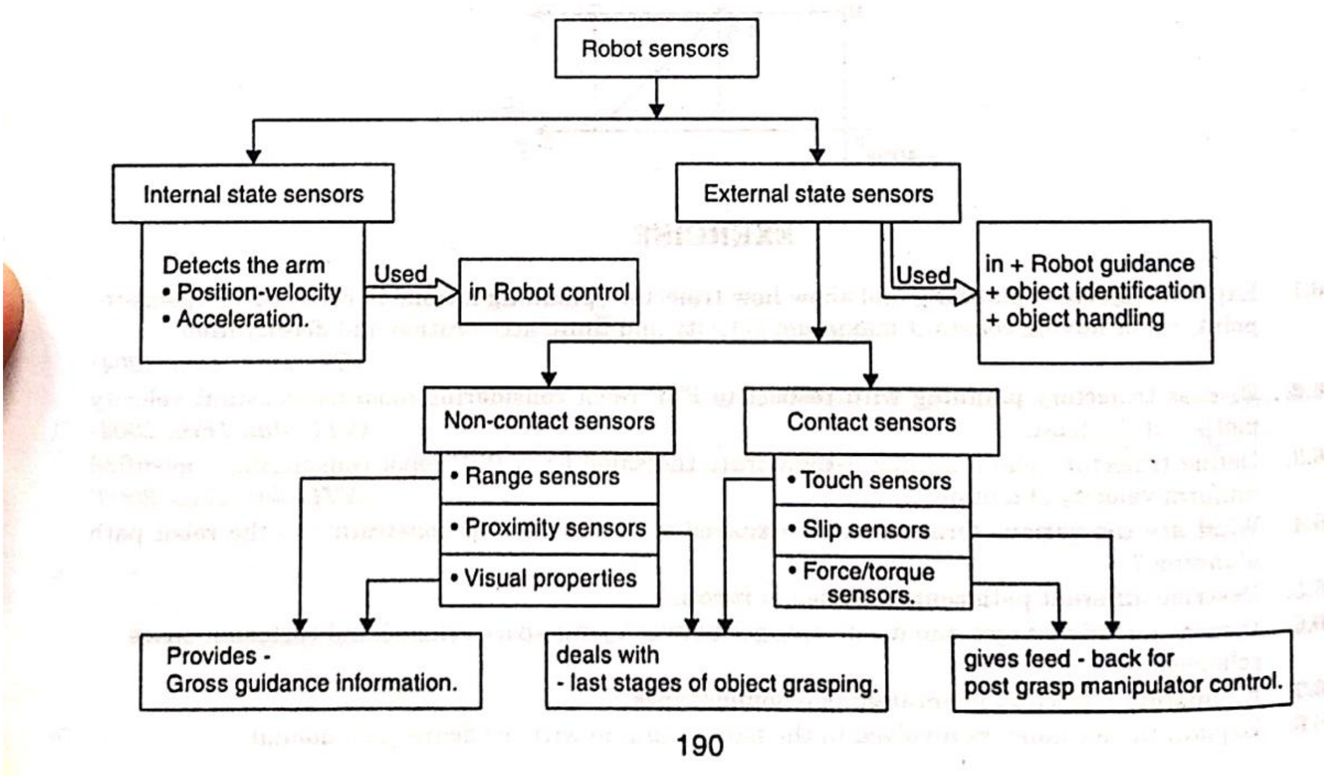
With a block diagram write the classification of sensors and their functions



Classification of Sensors

1. **Robot Sensors**
    - **Internal State Sensors**
        - Detect the arm's:
            - Position-Velocity
            - Acceleration
        - **Function**: Used in Robot Control.
    - **External State Sensors**
        - **Non-Contact Sensors**
            - Types:
                - Range Sensors
                - Proximity Sensors
                - Visual Properties
            - **Function**: Provides Gross Guidance Information.
        - **Contact Sensors**
            - Types:
                - Touch Sensors

- Slip Sensors
- Force/Torque Sensors

- **Functions**:
  - Deals with Last Stages of Object Grasping.
  - Provides Feedback for Post-Grasp Manipulator Control.

Explain proximity sensors with a neat sketch

7.8 PROXIMITY SENSORS

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

- **Inductive Sensors**

* *Principle*

The ferromagnetic material brought close to this type of 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 and shape is proportional to rate of change of flux line in magnet.

* *Construction*

The proximity inductive sensor basically consists of a wound coil located infront of a permanent magnet encased inside a rugged housing. The leads from the coil, embedded in resin is connected to the display through a connector. The schematic is as shown in Fig. 7.4.

