Assignment 4

Neuroscience 9520
Computational Models in Neuroscience
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Due Oct 28 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 4`. Please name the pdf file with your last name and the assignment number, for example `gribble4.pdf`.

Kinematic Model of a Two-Joint Arm

For all questions assume the location of the shoulder joint is at the origin $(0, 0)$, and that $l_1 = 0.34$ metres and $l_2 = 0.46$ metres.

1. How do patterns of noise in joint space manifest in hand space? Sample 3 x 3 = 9 locations equally spaced in shoulder/elbow joint space ((30,60,90) x (30,60,90) deg), and for each location, inject gaussian random noise into the shoulder and elbow joints. Noise should come from a gaussian distribution with $(\mu = 0, \sigma^2 = 3)$ deg. Do this 20 times for each of the 9 locations and plot the resulting cloud of positions in joint space, and in hand space. Describe the results. **Hint**: you can use the NumPy `randn()` function to generate random numbers drawn from a normal distribution with mean zero and variance 1. So to draw from a distribution with mean 0 and variance v, you would use `randn()*sqrt(v)`.

2. Write a function to compute the inverse kinematics of the two-joint arm. That is, given a hand position (H_x, H_y) compute the corresponding joint angles (a_1, a_2). Show that it is correct.

3. Repeat the simulations in Question 1 but now inject gaussian noise at the hand, and explore how this hand-level noise manifests at the joint level. Noise should come from a

gaussian distribution with ($\mu = 0, \sigma^2 = 2$) cm. Use the 9 hand positions corresponding to joint angles of ((30,60,90) x (30,60,90) deg).

4. Use the `minjerk.py` function on the website to construct 8 simulated hand movements, starting from a common central start location, $(H_x, H_y) = (-0.20, 0.55)$ metres, and moving out to 8 targets equally spaced around the circumference of a circle. Target 1 should be at zero degrees (East), target 2 at 45 degrees (North-East), target 3 at 90 degrees (North), etc. Movement distance should be 10 cm and movement time should be 500 milliseconds. Use 20 points for the `n` parameter in `minjerk()`. For each of your 8 movements you will thus have $H_x(t)$ and $H_y(t)$ with 20 time values each. For each of the 8 movements, compute the corresponding shoulder/elbow joint angles over time. Plot hand-space trajectories and corresponding joint-space trajectories.

5. Repeat Question 4 but this time, construct 8 min-jerk trajectories in joint space. Start from a central location, $(a_1, a_2) = (45, 90)$ deg, moving out to 8 targets equally spaced around a circle in joint space. Movement distance should be 10 degrees, and movement time 500 milliseconds. Again use $n = 20$ points per trajectory. For each of the 8 movements, compute the corresponding trajectory in hand-space. Plot joint-space trajectories and hand-space trajectories.