

ANNAI MATHAMMAL SHEELA ENGINEERING COLLEGE, NAMAKKAL
VII Semester Mechanical Engineering
ME2028 ROBOTICS
UNIT – I

FUNDAMENTALS OF ROBOTS

1. Define automation

It is a technology that is concerned with the use of mechanical, electronic and computer based system in the operation and control of production.

2. List out the types of automation

1.Fixed automation 2.Programmable automation 3. Flexible automation

3.Mention the benefits of industrial automation systems?

Improved quality , safety, manufacturing flexibility, operations reliability, decision making

4. Define Robot

A machine in the form of a human being that performs the mechanical functions of a human being, but lacks sensitivity

A reprogrammable multifunctional manipulator designed to move , materials, parts, tools, or specialized devices, through variable programmed motions for the performance of tasks

5. What is meant by Robotics?

It is the study and technology of robots. It enables us to design automated mechanisms capable of replacing people in certain jobs

6. What are the rule of Robotics?

1.Do not harm human being 2. Obey human being 3. Protect itself from harm

7. Why are robots used?

A)To reduce production rates – Fast, Accurate, Difficulties in human nature

B)To avoid 3-d jobs – Dirty, Dangerous, Difficult

8. What is meant by Robot anatomy?

Study of structure of robot is called robot anatomy.

Manipulator is constructed of a series of joints and links.A joint provides relative

motion bet.the input links and the output link. Each joint provides the robot with one degree of freedom.

9.List out the types of joint notati1.Linear joint (L-joint) 2. Rotational joint (R-joint) 3. Twisting joint(T-joint) 4.Revolving joint(V-joint) 5.Orthogonal Joint (O-joint)

10.Mention the classification of robots

(i)Physical configuration – 1. Cartesian coordinate configuration 2. Cylindrical coordinate configuration 3. Polar or spherical coordinate configuration 4.Jointed arm configuration 5.Selective Compliance Assembly Robot Arm (SCARA)

(ii)Control system – 1.Point to point robots 2. Straight line robots 3. Continuous robot

(iii)Movement – 1.Fixed 2.Mobile 3.Walking or legged robot

(iv)Types of drive – 1.Pneumatic drive 2.Hydraulic drive 3.Electric drive (v)Application – 1.Manufacturing 2.Handling 3.Testing

(vi)Degrees of freedom 1.Single degree of freedom 2.Two 3.Three 4.Six degrees of freedom

12. Define accuracy

The ability of a robot to position its wrist end at desired target point within its reach is called accuracy

13. What is meant by resolution(precision)?

The smallest increment of motion or distance that can be detected or controlled by the robotic control system

14. What is repeatability of robot?

It refers to robot's ability to return to the programmed point when it is commanded to do so.

15. List out the types of path control

1.Stop-to-stop 2. Point-to –point 3.Controlled path 4.Continuous

16.List out the robot major components

1.Robot arm 2. End of arm 3. Power source 4. Controller 5. Sensor 6. Actuator 7.Actuator

17.What is an end effector?Give examples?

It is a device that is attached to the end of the wrist arm to perform specific task. e.g Tools, Welding equipments , End of arm tooling

18. What is meant by work space and work volume?

The space in which the end point of the robot arm is capable of operating (or) the reach ability of robot arm is known as workspace.

The volume of the space swept by the robot arm is called work volume.

19. What is meant by pay load capacity of robot?

The maximum load which can be carried by the manipulator at low or normal speed

20. What are the types of wrist motions?

1.Wrist rolls 2.Wrist pitch 3.Wrist yaws

21. What is meant by palletizing and depalletizing?

1.Arranging materials on a pallet according to fixed rules

2.Removing in sequence, materials which have been arranged on a pallet

22. What are the factors to be considered while selecting the robot?

1.Load carrying capacity required 2. Speed of movement 3.Number of degrees of freedom 3.Reach 4.Velocity 5.Weight of the robot

23. What are the disadvantages of robots?

1.High initial cost 2. More unemployment problems 3. Need of skilled labour

AMSEC

UNIT-2
ROBOT DRIVE SYSTEM AND END EFFECTORS

1.What is actuators?

