Assignment - I

1) Explain the advantages and dis-advantages of using robotes in industries.

Ans:-

Advantages:

* Increased productivity:- Robots can work continuously without breaks, enabling around the clock operations. This significantly boosts production output compared to human workers who require rest and shift changes.

* consistency and precision:- Robots perform tasks with high accuracy and precision, ensuring consistent quality of products. This reduce wastage and improves overall product quality.

* work in hazardous Environments:- Robots are often deployed in dangerous conditions, such as high temperature toxic environments, or in handling hazardous materials, where human safety is a concern.

* flexibility in Reprogramming:- modern robots can be reprogrammed to handle different tasks, making them versatile and adaptable to new manufacturing processes.

Disadvantages:

* High initial costs:- Setting up robotic systems require significant capital investment. Purchasing the robots, installation, and setting up proper safety systems can be expensive.
* Job Displacement:- The automation of tasks traditionally performed by humans can lead to job losses, especially in labour-intensive industries. This may contribute to economic and social issues.
* Technical Expertise Required:- Robots need skilled technicians for programming, maintenance, and troubleshooting. These workforce must be trained to manage these tasks, which requires additional resources and time.
* Limited flexibility:- While robots excel in repetitive tasks, they may struggle with tasks requiring human intuition, creativity or adaptability in dynamic environments. Complex decision making and tasks with significant variability are challenging for robots.

Q: Discuss the five common robot configurations with sketch.

1) Cartesian Robot:-

* It is also known as rectilinear robot and x-y-z robot. It consists of three sliding joints, two of which are orthogonal 0-joints
* Number of Revolute joints Nil.
* Number of Prismatic joints Three (x-y-z)
* Example PS-I robot - IBM's
* Type of work space rectangular

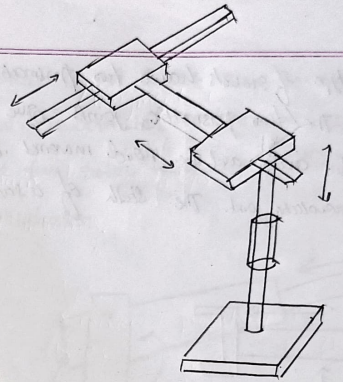
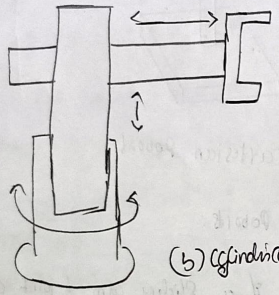


Fig: Cartesian Robot

2) Polar Configuration Robots:-

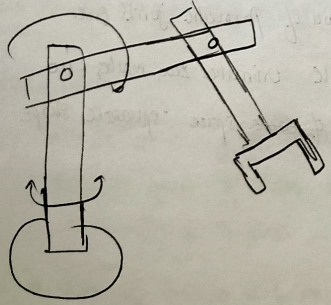
* It consists of a sliding arm L-joint, actuated relative to the body, which rotates about both a vertical axis (T-joint) and horizontal axis (R-joint)
* Number of Revolute joints Two.
* Number of Prismatic joints One
* Example Unimate 2000 models - 110
* Type of work space spherical shape

2. Cylindrical Robot:- This type of robots have two prismatic joints and one revolute joint. The two prismatic joints give linear movements about any two axes and the third movement obtained is produced by the revolute joint. The sketch of a SCARA robot is given

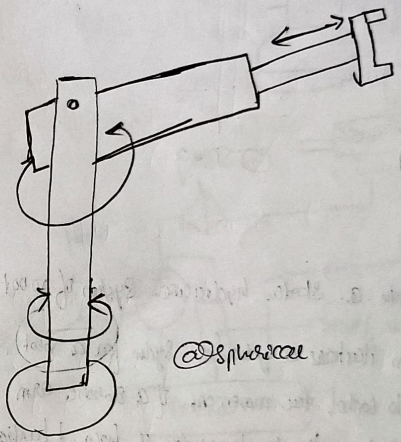


(b) Cylindrical

3. Articulated / Anthropomphic Robot: The Robots of this type have three revolute joints giving three rotary movements resembling the human hand

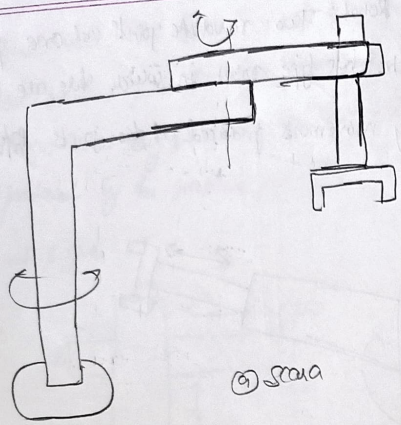


+ Spherical (2 RP) Robot:- Two revolute joints and one prismatic joint characteristic this type robot in which there are one linear and two rotary movements produced at the joints refer for the illustration



