FUNDAMENTALS OF EMBEDDED SYSTEMS

From Microcontrollers to Real-World Application

Presented by

AlignTechnology

INTRODUCTION TO EMBEDDED SYSTEMS

What is an Embedded System?

- A dedicated computing system designed to perform a specific function
- Combines hardware and software into a single unit

Key Characteristics

- Real-time operation
- Low power consumption
- Reliable and application-specific

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WHY EMBEDDED SYSTEMS?

Dedicated Functionality

Designed to perform specific tasks with high reliability.

Real-Time Operation

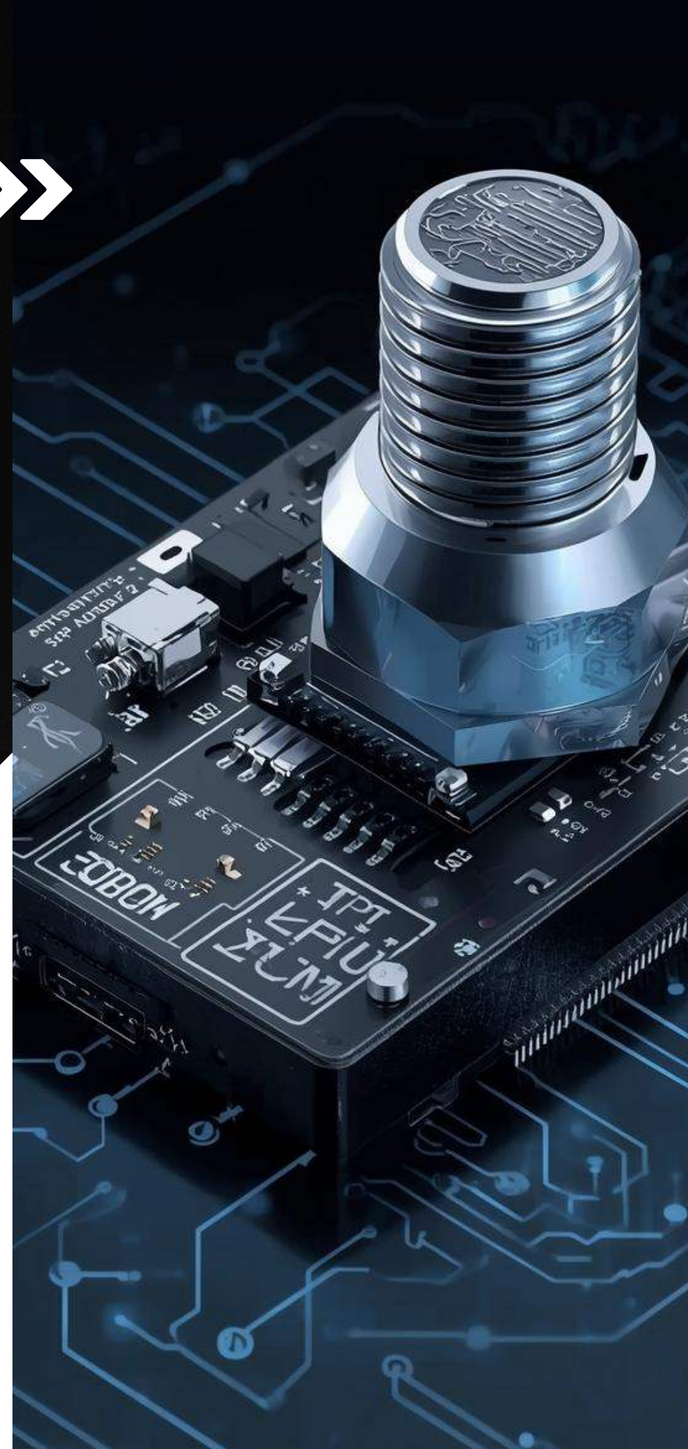
Responds to inputs within strict timing constraints.

Efficient Resource Usagey

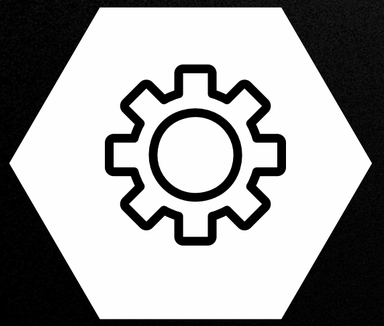
Optimized use of memory, processor, and power.

Wide Industry Applications

Used in automotive, consumer electronics, medical, and industrial systems.