Device used for converting hydraulic, Pneumatic or electrical energy into mechanical energy. The mechanical energy is used to get the work done.

2.What are the factors which must be considered while choosing the drive system for robots?

a)Accuracy b)Repeatability c)Degree of freedom d)Mobility e)Coordinate systems
f)Gravitational and acceleration force
g)Backlash, friction and thermal effects h)Weight i)Power-to-weight ratio
j)Operating pressure k) Stiffness Vs complianc

3.List the advantages and dis-advantages of hydraulic drive

Adv: 1.Precision motion control over a wide range of speeds and loads 2. Robust 3. Greater strength

Dadv: 1. Expensive 2. High maintenance 3. Not energy efficient 4. Noisy 5. Not suited for clean-air environment

4. List the advantages and disadvantages of pneumatic actuators?

Adv: 1. Compact 2. Control is simple 3. It is cheapest form of all actuators
4. Individual components can be easily interconnected

Dadv: 1. More noise and vibration 2. Not suitable for heavy loads 3. If mechanical stops are used resetting the system can be slow

5. List the advantages and disadvantages of Electrical actuator

Adv: 1. High power conversion efficiency 2. No pollution of working environment 3. They are easily maintained and repaired 4. Light weight 5. The drive system is well suited for electronic control

Dadv: 1. Poor dynamic response 2. Conventional gear driven create backlash 3. A larger and heavier motor must be used which must be costly

6. Enumerate the difference between Open loop and closed loop control system?

s.no Open loop control system

- 1 It is being relatively simple
- 2 Low cost
- 3 Good reliability

Closed loop control system More complex
More costly

Greater chance of break down as a consequence of the greater no. of components

They often in accurate since there are

4. no correction for error

Relatively accurate in matching the actual to the required values

7. What are the elements of the closed loop control system ?

1. Comparison element 2. Control element 3. Correction element 4. Process element 5. Measurement element

8. What is a stepper motor?

It is a device which transforms electrical pulses into equal increments of rotary shaft motion called steps

9. What are the different types of stepper motor?

1. Permanent magnet stepper motor 2. Variable reluctance stepper motor 3. Hybrid stepper motor

10. What are the advantages and disadvantages of Stepper motor?

Adv: 1. The rotation angle of the motor is proportional to the input pulse 2. The motor has full torque at standstill 3. Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3-5% of a step and this error is non-cumulative from one step to the next. 4. Excellent response to starting

D.adv: 1. Resonance can occur if not properly controlled 2. Not easy to operate at extremely high speeds 3. Very low torque to weight ratio 4. Torque decreases with increase in the stepping frequency 5. For sufficiently high stepping speeds the stepper motor may skip steps due to overshoot.

11. What are the characteristics of servomotor?

1. Linear relationship bet. The speed and electric control signal 2. Steady state stability 3. Wide range of speed control

3. Linearity of mechanical characteristics throughout the entire speed range. 4. Low mechanical and electrical inertia 5. Fast response

12. Compare the AC and DC servomotors?

S. NO DC SERVO MOTORS

- 1 High power output
- 2 Characteristics are linear
- 3 Fast response due to low electrical and mechanical time constant
- 4 Suitable for larger power applications

AC SERVO MOTORS

- 1 Relatively lesser power o/p for same size
- 2 Non-linear
- 3 Relatively slower due to higher values of time constants
- 4 For low power applications

13. Write about various types of motion conversion?

1) Rotary – i) Belts and pulleys ii) Gear trains iii) Harmonic drives iv) Chains

2) Rotary to Linear motion conversion - i) Rack and pinion ii) Lead screw

3) Linkages- i) Four bar linkage ii) crank and rocker iii) Slider crank

14. Write about the balls screw?

Wherever the rack and pinion and hydraulic ram are not quite accurate, the linear screw and ball screws provide accurate movements, which are necessary in automated microscopes.