(a) Spherical

+ SCARA (Selective Compliance Assembly Robot Arm): This is specially configured robot which has two horizontal and parallel revolute joints which have vertical and one prismatic joint which can move the arm vertically up and down. This finds use in assembly operations. Shown schematic of the SCARA robots



(a) SCARA

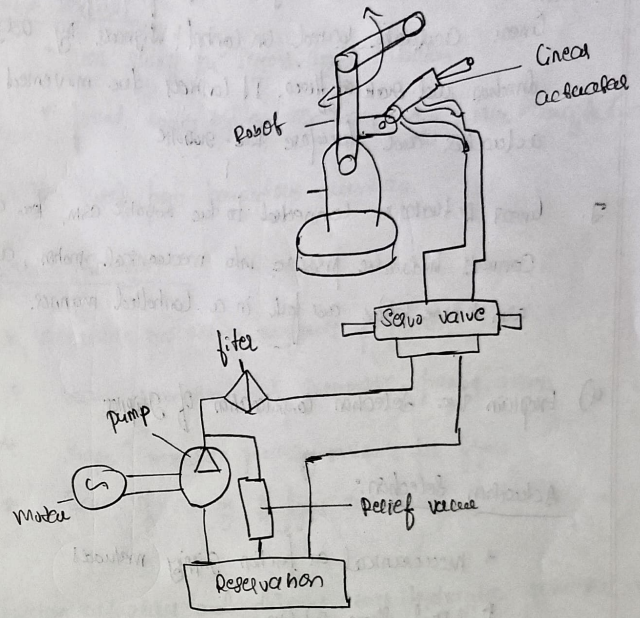
(3) Explain with a sketch hydraulic system of robot

This diagram illustrates a hydraulic system for a robot, using hydraulic components to control the movement of a robotic arm. Key components include a reservoir, pump, motor, filter, relief valve, servo valve, and linear actuators, which work together to control the robot's movements.

1) Reservoir:- This component stores hydraulic fluid. Fluid is essential for transferring energy throughout the system.

2) Pump:- Driven by a motor, the pump draws fluid from the reservoir and pressurizes it. This pressure generates the necessary force to move the robotic arm.

3) Motor:- The motor powers the pump, helping it circulate hydraulic fluid through the system.



(b) hydraulic system for Robot

4) filter:- The filter ensures that only clean hydraulic fluid enters the system by removing any impurities, which prevents damage to the system components.

5) Relief valve:- This valve control the maximum pressure within the system to prevent overload and damage. If the pressure exceeds a certain limit the valve releases excess fluid back to the reservoir.

6. Servo valve:- This valve regulates the speed flow to the linear actuator based on control signals. By adjusting the direction and rate of flow. It controls the movement of the actuator and therefore the robot.

7. Linear Actuator:- connected to the robotic arm, the actuator converts hydraulic pressure into mechanical motion, allowing the arm to move back and forth in a controlled manner.

4) Explain the Selection Consideration of Gripper:

Actuation Selection:-

* mechanical or friction gripping methods
* pad shape selection
* vaccum actuation
* magnetic gripping
* Adhesive gripping

Drive Selection:-

* pneumatic drive systems.
* Hydraulic drive system for heavy duty operation
* Speed reduction of the mechanical transmission

* protection selection
  * Heat sweld for sensors and actuators
  * forced cooling by air or water cooling to take away the heat
  * sweld from hazardous chemicals.
* Process Selection
  * Accurate processing methods for fingers.
  * leak prevention for pneumatic gripper actuators
  * Shape compatible processing methods for fingers.
  * Ease of assembly of fingers and linkages

(5) Explain actuators and discuss about hydraulic actuators used in a robot system:

* Actuators: are devices used in robotics and mechanical systems to convert energy into motion. they play a crucial role in controlling movement by providing the force necessary to move manipulate objects. Actuators respond to control signal like electrical current - hydraulic pressure or pneumatic pressure, to perform specific tasks, common types of actuators include electric, pneumatic and hydraulic actuators, each having unique application based on power needs, control precision and environmental considerations

Hydraulic Actuators:

The hydraulic actuators receive pressurised hydraulic oil with controlled direction and pressure through a system known as "power parts". The speed and volume flow rate are also controlled by the elements of the power train. The produces linear motion the hydraulic cylinders are used and hydraulic motors are used produce rotational movements. A list of almost of a hydraulic power pack along with their function are given here

* Reservoir or tank: Stores and supply hydraulic oil to the system in a closed circuit.
* Hydraulic pump: Receives oil from the reservoir and pressurises the oil in accordance with its capacity.
* Electric motor: Receives electric current from mains and provides rotational movement to the pump.
* Valves: Control the direction of flows, regulate the pressure and provide safety to the system

