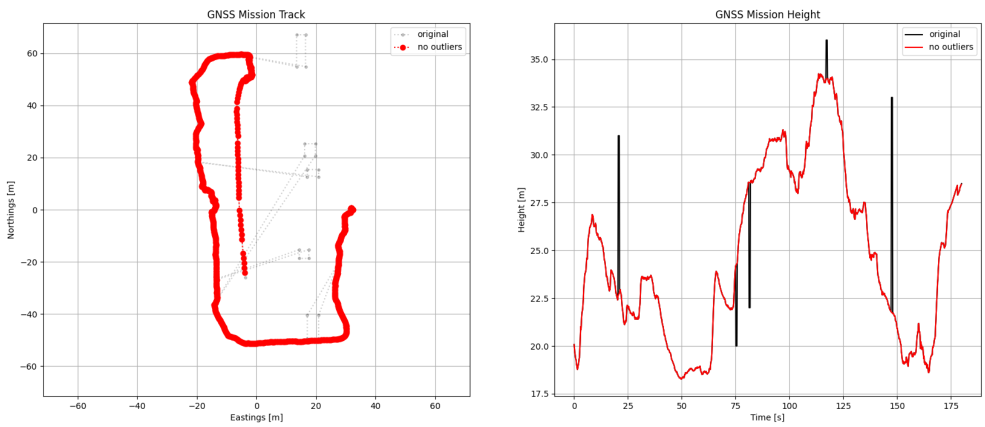


Figure 1: Original mission with random noise and outliers removed.

3.2 Simplify the track

The following three simplification techniques are implemented:

1. Maximum waypoints allowed (figure 2)
2. Minimize distance deviation from track (figure 3)
3. Minimize distance and bearing angle deviation from track (figure 4)

The efficiency of all simplification algorithms rely heavily on the outlier-filtering performance.

3.2.1 Maximum waypoints allowed

The maximum waypoints allowed simply divides the number of points into 10 evenly divided waypoints.

This method can easily cut off sections of the original track, since two of the resulting points can easily cut corners.

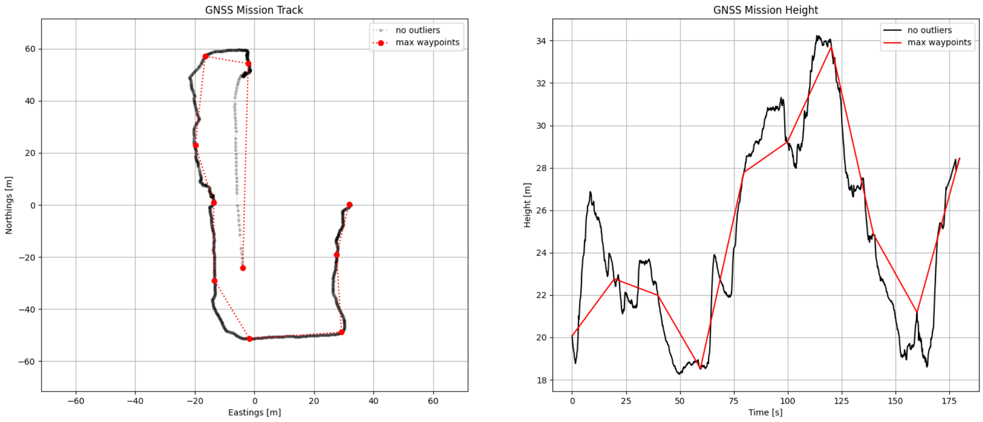


Figure 2: Simplification by limiting to 10 evenly divided waypoints.

3.2.2 Minimize distance deviation from track

This method ensures the maximum deviation of the resulting points deviate with a maximum distance of a given distance (this case 3m). The method is implemented with the Ramer-Douglas-Peucker recursive algorithm.

This algorithm efficiently removes unnecessary points, but can in some cases cut off sharp corners.

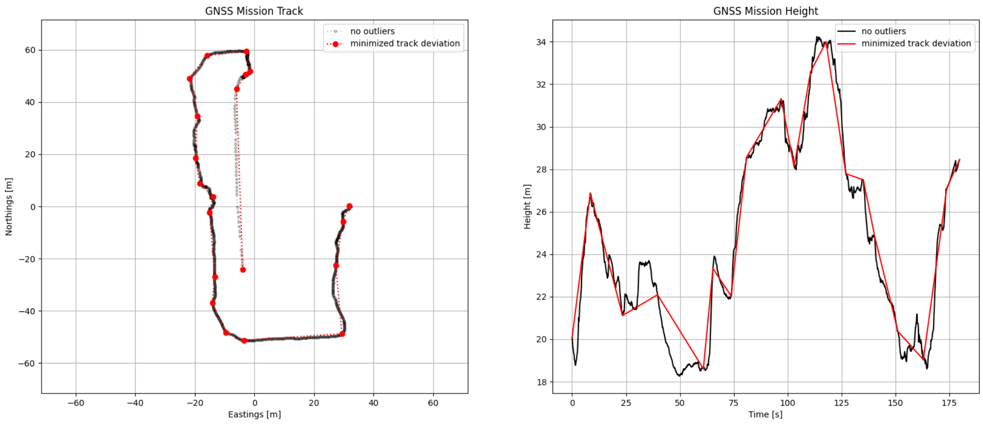


Figure 3: Simplification by maximum 3m track deviation.