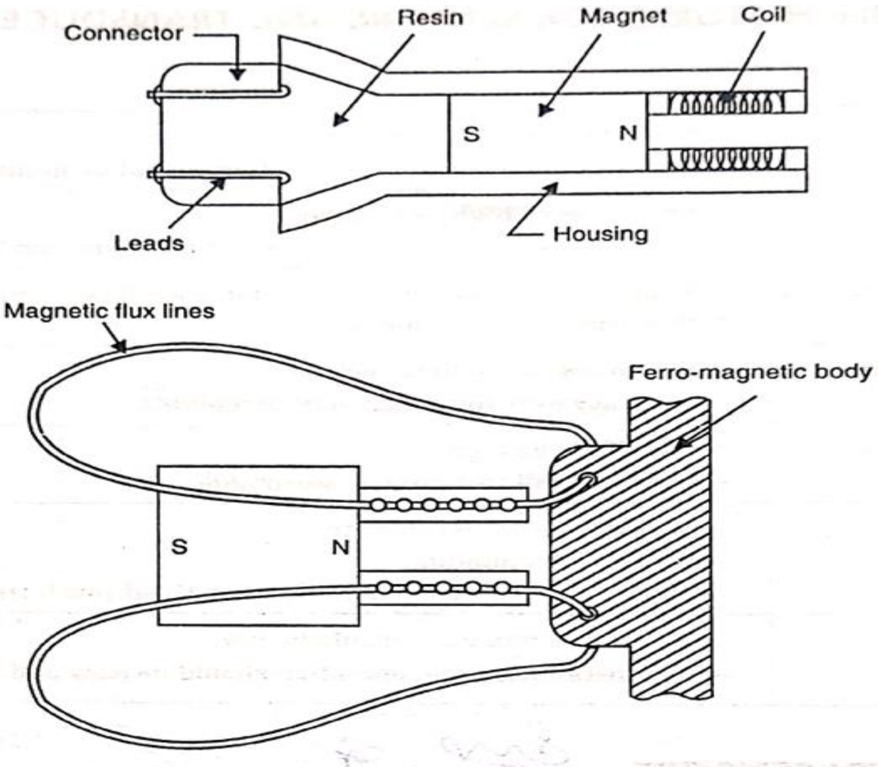


Fig. 7.4. Inductive Sensor.

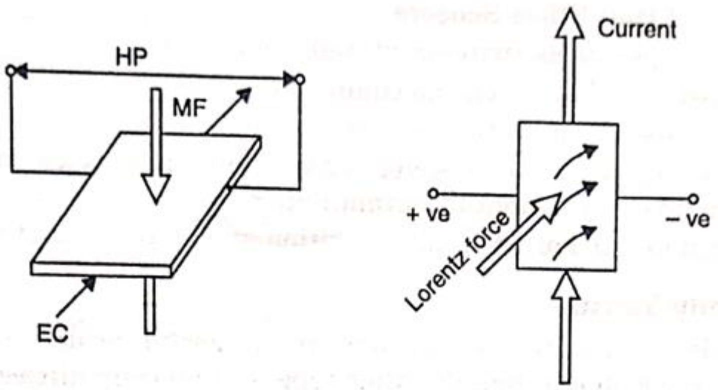
Explain hall effect sensors with a neat sketch

*** Principle**

Hall-Effect deals with the voltage between the two points in a conductor which changes by the near field of the magnetised or ferromagnetic material. The sensor experiences a weakened magnetic field in the close proximity of a ferromagnetic materials, due to the bending of the flux lines of the magnet through approaching object.

E.R. 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 plate rectangular in shape and a magnetic field is applied at right angle to the plane of plate as shown in Fig. 7.5(*a*). The electrons are deflected towards one side of the plate making that side negatively charged and other side positively charged. The 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 electrons.



HP = Hall Potential ; MF = Magnetic Field ; EC = Electric Current

Fig. 7.5 (*a*) Hall Effect Principle.

*** *Construction***

A sensor element is stationed between the poles of a horse shoe magnet constructed inside a container. The principle of operation is as depicted in Fig. 7.5 (*b*).

The decrease in the strength of the magnetic field resulting due to the proximity of the object field reduces the voltage across the sensor. The sensor gives binary output for the decision making devices of control for further actions. The silicon makes the ideal selection for a semiconductor interms of size, strength and capacity to electrical interference prevention.

