Lab 10 - UAS positioning & navigation
Introduction to Drone Technology

Group 8
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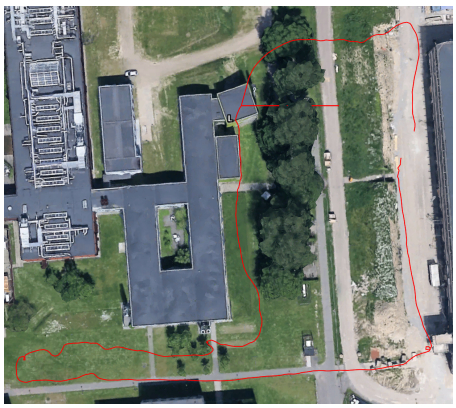
3 Remove outliers

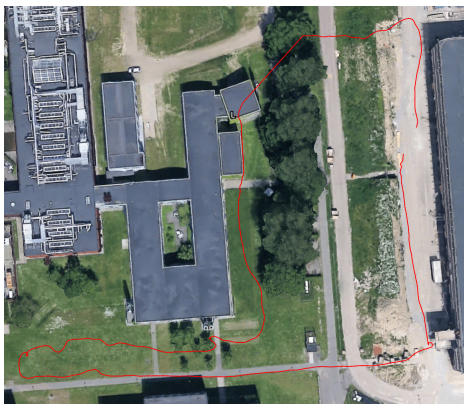
Outliers are considered observations that lie an abnormal distance from other values in a random sample from a population. An outlier ex. in a drone track, such as figure 1, is considered a nuisance and should be removed. The way the outliers were removed, was to define an acceptable distance between each consecutive point as a function of the realistic speed and the time taken between the points. The below code implements this, adding a margin to account for inaccuracies for points further away time-wise.

```
margin = 0.5 + time_diff * 0.5
if (dist < (expected_distance * time_diff + margin)):
    accepted.append([northing, easting])
```

In figure 1 is the original track compared with the result from the algorithm. It is seen that the exaggerated outlier is removed from the track.



(a) Original path, points = 426



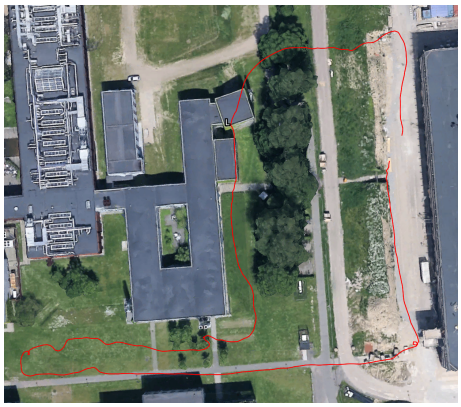
(b) Removed outliers, points = 406

Figure 1: Removing outliers from the track

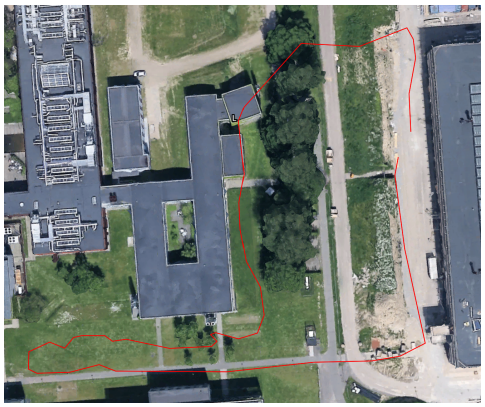
4 Simplify the track

The reason for simplifying the track is to remove excessive track points. The algorithm used for this simplification was the Ramer-Douglas-Peucker Algorithm[1], and is also defined as an iterative end-point fit algorithm. What it does is reduce the number of points in a curve or line without losing their shape. Before simplification, but after removal of outliers, the track consisted of 406 points. After the simplification method its points depended on the tolerance parameter ϵ, which can be seen in figure 2c. If the tolerance parameter is "high", the track will be sharper in its corners and lines with a low amount of points, but it can be smoother if the parameter gets lowered. For

