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Cooperative Control and Collision Avoidance in Multi-UAV Swarms

ABSTRACT

Multi-UAV coordinated formation control has overwhelming superiority in high efficiency in performing tasks, low cost of fuel, strong robustness and more flexible. We analyze and solve the 3D formation control paradigm of lidar equipped leader-follower based Multi-UAV swarms with varying time delay and communication loss in Microsoft AirSim using Model Predictive Controller. We model a double integrator system in 3DOF which is capable of real-time motion planning based on potential fields avoidance method.

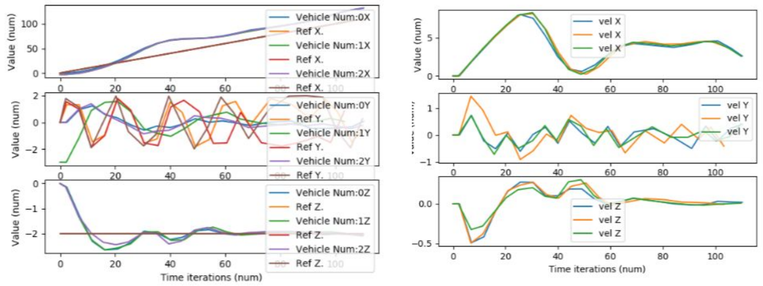
OBJECTIVE

Given a reference trajectory and a subset decided as leaders, we attempt to provide a perception aware UAV Swarm which minimizes the formation loss and maximises the connectivity using optimal inputs. We attempt to provide a robust model to guide the followers using local cooperation maintaining pattern and avoiding obstacles with minimal control effort. A delay matrix is used to render the effects of symmetric, asymmetric and self delays, and sufficient noise is added to the simulation to make it more reliant.

We benchmark our result by measuring the RMS losses of position and velocity and the algebraic connectivity with different environments. We also evaluate our model on time varying network topology by using symmetric, asymmetric delays, and randomly switching off edges.

METHOD

1. Our model takes as input the set of leaders and the initial desired trajectory, the communication happens via shared pool.
2. The leader(s) scans, and generates the potential fields as per the total attractive and repulsive force. A reference spline is thus generated is passed to the followers on top of the communication topology.
3. Based on the connectivity graph, each node interact only with the neighbors.
4. The MPC onboard computes the optimal control inputs has it’s objective based on the splines received with appropriate control constraints.



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