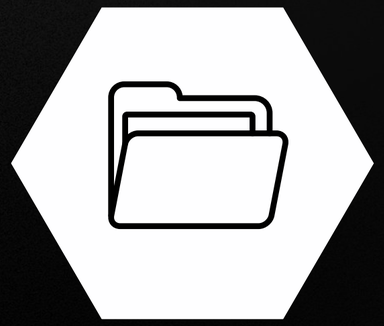


KEY COMPONENTS OFAN EMBEDDED SYSTEM



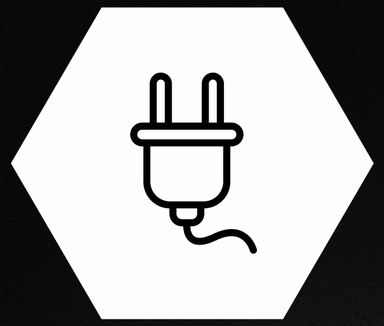
Processor (MCU / MPU)

Acts as the brain of the system and executes the embedded program.



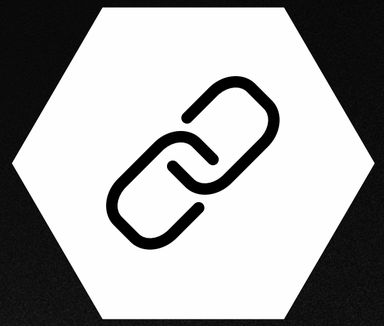
Memory

Includes **Flash, RAM, and EEPROM** for program storage and data handling.



Input / Output Interfaces

Connects sensors, switches, displays, relays, and actuators.



Peripherals & Communication

Timers, ADC, UART, SPI, and I2C for control and data exchange.

MICROCONTROLLER ARCHITECTURE OVERVIEW

What is a Microcontroller?
A microcontroller is a compact integrated circuit designed to control a specific operation in an embedded system.

Core Blocks
- CPU – Executes instructions
- Memory – Flash, RAM, EEPROM
- Peripherals – Timers, ADC, Communication modules

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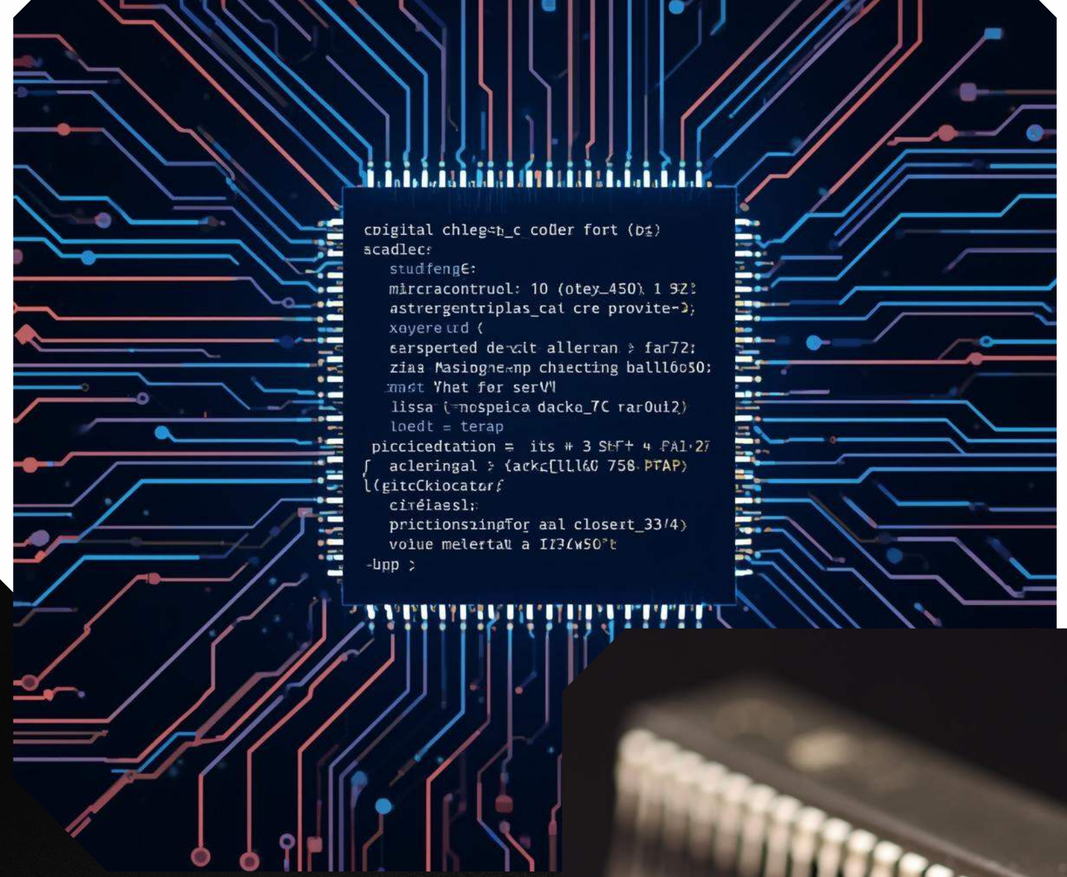
EFFICIENT EMBEDDED C PROGRAMMING



