NPTEL Course

Robotics and Control: Theory and Practice

Assignment 4

1. Consider dynamic equation given by:
   $m\ddot{x} = f$, where m denotes mass, x denotes displacement and f denotes force.
   If m=1 unit, $x_d(t) = const.$ is the desired trajectory, and error
   $e = x - x_d, if\ we\ \ apply\ P.D.control\ f = Ke + L\dot{e}$
   Then resulting trajectory is asymptotically stable when:
   a. $L > 0\ and\ L^2 + 4K < 0$
   b. $L < 0\ and\ L^2 + 4K < 0$
   c. $L > 0\ and\ L^2 + 4K > 0$
   d. $L < 0\ and\ L^2 + 4K > 0$
2. Dynamic equation on one arm manipulator with mass M, torque τ joint angle θ and length L is given by:
   $$\frac{1}{3}ML^2\ddot{\theta} + \frac{Mg}{2}L\sin\theta = \tau$$
   If θ_d denotes desired trajectory, and the error is given by:
   $$e = \theta - \theta_d$$
   If we apply P.D control:
   $$\tau(t) = \frac{Mg}{2}L\sin(e + \theta_d) - \frac{1}{3}ML^2[-Ke - L\dot{e}]$$
   Then resulting trajectory is asymptotically stable when:
   a. $L^2 - 4K > 0$
   b. $L^2 - 4K \leq 0$
   c. $L^2 - 4K < 0$
   d. $L^2 - 4K \geq 0$
3. If a biped robot is walking in x-direction and z-direction is vertical then:
   a. x-z is frontal plane
   b. x-z is sagittal plane
   c. x-z is transverse plane
   d. x-y is sagittal plane
4. In case of a person running fast:
   a. There is no single support Phase.
   b. There are both single support Phase and double support phase.
   c. There is only double support Phase.
   d. There is no double support Phase.
5. Zero Moment Point for a stable walk should lie:
   a. Between hips in single support phase.
   b. Below stable leg in single support phase.
   c. Below swing leg in single support phase.

d. Anywhere outside support region in single support phase.

6. Which of the following is not a sigmoid function?
   a. $\frac{1}{1+e^{-x}}$
   b. e^{-x}
   c. $\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$
   d. $\frac{x}{\sqrt{1+x^{2}}}$
7. For a neural network with n input, m output with l neurons in hidden layer; equation for output y in terms of input x with weights $u_{ij}\ and\ v_{jk}$ for input to hidden layer and hidden to output layer respectively can be given by:
   a. $y_k = \sum_{j=1}^{l} v_{jk}\,\sigma\left[\sum_{i=1}^{n} u_{ij}x_i\right]$
   b. $y_k = \sum_{j=1}^{l-1} v_{jk}\,\sigma\left[\sum_{i=1}^{n-1} u_{ij}x_i\right]$
   c. $y_k = \sum_{j=1}^{n} v_{jk}\,\sigma\left[\sum_{i=1}^{l} u_{ij}x_i\right]$
   d. $y_k = \sum_{j=1}^{n-1} v_{jk}\,\sigma\left[\sum_{i=1}^{l-1} u_{ij}x_i\right]$
8. Consider a neural network as in (7) with one input, two hidden neurons and one output. If the input x=1, output y=5 , logistic function as the transfer function with learning rate α=0.1, weights $\begin{pmatrix} v_{11} \\ v_{21} \\ u_{11} \\ u_{12} \end{pmatrix}$ after first iteration using gradient descent will be (consider null weights initially):
   a. $\begin{pmatrix} 1 \\ 1 \\ 0 \\ 0 \end{pmatrix}$
   b. $\begin{pmatrix} 0.5 \\ 0.5 \\ 0 \\ 0 \end{pmatrix}$
   c. $\begin{pmatrix} -1 \\ -1 \\ 0 \\ 0 \end{pmatrix}$
   d. $\begin{pmatrix} -0.5 \\ -0.5 \\ 0 \\ 0 \end{pmatrix}$
9. Which of the following hold true for a n arm manipulator whose dynamic equation is:
$$M(q)\ddot{q} + V(q,\dot{q})\dot{q} + G(q) + Fr(\dot{q}) + T_d = \tau$$
with symbols have their respective meanings?
   a. $\left(\frac{1}{2}\dot{M}(q) - V(q,\dot{q})\right) is$ skew symmetric.
   b. $\left(\frac{1}{2}M(q) - V(q,\dot{q})\right) is$ skew symmetric.

c. $\left(\frac{1}{2}M(q) + V(q,\dot{q})\right) is$ skew symmetric.

d. $\left(\frac{1}{2}\dot{M}(q) + V(q,\dot{q})\right) is$ skew symmetric.

10. Pseudo inverse of matrix $[1 \quad 2]$ is given by:

a. $\begin{bmatrix}1\\2\end{bmatrix}$

b. $\begin{bmatrix}2\\1\end{bmatrix}$

c. $5\begin{bmatrix}1\\2\end{bmatrix}$

d. $\frac{1}{5}\begin{bmatrix}1\\2\end{bmatrix}$