Assignment 5

Neuroscience 9520
Computational Models in Neuroscience
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Due Nov 4 2012 11:59pm EST

Submit your assignment as a single `.pdf` file sent by email to `paul@gribblelab.org` with the subject line `compneuro assignment 5`. Please name the pdf file with your last name and the assignment number, for example `gribble5.pdf`.

Two Joint Arm Dynamics

For these questions, make use of the code found in:

`http://www.gribblelab.org/compneuro/code/twojointarm.py`

1. **Joint Torque space trajectories**. Compute torques using inverse dynamics for the 8 hand movements you constructed for Question 4 in Assignment 4. Plot trajectories in shoulder/elbow joint torque space and in hand space.

2. **"Single-joint" elbow movement**. Design an arm movement that involves zero motion at the shoulder joint and a min-jerk change in elbow joint angle. Starting angles should be (45,110) degrees (shoulder,elbow) and ending angles should be (45, 70) degrees. Movement speed should be 500 milliseconds. Compute joint torques using inverse dynamics and plot shoulder and elbow joint torques over time. Comment on the relationship between time-varying joint torques and joint motion.

3. **"Single-joint" shoulder movement**. Do the same thing but this time design a movement that involves shoulder joint rotation but no elbow joint rotation. Starting angles should be (30,90) degrees (shoulder,elbow) and ending angles should be (60,90)

degrees. Again, compute joint torques using inverse dynamics, plot them over time and comment on the relationship between time-varying joint torques and joint angular motion at the shoulder and elbow.

4. Compute joint torques for an arm movement starting from H(Hx,Hy) = (-0.2,0.4) metres and ending at (-0.2,0.6) metres. Movement duration should be 500 milliseconds. Run a forward simulation and plot the hand trajectory over time.

5. **How does noise in initial hand location manifest in endpoint errors, assuming no recomputation of joint torques?** Repeat the simulation in Question 4 using the *same joint torques*, but run the forward simulation 25 times, each time starting the hand from a slightly different initial location. Each location should be chosen based on adding gaussian noise to the initial location (-0.2,0.4). Noise should be mean zero with a variance of 1 mm. Do not recompute joint torques — use the same joint torques computed for the non-noisy starting location, for all of the noisy starting locations. Plot resulting trajectories. On a separate figure, plot the endpoints of each trajectory. Comment on the relationship between the distribution of initial positions and final endpoints.

6. **What if we use the same joint torques for a range of movements along the X axis?** Repeat the simulation in Question 4 but this time instead of adding gaussian noise to the (-0.2,0.4) starting location, simply start the simulation from a range of X initial positions (same Y position). X positions should range from -10 cm to +10 cm relative to the (-0.2,0.4) starting position. Including the (-0.2,0.4) starting position you should run 11 simulations. Measure the endpoint error in X and in Y for each movement, relative to the desired movement, which is zero in X and +20cm in Y.