Homework 3
AOE 5984 Cyber-Physical Systems and Distributed Control
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The HW is due on March 2nd in class.

1 Assignment

Consider the double integrator dynamics (Netwton's motion) in the plane as,

$$\begin{aligned}\dot{x}_i &= v_i\\ \dot{v}_i &= u_i,\ i = 0, 1, \cdots, N\end{aligned}$$

where $x_i, v_i, u_i \in \mathbb{R}^2$ and 0 the leader agent.

The formation control is defined as,

$$\begin{aligned}u_i = cK_p\big(\sum_{j\in N_i} a_{ij}(x_j - \Delta_j - x_i + \Delta_i) + g_i(x_0 - x_i + \Delta_i)\big) +\\ + cK_d\big(\sum_{j\in N_i} a_{ij}(v_j - v_i) + g_i(v_0 - v_i)\big)\end{aligned}$$

with coupling gain $c > 0$, Δ_i the constant desired position offset in the formation of node i from the leader node 0 and g_i is non zero only for the agents connected to the leader. Take a graph of your liking (that contains a spanning tree) with more than 5 agents and a leader node connected to a subset of the agents. Select γ large enough and the gains $K_p = I_2, K_d = \gamma I_2$. Pick the desired position offsets as vectors of size 2, and specify the desired x and y position of each node. Pick the leader in a nice way ($u_0 = \begin{bmatrix}0\\0\end{bmatrix}$, $x_0 = \begin{bmatrix}0\\0\end{bmatrix}$ and $v_0 = \begin{bmatrix}1\\1\end{bmatrix}$) and select random initial positions and

velocities. Simulate the plot positions in a 2D plane and make them reach formation by picking different Δ_i. A suggestion is to make the formation be different polygons.