A PROJECT ON FLIGHT FORMATION OF DRONES

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Consider a group of drones or robots that moves on a plane. The trajectories of each robot can be described by Newton's Second Law of Motion. We can assume that the plane is frictionless. The robots can communicate with each other. A control protocol is a way of determine the communication network (digraph) among the robots, and robots can make changes in their velocity according to the control protocol, without external influence.

The paper [1] is an example of designing effective and economical control protocols so that a group of robots achieves a certain type of flight formation.

The objective of the project is to learn and experiment different protocols for the following flight formations:

- A group of drones move along a line and maintain distances with their neighbors (no collisions). Can you allow small variations in their positions and they still follow the same general direction?
- A group of robots move along a closed loop, and maintain distances with their neighbors.
- If you manage to achieve the previous steps, you may consider the following:
  - is the loop necessarily a circle? Can it be a figure 8? What are the differences in the communication topology of these configurations?
  - if your configuration is a circle, how is the center of the circle determined? how is the radius determined? and what factors can influence the center and the radius? in what ways?
- Can you design a protocol so that the movements of the drones mimic a swarm of birds in 2D or 3D (this can be a project on its own)?

You are expected to set up systems of differential equations for the movements of the robots, with your control protocols, and simulate the solutions and visualize the movement of the robots.

Reference

1. John Maidens and Michael Y. Li, Global Lyapunov functions and a hierarchical control scheme for networks of robotic agents, American Control Conference (ACC), 4050-4055, 2013.