15. Why servomotors are preferred with stepper motor in robot applications?

Servomotors are easy to control compared to the stepper motors.

16. What are the parts used in harmonic drive?

1. Elliptical wave generator 2. Flex spline with external teeth 3. Rigid circular spline with internal teeth

17. Define End effector and Gripper

End effector is a device that is attached to the end of the wrist arm to perform specific task

Gripper is the end effector which can hold or grasp the object

18. What are the types of grippers?

1.Mechanical 2.Hooking 3.Vaccum 4.Fragile object 5. Magnetic(i)permanent
(ii)Temporary Grippers

19. What is a stripping device?

A device used to remove workpiece from the magnetic gripper

20. What are the elements of end arm tooling?

1.Mounting plate 2.Power for actuation of tooling motion 3.Mechanical linkage 4.Sensors

21. List the advantages and disadvantages of magnetic grippers

1.Pick up times are very fast 2.Variations in part size can be tolerated .The grippers do not have to be designed for one particular work part 3.They have the ability to handle metal parts with holes 3.They require only one surface for gripping

22. List out the gripper design considerations

1.Material specification 2. Part specification 3. Performance specification 4.
Source specification 5. Position specification 6. Environment specification

UNIT III

SENSORS AND MACHINE VISION

1.What is a sensor and transducer?

Sensor is a transducer that is used to make a measurement of a physical variable of interest.

Transducer is a device that converts the one form of information into another form without changing the information content.

2.What are the basic classification of sensors?

1.Tactile sensors –device that indicates the contact between themselves and some other solid objects 2.Proximity Sensors – which senses the presence or absence of the object without having physical contact

between the objects

3.Range sensors - which senses the range of the object

4.Voice sensors – advanced sensor system used to communicate commands or information orally to robot
5.Vision sensor - advanced sensor system used in conjunction with pattern recognition and other

technique to view and interpret event occurring in the robot work space

3.List the different types of tactile sensor

1.Digital (Touch)sensor 2. Analogue (Force)sensor

4.What are the classifications of a proximity sensors?

1.Inductive 2. Capacitive 3.Ultrasonic 3.Magnetic sensors

5.What are the terms that define the performance of the transducers?

a)Range and span b)Error c)Accuracy d)Sensitivity e)Non-linearity error f) Repeatability g)Stability h)Dead

band/time i)Resolution j)Output impedance

6.What is LVDT and how does it work?

The linear variable differential transformer consists of 3 coils symmetrically placed along an insulated tube ,the central coil is the primary coil and the other two are identical secondary coils which are connected in series in such a way that their outputs oppose each other.

When there is an alternating voltage input to the primary coil alternating e.m.f s are induced in the secondary coils with the magnetic core, central the amount of magnetic materials in each of the secondary coil is the same.

It is widely used as primary transducers for monitoring displacements.Also as secondary transducer in the measurement of force,weight and pressure.

7.What is an encoder and name the types of position encoders?

It is a device that provides a digital output as a result of a linear or angular displacement 1.Incremental encoders 2.Absolute encoders

8. Write about hall effect sensors

When a beam of charged particles passes through a magnetic field forces act on the particles and the beam is deflected from the straight line path , a current flowing in a conductor is like a beam of moving charges and thus can be defined by magnetic field.

The transverse potential difference is given by $V = K hBI / TKh$ – Hall coefficient B- Magnetic flux, I – Current T – Plate thickness

9Write about pyroelectric sensor and piezoelectric sensors

A pyro electric sensor consists of a polarized pyroelectric crystal with thin metal film electrodes on opposite faces ions are drawn from the surrounding air and electrons from any measurement circuit connected to the sensor to balance the surface charge.

Piezoelectric materials when stretched or compressed generate electric charges with one face of the material becoming positively charged and the opposite face negatively charged as a result a voltage is produced.

