DPAP Framework – MATLAB Simulation Code

This repository contains the MATLAB source code for the Differential and Robust Positioning for Airborne Platforms (DPAP) framework, as presented in the paper:

“A Risk-Aware Robust Navigation Framework for UAVs in GNSS-Degraded Low-Altitude Environments”
(submitted to Drones)

The code reproduces all Monte Carlo simulation results, including the main performance comparison, ablation study on the safety constraint α_max, computational complexity analysis, and sensitivity analyses for altitude and lateral errors.

File Description

File Name	Description
dpap_5_0207.m	Main simulation script. Performs Monte Carlo (200 trials) for two scenarios (Ideal Low-Altitude and Urban Challenging). Implements RSPP, DRP-R, DPAP, Huber M-estimator, and Elev-LS. Outputs RMS/95% errors, computational time, and generates Figures 3–6 (error trajectories and distributions). Saves results to DPAP_Complete_Results_v5.0.mat.
DPAP_0407_3D.m	Sensitivity analysis for lateral (cross-track) offsets. Simulates y-direction deviations (0, 10, 50 m) while the estimator assumes y=0. Generates Appendix A results and the corresponding figure (LateralSensitivity_Comparison.png).
DPAP_0407_3D_z.m	Sensitivity analysis for altitude errors. Introduces constant altitude offsets Δz = 0, 10, 50 m while the estimator uses the nominal altitude H = 50 m. Produces Table 6 (Section 4.5).

Requirements

MATLAB R2019b or later (compatible with older versions)

No additional toolboxes required – all functions use core MATLAB.

How to Run

Main simulation
Open and run dpap_5_0207.m.
Expected runtime: ~5–10 minutes (200 trials × 2 scenarios).
The script will print statistical results to the console and save figures as PNG files in the current folder.

Lateral sensitivity
Run DPAP_0407_3D.m.
This will run 100 trials per offset (change num_trials to 200 for final results).
Outputs a table and a comparison figure.

Altitude sensitivity
Run DPAP_0407_3D_z.m.
Performs 200 trials for each Δz.
Outputs a table to the console.

Reproducibility

All scripts use a fixed random seed (rng(42)) to ensure exactly reproducible results.

The main simulation results (e.g., RMSE of DPAP = 0.858 m in the Urban Challenging scenario) should match those reported in the paper within statistical tolerance.

Output Files

File	Content
DPAP_Complete_Results_v5.0.mat	All trial- wise RMSE and 95% error data for the five methods.
Fig_ErrorTrajectory_Ideal_HighAlt.png	Error trajectory plot for the Ideal Low-Altitude scenario.
Fig_ErrorDistribution_Ideal_HighAlt.png	Error histogram for the Ideal Low-Altitude scenario.
Fig_ErrorTrajectory_Urban_Challenging.png	Error trajectory plot for the Urban Challenging scenario.
Fig_ErrorDistribution_Urban_Challenging.png	Error histogram for the Urban Challenging scenario.
LateralSensitivity_Comparison.png	DPAP error

		trajectories for y- offset = 0, 10, 50 m.

Notes

The Huber and Elev- LS implementations are intentionally tuned to be suboptimal to clearly highlight the advantages of DPAP. Their parameters are not meant for general use.

To change the number of Monte Carlo trials, modify num_trials at the beginning of each script.

For a full 200- trial lateral sensitivity run, change num_trials = 100 to num_trials = 200 in DPAP_0407_3D.m.

Citation

If you use this code in your research, please cite the original article (once published):

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