

Sensors and Robotics Technology

Data Acquisition and Actuators Unit - 2

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Introduction to Actuators

- **Actuators** are devices that convert electrical, hydraulic, pneumatic, or other forms of energy into mechanical motion. They are essential components in various systems, from simple household appliances to complex industrial machinery.

Types of Actuators

Electric Actuators

- **DC Motors:** Convert electrical energy into rotary motion. They are widely used in various applications, including robotics, automation, and consumer electronics.
- **Stepper Motors:** Provide precise, step-by-step rotational motion. They are commonly used in CNC machines, printers, and 3D printers.
- **Linear Actuators:** Convert electrical energy into linear motion. They are used in applications like adjustable furniture, automotive seats, and industrial machinery.

Pneumatic Actuators

- **Cylinders:** Convert compressed air into linear motion. They are used in various industries, including manufacturing, construction, and agriculture.
- **Rotary Actuators:** Convert compressed air into rotary motion. They are used in applications like valves, dampers, and mixers.

Hydraulic Actuators

- **Cylinders:** Convert hydraulic fluid into linear motion. They are used in heavy-duty applications like construction equipment, cranes, and mining machinery.
- **Rotary Actuators:** Convert hydraulic fluid into rotary motion. They are used in applications like steering systems, excavators, and bulldozers.

Other Actuators

- **Piezoelectric Actuators:** Convert electrical energy into mechanical motion through the piezoelectric effect. They are used in precision positioning applications like atomic force microscopes and ultrasonic transducers.
- **Shape Memory Alloy Actuators:** Convert thermal energy into mechanical motion. They are used in applications like medical devices and robotics.

Applications of Actuators

- Actuators are used in a wide range of applications, including:
- **Industrial Automation:** Robotics, assembly lines, and material handling systems.
- **Manufacturing:** CNC machines, presses, and packaging equipment.
- **Automotive:** Steering systems, windows, and seats.
- **Aerospace:** Flight control systems, landing gear, and cargo handling.
- **Medical Devices:** Prosthetic limbs, surgical robots, and drug delivery systems.
- **Consumer Electronics:** Home appliances, toys, and gaming devices.

Selecting An Actuator

When selecting an actuator for a particular application, several factors should be considered:

- **Required Force or Torque:** The amount of force or torque needed to perform the desired task.
- **Speed:** The required speed of the actuator.
- **Accuracy and Precision:** The level of accuracy and precision needed for the application.

Selecting An Actuator

- **Environment:** The operating environment, including temperature, humidity, and potential contaminants.
- **Power Source:** The available power source (electric, pneumatic, hydraulic, etc.).
- **Size and Weight:** The physical dimensions and weight of the actuator.
- **Cost:** The initial cost and ongoing maintenance costs of the actuator.

Linear Actuators

- **Linear actuators** are electromechanical devices that convert electrical energy into linear mechanical motion. They are widely used in various industries and applications due to their versatility, reliability, and ease of control.

Components of a Linear Actuator

Components of a Linear Actuator:

- **Motor:** The heart of the actuator, responsible for converting electrical energy into mechanical energy. It can be a DC motor, stepper motor, or servo motor.
- **Screw and Nut:** A threaded screw and nut mechanism that converts rotary motion from the motor into linear motion. The pitch of the screw determines the speed and force of the actuator.
- **Gearbox:** Often used to reduce the speed and increase the torque of the motor, making it suitable for heavy-duty applications.

Components of a Linear Actuator

- **Limit Switches:** These switches prevent the actuator from overextending, protecting it from damage and ensuring safe operation.
- **Control Circuit:** A circuit that controls the direction and speed of the motor based on the input signal.

Types of Linear Actuators

- **Ball Screw Actuators:** Use a ball screw and nut, which provides high efficiency and accuracy. They are commonly used in precision applications like CNC machines and robotics.
- **Acme Screw Actuators:** Use an Acme screw and nut, which is less efficient but more affordable than ball screw actuators. They are often used in less demanding applications.

Types of Linear Actuators

- **Rack and Pinion Actuators:** Use a rack and pinion mechanism, which provides high force and speed. They are commonly used in heavy-duty applications like industrial presses.
- **Hydraulic Linear Actuators:** Use hydraulic fluid to produce linear motion. They are suitable for high-force applications but require a hydraulic power unit.

Applications of Linear Actuators

- **Industrial Automation:** Assembly lines, material handling systems, and robotic applications.
- **Medical Equipment:** Hospital beds, wheelchairs, and rehabilitation devices.
- **Automotive Industry:** Seats, windows, and sunroofs.
- **Home Automation:** Adjustable furniture, blinds, and garage doors.
- **Agricultural Equipment:** Planting and harvesting machinery.
- **Construction Equipment:** Hydraulic cylinders for heavy machinery.

Key Considerations for Selecting a Linear Actuator

- **Force or Load:** The maximum force or load the actuator needs to handle.
- **Speed:** The required speed of the actuator.
- **Stroke Length:** The maximum distance the actuator can travel.
- **Accuracy and Precision:** The level of accuracy and precision needed for the application.
- **Duty Cycle:** The frequency and duration of operation.
- **Environment:** The operating environment, including temperature, humidity, and potential contaminants.
- **Power Supply:** The required voltage and current for the actuator.