

The final conference of the POLNOR-LEADER project

Mission Planning for Adaptive Pollution Sampling - Examples

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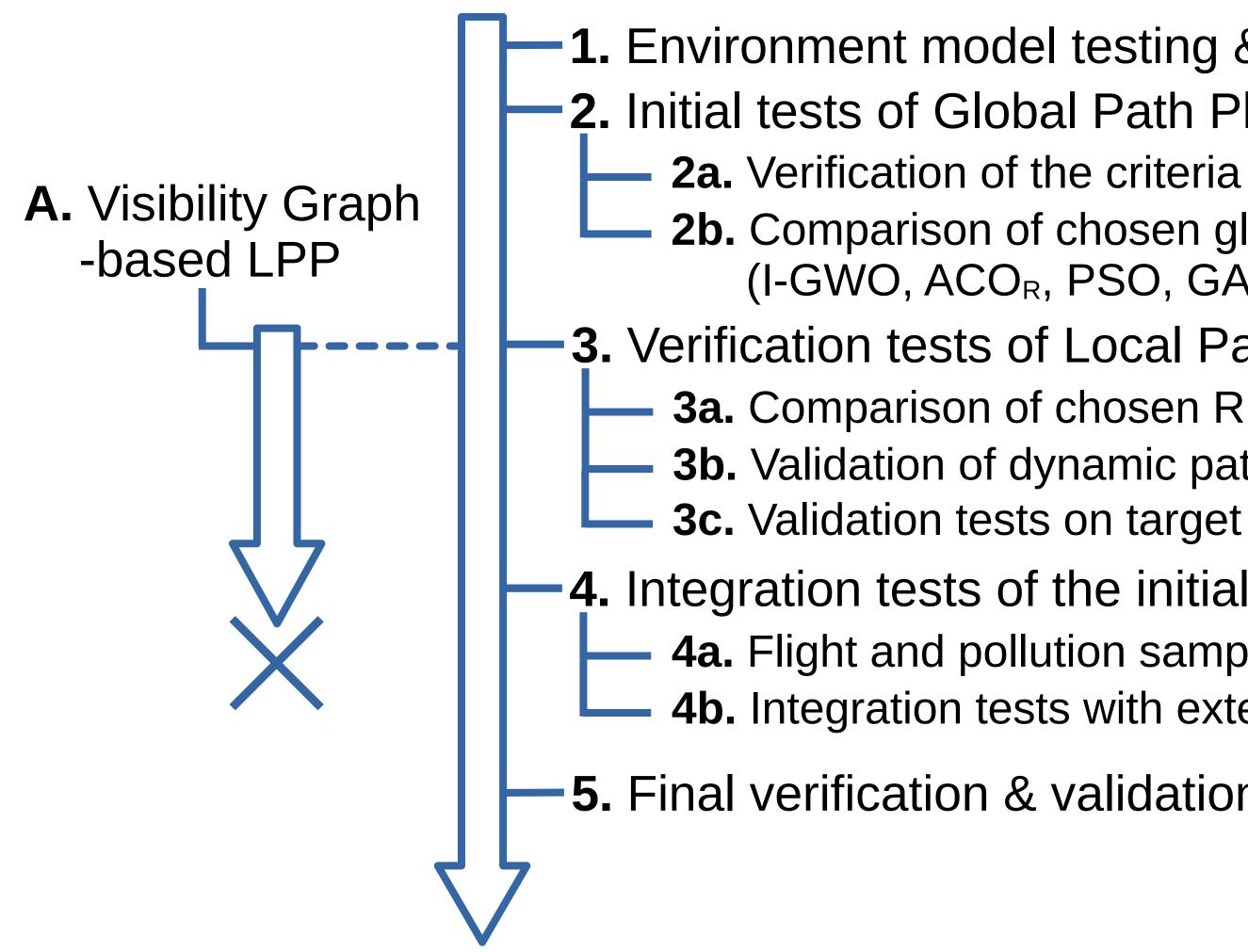
Gliwice, 26.06.2024

Agenda

- 1) Research timeline
- 2) Early concepts
- 3) Alternative approach
- 4) Final solution
- 5) Summary & conclusions



