Department of Mechanical Engineering
Cleveland State University

MCE/EEC 647/747: Robot Dynamics and Control
Homework 6- Spring 2015

Due April 23rd (email only)

In this homework you will be setting up simulations of two trajectory tracking controllers for the first 3 links of the PUMA robot. The coordinate frames, parameter definitions and sign conventions are the same. The regressor and parameter vectors are provided, leaving it to you to find the control regressor (Y_{av}) and preparing the simulations. A Simulink template with a blank controller is also provided.

Supplied Code

1. Simulink file: `RPBC560_647.mdl` Use this as a template to insert the controllers and tune them as indicated below.
2. Plant state derivatives: `statederPUMA3.m` Contains parameterized versions of the inertia, Coriolis and gravity matrices. Note that the control voltage is multiplied by the effective amplifier+motor+gear constants in K_u. The controller block must invert these gains so cancellation occurs. These constants are included so the actual control voltages can be calculated. The parameter values included in this file were randomly-generated in the setup file and copied.
3. Setup file: `setupRPBC.m`: Defines nominal parameters (for use by the controller) and creates a perturbed version (for use in the state derivative file). Theta parameters are defined in this file in terms of physical constants. The file also defines a set of sinewaves to be tracked and sets the initial conditions for simulation.

Control Regressor

Use the supplied information and the methods described in class to find $Y_{av}(q, \dot{q}, v, a)$ and to verify that it is correct. Caution: Avoid a duplicate variable name (a_2 could be a length or it could be the second component of virtual acceleration).

Robust Passivity-Based Controller

Use the setup file to generate a 20% perturbation and find the bound ρ. Set up and tune the controller to obtain good tracking with as little control chattering as possible. All control voltages must be between -10 and 10V.

Doctoral students only: Add an rms error calculation to the Simulink file. Report on the rms error of each joint, the maximum control amplitudes and the amount of chattering. For this, you can find a Fast Fourier Transform (FFT) of the control signal in a suitable frequency range and integrate (add) to find the total spectral energy in each control signal. Or you can just make a qualitative assessment.

Adaptive Passivity-Based Controller

Make a copy of the RPBC control system and modify it to include an adaptation law. Use the setup file to generate a 20% perturbation and use this in the plant. Use the nominal parameter vector as initial condition in the adaptation law integrator. Tune the adaptation gain (Γ^{-1}) to obtain satisfactory performance.

Doctoral students report on the rms error and the maximum control amplitudes.