Sharif University of Technology
Department of Electrical Engineering

Assignment for Robot Control 2

Spring 2009
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Problem 1: Consider a 2-DOF manipulator with symmetric links of 0.5 meter. Motor masses are considered as 1kg. given in the previous assignments. Assume that the robot base is located at $x = (0, 0)$ and its end-effector is constrained on a hyperbolic curve $x_2 = 0.75 + x_1^2$.

a) Design and simulate a force-motion controller such that the end-effector moves sinusoidally between $(-0.3, 0.84)$m and $(0.3, 0.84)$m with a frequency of 1rad/s. and the normal force exerted from end-effector to the environment is regulated at 1N.

b) Use force feedforward and force feedback and compare them.

Problem 2: Consider kinematic model of a four-wheeled rover described by a driftless differential equation given in Example 2 of the attached paper. Control inputs u_1, u_2 are the velocity of the rear wheels and angular velocity of the steering wheels, respectively.

Configuration of the rover is described by $q = (x, y, \theta, \phi)$ where x, y specify location of the rear wheels axis center. θ represents the orientation of the rover with respect to the horizontal axis and ϕ denotes the steering angle.

Due to geometric restrictions we assume that $\phi \in [-80, 80]$degs.

Use the transformation given in Example 9 and change kinematic equations into the chained form. Assume $l = 2$m.

a. Apply the sinusoidal steering method to bring the system from the initial configuration $q(0) = (-2, 2, \frac{\pi}{6}, 0)$ to $q = (0, 0, 0, 0)$ within $T = 4\pi$ secs. Try other sinusoids to reduce the time. Plot $x, y, \theta, \phi, u_1, u_2$ as a function of time. Plot y as a function of x.

b. Repeat part a. using the back-stepping method.

c. Compare two methods in terms of convergence rate, number of jumps in control signals, trajectories of the rear axis center, ...