Research timeline



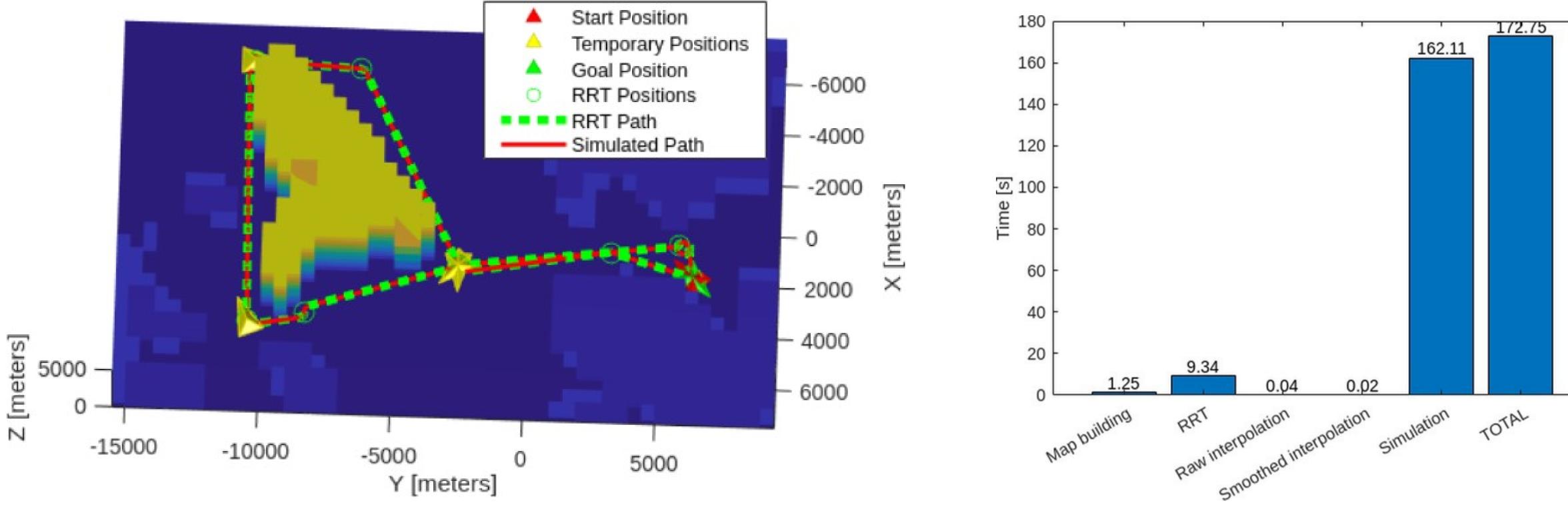
1. Environment model testing & development **2.** Initial tests of Global Path Planner (GPP)

- **2b.** Comparison of chosen global optimization algorithms
 - (I-GWO, ACO_R, PSO, GA)
- **3.** Verification tests of Local Path Planner (LPP)
 - **3a.** Comparison of chosen RRT algorithms (RRT, RRT*, BiRRT)
 - **3b.** Validation of dynamic path planning in simulation
 - **3c.** Validation tests on target hardware
- **4.** Integration tests of the initial version of APP
 - **4a.** Flight and pollution sampling tests in simulation
 - 4b. Integration tests with external software (ArduPilot Mission Planner)
- **5.** Final verification & validation of updated APP