Discuss the impact of robotics on direct labour

* A robot performing multiple tasks can be a substitute for more than one human workers leading to the displacement. Shift of direct labour to indirect labour activities and change in strategy in the appointment of new workers.
* The set up of the work space and operating the robots need the education and training the direct labour in conversion to indirect labour which involves diversion from direct manual participation in the production work performed.
* The change from direct to indirect jobs is sequential removal of skill, monotony and organisation of activities in the conventional work area occupied by non-robotic machines
* The new workers appointed in a robot installed industries need to be knowledgeable in installing, programming, inspecting, house keeping and maintenance of the industrial robots.
* The knowledge content, the technological skill and the education standard of the operator has to be improved as the experience needed in a robotic cell has to be considered

11. Discuss force analysis of grippers mechanism in detail.

A gripper mechanism consisting of fingers, linkages, frame and a pneumatic cylinder is Air pressure supplied to the cylinder aids in actuating the fingers to grab an object with a gripper force P_3, P_4.

If the mass of the object is 'm' and 'g' is gravity acceleration

The force due to mass = mg = W newtons

The friction between the fingers pads is responsible for the gripper to hold the object counting the force W

The friction force is given by:

$$f = \mu N P_g$$

μ: coefficient of friction

N = the number of fingers

Due to the unloading of circumstances the capacity the finger load is increased due to incorporate a safety by a factor of safety n.

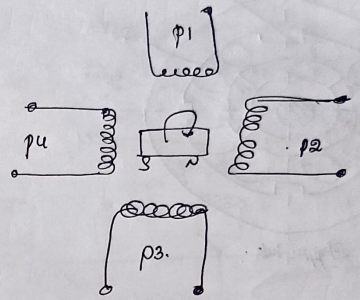
$$F_d = \text{design force} = n.W$$

Equating equation (8.15) $\Rightarrow$ $n.W = \mu N P_g$

$$P_g = \frac{n.W}{\mu.N} = \frac{n.mg}{\mu N}$$

$$P_g = \frac{n.m(g+a)}{\mu N}$$

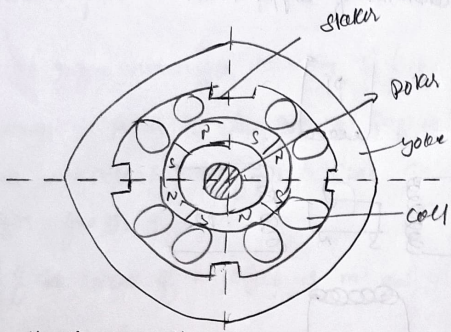
10. Describe the construction of Stepper motor



(a) Schematic of stepper motor

* The stepper motor are unique type of motor that produces rotational movement in the form of finite equal steps. The intermittent electrical pulse make the stepper motor shaft to rotate in steps.

Eg. Discuss the schematic arrangement of the stepper motor principle. The stator in this case is made up of four electromagnetic poles. The rotor is a permanent magnet with two poles N and S, when the excitation of pole 2 (P_2) is equal to P_3 pole the magnetic nature of the rotor by 90 clockwise. By continuous change in excitation in the order P_2-P_3-P_4-P_1-P_2 the clockwise rotation is produced in the shaft of the rotor. which results in continuous movement



Multiple pole stepper motor.

(13) Explain performance parameters used to describe a servo describe repeatability resolution and accuracy

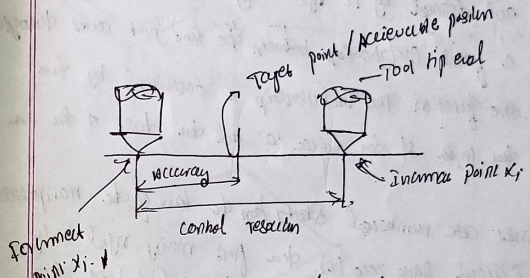
* **Accuracy:** Accuracy refers to how close a measurement is to the true value or standard. It's the degree to which the result of measurement conforms to the correct value or standard

* **Repeatability:**

Repeatability is the ability of a measurement system to give consistent results for the same input under the same conditions. It refers how much the measurements vary when repeated several times. High repeatability means the results are consistently close to each other

3. **Resolution:**

Resolution is the smallest detectable change in the measured quantity that the system can reliably display. A high-resolution system can detect very minute changes in the input.



Representation of control resolution and accuracy

14 Short notes on

* robot links

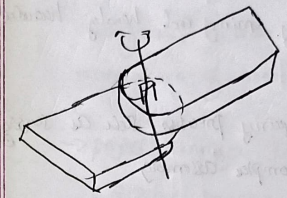
The two adjacent joint axes of a robotic manipulator are connected and defined by a rigid body called "link" which maintains a fixed relationship between the two joint axes through a kinematic function. The relationship is described by two variables - link length of the link 'a' and the twist of the link

The links are numbered starting from the base of the manipulator which is called link zero (0). The first moving rigid body is link 1. Between the joint axes i and (i-1) the link is numbered (i-). A general link is represented.

