ROB-GY 6333
Swarm Robotics

Homework 3

To make it easy for the TA to grade, please submit your homework as two attachments:

1 . Main document file in *.pdf format that contains all your answers, including any plots where requested

2 . Code used to generate your results as either a Jupyter notebook or MATLAB live script.

Note: My personal recommendation is that you write your entire homework as a stand-alone Jupyter notebook/MATLAB live script and then simply export it all as a single pdf. However, some of you may opt for a boutique, scrapbook approach of stitching together handwritten notes, screenshots, etc. As long as it is legible, it is fine.

As usual, you are encouraged to use Python, as assumed by the instructions below, but there is no penalty for using MATLAB. All code should be written such that it can be run by the TA directly with minimal effort. Include comments explaining how the functions work and how the code should be run if necessary.

Exercise 1

Exercise 1 is given in the Jupyter notebook called *Exercise1.ipynb*.

Exercise 2

Consider the framework depicted in Figure 1.

- Compute the rigidity matrix. What is the dimension of its kernel? What is the dimension of its range space?
- How many directions of motions are there that do preserve the distance constraints of the framework?
- Prove that the vectors of infinitesimal motions in the x direction and y direction and rotations around a point p^* form a basis for the kernel of the rigidity matrix. (Use the unit vector $\dot{q}_x = [1,0,1,0,1,0,1,0]^T$ for infinitesimal motions of all the agents in the x direction. For a rotation around a point p^* use the following infinitesimal rotation for one agent $\dot{\mathbf{p}} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} (\mathbf{p} - \mathbf{p}^*)$).

Exercise 3

Exercise 3 is given in the Jupyter notebook called *Exercise3.ipynb*.

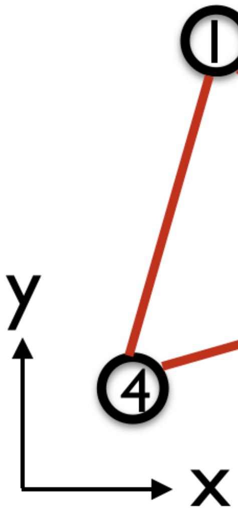

Figure 1: Framework with distance constraints $d_{12} = 1,\ d_{23} = 1,\ d_{13} = \sqrt{2},\ d_{14} = 1.5,\ d_{34} = 1.5$