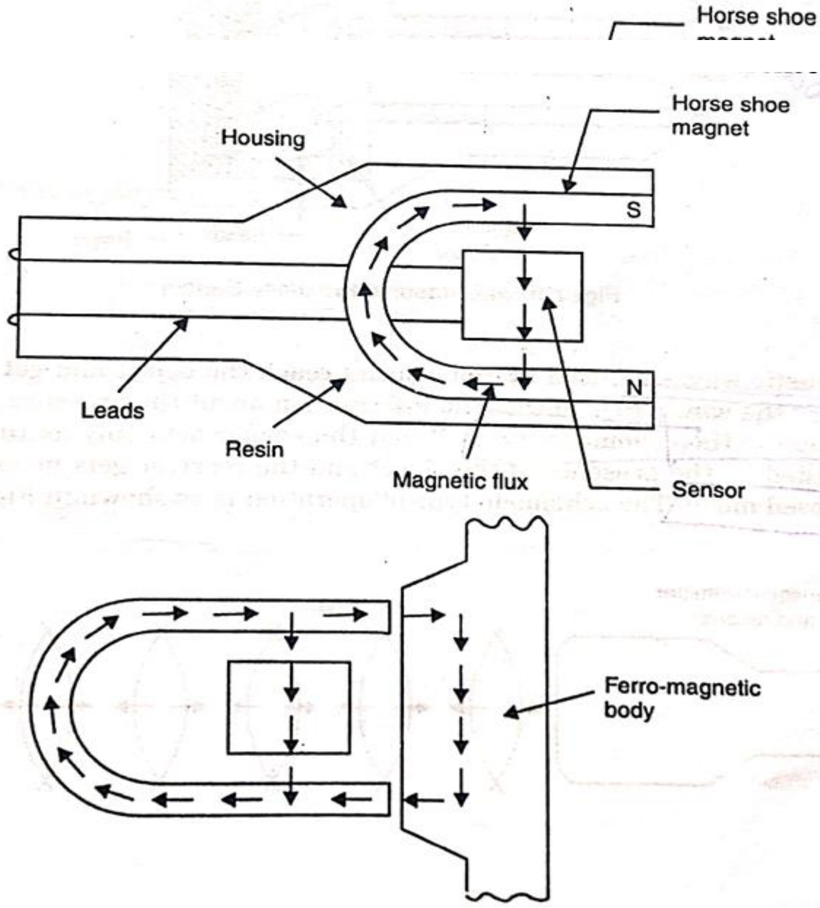
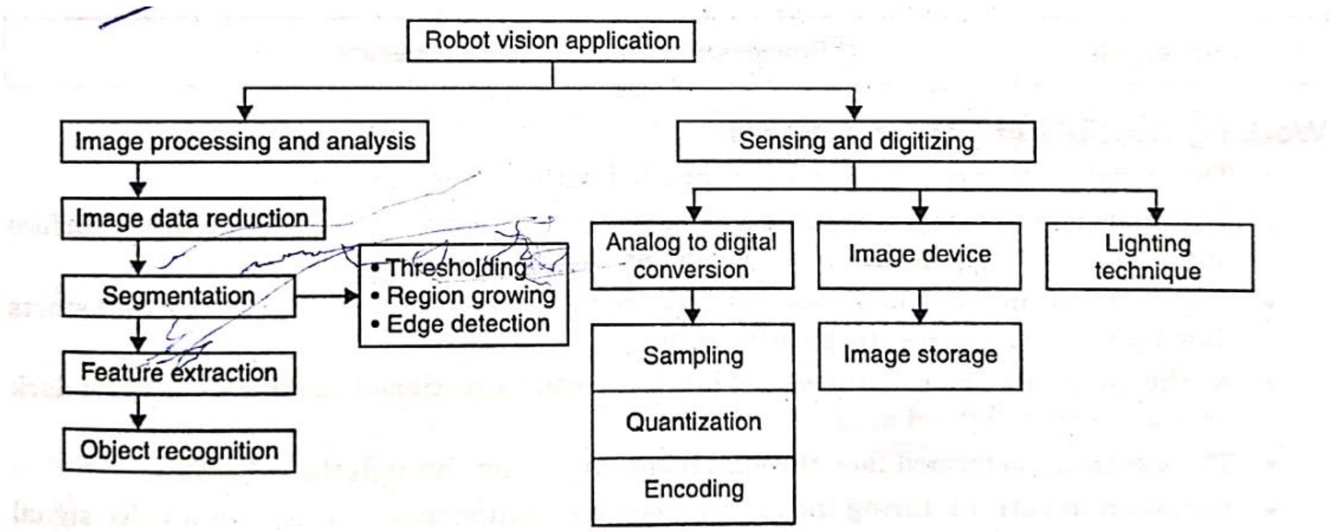


Fig. 7.5 (*b*) Hall-Effect Sensor.

- Advantages of Hall Effect Sensors :
  - ✓ They can operate as switches at high frequency.
  - ✓ They cost less than electromechanical devices.
  - ✓ They are free from contact bounce problem.
  - ✓ They can be used under severe environmental service conditions as they are immune to environmental contaminations.
  - ✓ They can be used as proximity, position and displacement sensors.

