Fundamentals of Software Development for Electronics

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Course outline

- Session 1: Importance of Software Engineering in Electronics
- Session 2: Basic Concepts and Terminologies
- Session 3: Software Development Life Cycle (SDLC)
- Session 4: Integrated Development Environments (IDEs) and Basic Git Workflow
- Session 5 and 6: JavaScript & Introduction to TypeScript
- Session 7 and 8: Building Web Applications with ReactJS
- Session 9: CSS Basics and Responsive Design Principles
- Session 10: Basics of Flutter / React Native / Ionic
- Session 11: Project Presentation & Final Review

Importance of Software Engineering in Electronics

Objectives

- Understand the role of software engineering in electronics.
- Explore the intersection of software and hardware.
- Learn about real-world applications of software in electronics.

What is Software Engineering?

- Software engineering involves designing, developing, and maintaining software systems.
- Importance of software development in creating solutions for various industries, including electronics.

Key Points:

- Software is used to control electronic devices, automate processes, and manage data.

- Examples: Firmware for microcontrollers, operating systems for embedded devices, etc.

Embedded Systems vs. General-Purpose Software

Embedded Systems:

- Special-purpose software integrated into electronic hardware.
- Used for specific tasks (e.g., controlling motors, sensors).
- Example: Software in washing machines, automotive systems.

General-Purpose Software:

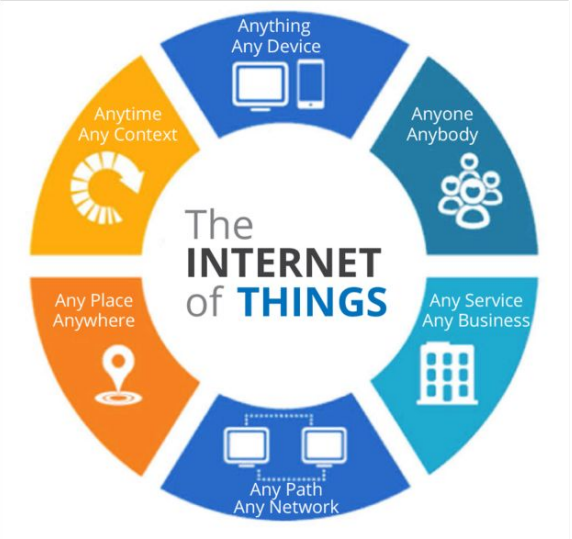
- Runs on general-purpose hardware, like PCs or mobile phones.
- Can perform a wide variety of tasks.
- Example: Software for data analysis, web browsers.

Importance of Software in IoT, Robotics, and Automation

IoT (Internet of Things):

- Software enables devices to communicate and interact over the internet.

- Examples: Smart homes, connected wearables.

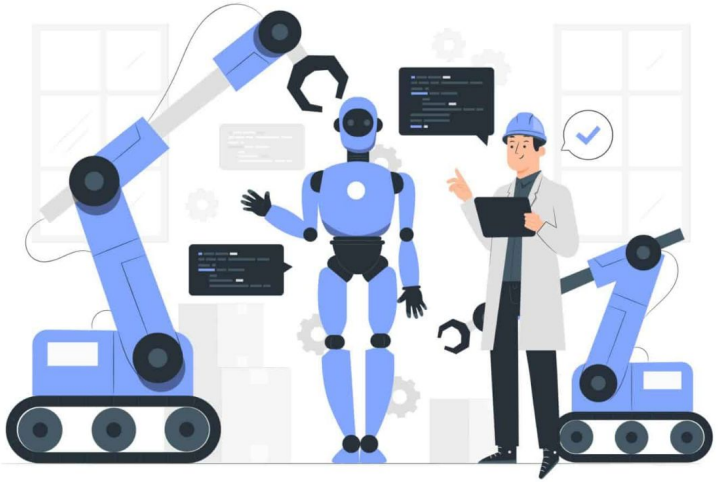


Importance of Software in IoT, Robotics, and Automation

Robotics:

- Software controls the movement, decision-making, and behavior of robots.

- Examples: Robotic arms, drones.

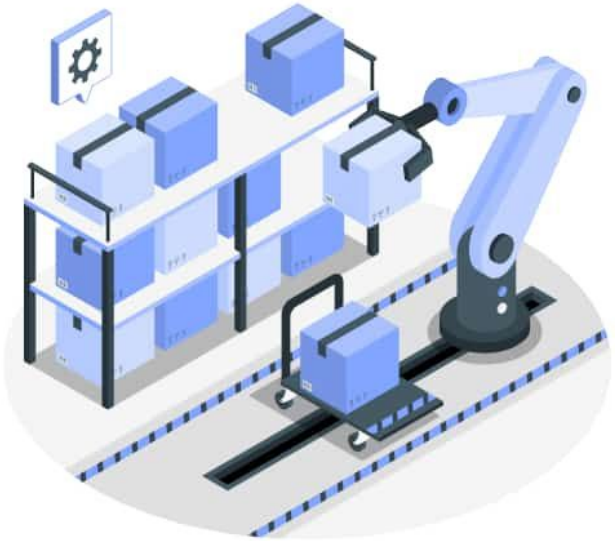


Importance of Software in IoT, Robotics, and Automation

Automation:

- Software automates processes, reducing human intervention.

- Examples: Automated factories, self-driving cars.