Early concept: Simple collision avoidance

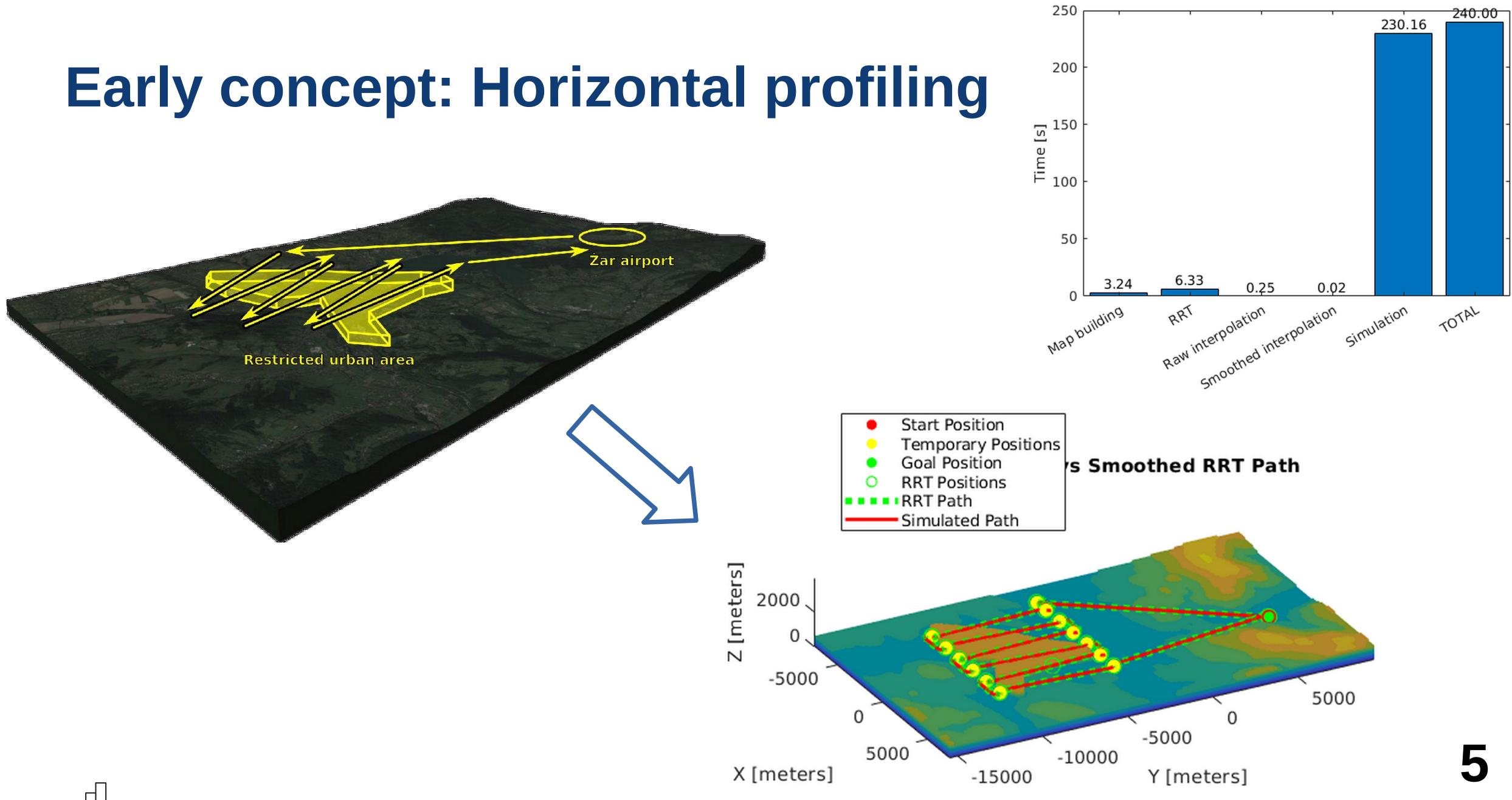
Simulated Path vs Smoothed RRT Path



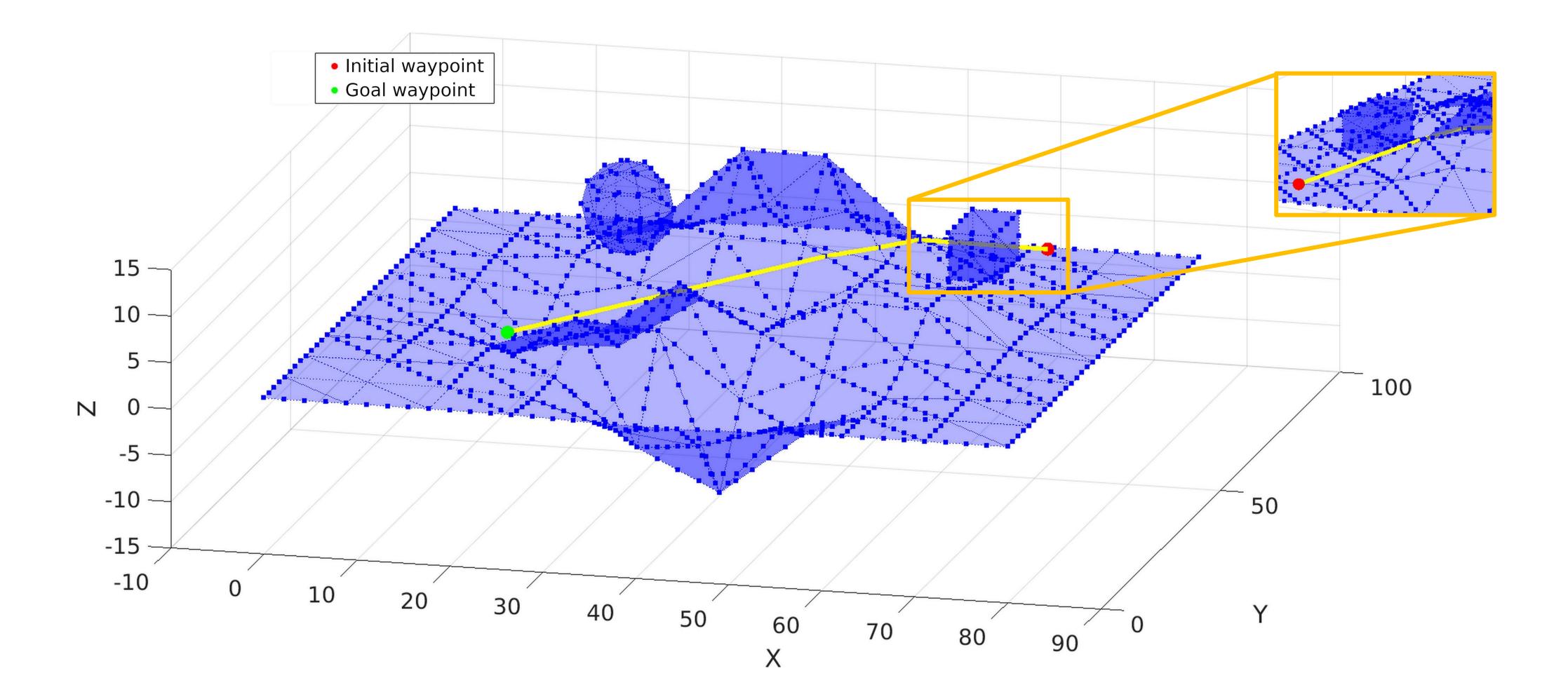
		Computation Time [s]	Path Length [m]	Path Nodes	Smoothness
1	Raw RRT	9.3731	5.7901e+04	33	3.3882e-06
2	Smoothed RRT	9.3510	5.3493e+04	10	2.5550e-07
3	Simulated	162.1081	5.3493e+04	'N/A'	'N/A'