Why Efficiency Matters in Embedded Systems

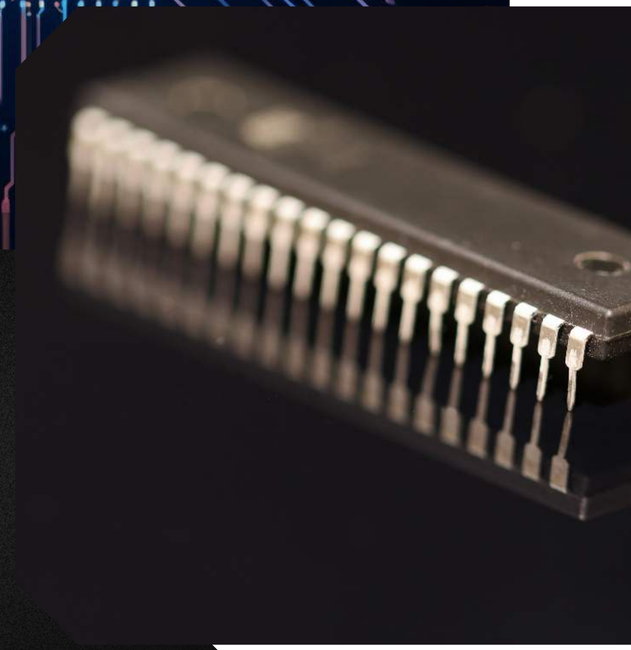
Embedded systems run on limited **memory, processing power, and energy,** so code must be optimized and reliable.

Optimized Resource Usage

- Efficient use of CPU, RAM, and Flash memory
- Avoid unnecessary delays and blocking code

Reliable & Maintainable Code

- Clean, readable Embedded C code
- Proper use of registers, pointers, and bit manipulation



DEVELOPMENT TOOLS & EMBEDDED ENVIRONMENT

Embedded Development Environment
Embedded software development requires specialized tools for **coding, compiling, flashing, and debugging** microcontroller-based systems.

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CHALLENGES IN EMBEDDED SYSTEMS DEVELOPMENT

Embedded System Challenges

Developing embedded systems involves working with hardware constraints, real-time requirements, and low-level programming, which makes design and debugging challenging.

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01

Limited Resources

Embedded systems have limited memory, processing power, and storage, requiring optimized design.

02

Real-Time Constraints

Tasks must respond within strict timing deadlines, especially in automotive and industrial systems.

03

Hardware–Software Integration

Tight coupling between hardware peripherals and embedded software increases complexity.

THE FUTURE OF EMBEDDED SYSTEMS

Embedded Systems in the Future
Embedded systems are becoming more intelligent and connected, driven by automation, real-time control, and advanced software architectures across industries.

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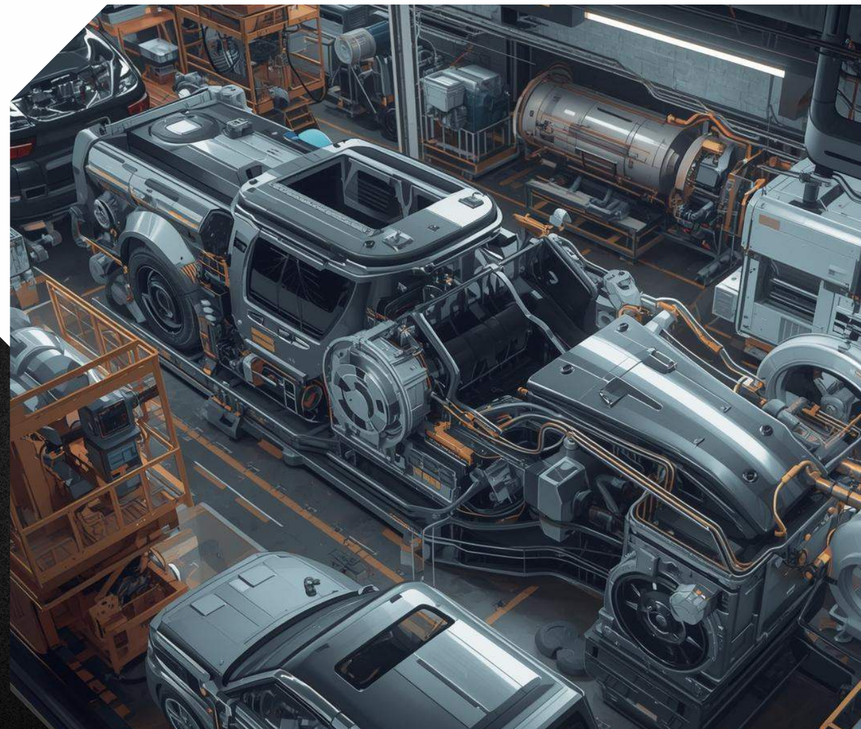

