Lab 1b: Rock 'em Sock 'em Robots

CS6310/5310 ME6220/5220

In this lab, you will generate two different trajectories of the Baxter robot arm that resemble a punch. This lab is divided into two sections; the first section is to generate the trajectories in the joint space of the robot. The second section is where you will then run the trajectory on the robot.

Section 1: Generate Trajectories

This section is to be completed before you come to the lab. You will calculate multidimensional trajectories for two different punches, an uppercut and a jab. Both punches have three points. You will generate a 7-dimensional spline within the joint space between these three points. At any points where two polynomials meet, they have the same position, velocity, and acceleration. The initial and final velocities are zero.

Here are the points of interest for the uppercut punch:

> Starting position: [-2.75771,0.879738,-0.203636,0.867466,-0.5184,-0.02646,3.04725]
> Mid position: [-3.0323,1.3127,-0.859796,0.333257,0.234699,1.03275,3.04725]
> End position: [-2.75771,0.879738,-0.203636,0.867466,-0.518486,-0.0264612,3.04725]

Here are the points of interest for the jab:

> Starting position: [-1.94854,2.14566,0.233549,1.01856,0.552617,0.595568,3.04687]
> Mid position: [-2.45552,0.576393,-0.466714,0.132306,2.71285,0.137291,2.94601]
> End position: [-1.94854,2.14566,0.233549,1.01856,0.552617,0.595568,3.04687]

You should have 14 spline functions by the end of this section that describe two multidimensional trajectories through the arm's joint space.

You will need to bring your numerical solution that explains the degree of your polynomials. Explain your reasoning for choosing your polynomials. Also, bring plots that show your splines to compare with the actual motion of the joints of the Baxter robot. Predict what kind of behavior you should expect from the robot.

After calculating your trajectories, you will now generate a text file for each punch that describes the point in the joint space that the robot will follow. The first line of the file should contain the time step you used to generate the points. The rest of the file should have rows of 7 columns.

Example:

```
1
1.6451, -0.0924, -1.8227, 2.3776, -1.0707, -0.09817, 1.0032
0.06174, -0.03950, -1.6720, 0.8038, -1.3337, -0.1326, 1.7418
0.8383, 0.03758, -1.6977, 1.7111, -1.3265, -0.1319, 1.5681
```

Hint: use the 'dlmwrite' function in MATLAB to make your file.

You will bring these files to the lab (on a flash drive) where you will run them on the baxter robot using the following commands. You should also bring the MATLAB script so you can generate new trajectories with different **final** and **mid-point** times as well as different **time step** sizes so you can tune these values for the speed of the robot joints (use large enough time steps because the joints move slowly).

Section 2: Run trajectories on Baxter robot

To run the baxter, navigate to:

$cd catkin_ws

and run the following command:

$./baxter.sh

This sets up ROS to work with the Baxter and is a more streamlined setup than in the first lab. You will need to do this in two terminal windows or tabs. In a new tab, after initializing the Baxter environment, navigate to the directory containing your text file and run:

$rosrun baxter_cs5310 trajectory_player -f <your file name>

Observe the motion of the Baxter robot relative to your expected trajectory and plots. Bring your MATLAB script that generates the text file so that you can tune the time step to work with the Baxter.

Submission:

Submit a report (one per group) as a 'pdf' document using gradescope containing the following:

1. Numerical solution for the two trajectories (written up like a homework problem).
2. Plots for jab and uppercut trajectories (Joint angles vs Time). Use Matlab's subplot.
3. The code you used to generate the trajectories,
4. The trajectory points generated from your code.
5. A sheet listing group member names.