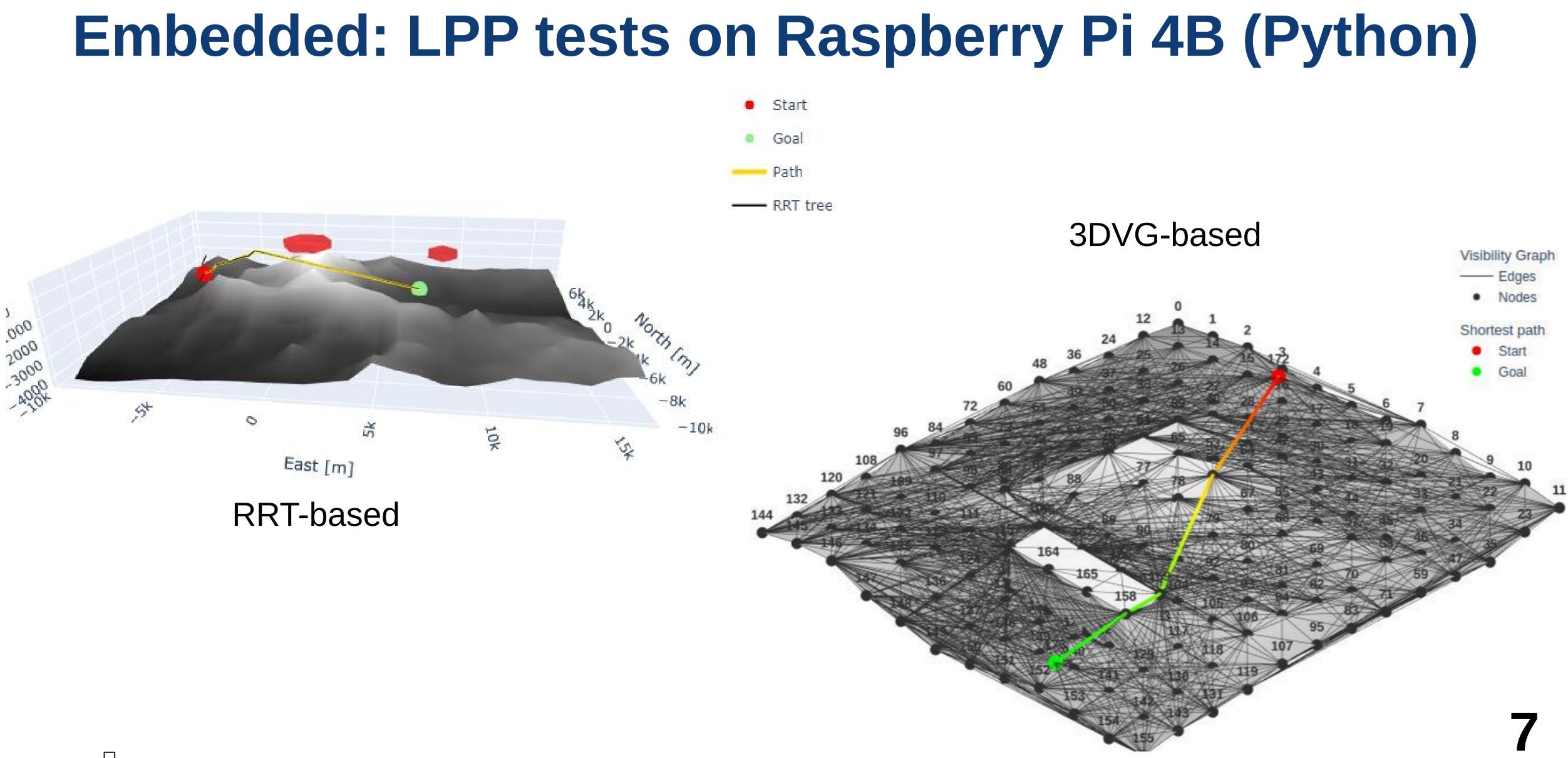




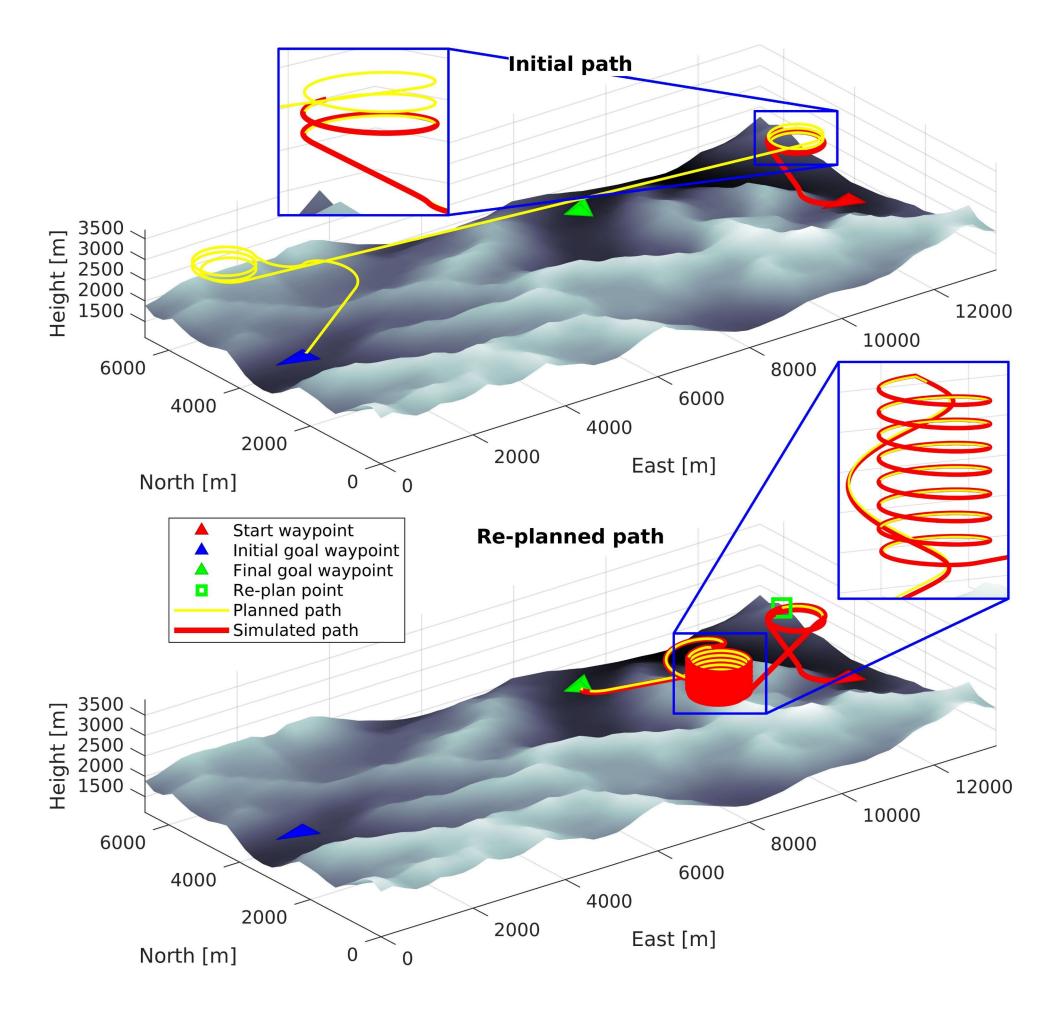
Alternative: 3D Visibility Graph LPP in MATLAB