Explain ultrasonic proximity sensors with a neat sketch

With a block diagram explain vision system



1. Image Processing and Analysis

This branch focuses on analyzing the captured images to extract meaningful information for decision-making.

Steps:

1. **Image Data Reduction:**
    - Reducing the amount of data in an image while retaining essential details. This prepares the image for further processing.
2. **Segmentation:**
    - Dividing the image into distinct regions or objects for focused analysis.
    - Techniques for segmentation include:
        - **Thresholding:** Separating objects based on pixel intensity levels.
        - **Region Growing:** Grouping neighboring pixels with similar properties.
        - **Edge Detection:** Identifying boundaries of objects in the image.
3. **Feature Extraction:**
    - Extracting specific features (e.g., shape, texture, or color) from the segmented regions for further analysis or recognition.

4. **Object Recognition:**
    - Identifying and classifying objects in the image based on the extracted features.

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2. Sensing and Digitizing

This branch involves capturing the visual data and converting it into a digital format that can be processed.

Steps:

1. **Analog to Digital Conversion:**
    - **Sampling:** Capturing image data at discrete intervals.
    - **Quantization:** Mapping the sampled data into discrete intensity levels.
    - **Encoding:** Representing the data in a format suitable for digital storage or processing.
2. **Image Device:**
    - Refers to the hardware used for image capture (e.g., cameras or sensors).
    - **Image Storage:** Storing the captured image data for processing or future use.
3. **Lighting Technique:**
    - Ensures proper illumination of the scene for accurate image capture and processing.
    - Good lighting is critical for reducing noise and enhancing the clarity of the image.

What is image storage explain image processing and analysis in detail

What do u understand by the term robot vision explain its principal functions And functional description in detail

7.20 COMPONENTS OF DIGITAL IMAGE PROCESSING

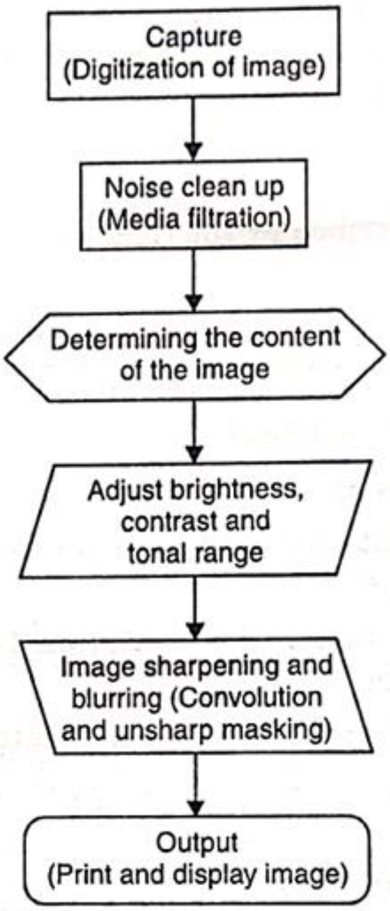

Fig. 7.14. Image Processing Block Diagram.

Components of Digital Image Processing

1. **Capture (Digitization of Image):**
   - This is the first step where an analog image is captured and converted into a digital form using sensors and digitization techniques.
   - The image is stored as a grid of pixels, each representing a specific intensity or color.
2. **Noise Clean-Up (Media Filtration):**
   - Removes unwanted distortions or noise from the image to improve its quality.
   - Techniques such as **median filtering**, **Gaussian filtering**, or other noise-reduction methods are used to smooth the image.
3. **Determining the Content of the Image:**
   - This step involves analyzing the image to identify and define its contents.

- May include segmentation, edge detection, or feature extraction to prepare the image for further processing.

4. **Adjust Brightness, Contrast, and Tonal Range:**
   - Enhances the visual quality of the image by modifying its brightness, contrast, and tonal properties.
   - Techniques include histogram equalization or gamma correction to balance the image's lighting conditions.
5. **Image Sharpening and Blurring:**
   - **Sharpening:** Improves the clarity of edges and details in the image. Common methods include convolution with sharpening kernels.
   - **Blurring:** Smoothens the image by reducing sharp changes in intensity. Often used for noise reduction or artistic effects.
   - Techniques like **unsharp masking** or **convolution filtering** are applied.
6. **Output (Print and Display Image):**
   - The processed image is then prepared for display or printing.
   - The output can be used in applications such as medical imaging, object recognition, or computer vision.

Purpose of Each Component:

- **Capture:** Converts real-world images into a digital format for processing.
- **Noise Clean-Up:** Improves the quality of the raw image.
- **Content Analysis:** Prepares the image for further specific tasks, like classification or object detection.
- **Enhancements:** Improves visual appeal and usability.
- **Output:** Ensures the processed image meets the application's requirements.