First Semester M.Tech. Degree Examination, February 2013
Robotics for Industrial Automation

Time: 3 hrs.   Max. Marks: 100

Note: *1. Answer any FIVE full questions.*
2. Missing data, if any, may be suitable assumed.

1   a.   Define a robot and explain four basic robotic configurations with symbolic sketches.
                                                                     (10 Marks)

  b.   Give the detailed classification of robots.   **(05 Marks)**

  c.   Explain the following robot performance characteristics :
      i)   Spatial resolution
      ii)   Accuracy.   **(05 Marks)**

2   a.   With a neat sketch, derive the composite matrix for rotation about an arbitrary axis.
                                                                      (08 Marks)

  b.   The desired final position and orientation of the hand of a Cartesian – RPY robot is given below. Find the necessary RPY angles and displacements.

$$R_{T_P} = \begin{bmatrix} 0.354 & -0.674 & 0.649 & 4.33 \\ 0.505 & 0.722 & 0.475 & 2.50 \\ -0.788 & 0.160 & 0.595 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

                                                                           (07 Marks)

  c.   Determine the homogenous transformation matrix for the following sequence of motions :
      i)   60° rotation about x – axis
      ii)   4 units translation along a – axis
      iii)   –6 units translation along a – axis
      iv)   30° rotation about 0 – axis.   **(05 Marks)**

3   a.   In a robotic set-up, a camera is attached to the fifth link of a 6 – DOF robot. It observes an object and determines its frame relative to the camera's frame. Using the following information, determine the necessary motion the end effector must make to get to the object:

$$^5T_{cam} = \begin{bmatrix} 0 & 0 & 1 & -3 \\ 0 & -1 & 0 & 0 \\ -1 & 0 & 0 & 5 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad ^5T_H = \begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{cam}T_{obj} = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \qquad ^H T_E = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

                                                                           (10 Marks)

  b.   Obtain Base$_{[T]_{EE}}$ matrix for a cylindrical arm robot, using D.H representation.   **(10 Marks)**

4 a. What is trajectory planning? Briefly explain third-order trajectory planning.   (10 Marks)
   b. Explain the calculations involved in 4 – 3 – 4 trajectory planning.   (10 Marks)

5 a. In its usual form, discuss the Lagrangian – Euler dynamic modeling of robotic arms.
   (06 Marks)
   b. For a two axis articulated planar robot, derive the equations of motions with distributed masses.   (14 Marks)

6 a. Discuss the various programming methods used in robot teaching with their merits and demerits.   (10 Marks)
   b. Explain with example WAIT, SIGNAL and DELAY commands used in robot programming.
   (10 Marks)

7 a. Discuss briefly the following techniques of image data analysis :
      i) Image data reduction
      ii) Segmentation
      iii) Feature extraction
      iv) Object recognition.   (10 Marks)
   b. Give the classification of sensors used in robotics and explain any one proximity sensor, with a neat sketch.   (10 Marks)

8   Write short notes on :
   a. Bondgraph modeling in robotics
   b. Robot vision system
   c. AI and expert systems in robotics
   d. Future applications of robots.   (20 Marks)

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