Projeto de Formatura – 2025

PCS - Departamento de Engenharia de Computação e Sistemas Digitais

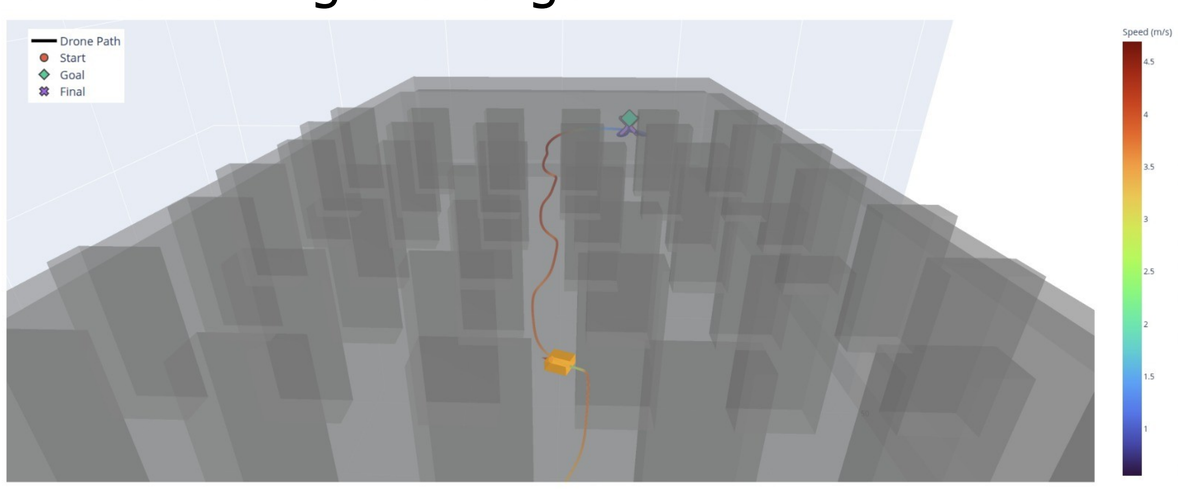
Engenharia de Computação

Tema:

VFF-Nav: Autonomous Drone Navigation using Virtual Force Fields

Context and Motivation

Drones are increasingly vital for tasks like inspection and surveillance, requiring robust autonomous navigation. A key method, Virtual Force Fields (VFF), provides efficient obstacle avoidance but is highly sensitive to its parameter settings, limiting its reliability. This project introduces an autonomous VFF calibration system designed to tackle this critical tuning challenge..



Goal

To develop, genetically and heuristically optimize, and validate a robust Virtual Force Field (VFF) navigation system for autonomous drones in a realistic simulation environment.

Method

The project was done in four stages : a literature review on autonomous navigation ; implementation of the VFF algorithm ; development and execution of an heuristic parameter optimization; and implementation in the simulation for validation.

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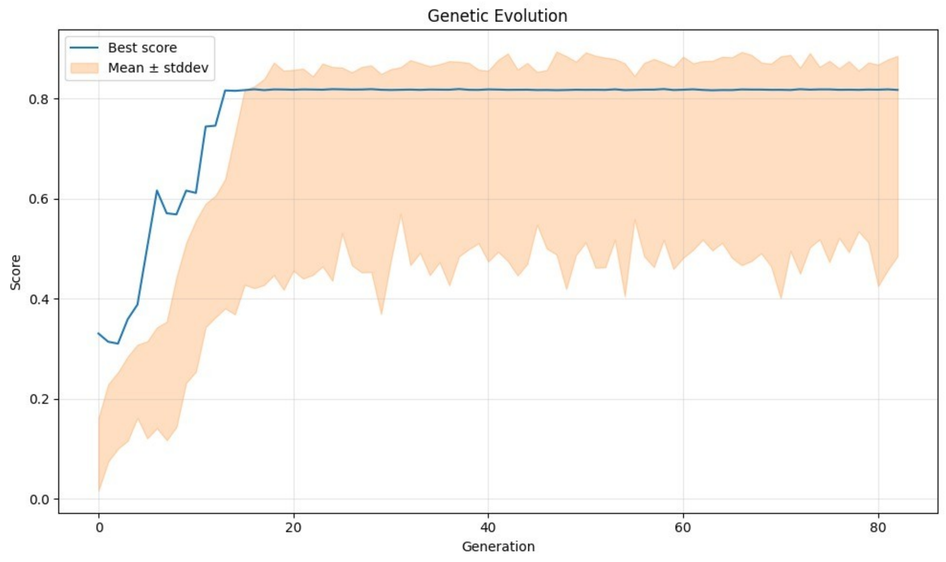

Architecture

This project is composed of three main parts: the **ROS 2/Gazebo Simulator**, which provides the virtual environment and the dynamic model of the PX4 drone for the virtual testbed and validation; the **Parameter Optimization Module**, which explores the VFF parameter space to identify the optimal configuration using a genetic algorithm; and the **VFF-Nav Controller**, which implements the force field algorithm for reactive navigation and obstacle avoidance and is used in the ROS 2/Gazebo Simulation..

Conclusion

The project successfully resulted in a fully functional, optimized VFF navigation system. Simulation tests confirm the drone can reliably navigate complex environments, validating both our VFF implementation and the effectiveness of the heuristic-based parameter search.