START YOUR JOURNEY IN EMBEDDED SYSTEMS

Hands-on Learning & Real Projects

This program equips students with **practical embedded system skills**, enabling them to design, program, and implement real-world embedded applications confidently.

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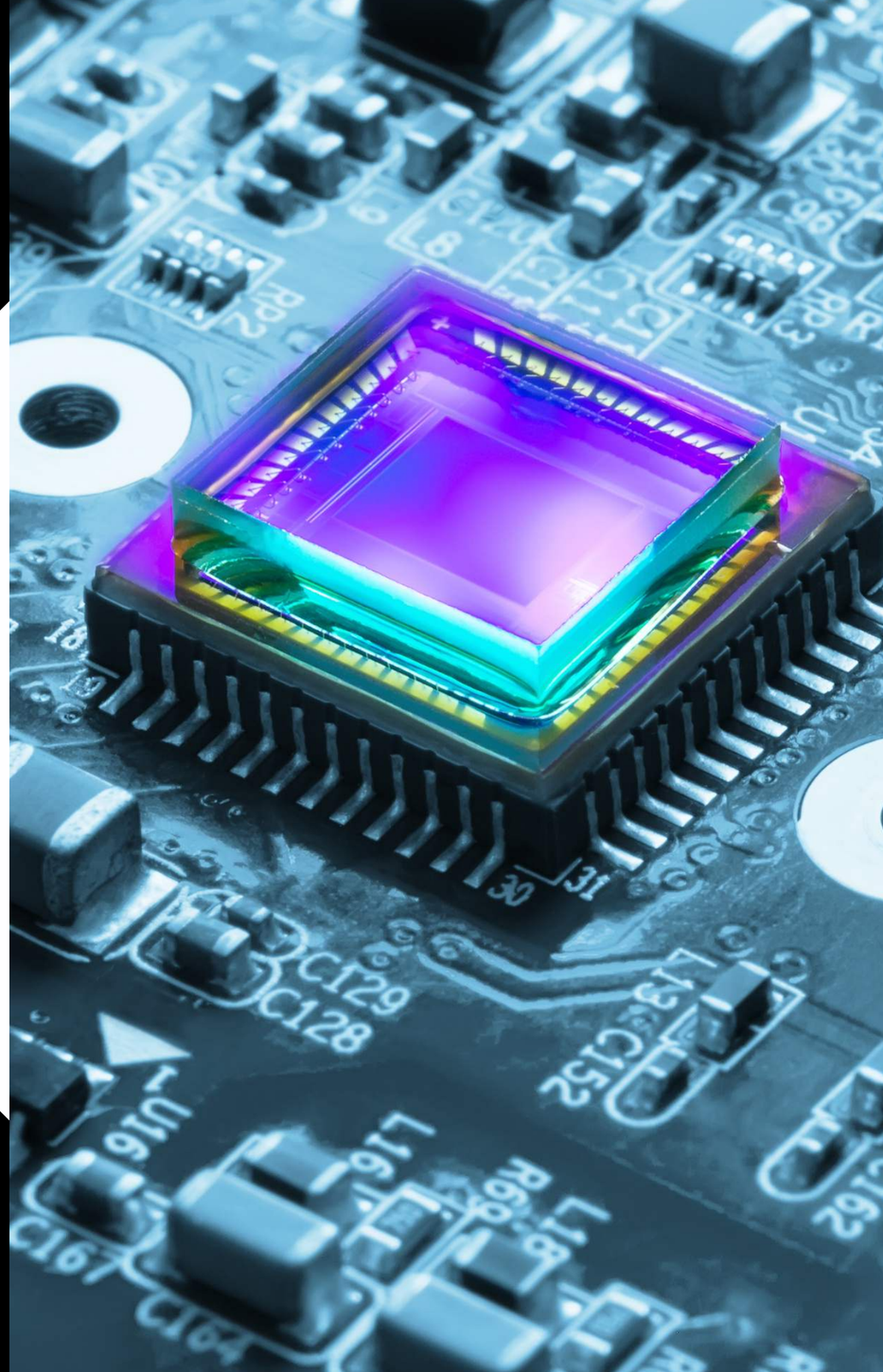
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