10. What are the types of light sensors?

1.Photo diodes 2. Photo transistors 3. Photo resistors

11. What are photodiodes?

Photodiodes are semiconductor junction diodes which are connected in to a circuit in reverse bias so giving a very high resistance so that when light falls on the junction the diode resistance drops and the current in the circuit rises appreciably,

12. What are the uses of Sniff sensors?

It is similar to smoke detectors,these are sensitive to particular gases and send a signal when they detect those gases.

13.What are the types and uses of Remote Center Compliance devices (RCC)?

1.Lateral 2.Rotational 3.Axial and is attached bet.the wrist end and the gripper

It is commonly used in automated assembly applications to provide compliance for misalignment during assembly.

14. Define vision and vision system

It is the ability to see and recognize objects by collecting the light reflected of these objects into an image and processing that image.

A vision system can be defined as a system for automatic acquisition and analysis of images to obtain desired data for interpreting or controlling an activity.

15.Classify the vision systems

According to the no. of gray levels a) Binary image(black or white) b)Gray image c)Color image (RGB image)

16. What are the common imaging device used for robot vision system?

1.Black and vidicon camera 2.Charge coupled devices (CCD) 3.Solid state camera 4.Charge injection devices(CID)

17. Define machine vision and its functions

Machine vision can be defined as a means of simulating the image recognition and analysis capabilities of the human system with electronic and electronic and electromechanical techniques.

1.Sensing and digitizing image data 2. Image processing and analysis 3. Application

18. Write the machine vision stages

1. Analog to digital conversion 2. Remove noise /patterns, improve contrast 3. Find regions (objects) in the image 4. Take measurements of objects/ relationships 5. Match the above description with similar description of known objects (models)

19. What is an histogram of images?

A histogram is a representation of the total no. of pixels of an image at each gray level. Histogram information can help in determining a cutoff point when an image is to be transformed into binary values.

20. What is meant by windowing and image restoration?

(i) Processing in the desired area of interest and ignores non-interested part of image.

(ii) a) Preparation of image during pre-processing by remove the degrade

b) Blurring of lines, poor contrast bet. Images, and presence of noise are the degrading.

21. What are the different image processing techniques?

1. Image data reduction 2. Segmentation 3. Feature extraction 4. Object recognition

22. What is segmentation?

It is the method to group areas of an image having similar characteristics or features into distinct entities

representing part of the image.

23. What is thresholding?

It is a binary conversion technique in which each pixel is converted into a binary value either black or white.

24. What is region growing?

It is a collection of segmentation techniques in which pixels are grouped in regions called grid elements based on attribute similarities.

24. What are the common imaging device used for robot vision system?

1.Black and white Videocon camera 2.Charge coupled devices (CCD) 3.Solid state camera 4.Charge Injection devices (CID).

25.What is region splitting and edge detection?

1.Region splitting begins with with the whole image represented as a single region which does not usually satisfy the condition of homogeneity.

2.Edge detection considers intensity change that occurs in the pixels at the boundary or edges of the part.

26.What is meant by feature extraction and pattern recognition?

In vision applications distinguishing one object from another is accomplished by means of features that uniquely characterize the object.A feature (area, diameter,perimeter) is a single parameter that permits ease of comparison and identification.

Pattern recognition means classifying an image (region) into one of a number of known classes.

27. What is meant by an object recognition?

The next step in image data processing is to identify the object the image represents.This identification is accomplished using the extracted feature information described. The recognition algorithm must be powerful enough to uniquely identify the object.

28. What is meant by quantitation and morphology?

The transition between continuous values of the image function (brightness) and is digital equivalent is called Quantitation.