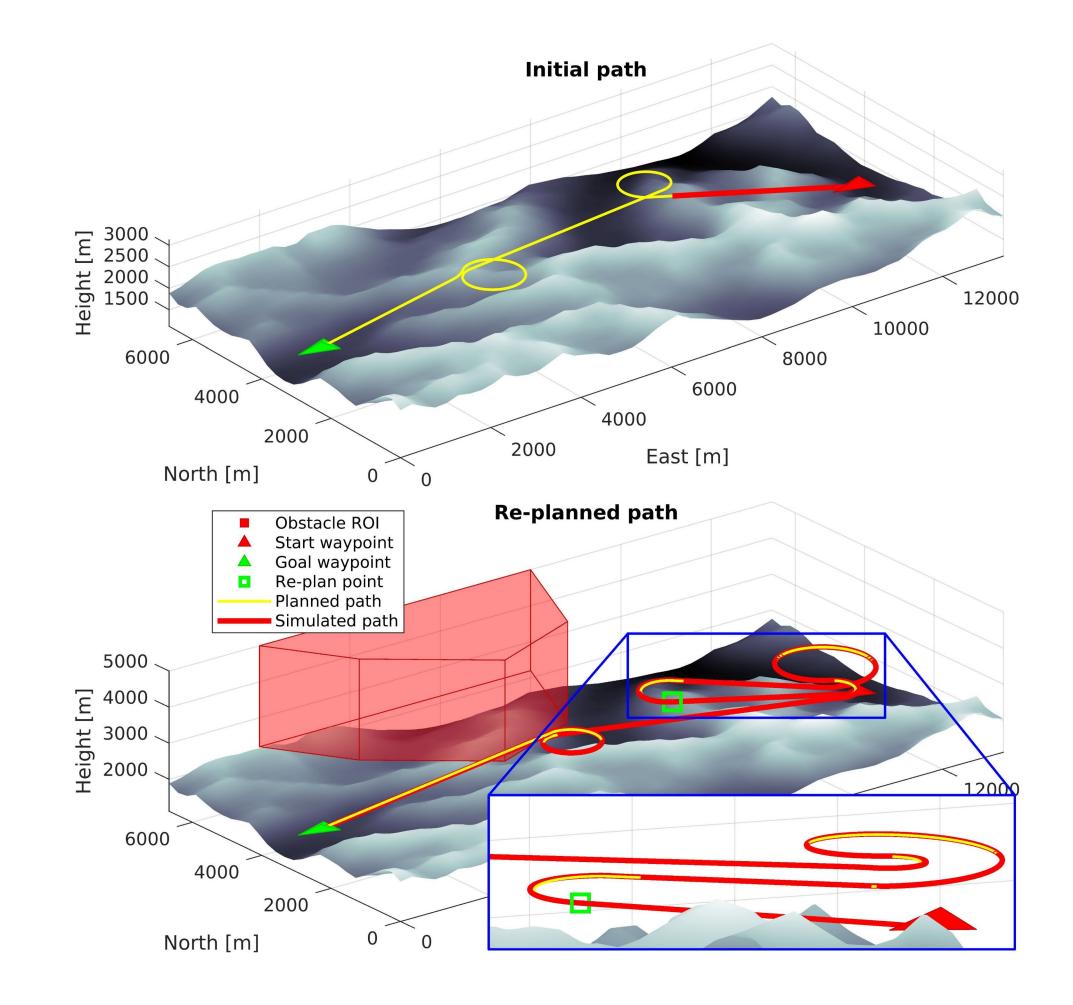






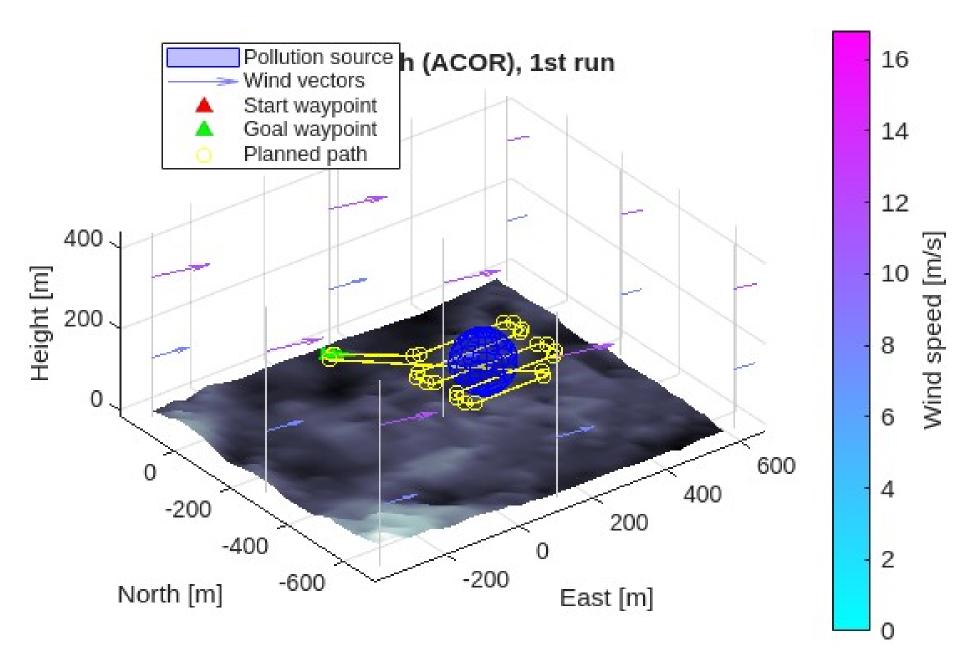
Final: Dynamic local re-planning

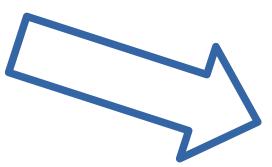






Final: APP integration with TS110





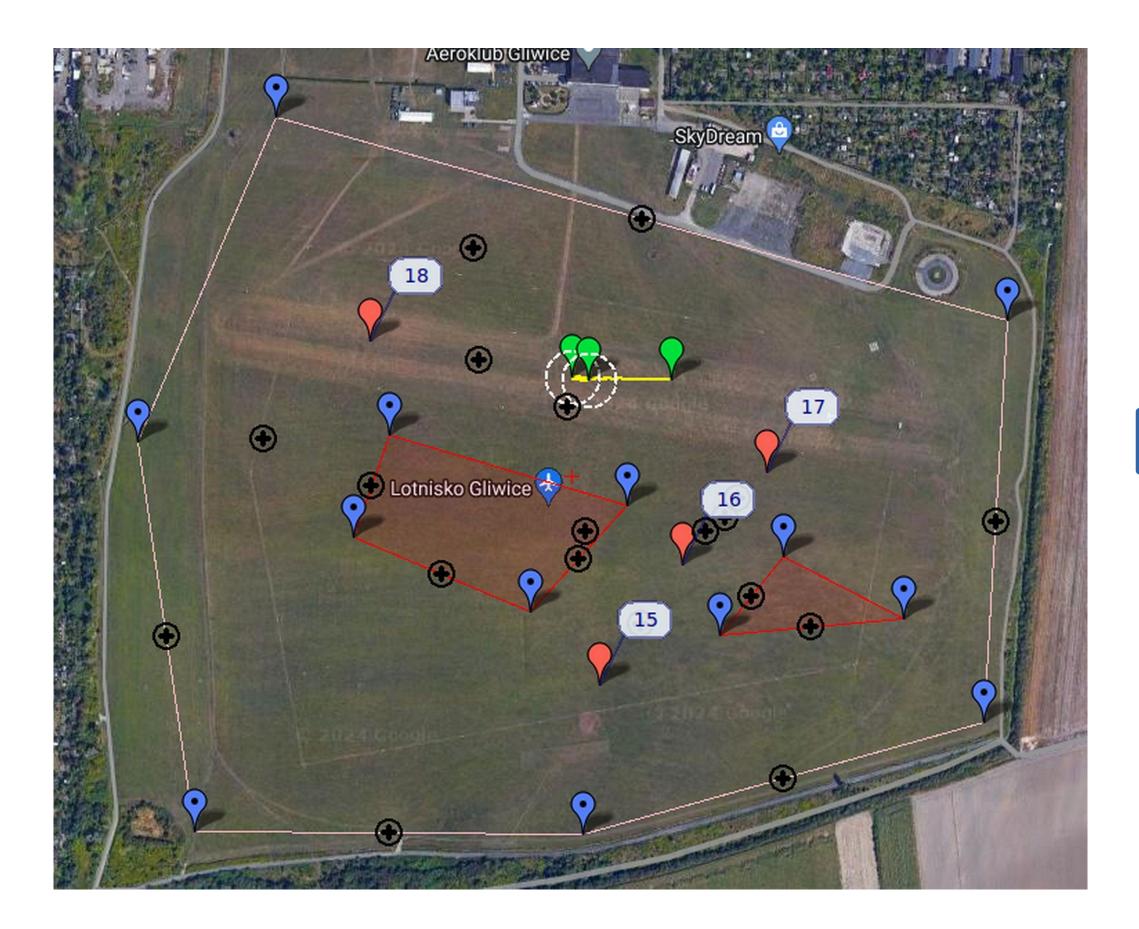


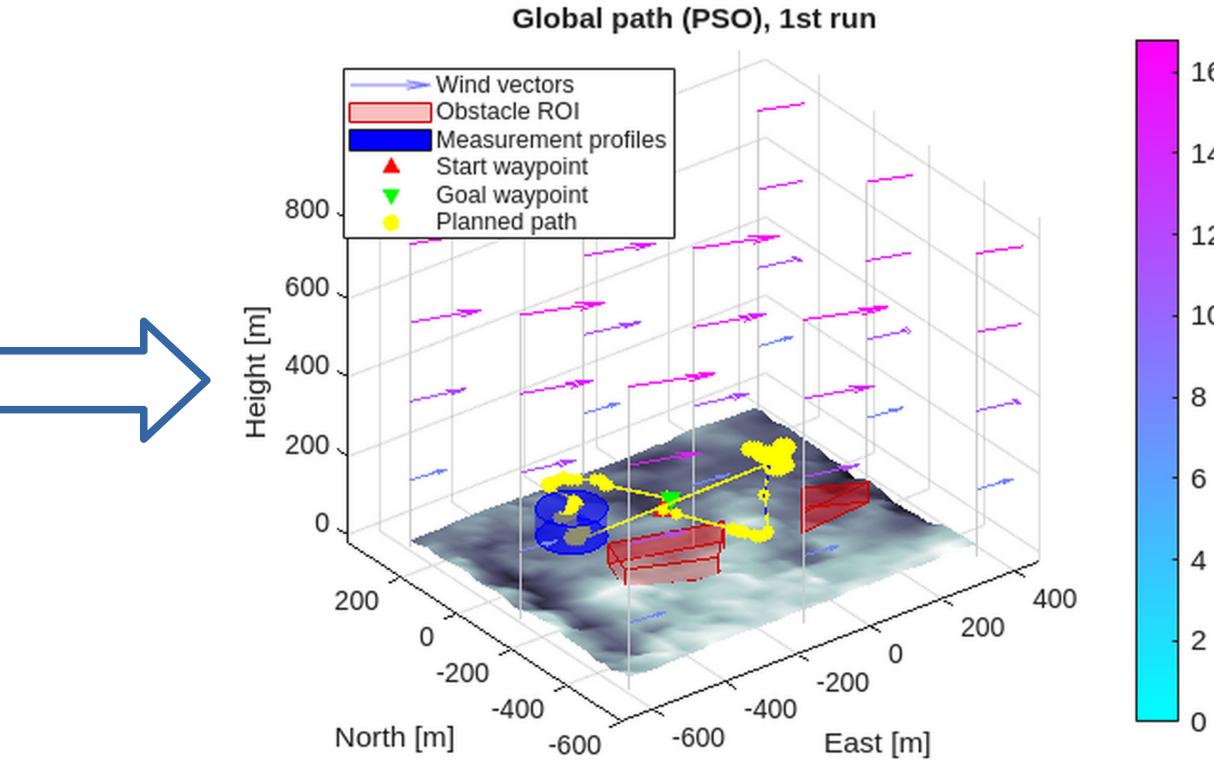


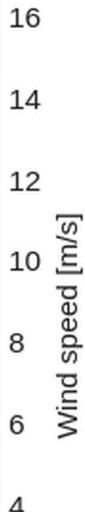




Final: APP integrated with Mission Planner









Summary & conclusions

- APP was successfully integrated with ArduPilot Mission Planner and validated on a real UAV
- Elevation map is more efficient than 3D occupancy map
- Visibility Graphs present an interesting option, but in their current 3D implementation are computationally intensive
- Stochastic RRT algorithms are fast, but in limited time provide non-repeatable solutions
- ACO_R & PSO were found optimal for global planning (multi-criteria optimization) and RRT* for local planning



Related publications

- Aerial Vehicles. PhD thesis. Silesian University of Technology, Faculty of Mechanical Engineering, 2022.
- Student scientific conference. Silesian University of Technology, 2022, pp. 69-72.
- of the 3rd Polish Conference on Artificial Intelligence. Gdynia Maritime University, 2022, pp. 94-77.

