53 (IT 813) RBCV

2017

ROBOTICS AND COMPUTER VISION

Paper : IT 813

Full Marks : 100

Time : Three hours

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

Answer ***any five*** *questions.*

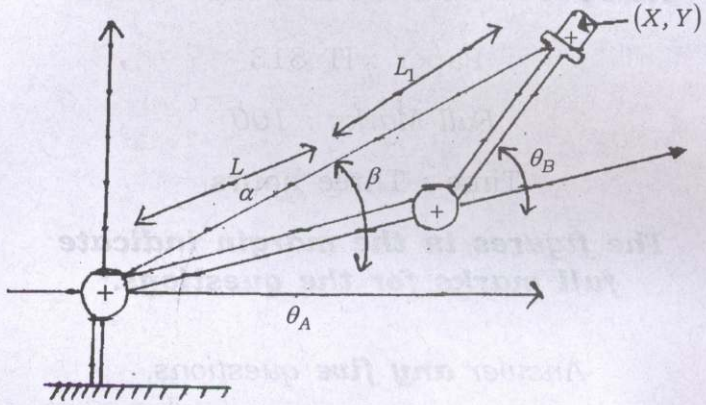
1. *(a)* Define anatomy of robot and draw a diagram of robot manipulator which consist of links and joints. 6

   (b) Write down the manipulator joints with their notations and diagram. Sketch the following manipulator configuration

   (i) LOO *(ii)* TRR *(iii)* TRL 8

   (c) Describe the wrist configuration with a diagram. Mention the coordinate systems with a diagram. 6

2. *(a)* Describe 2-dimensional 2-DOF robot manipulator (R-R) and also define the position of end arm in the world space (Forward Transformation) using the vector of links L and L_1. Calculate the reverse transformation (θ_A and θ_B) from the figure given below 14



(b) Two points $a_{\overline{UVW}}(6, 5, 4)^T$ and $b_{UV\overline{W}(8,4,6)^T}$ are to be translated a distance + 5 unit along *OX* axis and – 3 units along *OZ*-axis. Using the homogenous transformation matrix, determine the new points a_{XYZ} and b_{XYZ}. 6

(Hints : Forward transformation i.e. coordinates X and Y)

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

At joint 1 = Type T : (Rotation about 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 axis ; angle makes with X-Y plane called pitch angle ψ 20

4. *(a)* For the vector, $V = 25i + 20j + 40k$, rotate by an angle of 60° about the X-axis. Derive the rotation transformation. 6

(b) Explain the Kinematics Function of link ? Describe the method of measure link length and link twist ? 6

(c) Calculate this T matrix for the given parameter values in table '1' using D-H transformation 8

Joint i	$\square_i$	a_i	d_i	$\square_i$
1	0	a_0	0	$\square_0$
2	−45	a_1	0	$\square_1$
3	0	0	d_1	$\square_2$
4	45	0	d_2	$\square_3$

5. (a) A robot a loading and unloading operation for a machine tool as follows : 8

(i) A robot pick-up part from conveyor load into machine (Time = 6·5*sec*)

(ii) Machine cycle in automatic manner with time = 32·0*sec.*

(iii) Robot reclaim part from machine and deposits to outgoing conveyor with Time = 4·5*sec.*

(iv) Finally Robot moves back to pick up position with in time = 1·4*sec.*

Every 25 work parts, the cutting tool in the machine are changed which takes 2·5 minutes. The uptime efficiency of the robot is 96% ; and the uptime efficiency of machine tool is 97% which rarely overlap. Determine the hourly production rate.

(b) Write down the five steps for developing the program in robot level language with the diagram. 12

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

(i) INS and GPS applications

(ii) Sensor Fashion

(iii) Kinematics

(iv) Denavit-Hartenberg (D-H) Representation

(v) DOF in a plane and space

(vi) Entropy.

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

(i) Powered Leadthrough *Vs* Manual Leadthrough

(ii) Passive sensor *Vs* Logical sensor

(iii) Humanoid robot and Industrial robot

(iv) Revolute joint and prismatic joint

(v) Joint arm robot and SCARA Robot.
