Intelligent Control – Interactive Session on Dynamic Movement Primatives

April 4, 2018

Problem 1:

In this interactive session you are going to experiment with changing the parameters to change the behavior of a dynamic movement primatives system. To help you I have attached the following files:

- "dmpderivative.m": This function computes the derivatives $\dot{y}$ and $\dot{z}$ of the transformation system given the parameters and current value of y and z.
- "dmpbasis.m": This function computes the value of the nonlinear forcing function given the parameters of the basis functions and the current value of the phase variable x.
- "dmpPhasePortrait.m": This function plots the phase portrait of the transformation system given the parameters and the value of the forcing function.

(a) Integrate the DMP equations. Use Euler integration (like you did to make your original pendulum simulation) to solve the transfomation and canonical equations. Your Euler steps will look like this:

$$\begin{aligned}\dot{y}_{i+1} =& \dot{y}_i + \ddot{y}\Delta t \\ y_{i+1} =& y_i + \dot{y}_i\Delta t \\ x_{i+1} =& x_i + \dot{x}\Delta t\end{aligned}$$

where you can find $\ddot{y}$ and $\dot{x}$ by rearranging the transformation and canonical systems. "dmpderivative.m" will help you to compute derivatives, and "dmpbasis.m" will help you to compute the nonlinear forcing function. Start by using $\tau = 1$, $\alpha_z = 4$, $\beta_z = 1$, $\alpha_x = 1$, $g = 1$, and $y_0 = -5$. Make 11 basis functions with centers distributed evenly from 0 to 1 and with $\sigma_i = 0.1$ for each basis function and the weight $w_i = 1$ for each basis function. Make your simulatio run for 10 seconds. Do the following:

1. Plot the position, velocity, phase variable, and forcing term as functions of time.
2. Plot the phase portrait once every second to observe how it changes. Use "dmpPhasePortrait.m" to do this.
3. Compute the fixed point of the transformation system. The fixed point is at $z = 0$ and $y = g + \frac{f}{\alpha_z\beta_z}$.

(b) Experiment. Try these things and make the same plots as in part (a) for each one.

1. Change τ.
2. Change $g - y_0$.
3. Use random weights for the basis functions. Make the weights bigger and bigger random numbers and see what happens. You would generally find these weights from demonstration data.