53 (CS 812) RBTC

2018

ROBOTICS

Paper : CS 812

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **six**.*

1. *(a)* Define anatomy of robot and also draw a diagram of robot manipulator which consist links and joints. 6

   (b) Write down the manipulator joints with their notations and diagrams. Sketch the following manipulator configurations : 8

   (i) LOO

   (ii) TRR

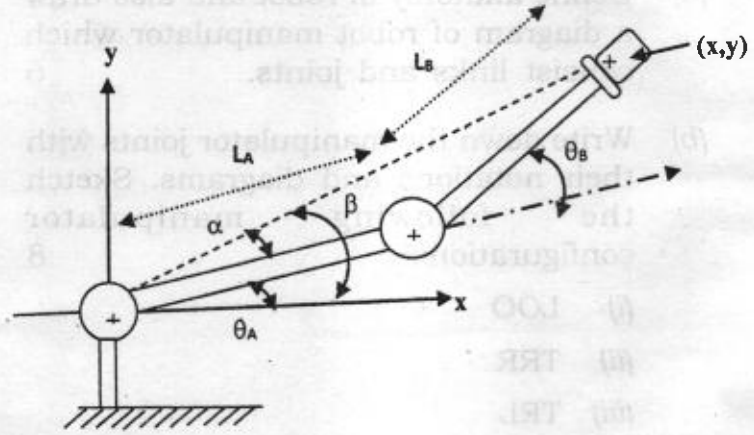
   (iii) TRL

(c) Describe the wrist configurations with a diagram. Mention the types of end-effector. 6

Or

Explain reinforcement learning in hybrid architecture with a diagram. 6

2. (a) Describe 2-DOF robot manipulator (R-R) and also define the position of end arm in the world space (forward) transformation using the links L_A & L_B. Calculate the reverse transformation (θ_A and θ_B) from the *figure* given below : 14



(b) Two points $a_{uvw} = (8,6,4)^T$ and $b_{uvw} = (9,3,5)^T$ are to be translated a distance +6 unit along OX-axis & –5 unit along OZ-axis. Using the appropriate homogeneous transformation matrix, determine the new points a_{xyz} and b_{xyz}.

(Hint : *Forward transformation i.e. co-ordinates x & y)* 6

3. (a) Derive the joint angles using reverse transformation of the 4-DOF arm in three dimensional space. Information related to angles are given below here

At Joint = Type T : (Rotation about the z-axis) ; base rotation, θ

At Joint 2 = Type R : (Rotation about an axis, i.e. perpendicular to z-axis) ; elevation angle, ϕ

At Joint 3 = Type L (Linear) : (Sliding over a certain range) ; Extension L, represents a combination of links 2 and 3.

At Joint 4 = Type R : (Rotation about an axis, i.e. parallel to the joint 2 axis) ; angle makes with x–y plane called pitch angle ψ. 20

4. *(a)* For the vector, $V = 15i + 30j + 35k$, rotate by an angle of 45° about the *x-axis*. Derive the rotation transformation.

(b) Explain the Kinematics Function of link. Describe the method to measure Link Length and Link twist.

(c) Calculate this T matrix for the given parameters values in table '1' using D-H transformation.

6+6+8=20

Joint i	α_i	a_i	D_i	θ_i
1	0	a_0	0	θ_0
2	−60	a_1	0	θ_1
3	0	0	d_1	θ_2
4	45	0	d_2	θ_3

5. *(a)* A robot performs a loading and unloading operation for a machine tool as follows :

(i) A Robot pick up part from conveyor and loads into machine (Time=9·5 sec)

(ii) Machining cycle in automatic manner with time = 42·0 sec

(iii) Robot reclaim part from machine and deposits to outgoing conveyor with time =5·5*sec*

(iv) Finally Robot moves back to pickup position with in time = 1·8*sec*

Every 20 work parts, the cutting tools in the machine are changed which takes 3·5 minutes. The uptime efficiency of the robot is 97% ; and the uptime efficiency of the machine tool is 98% which rarely overlap. Determine the hourly production rate. 10

(b) Write down the five steps for developing the program in robot level language with a diagram. 10

OR

Explain the steps in details for object recognition and describe the challenges in object recognition. 10

6. (a) Write down the short notes on the following : ***(any four)*** 4×2=8

(i) Sensor fashion

(ii) Convolution

(iii) Denavit-Hartenberg (D-H) representation

(iv) Four stages of object representation

(v) ERT.

(b) Differentiate between the following : ***(any three)*** 3×4=12

(i) Grayscale erosion *Vs* Grayscale dilation

(ii) Passive sensor *Vs* Logical sensor

(iii) Revolute joint *Vs* Prismatic joint

(iv) Top surface *Vs.* Umbra.