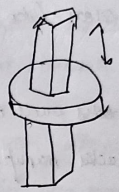
* joints in robots:

The relative motion featured by the study action between the two surfaces describes the characteristic connection known as the 'lower pair'. The lower pair formed between two links is termed as joint. The motion in the joint can be translatory as prismatic/ rotational. About or along the certain axes. The joints can exhibit one or more relative motion/ at a time, depending on

these they are classified into following categories

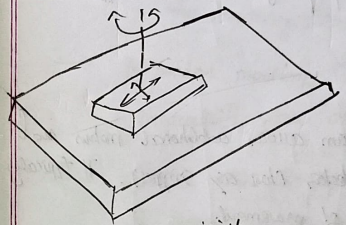


(a) Revolute pair

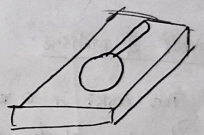


(b) prismatic pair

c. cylindrical pair



planar joint



(d) Spherical joint

(3) Need for Robot:

The need of robots arises from their ability to perform repetitive, hazardous, and precision-based tasks with high efficiency, speed and accuracy by reducing incurable

→ Efficiency and productivity. Robots can work continuously without fatigue, significantly increasing production rates

- Safety: Robots can handle dangerous tasks, reducing human exposure to risks in areas like manufacturing, mining and handling hazardous materials
- Precision: Robots excel at tasks requiring precision, such as surgery, semiconductor manufacturing and complex assembly
- Labor shortage Solutions: In industries facing labor shortages, robots help bridge gaps by performing routine or difficult jobs

(4) Levels of motions:

The wrist in a robotic arm allows additional motion and flexibility at the end effector, like a gripper. It typically provides three main type of movement.

Yaw - Side-to-side rotation

Pitch - Up-and-down rotation.

Roll - Twisting or rotating around the main axis of the first. These motions allow robots to position and orient tools or objects precisely, essential in applications like assembly lines, painting and precision machining

(5) Management of Robotics

Management in robotics involves overseeing the development, deployment and maintenance of robotic systems in an organization. It covers areas such as.

→ Project planning:- Ensuring robots are integrated seamlessly into existing processes or developing new processes around robotics

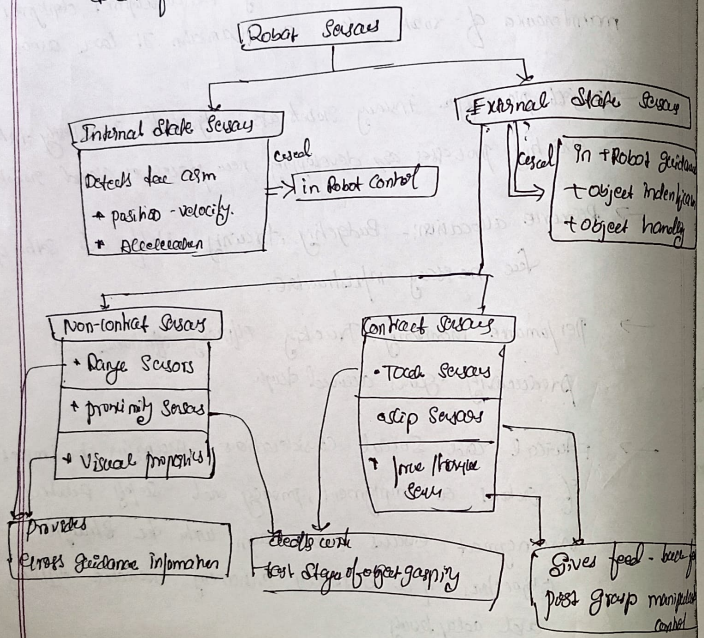
→ Resource allocation:- Budgeting, training staff and setting up the necessary infrastructure.

→ Performance monitoring:- Tracking efficiency, effectiveness and productivity gains achieved through

→ Ethical and Social Considerations:- Managing the impact of robotics on employment, privacy and safety. Robotics management ensures robots align with the strategic objectives of a business, enhancing overall efficiency and adaptability

Assignment - 2

1) Draw a Block diagram to explain the classification of sensors & their functions



2) Explain touch Sensors:-

The touch sensors gather the information established by the contact between the parts to be handled and the fingers in the manipulator end effectors. The signals of touch information are useful in

* locating the objects
* recognising the object type.
* force and torque control needed for fine manipulation

The types of Touch Sensors are:-

1) Binary sensors detect the existence of the object to be handled for example - microswitches and limit switches.

