

FUNDAMENTAL CONCEPTS IN ROBOTICS:

Definition for Robot:

The Robot Institute of America (1969) defines robot as —.... a re-programmable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through various programmed motions for the performance of a variety of tasks. A robot is a reprogrammable, multifunctional machine designed to move materials, parts, tools, or special devices through programmed motions to perform a variety of tasks.

Key characteristics of robots:

- Programmable
- Automatic operation
- High precision and accuracy
- Ability to perform repetitive tasks
- Capability to work in dangerous environments

ROBOTICS:

It is an art, knowledge base and also skill of designing, applying and using robots in human workplaces. Robotic systems consist of not just robots, but also other devices and systems used together with robots.

Asimov's laws of robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Components of a Robot

A robot system consists of several important parts:

1. Manipulator (Robot Arm)

The manipulator is the mechanical arm of the robot. It is made up of links and joints that allow movement similar to a human arm.

Functions:

- Positioning
- Movement of tools or objects
- Performing mechanical operations

2. End Effector

The end effector is the device attached to the end of the robot arm that interacts with the environment.

Examples:

- Grippers
- Welding tools
- Spray guns
- Vacuum cups

Purpose:

- Holding objects
- Performing tasks like welding, painting, assembling

3. Actuators (Drive System)

Actuators provide motion to the robot joints. They convert energy into movement.

Types of actuators:

- **Electric actuators** – use motors
- **Hydraulic actuators** – use pressurized fluid
- **Pneumatic actuators** – use compressed air

4. Sensors

Sensors help the robot detect and understand its environment.

Types of sensors:

- **Position sensors** – detect joint positions
- **Proximity sensors** – detect nearby objects
- **Vision sensors (cameras)** – provide visual information
- **Force sensors** – measure pressure or force

Sensors allow robots to respond intelligently to changes.

5. Controller

The controller is the **brain of the robot**. It processes data from sensors and sends commands to actuators.

Functions:

- Executes robot programs
- Controls movement
- Coordinates robot actions
- Ensures accurate operation

6. Power Supply

The power supply provides energy for robot operation.

Common power sources:

- Electrical power
- Hydraulic power
- Pneumatic power

4. Degrees of Freedom (DOF)

The degree of freedom refers to the number of independent movements a robot can perform.

Example movements:

- Rotation
- Linear movement
- Up/down motion

Most industrial robots have 4 to 6 degrees of freedom, allowing flexible movement similar to a human arm.

5. Robot Workspace

The workspace is the area within which a robot can operate and move.

Factors affecting workspace:

- Length of robot arms
- Type of joints
- Robot configuration

Types of workspace shapes:

- Cylindrical

- Spherical
- Rectangular

6. Robot Programming

Robot programming is the process of giving instructions to the robot to perform tasks.

Types of programming:

1. **Online programming** – teaching the robot directly using a teach pendant
2. **Offline programming** – programming using a computer without stopping robot operation