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First Semester M.Tech. Degree Examination, January 2011
Robotics for Industrial Automation

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer any FIVE full questions.
2. Missing data may be suitably assumed.

- 1 a. Define robots in various ways and justify any one of the definition as applicable to modern robots. (06 Marks)
- b. Discuss the different classifications of robots. (06 Marks)
- c. Discuss the merits and demerits of four basic robotic structures, with symbolic sketches. (08 Marks)
- 2 a. Briefly discuss the factors that are used for evaluating the performance of robotic systems. (06 Marks)
- b. Explain any five basic controllers along with their transfer functions. (07 Marks)
- c. With a neat sketch, derive the composite matrix for rotation about an arbitrary axis. (07 Marks)
- 3 a. A six joint robotic manipulator is equipped with a digital T.V. camera capable of monitoring the position and orientation of an object. The position and orientation of the object with respect to the camera is expressed by a matrix $[T_1]$, the origin of the robot base coordinate with respect to the camera is given by $[T_2]$ and the position and orientation of the gripper with respect to the base coordinate frame is given by $[T_3]$.

$$[T_1] = \begin{bmatrix} 0 & 1 & 0 & 5 \\ 1 & 0 & 0 & 6 \\ 0 & 0 & -1 & 10 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$[T_2] = \begin{bmatrix} 1 & 0 & 0 & -20 \\ 0 & -1 & 0 & 10 \\ 0 & 0 & -1 & 12 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$[T_3] = \begin{bmatrix} 1 & 0 & 0 & 8 \\ 0 & 1 & 0 & 6 \\ 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine :

- i) The position and orientation of the object with respect to the base coordinate frame.
- ii) The position and orientation of the object with respect to the gripper. (12 Marks)
- b. Discuss with a neat sketch, D.H. representation and method with usual notations. (08 Marks)
- 4 Apply D.H. method with usual notations for the typical following robotic arms assuming usual conventions and configurations and obtain the displacement matrices :
 - i) Cartesian robot
 - ii) Anthropomorphic robot (20 Marks)
- 5 a. Explain inverse kinematics for a 3-axis robotic system with proper illustration. (08 Marks)
- b. Discuss the trajectory planning with respect to a PTP robot considering a modified constant velocity motion of the joint and illustrate by suitable sketches and also obtain switching timings. (12 Marks)
- 6 a. In its usual form, discuss the Lagrange-Euler dynamic modeling of robotic arms. (06 Marks)
- b. For a two axis articulated planar robot, derive the dynamic equations with distributed masses. Use the notations of $l_1, l_2, m_1, m_2, \theta_1, \theta_2, \tau_1$ and τ_2 for link length, mass, displacement and torques respectively. (14 Marks)
- 7 a. Discuss various programming methods used in robot teaching and give clearly the typical applications of each of them. (10 Marks)
- b. With a neat sketch, explain the components and their functions in a robot vision system. (10 Marks)
- 8 Write short notes on : (20 Marks)
 - a. General features of RPL's
 - b. Task planning and AI related problems
 - c. Robotics sensors
 - d. Present and future robotic industrial applications.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg, 42+8 = 50, will be treated as malpractice.

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Srinivas Institute of Technology
Library, Mangalore

10MAR13

First Semester M.Tech. Degree Examination, June/July 2011**Robotics for Industrial Automation**

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions.

- 1
 - a. Explain the types of automation with suitable examples. (10 Marks)
 - b. Define robot and explain the structure of robot with neat sketches. (10 Marks)
- 2
 - a. Explain the devices like potentiometer and resolvers used in robot function. (10 Marks)
 - b. Define external sensor and explain their types with neat sketches. (10 Marks)
- 3
 - a. Explain the basic control system concepts and encoders related to robot. (10 Marks)
 - b. Write the schematic diagram with explanations of a robot joint control design. (10 Marks)
- 4
 - a. Explain the Euler angle table application and system II of Euler angles with neat sketches. (10 Marks)
 - b. Give an expression for kinetic energy of a robot system using joint velocities. (10 Marks)
- 5
 - a. What is trajectory planning? Explain with the example of 3rd degree polynomial. (10 Marks)
 - b. Write an expression for 4-3-4 trajectory planning calculations. (10 Marks)
- 6
 - a. Explain any three teaching methods of robot. (10 Marks)
 - b. A point $p_{abc} = (2, 3, 4)^T$ has to be translated through a distance of +4 units along OX-axis and -2 units along OZ axis. Determine the coordinates of the new point p_{xyz} by homogeneous transformation. (10 Marks)
- 7
 - a. Explain the classification of sensors with clear examples. (10 Marks)
 - b. What are the real requirements of end effectors in robots? (10 Marks)
- 8
 - a. Explain image processing and analysis in vision system. (10 Marks)
 - b. Give any five industrial applications of robot in the manufacturing industry. (10 Marks)

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