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Drone Swarm Simulation

Report

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1. Introduction

1.1 Objective

SwarmLab is a sophisticated drone swarm simulator developed in Matlab. Its primary objectives are to:

Provide realistic simulations for both single drones and drone swarms.

Facilitate rapid development and testing of algorithms related to drone operations.

Support educational purposes and training in the field of drone and swarm robotics.

Automate the collection of simulated data for further analysis.

1.2 Scope

SwarmLab is designed for versatility and scalability, allowing users to simulate various scenarios involving individual drones or complex swarms. The software caters to both academic research and practical applications by offering a range of tools and features that streamline simulation and analysis processes.

2. System Architecture

2.1 Requirements

Software: Matlab installation

Toolbox: Statistics and Machine Learning Toolbox

2.2 Simulation Architecture

SwarmLab's architecture is based on well-established theoretical frameworks and practical models, including:

Single-Drone Simulations: Built on the architecture proposed by Professors Beard and McLain.

Drone-Swarm Simulations: Utilize the Olfati-Saber and Vicsek (Vásárhelyi's version) algorithms.

3. Single-Drone Simulations

3.1 Overview

Single-drone simulations in SwarmLab focus on providing realistic models for individual drones. The system supports:

Quadcopters

Fixed-Wing Drones

3.2 Graphics Tools

3D Drone Viewer: Provides a three-dimensional visualization of the drone.

State Variable Plotter: Plots the drone's state variables for detailed analysis.

3.3 Examples Provided

Controller: Demonstrates drone control mechanisms.

Path Follower: Shows how drones follow a predetermined path.

Path Manager: Manages and adjusts drone paths during simulations.

Path Planner: Plans and generates optimal paths for drones.

3.4 GUI

A graphical user interface (GUI) is available to simplify the execution of single-drone simulations. Features include:

Selection of drone type

Choice of simulation type

Debugging plot options

Simulation time adjustments

4. Drone-Swarm Simulations

4.1 Overview

Drone-swarm simulations in SwarmLab are designed to analyze the behavior of multiple drones interacting within a group. The system supports:

Quads: Drones with realistic dynamics.

Point-Mass: Simplified models focusing on collective behavior rather than individual dynamics.

4.2 Algorithms Supported

Olfati-Saber Algorithm: Used for swarm coordination and control.

Vicsek Algorithm (Vásárhelyi's Version): Focuses on swarm dynamics and behavior.

4.3 Graphics Tools

Run-Time 3D Swarm Viewer: Real-time visualization of the swarm's dynamics.

Run-Time State Variable Plotter: Plots the state variables during the simulation.

Offline 3D Swarm Viewer with Wakes: Provides detailed post-simulation visualization including wake effects.

Offline State Variable Plotter: Analyzes state variables after simulation.

Offline Performance Analyzer: Assesses various performance metrics of the swarm.

4.4 Examples Provided

Olfati-Saber's Swarming Algorithm: Demonstrates swarm behavior using this algorithm.

Vásárhelyi's Version Swarming Algorithm: Showcases swarm dynamics based on this version.

4.5 GUI

The GUI for drone-swarm simulations includes options to:

Select drone types and swarming algorithms

Adjust simulation time and map plotting

Configure parameters such as the number of agents, preferred distances, orientations, and speeds

Make run-time adjustments to parameters like swarm direction

Conclusion

SwarmLab provides a comprehensive and flexible platform for simulating both individual drones and complex drone swarms. With its advanced graphical tools, user-friendly GUIs, and robust simulation capabilities, SwarmLab is well-suited for algorithm development, educational purposes, and automated data collection in the domain of drone and swarm robotics.