2) Analog Sensors produce proportional output signal for the force exerted locally for example, a caster wheel with a sprayer

3) Explain binary sensors with a sketch:

The device that delivers sensing signal by looked at two gripping points are termed fine binary sensors. The first stage accommodates the binary sensors. The contact with the parts results in deflection and this information is sufficient to determine the presence of the object between the fingers

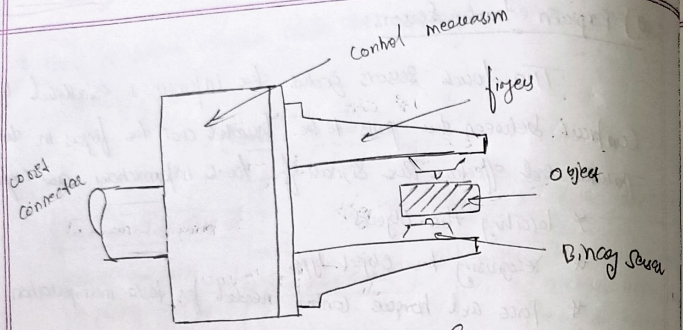
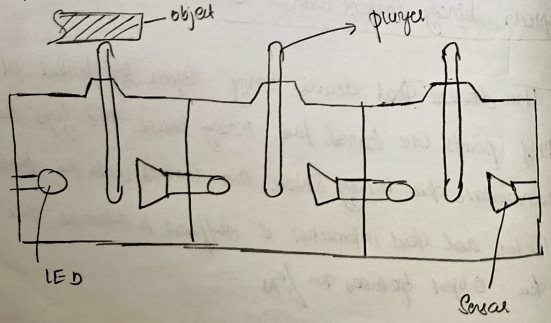
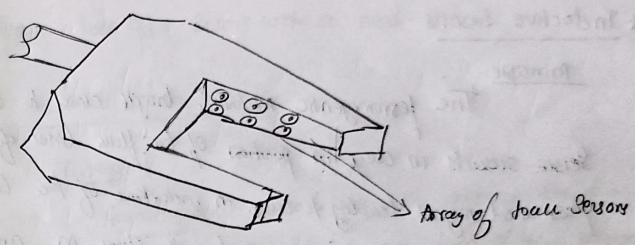


Fig:- Hand with Binary Sensors

4) Explain tactile Sensors with a neat sketch:

An array of touch Sensors arranged systematically to provide information about the contact of the fingers with the object is called tactile Sensors. Special tactile Sensors also provide additional information like shape, size and the type of material of the objects





b): Tactile Sensors

Each elements an array (tactile Sensor) have are three functional parts. A plunger a LED and a light Sensing device. The plunger is a spring. The movement of the plunger operates between the LED and the light Sensor gives output signal accordingly.

5) Explain proximity Sensors with a neat sketch:

The output of the proximity Sensor gives an indication of the presence of an object with in the vicinity for operation. In robotics these Sensors are used to generate information of object grasping and obstacle avoidance. This section deals with some of these important proximity Sensors used in robotics

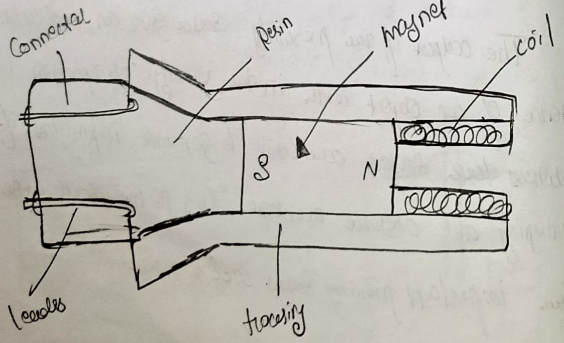
* Inductive Sensors:-

Principle:

The ferromagnetic material brought close to the ferro Sensor results in change in position of the flux lines of the permanent magnet leading to change in inductance of the coil. The induced current pulse in the coil with change in amplitude & shape is proportional to rate of change of flux line in magnet.

Construction

The proximity inductive Sensors basically consists of a wound coil located infront of a permanent magnet encased inside a rigid housing. The leads from the coil, embedded in resin is connected to the display device a connector. The schematic of a Sensor is



6) Explain hall effect sensors with a neat sketch

* Hall effect Sensors

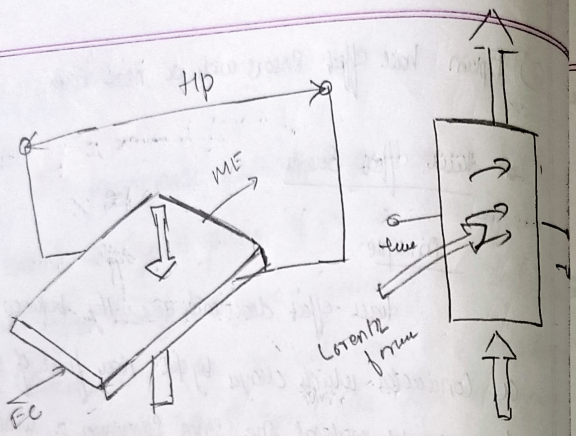
Principle:

