SC627 - Assignment 4

Veejay Karthik J - 203230010

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1 Multi Agent Co-ordination

1.1 The Simulation Setup

- There are totally 8 robots placed in a horizontal line with the 1st and the 8th robot fixed in their positions.
- The initial positions of the other robots between the fixed robots are picked randomly at the beginning.
- Each robot can communicate only with the neighbouring robots to the left and the right.
- The control objective is to generate control commands so that the moving robots co-ordinate among themselves to achieve an equidistant configuration.

1.2 Control Strategy

Considering the initial orientations of the agents are parallel to the horizontal line ($\theta = \frac{\pi}{2}$), the mobile robotic agents are controlled using linear velocity (v) and angular velocity ($\omega = 0$).

$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} v\cos(\theta) \\ v\sin(\theta) \\ \omega \end{bmatrix} \implies \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} v \\ 0 \\ 0 \end{bmatrix}$$

Based on the given communication constraints, the adjacency matrix of the system is as follows,

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Furthermore, the out-degree matrix of the system based on the given configuration is as follows,

$$D_{out} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Now, the control input $\vec{v}$ is computed as follows,

$$\vec{v} = -Lx \quad ; \quad L = D_{out} - A \quad : \quad x = \begin{bmatrix} 0 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ 0 \end{bmatrix}$$

On using the above control inputs, the overall system kinematics becomes as follows,

$$\dot{x} = -Lx$$

1.3 Simulation Results

The trajectories of each of the agents are plotted as follows,

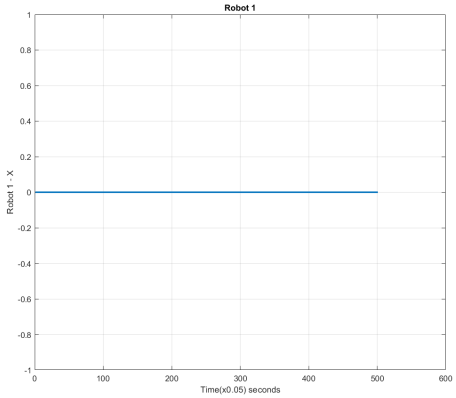

Figure 1: Robot 1 Trajectory

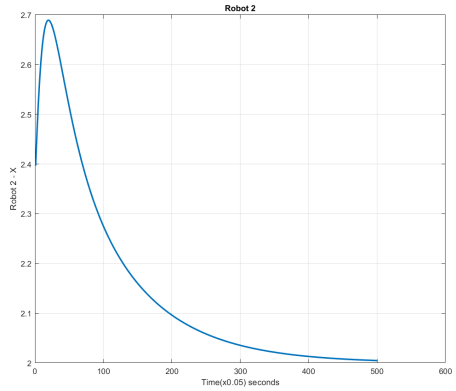

Figure 2: Robot 2 Trajectory

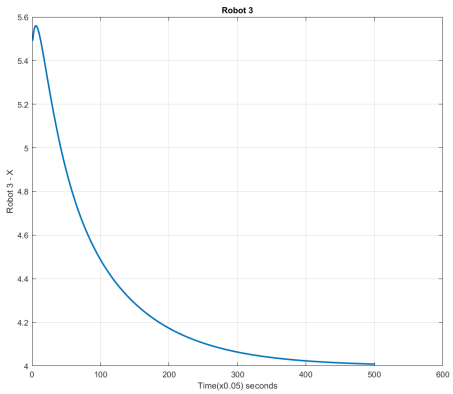

Figure 3: Robot 3 Trajectory

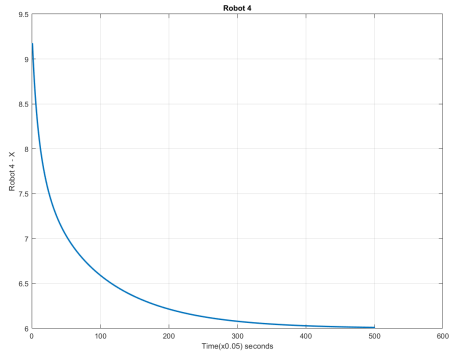

Figure 4: Robot 4 Trajectory

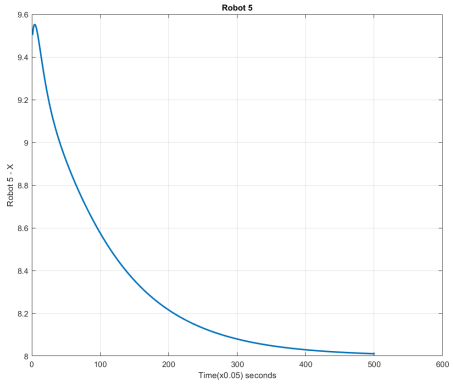

Figure 5: Robot 5 Trajectory

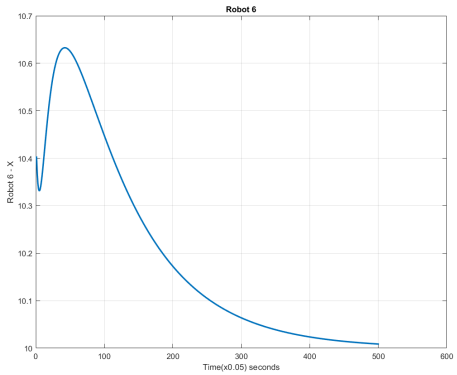

Figure 6: Robot 6 Trajectory

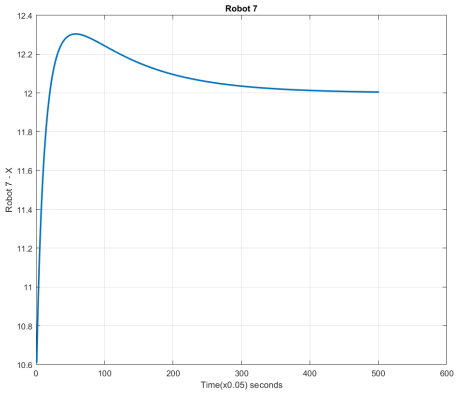

Figure 7: Robot 7 Trajectory

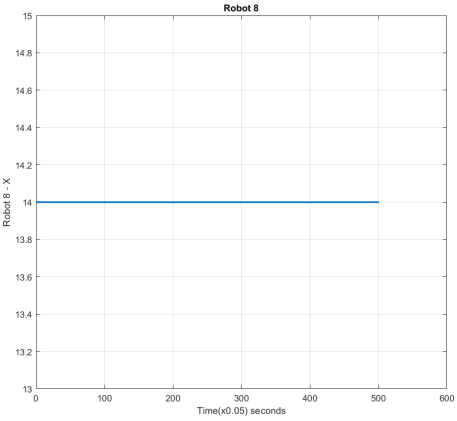

Figure 8: Robot 8 Trajectory