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V 4250

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

Seventh Semester

Mechatronics Engineering

MH 1401 — ROBOTICS AND MACHINE VISION SYSTEM

(Regulation 2004)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by spatial resolution?

2. Is a harmonic drive a speed reducer or increaser? For what speed ratio it can be used?

3. Rotate the point (3i + 7j + 5k) 30° about x axis.

4. What is meant by Denavit-Hartenberg matrix (D-H matrix)?

5. Give two examples of unilateral grippers with sketches.

6. What are the two types of tactile sensors? Give an example for each type.

7. What is a contrast operator?

8. Detail the equipments used in machine vision system.

9. How color filters will enhance the image?

10. Briefly explain visual servoing?

PART B — (5 × 16 = 80 marks)

11. (a) (i) List the rotary-to-linear motion conversion devices and explain its working with limitations. (8)

(ii) A motor has a torque constant, K_m = 10 oz-in./A and a voltage constant of 12 V/Kr/min (1Kr/min = 1000 r/min). The armature resistance is 2 Ω. If 24 V were applied to the terminals what would be :

(1) the torque at stall (0 r/min),

(2) the speed at 0 load (torque = 0), and

(3) the torque at 1000 r/min? Plot the results on a speed versus torque graph. (8)

Or

(b) (i) What is joint notation scheme? Denote and explain the scheme for all types of robots. (8)

(ii) Name the motor which provides output in the form of discrete angular motion increments. Explain its operation with suitable sketches. (8)

12. (a) A joint arm robot of configuration VVR is to move all the three axes so that the first joint is routed through 50°, the second joint is rotated through 90°, and the third joint is rotated through 25°. Maximum speed of any of these rotational joints is 10°/s. Ignore effects of acceleration and deceleration. Determine the time required

(i) to move each joint if slew motion is used.

(ii) to move the arm to the desired Position and the rotational velocity of each joint, if joint–interpolated motion is used. (16)

Or

(b) Consider the prism shown in Figure 1. The position of the prism vertices have been indicated relative to the reference axis system Positions are given in meters. From its current position, the prism is rotated 90° about the z axis, followed by a 90° rotation about the y axis, followed by a translation of -2 m in the x direction.

(i) Define the transformation which describes the change in Position of the prism. That is the 4 × 4 homogenous transform for the move.

(ii) What are the new coordinates of the vertices of the prism after the move?

(iii) What is the inverse transform and how should it be interpreted? (16)

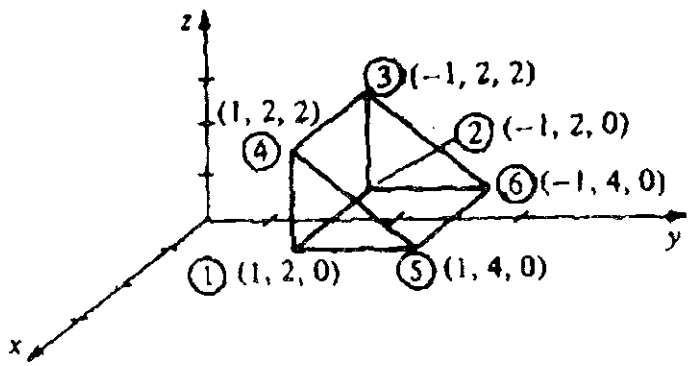

Figure 1

13. (a) (i) List the factors to be considered in the selection and design of grippers. (8)

(ii) Draw a flow chart for a robot's program that will permit shape information to be obtained if a single contact rod proximity sensor is mounted on a robot's gripper. Discuss any execution and/or time problems associated with such a process. (8)

Or

(b) (i) A part weighing 8 kg is to be held by a gripper using friction against two opposing fingers. The coefficient of friction between the fingers and the part is estimated to be 0.3. The orientation of the gripper will be such that the weight of the part will be applied in a direction parallel to the contacting finger surfaces. A fast work cycle is anticipated so that the g factor to be used in force calculations should be 3.0. Compute the required gripper force for the specifications given. (8)

(ii) For a LVDT, it is necessary to convert the ac voltage across the two series opposing secondary coils into a dc voltage. Show that a full wave bridge will provide only magnitude information (i.e. direction cannot be obtained in this way). (8)

14. (a) (i) Consider a vision system which provides one frame of 256 lines every 0.5 second. The system is a raster scan system. Assume that the time for the electron beam to move from one line to next line takes 15 percent of the time to scan a single line. Determine the sampling rate for the system if it is specified that there will be 320 pixels on each line. (8)

(ii) What types of solid state cameras are used for robot vision? Explain the working of any one type. (8)

Or

(b) (i) Consider a circle and an ellipse that might be viewed by machine vision system. The circle has 40 mm radius, where as the ellipse has semiaxes a and b of 40 mm and 20 mm respectively. Apply the two definitions of thinness to both elements and compare the results. (8)

(ii) Explain the working of volume sensors used for capturing three-dimensional information. (8)

15. (a) (i) Explain the region growing procedure used to determine the area of an object. (8)

(ii) How dynamic image is processed? Explain. (8)

Or

(b) (i) Classify machine vision in robot applications and explain each with a case study. (8)

(ii) What are the techniques used to reduce image-processing problems. Explain them with neat sketches. (8)