Hall-effect deals with the voltage between the two points in a conductor which changes by the new field of the magnetic ferromagnetic material. The Sensor experiences a weakened magnetic field in the close proximity of a ferromagnetic materials. due to the density of flux of the magnet through applicable object

E.H Hall in 1879 discovered hall effect. which States that "A beam of charged particles passing through a magnetic field experiences a force that deflect the beam from the straight line path"

Electrons (negative charged particles) are made to pass through a metal strip rectangular in shape and a magnetic field is applied at right angle to the plane of plate as shown in. The electrons are deflected towards one side of the plate making that side negatively charged ions themselves positively charged. This force due to applied magnetic field is known as Lorentz force. The mechanism of deflection is governed by the balance of Lorentz force and force on the beam of

Electron



Hp: Hall potential MF: Magnetic filed EC: Electric cu

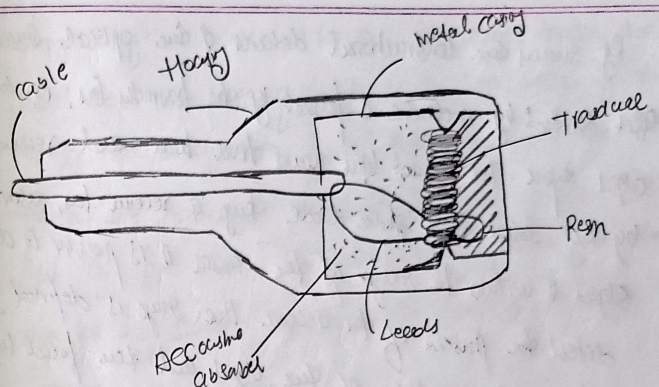
(a) Hall effect principle

(7) Explain ultrasonic proximity sensors with a neat sketch:

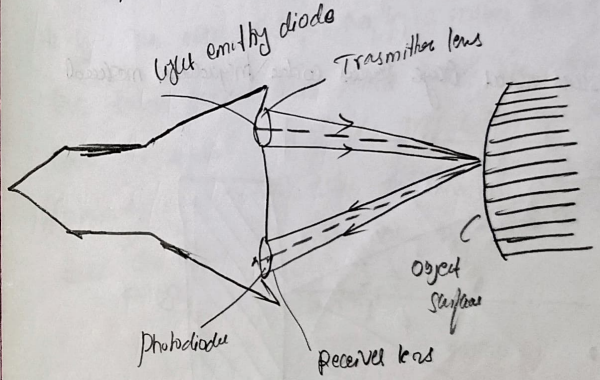
The previously discussed proximity sensors are useful for detection of ferro-magnetic materials only. But what if we have to handle other type of materials ultrasonic sensors find their applications

Construction:

The main part in this type of sensor is the transducer which can act both as transmitter and receiver. The sensor is covered by a sensing block which protects from dust and humidity. For the accurate clamping of material it provide us plane firmly a metallic housing gives good protection.



(8) Explain optical sensors with a neat sketch

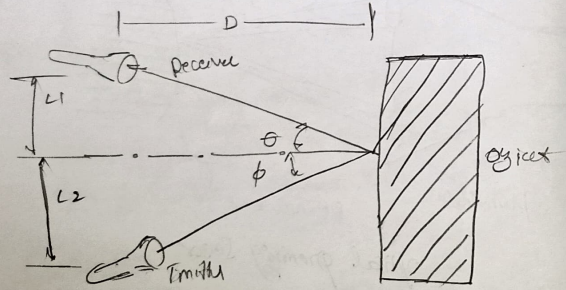


optical proximity sensor

Optical sensors are similar to Ultrasonic the presence of the proximity of the object is detected by the echos of the travelling light wave as it passes from the transmitter and reflected by the object towards the detector.

fig. shows the constructional details of the optical sensor. The object emitted by a diode, is focussed by the traymatic lens, on the object before. The reflected light waves travel back and received by the Solid-State photo diode. Here a receiver lens, when the object is within the range of the sensor it is positive to detect the presence of the receiver. The range is defined by position and orientation of the object and the focal length of the sensor lenses

(9) Discuss about range sensors with triangulation method



The distance between the object and the robot is measured using the range sensors working it is range of operation. The calculation of the distance is by triangulation process. Range sensors find use in robot navigation and

