PURPOSE OF EMBEDDED SYSTEMS

INTRODUCTION

Embedded Systems are used in various domains like consumer electronics, home automation, telecommunications, automotive industry, healthcare, control & instrumentation, retail and banking applications, etc.
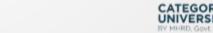
According to the application usage context, they have different functionalities.

Each embedded system is designed to serve the purpose of any one or a combination of the following tasks.

1. Data collection/Storage/Representation

2. Data communication

3. Data (Signal) Processing

4. Monitoring

5. Control

6. Application specific user interface

- **Data Collection, Storage, and Representation**

- **Purpose**: To collect data from the environment or other systems, store it for later use, and present it in a user-friendly format.

- **Functions**:
  - Sensing and recording data through sensors.
  - Storing data locally or transmitting it to external storage.
  - Representing data in visual or other formats for user interpretation.

- **Examples**:
  - Data loggers for weather conditions.
  - Medical devices storing patient health records (e.g., ECG machines).
  - Flight data recorders (black boxes) in aircraft.

- **Data Communication**

- **Purpose**: To facilitate the exchange of data between devices or systems for processing, monitoring, or control.

- **Functions**:
  - Transmitting and receiving data via wired or wireless networks.
  - Supporting communication protocols like Wi-Fi, Bluetooth, Zigbee, or CAN.

- **Examples**:
  - Routers and modems in networking.
  - IoT-enabled smart devices communicating with cloud platforms.
  - Vehicle-to-vehicle (V2V) communication systems.

- **Data (Signal) Processing**

- **Purpose**: To process raw input data (signals) into a usable form, often in real-time.

- **Functions**:
  - Filtering, analyzing, and transforming signals such as audio, video, or sensor inputs.
  - Executing algorithms to enhance or decode information.

- **Examples**:
  - Digital hearing aids processing sound for clarity.
  - Radar systems analyzing signals to detect objects.
  - Image processing in digital cameras and smartphones.

- **Monitoring**

- **Purpose**:To observe and report the state of a system or environment.

- **Functions**:

  - Continuously collecting data and analyzing it for anomalies or trends.

  - Triggering alerts or alarms based on predefined thresholds.

- **Examples**:

  - Security systems monitoring for unauthorized access.

  - Heart rate monitors tracking and reporting health metrics.

  - Environmental monitoring systems for air quality or pollution.

- **Control**

- **Purpose**:To regulate and manage the behavior of devices or systems based on input data or predefined parameters.

- **Functions**:

  - Controlling actuators or other hardware components.

  - Implementing feedback loops to maintain desired conditions (closed-loop control).

- **Examples**:

  - Anti-lock braking systems (ABS) in vehicles.

  - Robotic arms in manufacturing.

  - Thermostats regulating room temperature.

- **Application-Specific User Interface**

- **Purpose**: To provide a dedicated and user-friendly interface for interacting with the system.

- **Functions**:
  - Enabling users to configure, control, or monitor the system.
  - Displaying system status, alerts, or collected data.

- **Examples**:
  - Touchscreens on smartphones or tablets.
  - Control panels on home appliances like washing machines or microwaves.
  - Dashboards in cars providing information on speed, fuel, and navigation.