

MPC-MAP Assignment No. 1 - Report

Author: Tomáš Frigyik

Date: 23.2.2025

Task 1 – The simulator

No output is required in this step.

Task 2 – Sensor uncertainty

simulation_periods_amount: 200

Loaded map: indoor_1

Outputs:

Value of the standard deviation for channel 1 of the LiDAR is 0.051932

Value of the standard deviation for channel 2 of the LiDAR is 0.051299

Value of the standard deviation for channel 3 of the LiDAR is 0.047391

Value of the standard deviation for channel 4 of the LiDAR is 0.055738

Value of the standard deviation for channel 5 of the LiDAR is 0.053279

Value of the standard deviation for channel 6 of the LiDAR is 0.05149

Value of the standard deviation for channel 7 of the LiDAR is 0.0498

Value of the standard deviation for channel 8 of the LiDAR is 0.052326

Loaded map: outdoor_1

Outputs:

Value of the standard deviation for channel 1 of the GNSS is 0.48464.

Value of the standard deviation for channel 2 of the GNSS is 0.50729.

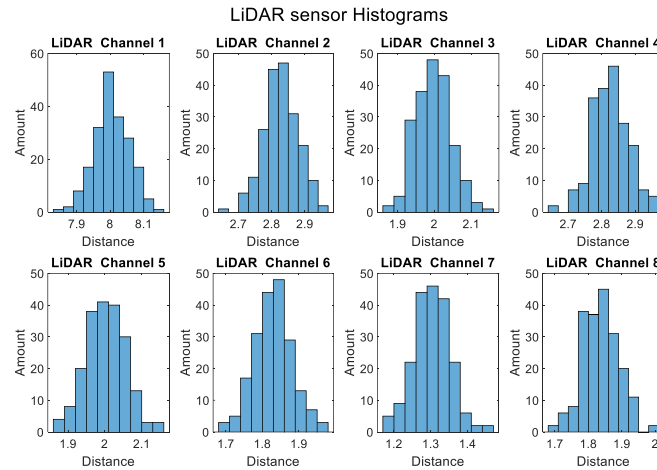


Figure 1 - Histograms of the measurements of LiDAR channels

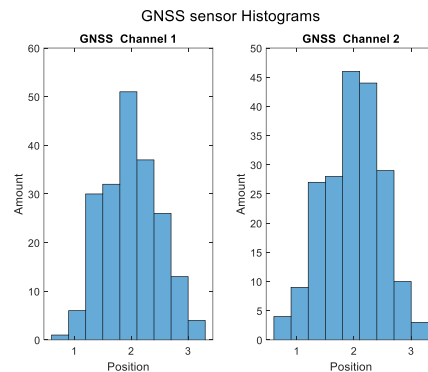


Figure 2 - Histograms of the measurements of GNSS channels

Discussion: Std across individual LiDAR channels and both GNSS axes are consistent based on outputs for std. In the case of the output above, the biggest difference in values of the LiDAR channels is between channel 3 and 4 and this difference has value of 0,008347.

Task 3 – Covariance matrix

```

lidar_cov =
    0.0027    0.0001   -0.0001   -0.0003   -0.0001    0.0004    0.0001    0.0003
    0.0001    0.0026   -0.0003    0.0000    0.0001    0.0000   -0.0001    0.0000
   -0.0001   -0.0003    0.0023    0.0001    0.0001    0.0001   -0.0002   -0.0001
   -0.0003    0.0000    0.0001    0.0031    0.0003    0.0001    0.0000   -0.0002
   -0.0001    0.0001    0.0001    0.0003    0.0029   -0.0001    0.0001    0.0001
    0.0004    0.0000    0.0001    0.0001   -0.0001   -0.0027    0.0001    0.0002
    0.0001   -0.0001   -0.0002    0.0000    0.0001    0.0001    0.0025   -0.0002
    0.0003    0.0000   -0.0001   -0.0002    0.0001    0.0002   -0.0002    0.0028

GNSS: Values on the main diagonal are almost equal to sigma^2
diff_gnss_diag_gnss_std_sq =
    0.0015
    0.0013

LiDAR: Values on the main diagonal are almost equal to sigma^2
diff_lidar_diag_lidar_std_sq =
    1.0e-04 *
    0.1355
    0.1322
    0.1129
    0.1561
    0.1426
    0.1332
    0.1246
    0.1376
  
```

Figure 3 - Covariance matrixes for GNSS and LiDAR and differences between values on main diagonal of covariance matrixes and σ^2

Discussion: Values on the main diagonal are almost equal to σ^2 .

Task 4 – Normal distribution

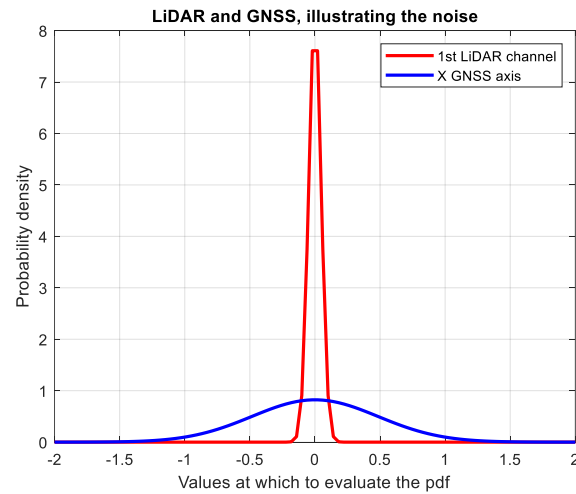


Figure 4 - Illustrating the noise characteristics of the robot's sensors

Discussion: Implemented function `norm_pdf` was utilized, figure 4 shows the noise characteristics of robot's sensors.

Task 5 – Motion uncertainty

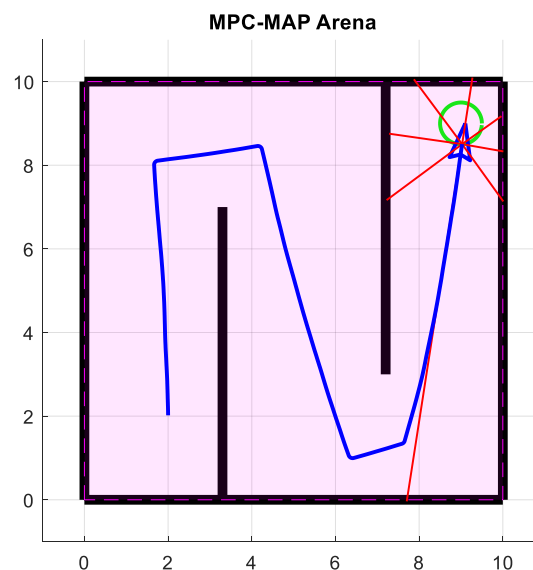


Figure 5 - Screenshot of a successful run

Discussion: Potential sources of uncertainty in the robot's motion could be for example mechanical motor and wheels imperfections, uneven surfaces, external forces, motor performance degradation due to battery discharging and lowering power.