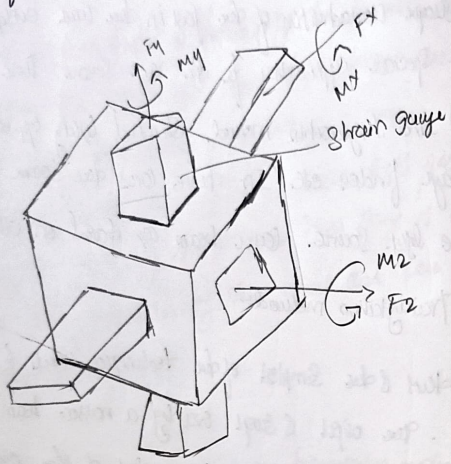
avoidance of the obstacles in their path. The exact location and the general shape characteristics of the part in the work envelope of the robot is done by. Special approaches for the range sensors there are several approaches like triangulation method, structured light approach and time-of-flight range finders etc. In these cases the source of illumination can be light source. Laser beam or focused ultrasonic

→ Triangulation methods:-

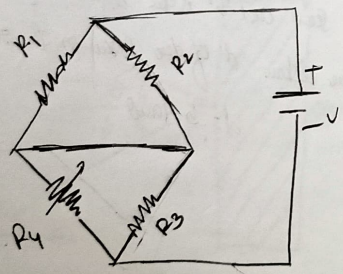
This is the simplest of the techniques which is easily demonstrated in fig. The object is swept over by a narrow beam of sharp light the sensor focussed on a small spot of the object surface detects the reflected beam of light if 'θ' is the angle made by the illuminating source and 'b' is the distance between source and the sensor lens the distance 'd' of the sensor on the robot is given as

$$d = b \cdot \tan\theta$$

(10) Explain force and torque sensor with a neat sketch



Deflection Bar



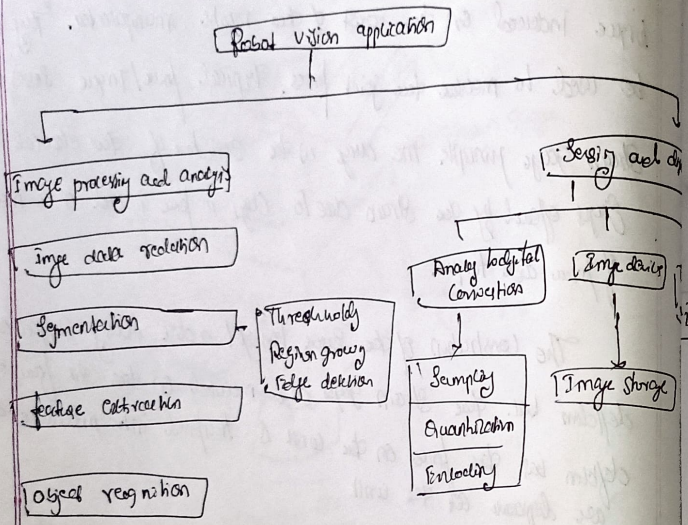
Wheat stone bridge

The wrist force sensor shown in fig. it used to measure the force and torque induced on the wrist of the robotic manipulator. They can also be used to measure the joint forces. Typical force/torque sensor make on strain gage principle. The change in the resistance of the electrical strain gages offered by the strain due to change in force induced as a measure of force and torque.

The construction of the sensor has got a cube having slotted and a deflection bar. Here strain gages are mounted on these six faces of the deflection bar. Here force on the wrist is transformed into measurable deflections or displacement at the wrist

A balanced wheatstone bridge is used to analyse the four resistance. The galvanometer connected between x and y where equal potential shows zero deflection. When there if no force applied. Then four on the wrist change the resistance in any one arm, which result in current flows and leads to the movement of the galvanometer needle. The change in resistance is given by $\frac{R_1}{R_4} = \frac{R_2}{R_3}$

11. write a block diagram explain vision system



1) Image processing and Analysis:

* Image Data Reduction:- Techniques to reduce image complexity
* Segmentation: Divides an image into regions or objects using
  * Thresholding
  * Region Growing
  * Edge Detection
* Feature Extraction:- Identifies essential features from segmented data
* Object Recognition:- Classifies and identifies objects

> Sensing and Digitizing

* Analog to Digital Conversion
  → Sampling
  → Quantization
  → Encoding
* Image Device:- Captures and stores image data
* Coding Technique: Enhances image quality of processing

12) What do you understand by the term robot vision explain its principal functions and functional description in detail

The process of deriving, features and analysis the desired from the three dimensional object in the form of pictures is known as Robot Vision or machine. Its application utilizes the computer for processing it is also known as Computer vision. The area of processing and analysis of the image are categorized as follows

Principal functions of functional Description

* Sensing:- The process that describes and gives out visual image
* Preprocessing:- Deals with the process of disturbance reduction and image development
* Segmentation:- Is associated with the technique of dividing the image into parts of need

* Description: Distinguish these parts of face from other object for comparison of the image feature

* Recognition:- So the identifying shape culture is parts like spanner, bolt and nuts are recognized

* Interpretation: In this process the recognized objects are given useful meaning for the application

13 Define the construction features of vidicon camera and explain the working principle of it in detail.

→ working principle of vidicon camera

* Construction features of vidicon camera:

→ Lens:- focuses the image of the object on the face camera.

