CS455/655. Spring 2023

Project 2. MSN Flocking Formation Control and Obstacle Avoidance

Project Deadline: 03/28/2023. Submit your project and codes (with instruction to install packages and run your code) into Canvas.

Project parameters:

Number of sensor nodes: n =150

Space dimensions: m = 2

Desired distance among sensor node: d = 15

Scaling factor: k = 1.2 and interaction range $r = k*d$

Epsilon = 0.1 and *Delta_t = 0.009* (These two parameters are optional and you can change them)

Implement Algorithm 3 (MSN Quasi-Lattice Formation) with obstacle avoidance:

Case 1 (60 points). Randomly generate a connected network of **150** nodes in the area of 70x70. In this case you plan a target (gamma agent) at the location of (250, 25). The obstacles are circular shape. Obstacle 1 with radius of 15 and its center location is (100,25). Obstacle 2 with radius of 25 and its center location is (150,30). Obstacle 3 with radius of 30 and its center location is (200,25). Then implement the Algorithm 3 to show the flocking behavior of the MSN.

1. Plot the initial deployment of the MSN of 100 nodes. Link neighboring nodes together by a line (prefer: blue line). Plot the obstacle (circular shape) on this figure also. (UG: 10 points, G: 9 points)

2. Plot/show the 6 snapshots of the MSN to show how it is flocking and avoiding obstacles. (UG: 10 points, G: 9 points)

3. Plot the trajectory of the all sensor nodes in the *xy* coordinate. (UG: 10 points, G: 9 points)

4. Plot the velocity of the all sensor nodes in the *xy* coordinate. (UG: 10 points, G: 9 points)

5. Plot the Center of Mass (COM) of the MSN and plot the trajectory of the target on the same figure to show how the MSN follows the moving target. (UG: 10 points, G: 9 points)

6. Check and plot the connectivity of the MSN (UG: 10 points, G: 9 points)

7. Plot output of the Energy Function as Equation (7) (**Graduate Student only: 6 points**)

$$E(q) = \frac{1}{(|\mathcal{E}(q)|+1)} \sum_{i=1}^{n} \sum_{j \in N_i} \psi(\|q_j - q_i\| - d) \qquad (7)$$

Case 2 (40 points). Randomly generate a connected network of **150** nodes in the area of 70x70. In this case you plan a target (gamma agent) to move in sine wave trajectory with its starting location of (40, 25) and ending at location of (250, 25). The obstacles are circular shape. Obstacle 1 with radius of 15 and its center location is (100,25). Obstacle 2 with radius of 25 and its center location is (150,30). Obstacle 3 with radius of 30 and its center location is (200,25). Then implement the Algorithm 3 to show the flocking behavior of the MSN.

1. Plot the initial deployment of the MSN of 100 nodes. Link neighboring nodes together by a line (prefer: blue line). Plot the obstacle (circular shape) on this figure also. (UG: 8 points, G: 7 points)

2. Plot/show the 6 snapshots of the MSN to show how it is flocking and avoiding obstacles. (UG: 10 points, G: 7 points)

3. Plot the trajectory of the all sensor nodes in the *xy* coordinate. (UG: 8 points, G: 7 points)

4. Plot the velocity of the all sensor nodes in the *xy* coordinate. (UG: 8 points, G: 7 points)

5. Plot the Center of Mass (COM) of the MSN and plot the trajectory of the target on the same figure to show how the MSN follows the moving target. (UG: 8 points, G: 7 points)

6. Check and plot the connectivity of the MSN (UG: 8 points, G: 7 points)

7. Plot output of the Energy Function as Equation (7) (**Graduate Student only: 8 points**)

$$E(q) = \frac{1}{(|\mathcal{E}(q)|+1)} \sum_{i=1}^{n} \sum_{j \in N_i} \psi(\|q_j - q_i\| - d) \qquad (7)$$

Sample Result of MSN formation control and obstacle avoidance.