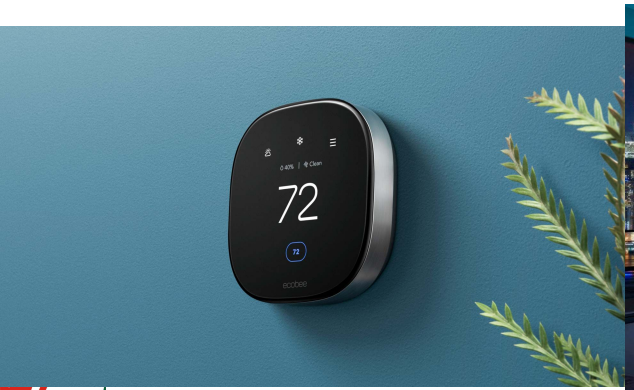


Software and Electronics: A Perfect Pair

- Electronics enable interaction with the physical world.
- Software provides flexibility to customize and control the hardware behavior.

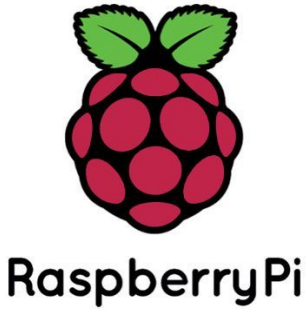
Examples of software-controlled electronics:

Smart thermostats, automated lighting, medical devices.



Introduction to Raspberry Pi

- Raspberry Pi is a low-cost, credit-card-sized computer that can control electronic devices.



- **Use Cases:**
  Home automation, sensor data collection, robotic control.

- **Key Components:**
  - GPIO pins to connect sensors, motors, and other devices.
  - Compatible with multiple programming languages like Python and JavaScript.
  (https://www.w3schools.com/nodejs/nodejs_raspberrypi.asp)

Exercise 1 – Group Discussion

Question:

Identify real-world examples where software engineering has significantly impacted the electronics industry.

Exercise 2 – Research Assignment

Task:

Research examples of electronics projects using Raspberry Pi.

Exercise 3 – Hands-On with Embedded Systems

Task:

Write pseudocode for a basic electronic device, like a smart light switch.

Instructions:

- Identify the inputs (e.g., motion sensor or button) and outputs (e.g., light).
- Write pseudocode for how the software will interact with the hardware.
- Assume the light should turn on when motion is detected or the button is pressed, and turn off after 30 seconds of no motion.

Exercise 3 – Solution

IF motion_sensor_detects_motion OR button_is_pressed

  TURN_ON the light

  START_TIMER 30 seconds

ELSE IF NO motion_detected for 30 seconds

  TURN_OFF the light

Exercise 4 – Identifying Components of Software in Electronics

Task:

Break down the software architecture for an IoT-based home automation system.

Instructions:

- Identify the key components (sensors, actuators, software systems).
- For each component, explain the role of software in controlling or managing the electronics.
- Use a smart thermostat as an example.

Exercise 4 – Solution

Sensors: Temperature sensors send data to the control unit.

Actuators: The control unit turns the heating or cooling system on or off.

Software Components:

- Data processing: The software processes temperature data to make decisions.
- Control logic: If the temperature is too low, software triggers the heating system.
- User interface: A mobile app allows the user to manually adjust settings.

Exercise 5 – Embedded Systems vs. General Software

Task: Classify the following systems as either *Embedded Systems* or *General-Purpose* Software.

Instructions: Read each example and classify it.

1. A software system controlling an automated conveyor belt in a factory.
2. A web browser running on a PC.
3. Software in a microwave oven to manage cooking time.
4. A game played on a mobile phone.
5. An operating system for a smartwatch.

Exercise 6 – Analyzing Raspberry Pi Use Cases

Task: Identify how Raspberry Pi is used in the following projects:

1. A weather station that reports temperature and humidity to a web server.
2. A smart camera that captures images when motion is detected and uploads them to the cloud.
3. A robot controlled through a mobile app to perform tasks like moving or picking objects.

Instructions:

- For each project, identify the sensors and software needed.
- Describe the role of Raspberry Pi as the controller.

Exercise 6 – Solution

Weather Station:

- Sensors: Temperature and humidity sensors.
- Software: A Python script reads sensor data and sends it to a web server via an API.

Smart Camera:

- Sensors: Motion sensor, camera module.
- Software: Python or C++ script to trigger image capture and upload images to the cloud.

Exercise 6 – Solution

Robot:

- Sensors: Motor drivers, actuators.
- Software: Mobile app sends commands to the Raspberry Pi, which controls motors via GPIO pins.

Exercise 7 – Real-World IoT Example Breakdown

Task: Break down the components of a smart home lighting system (IoT).

- For each component, identify whether it is hardware or software, and explain its role in the overall system.
- Example components: smart bulb, mobile app, cloud server, Raspberry Pi as a gateway.

Exercise 7 – Solution

- **Smart Bulb (Hardware):** Receives on/off commands via Wi-Fi or Bluetooth.
- **Mobile App (Software):** Allows the user to control the bulb, sends commands to the cloud.
- **Cloud Server (Software):** Stores user preferences and handles communication between the app and the smart bulb.
- **Raspberry Pi (Hardware/Software):** Acts as a gateway to manage communications between local devices and the cloud.

Recap & Key Takeaways

- Software plays a critical role in controlling and automating electronics.
- Embedded systems are tightly integrated with hardware, while general-purpose software is more versatile.
- Real-world applications like IoT and robotics depend heavily on software engineering.
- Raspberry Pi is a powerful tool for learning software and hardware integration.

Next Session Preview

- **Topic for Next Session: Basic Concepts and Terminologies**
- We will explore key programming concepts and terminologies that are foundational for software development.
- Hands-on exercises to write pseudocode for an electronic device functionality.