ELEC442
Assgt #3
Due Nov 17, 2017 (11:59pm)

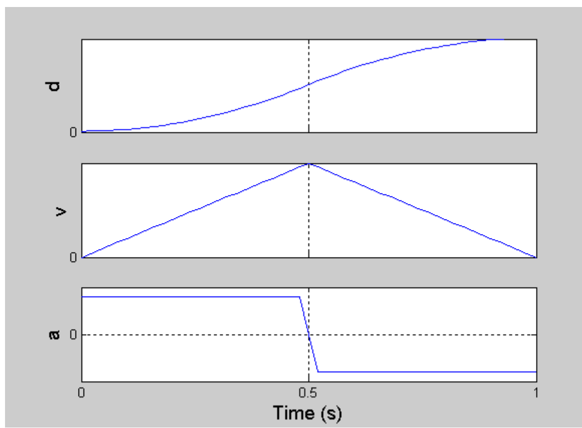
- You may submit your work in groups of up to 3 individuals.

1. Given an initial frame $\underline{C}_i$, a final frame $\underline{C}_f$ and a relationship $\underline{C}_f = \underline{\underline{R}}\,\underline{C}_i$ (i.e., $\underline{\underline{R}}$ is the rotation that takes $\underline{C}_i$ to $\underline{C}_f$. If $R = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$ is the representation of $\underline{\underline{R}} = e^{\theta \underline{s}\times}$ in the base frame ($\underline{C}_o$), compute the representation $\boldsymbol{s}$ of $\underline{s}$ in the base frame and the value of θ in terms of the elements of R. Avoid using $\cos^{-1}(\cdot)$ and $\sin^{-1}(\cdot)$ and consider how to handle the special case of $\sin(\theta)=0$.

2. **Trajectory Generation:**

Consider the Puma 560 already analyzed in assgts #1 & #2 (use the D-H table from assgt #2 but ignore the joint limits for this assignment). Suppose that the initial joint variables are **q**=[0º, 0º, 90º, 0º, 90º, 0º]^T (so that it is not near a singularity). Determine the resulting initial end-effector pose using the solution to assgt #1.

Write a Matlab script prompting the user for the desired final end-effector pose (with $\underline{\mathbf{k}}_d$ and $\underline{\mathbf{j}}_d$ being sufficient for the orientation). You wish to drive the end-effector in a straight line to this pose in a duration of 1 second. The desired displacement, velocity and acceleration profiles are (roughly) as shown on the right and similarly for the angular trajectory profiles (for this, you should use the result from Q1 above). Record the user input that resulted in the greatest linear motion traveled for your code.



For this assignment, you may assume that singularities are avoided and the solution always exists so no error checking is required. (In practice, these conditions would obviously need to be checked.)

Assume that the update rate is at 50 Hz (i.e., 20 ms intervals). Use equations (25) and (26) in Section 3.3.2 of the notes to compute the joint displacements, velocities, and accelerations at each time step **without** solving the inverse kinematics problem directly; plot these on 3 separate graphs.

Animate the motion in 3-D showing each linkage with joints indicated by a "*". At each joint, plot the $\underline{\mathbf{j}}$ and $\underline{\mathbf{k}}$ vectors for the associated frame.