UNIT I- INTRODUCTION:

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

OVERVIEW OF A SMART SYSTEM:

A smart system is an intelligent, interconnected system capable of sensing, processing, communicating, and taking actions automatically with minimal human intervention.

Examples

- Smart home (lighting, HVAC, security)
- Industrial automation systems
- Smart agriculture systems
- Smart energy meters
- Health monitoring devices

Examples of Smart Systems:

- **Smart Home System**

- Uses smart sensors (motion, temperature), smart lights, smart locks.
- Automatically controls lighting, security, and appliances.

Example: Light turns ON when movement is detected.

- **Smart Grid**

- Intelligent electricity network.
- Monitors energy demand in real time and reduces power loss.

Example: Automatic rerouting of electricity during faults.

- **Smart Healthcare System**

- Wearable health trackers monitor heartbeat, oxygen level, steps, sleep.
- Sends data to cloud for analysis.

Example: Smartwatch detects abnormal heart rate and alerts the user.

- **Smart Agriculture System**

- Sensors measure soil moisture, humidity, temperature.
- Automated irrigation system waters the plants only when needed.

Example: Drip irrigation starts when soil moisture is low.

- **Smart Vehicle / Autonomous Car**

- Uses cameras, sensors, GPS, radar.
- Detects obstacles and drives safely.

Example: Automatic braking when an obstacle is detected.

- **Smart City System**

- Smart traffic management, smart parking, smart waste bins.
- Enhances public services using IoT and automation.

Example: Smart signals reduce traffic congestion based on traffic flow.

Key Characteristics of Smart Systems:

- **Automation** – Works with minimal human effort
- **Intelligence** – Uses algorithms, logic, or AI
- **Adaptability** – Adjusts based on conditions
- **Connectivity** – Communicates with other devices/systems

- **Efficiency** – Saves energy, time, and resources
- **Reliability** – Continuous and accurate operation

COMPONENTS OF SMART SYSTEM:

Sensors

Sensors detect physical parameters and convert them into electrical signals. Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment.

Examples:

- Temperature sensor (LM35, DHT11)
- Pressure sensor
- Light sensor (LDR)
- Proximity sensor
- Gas sensor

Function:
Converts *physical quantity → electrical signal*

Signal Conditioning

Raw sensor signals are usually weak or noisy.

Functions include:

- Amplification
- Filtering
- Analog-to-Digital Conversion (ADC)

Purpose:
To make signals suitable for processing.

Processing Unit (Controller)

The controller is rather similar to your cerebellum; although it does not have the power of the brain, it still controls your motions. The controller receives its data from the processor (the brain of the system), controls the motions of the actuators, and coordinates the motions with the sensory feedback information.

Examples:

- Microcontroller (Arduino, PIC, ATmega)
- Microprocessor
- Embedded system
- PLC (Programmable Logic Controller)

Functions:

- Data processing
- Decision making
- Running control algorithms
- Executing automation logic

Software / Control Algorithm

Software defines how the system behaves. It processes sensor data, makes decisions, and controls actuators automatically to achieve the desired operation.

The software:

- Collects data from smart sensors
- Analyzes and processes data
- Makes decisions using control logic
- Sends commands to actuators
- Communicates with other systems or cloud platforms

Includes:

- Embedded C / Python code
- Control logic
- AI / Machine Learning algorithms
- Rule-based decision making

Example:
if temperature > 30°C → turn ON fan

Communication Module

Allows the system to exchange data with users or other systems.

Communication technologies:

- Wired: UART, SPI, I²C, Ethernet
- Wireless: Wi-Fi, Bluetooth, ZigBee, LoRa, GSM

Purpose:

- Remote monitoring
- Cloud connectivity
- System integration

Actuators

Actuators convert electrical signals into physical action.

Examples:

- DC motors
- Servo motors
- Relays
- Solenoid valves
- LEDs

Function:
Electrical signal → Physical movement/action

Feedback System

Feedback improves accuracy and stability. A feedback system in a smart system continuously monitors the output using sensors and feeds this information back to the controller to automatically correct errors and improve performance.

Types:

- Open-loop system (no feedback)
- Closed-loop system (with feedback)

Example:
Speed sensor feedback to motor controller.