• **Kosior** M.: Model-Based Adaptive Path Planning Algorithm for Unmanned

• Kosior M., Przystałka P., Panfil W.: Wind Forecast Map for Adaptive Path Planning with an Unmanned Aerial Vehicle. Metody komputerowe - 2022.

• **Kosior** M.: A Glimpse into the Adaptive Path Planner for a UAV. Proceedings





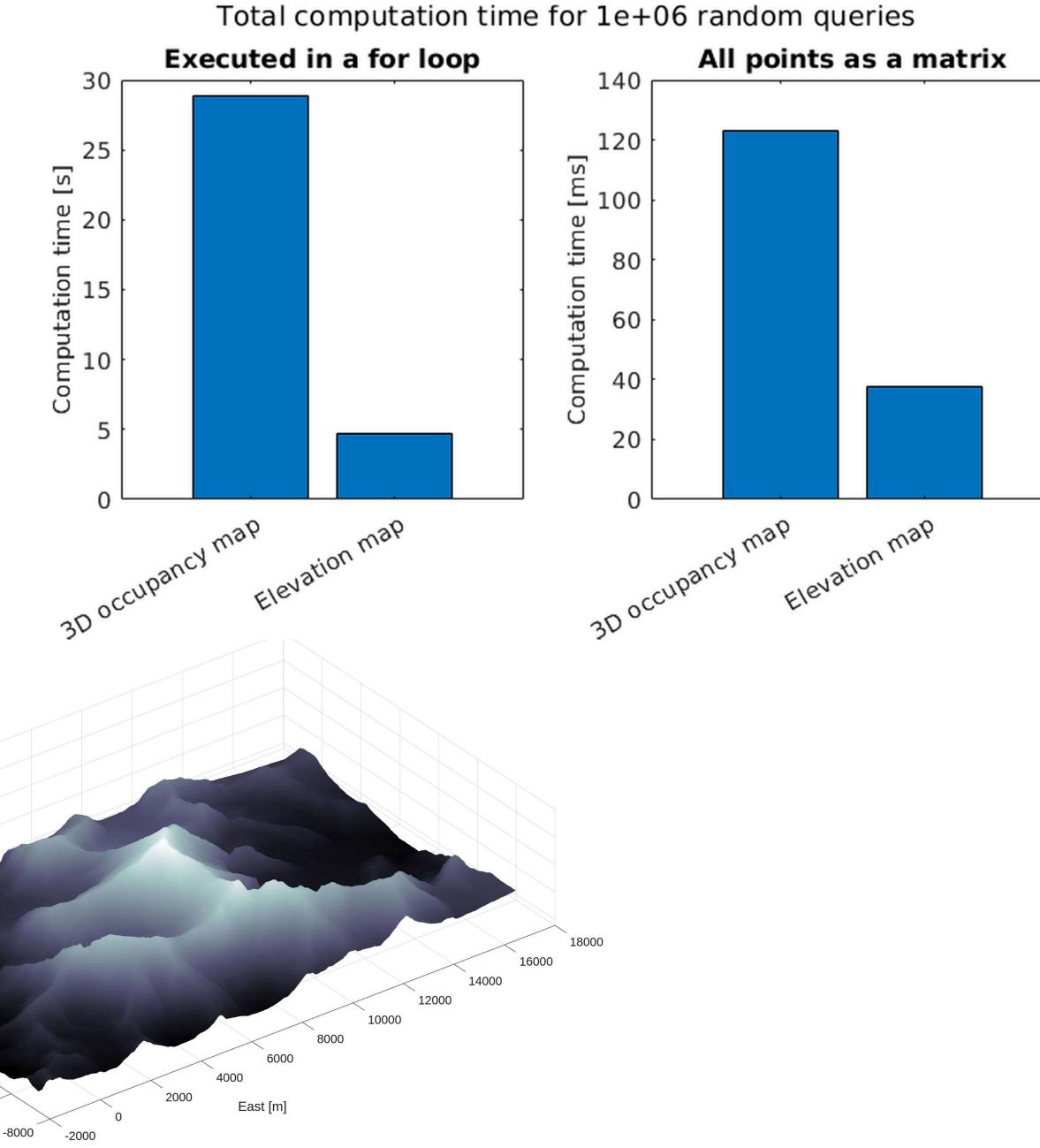
Thank you!

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Environment modeling

Occupancy Map Start Position **Temporary Positions** Goal Position 3000 Z [meters] 2000 1000 0 5000 5000 Y [meters] 0 -5000 ~ -5000 X [meters] 4000 3000 [프 2000] 같 Heig 1000 6000 4000 2000 0 -2000 -4000 -6000 North [m]







Early concept: Dynamic local re-planning