Morphology is the study of shapes and those methods used to transform or describe shapes of objects

29. Write the advantages of machine vision system.

1.Reduction of tooling and fixure cost 2. Elimination of need for precise part location 3.Integrated automation of dimensional verification 4.Defect detection

UNIT – IV

ROBOT KINEMATICS AND ROBOT PROGRAMMING

01. Differentiate bet. Forward kinematics and reverse kinematics

Forward kinematics: 1. Given the joint angles,determine the position and orientation of the end effector

2 The outcome of the forward kinematics problem is always unique.There are no

multiple solution.

Inverse kinematics: 1. Given the position and the orientation of the end effector, determine the numerical values for the joint variable.

2 This problem is not quite straight forward like the forward kinematic problem

3 It is not possible to obtain closed form solutions due to the non-linear simultaneous equations

02. Explain redundancy

Most industrial robots have 6 or less joints, thus ,redundancy is not inherent to their design.

Some robots, though, do not have a certain joint arrangement in their final orientation joints that can lead to redundancy for certain orientations.

For example, some robots have the final three joint axes (joints 4,5 and 6 in a six axis robot) arranged in a roll, pitch, roll sequence.

3. What are the methods of robot programming?

1. Lead through methods 2. Textual robot languages 3. Mechanical programming

4 What is teach pendant?

The teach pendant is usually a small hand held control box with combinations of toggle switches, dials and buttons to regulate the robot's physical movements and program capabilities.

5 Define servo control robots

Servo control robots, which are programmed by lead through and textual language methods, tend to activate all axes simultaneously.

6 Explain joint mode of teaching robots

The teach pendant has a set of toggle switches (or similar controlled devices) operate each joint either of it to directions until the end effector has been positioned to the desired point.

7 What is manual lead through programming?

In manual lead through programming moves manipulated wrist to teach spray-painting or arc welding. The movements consists of combination of smooth motion segments.

8. What are irregular smooth motions?

The segments in manual lead through programming are sometimes approximately straight sometimes curved and sometimes back and forth motions, These motions are called irregular smooth motions.

UNIT – V

IMPLEMENTATION AND ROBOT ECONOMICS

1. What is AGV?

Automated guided vehicle (AGV) is an independently operated self-propelled vehicle guided along defined pathways in the floor. It is normally powered with batteries. It is mainly used for handling of materials from one place to another place.

2. What are the general characteristics that make potential robot application technically practical and economically feasible?

1. Hazardous or uncomfortable working conditions
2. Repetitive operations
3. Difficult handling jobs
4. Multicast operation

3. Define MTTR, MTBF

MTTR - The mean time between failures indicates how long, on average, the machinery will operate between breakdowns.

MTBF - The mean time between failures indicates how long, on average, the machinery will operate between breakdowns.

4. What is meant by palletizing and depalletizing?

Arranging materials on a pallet according to fixed rules called palletizing
Removing in sequence, materials which have been arranged on a pallet

5. What are Gantry Robot?

If the robots are mounted overhead, they are called Gantry robot

6. Define a dead man switch

A deadman switch is a useful control feature during leadthrough programming. It is a trigger or toggle switch device generally located on the teach pendant which requires active pressure to be applied to the device in order to drive the manipulator.

7. Define payback period

It is the length of time for the net accumulated cash flow to equal the initial investment in the project.

8. What are the different methods of cost analysis?

1. Payback method
2. Equivalent uniform annual cost (EUAC) method
3. Return on investment (ROI) method.

9. Define EUAC method

Equivalent uniform annual cost method converts all of the present and future investments and cash flows into their equivalent uniform cash flows over the anticipated life of the project.

10. What is image resolution?

The resolution of a digital camera is often limited by the camera sensor (typically a CCD or CMOS sensor chip) that turns light into discrete signals, replacing the job of film in traditional photography.

This means that the brighter the image at that point the larger of a value that is read for that pixel.

11. Define Tracking

Tracking is defined as the motion of the scene, objects or the camera given a sequence of images.

Knowing this motion, predict where things are going to project in the next image, so that we don't have so much work looking for them.

12. What are the techniques used in object recognition?

1. Template matching technique 2. Structural technique

AMSEC