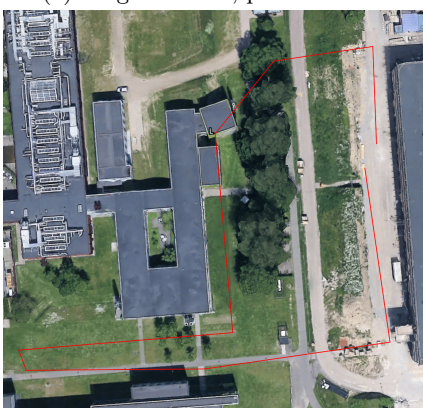
this track, an epsilon value of 5 or beneath is preferred, because above this value, the corners are very sharp and the robot would be able to fly off track depending on its speed.



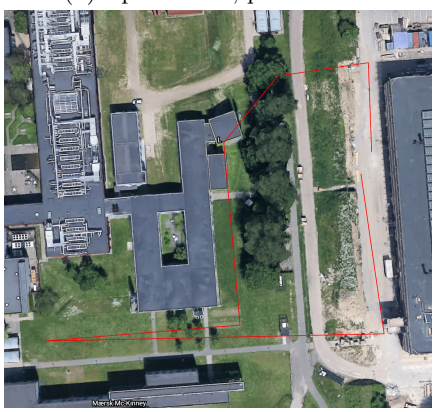
(a) Original track, points = 406



(b) Epsilon = 1, points = 46



(c) Epsilon = 5, points = 10



(d) Epsilon = 10, points = 8

Figure 2: Simplifying the track with different threshold values epsilon.

6 Export as a route plan to QGroundControl software

The Python class exporting a path of geodetic coordinates to QGroundControl, is based on the example script `qgc_generate_plan_example.py`. It loops through all the data points of a track, and writes the point to a file, specifying a specific mission command[2] to execute. The first point is `MAV_CMD_NAV_TAKEOFF` to take-off and landing is `MAV_CMD_NAV_LAND`. All points in between are `MAV_CMD_NAV_WAYPOINT` to navigate between the waypoints.

On figure 3 is the exported plan imported in QGroundControl, ready to be deployed on the drone. Note that the track in the example has not been simplified.

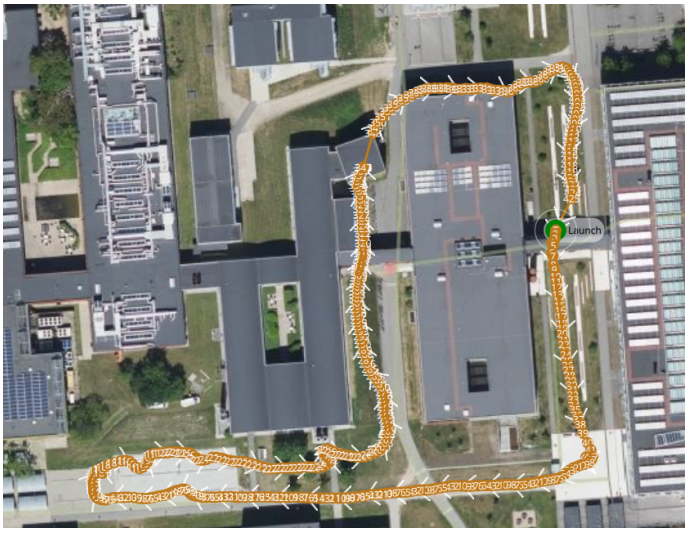


Figure 3: Track in QGroundControl

1 Bibliography

[1] Wikipedia. Ramer-douglas-peucker algorithm. `https://en.wikipedia.org/wiki/Ramer-Douglas-Peucker_algorithm`. Online; accessed 06 December 2021.

[2] PX4. Mission mode. `https://docs.px4.io/v1.12/en/flight_modes/mission.html`. Online; accessed 06 December 2021.