Roll No. | | | | | | | | | | | | | Total No. of Pages : 03

Total No. of Questions : 09

B.Tech (Automation & Robotics) (2011 & Onwards) (Sem.-6)

ADVANCED ROBOTICS

Subject Code : BTAR-601

Paper ID : [A2280]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.
3. SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.

SECTION-A

1. Write briefly :

a) What is the significance of Euler angles in robotics analysis?

b) What is degree of freedom of a robotic arm? How does it affect the working of a robot?

c) What is the difference between forward aid inverse kinematics in case of robotics?

d) What is a fundamental rotation transformation matrix? State its unique characteristics.

e) What does the various components of a tool configuration matrix represent?

f) Name the various types of singularities encountered in robotic work space analysis?

g) Explain in short the difference between direct and inverse dynamics?

h) What are the advantages of using independent joint PID control in robotics?

i) What is a teach pendent? Why is it used with industrial robotics?

j) Differentiate between on line and off line programming?

SECTION-B

2. Prove that the inverse of a fundamental rotation transformation matrix is equal to its transpose. Also state what the various component of a fundamental rotation transformation matrix represents.

3. What are the general properties of inverse kinematic solution of a robotic manipulator?

4. Sate how joint coupling can be beneficial in robotic manipulations. Also state the analytical methods which can be used to detect the regions of joint couplings for an industrial robotic arm.

5. Develop the work space analysis for a 4-axis SCARA robot when the two of its horizontal links are of equal length.

6. What do you mean by joint space trajectory planning? State how the joint space trajectory can be established for a required tool space trajectory.

SECTION-C

7. The link-coordinate diagram for the four-axis cylindrical-coordinate robot with tool roll motion is shown in figure 1. Here the vector of joint variables is $q = [\theta_1\ d_2\ d_3\ \theta_4]^T$, and the kinematic parameters are also shown in Table 1. For this robotic arm :

   a) Find the tool-configuration vector $w(q)$ and using it solve the inverse kinematics equations for this robot and thus find base angle $q_1(w)$, vertical extension $q_2(w)$, radial extension $q_3(w)$ and finally the tool roll angle $q_4(w)$ in any suitable order.

   b) Use the rotation matrix $R(q)$ to find the tool roll angle q_4 .

Joint (i)	θ_i	d_i	a_i	α_i	**Home**
1	q_1	d_1	0	0	0
2	$\pi/2$	q_2	0	$\pi/2$	$\bar{d}$
3	0	q_3	0	$\pi/2$	$\bar{r}$
4	q_4	d_4	0	0	π

Table 1 : Kinematic parameters for a four axis cylindrical robotic arm

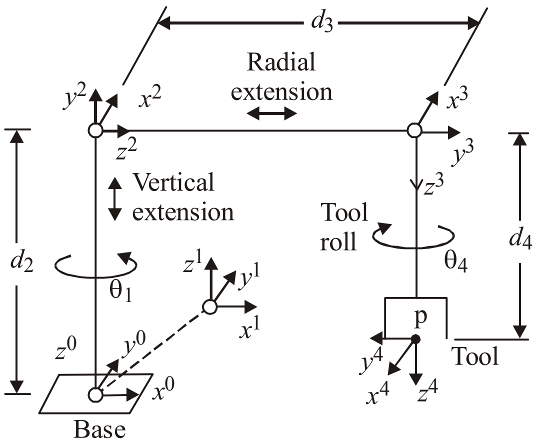

Figure 1: A four axis cylindrical robotic arm

8. Explain the methods of modelling and control of a single joint robotic arm.

9. Derive the generalized formulation for determining the following :

   a) Kinetic energy at a link for Lagrange-Euler model of robotic dynamics.

   b) Recursive equations of motion of a link about its own coordinate frame for a robotic manipulator based on the Newton-Euler formulation.