→ Face plate:- glass area at front end of camera.

→ Transparent metal coating:- Acts as electrode which derives electrical video signal

→ Photo sensitive layer: * It acts as resistive particle whose resistance inversely proportional to light intensity.

→ Wire mesh: Decelerate the beam of electrons so that they reach photo sensitive layer with velocity

→ Electron gun: Generates beam of electrons which scans the photo sensitive layer.

Beam deflection coil:- Deflects the beam of electrons vertically and horizontally for scanning.

* Beam focusing coil:- The electron beam is focused by this coil

* Tube pins:- Acts as connectors to the electric supply source

* Glass envelope: provides a housing for above elements

* The metal coating of the faceplate is applied with positive voltage

* The photosensitive layer acts like a capacitor with negative charge on the inner surface and positive charge on the opposite side, as electron beam strikes.

* The light strikes the photosensitive layer reduces the resistance and the current starts flowing and neutralizes the positive charge

* As the image is formed on the target layer the concentration of electrons is high in dark area and low in light area

* The electrons so formed flows through metal layer and strike the tube pins

* variation in current due the electron beam scanning makes produce a video signal proportional to the intensity of input image.

14. Explain in detail analog to digital conversion

The imaging device like video camera gives analog signal denoting three two dimensional images of the objects. This information cannot be stored in the bit memory of the computer any on conversion to digital signal. digital conversion of the analog signal is an approximation of reality with minimum done using a analog to digital (A/D) converter. That process has three steps namely

① Sampling ② Quantization ③ Encoding.

* Sampling:- let the function $f(x,y)$ denote the two-dimensional image on the image device. The geometric co-ordinate x axis of the image pixel digitized the set information by the process known as Image Sampling. After Sample the digitized function $f(x,y)$ in the spatial co-ordinates is stored which can be easily stored in the computer memory Discrete.

* Quantization:- The digitization of amplitude of the image function $f(x,y)$ depends on the intensity of the pixel is known as Quantization.

The number of quantization level

$$Q = 2^n$$

where the n in is number of memory bits in the A/D Converter the quantization level space is given as $L = \frac{Fr}{Q}$

On camera

where Fr = full scale range of the camera in volts

from equation (3.6) and (3.7)

$$L = \frac{Fr}{2^n}$$

The digital approximation of the analog signal into the set in quantization as Quantization error. $Qe = \pm\frac{1}{2}(L)$

$$Q = \pm\frac{1}{2}\left(\frac{Fr}{2^n}\right)$$

Encoding:- Depending on the image recorded on the faceplate of the camera. the intensity of the different pixel would be different. The conversion into the digital codes of the amplitude levels follow the process of quantization. The digital amplitudes code is represented by the binary sequence of digits. which is known as Encoding The Spatial quantization level where the difference in intensity and the appropriate All zeros in the binary sequence of digits represent dark (black) intensity level and one in the bit memory is the representation bright (white) intensity pixel. In between the two with combination of zeros and ones where the gray colors

(15) what is image Storage explain image process and arrays in detail

* Image Storage:- The Storage of image (digitized) in the computer memory is done by the frame buffer which can be made a part of the computer or frame grabber. The more popular frame grabber techniques can be explained.

image processing and analysis:

In the industrial applications these algorithms and programs are developed to process the image captured, digitized and stored in the computer memory. The size of data to be processed is huge. Of the order of 10 which is to be substantially executed in 1/30 seconds the efficient and time consuming type of processing is handled effectively by the following techniques

1) Image data reduction
2) Segmentation
3) feature extraction
4) object recognition.

16 Explain Segmentation in detail

* Segmentation: The segmentation different distinct parts of the entities in data are grouped into area of similar characteristic is known as Segmentation. The major segments of the image are region and edge that differentiate them from the background. The image process and analysis are performed by the following segmentation techniques

1. edge detection
2. Region growing
3. Thresholding

Edge detection:

At boundary the pixels on the facepoint differs in gray levels and are stored in the computer in the binary form. Next is the distinguishing features of the object image the features of similar region at the edges shows discontinuity may over one of the attributes. The edge detection is based on follow the edge process.

Region growing is the process techniques area grid elements process similar attributes are grouped to form a region. The grid elements are certain of pixels exhibit distinctive the object image and the background formed on the facepoint the properties and their spatial geometric co-ordinates of a region based on the process of merge a it is to be in keeps independent as a separate entity. The region growing procedure can be better understood by assigning the for the background and 0 for the object region. This is depicted

(12) Explain object recognition from vision point of view

One of the major approaches in image processing in the techniques of matching the captured image with the object to be recognized. The technique of object recognition is based on the feature extraction described previously The powerful algorithms are used for these purpose the features and which are

* Template matching
* Shearlet Technique

(8) Explain with block diagram components of digital image processing