3.2.3 Minimize distance and bearing angle deviation from track

This method also uses the Ramer-Douglas-Peucker recursive algorithm, with the addition of an angle-checker between three consecutive points, that ensures the angle is larger than a given angle (this case 120°) in addition to the given distance (this case 10m for proof of concept).

This algorithm efficiently removes unnecessary points.

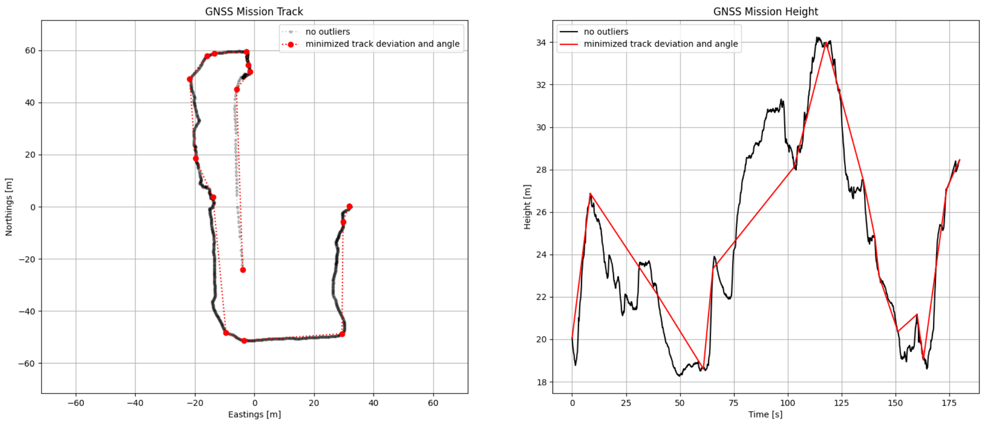


Figure 4: Simplification by maximum 10m track deviation and minimum 120 degrees between 3 consecutive points.

3.3 Export as a route plan to QGroundControl software

Figure 5 shows the simplified route plane exported to Qgroundcontrol.

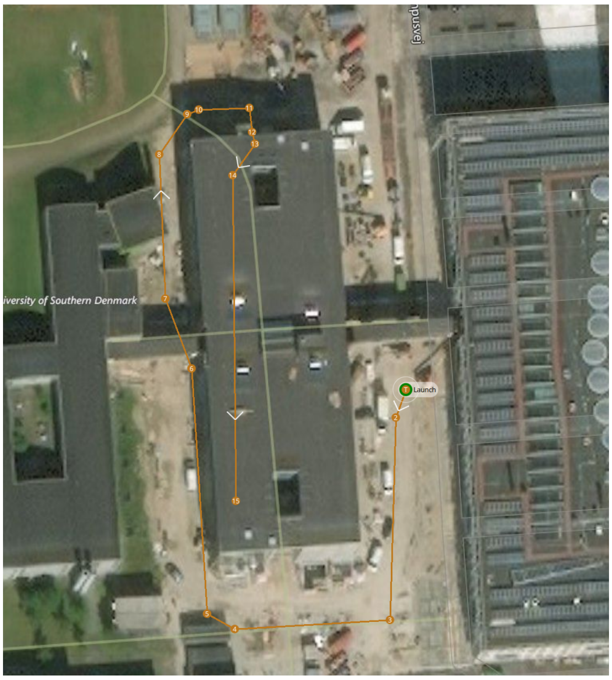
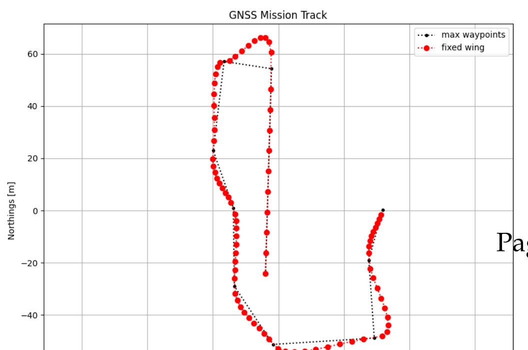


Figure 5: Route Plan exported to QGroundControl

3.4 Fixed wing optimization

The fixed wing optimization is calculated in 2 dimensions on the output of the max waypoints simplifcation methods and yields the final track shown in figure 6 with 10 spline points between each point.

The optimization algorithm calculates splines. The tangents for the splines are tangents from



each point to the immediately consecutive point. The final point uses the same tangent as the previous point.