Midterm Exam

Legged Robotics

Prof. Agheli

Problem#1 (Calibration) – 100 points

Using parameters given in Table 1 and 2 in the calibration paper (Paper 3), write a MATLAB code to calibrate the hexapod Stewart platform in the paper.

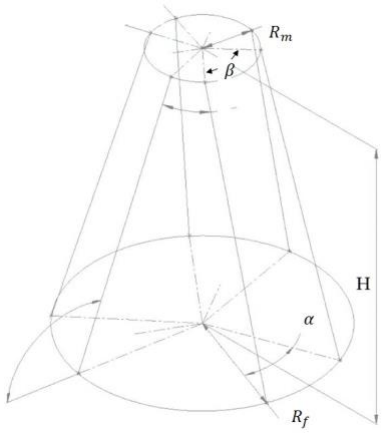
This is all simulation, so you need to follow the steps mentioned in the lectures and provided in the paper. First, you need to develop IK, FK, and Jacobian codes and make sure that they work correctly. You can get help from the codes developed in class. I have also attached my own codes so you can start with them. It is your responsibility to check and make sure that the parameters/values in the codes match those in the paper (Table 1 for example) and to make any necessary adjustments. Use XYZ Euler sequence.

For selecting configurations, it does not matter how many configurations you choose, but it should not be less than 10 and your configurations should be chosen very close to the boundary of the workspace. This is because of the error observability consideration. When you choose your configurations close to the workspace boundary, you will get better calibration results. Also, try to choose your configurations to be distributed among the whole workspace boundary. In other words, do not choose your configurations very close to one another. Depict the calibration results in a graph similar to what you see in the paper (Figure 9). Use Least Square method to minimize the cost function. You can use the available functions in MATLAB (such as 'lsqnonlin') and to minimize the cost function and find the identified real values. For simplification purpose, assume that the error of measurement device, called 'measurement error', is zero/negligible when measuring the position/orientation (configuration) as well as when applying leg lengths variation to the robot.

Hint 1: If you follow the methodology I covered in the midterm exam review session, you should be able to do the exam with no issues. The only tricky part might be how to correctly write your Real FK code.

Hint 2: You can find l_{min} from the paper (last column of Table 1). Consider $l_{max} = 1100\ mm$.

Hint 3: You may find the following figure helpful to help understand my codes.



Good Luck!