EMBEDDED SYSTEM COURSE

LECTURE 1: GETTING STARTED

Learning Goals

- Understanding about the embedded system and its products in real world

- Understanding about the microcontroller: a microprocessor and common architectures nowadays.

Table of contents

1. Embedded system Introduction

2. Microcontroller & Microprocessor

3. Processor Architecture

4. Instruction Set Architecture

5. Summary

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Embedded system Introduction

Definition

Embedded System = Computers Inside a Product

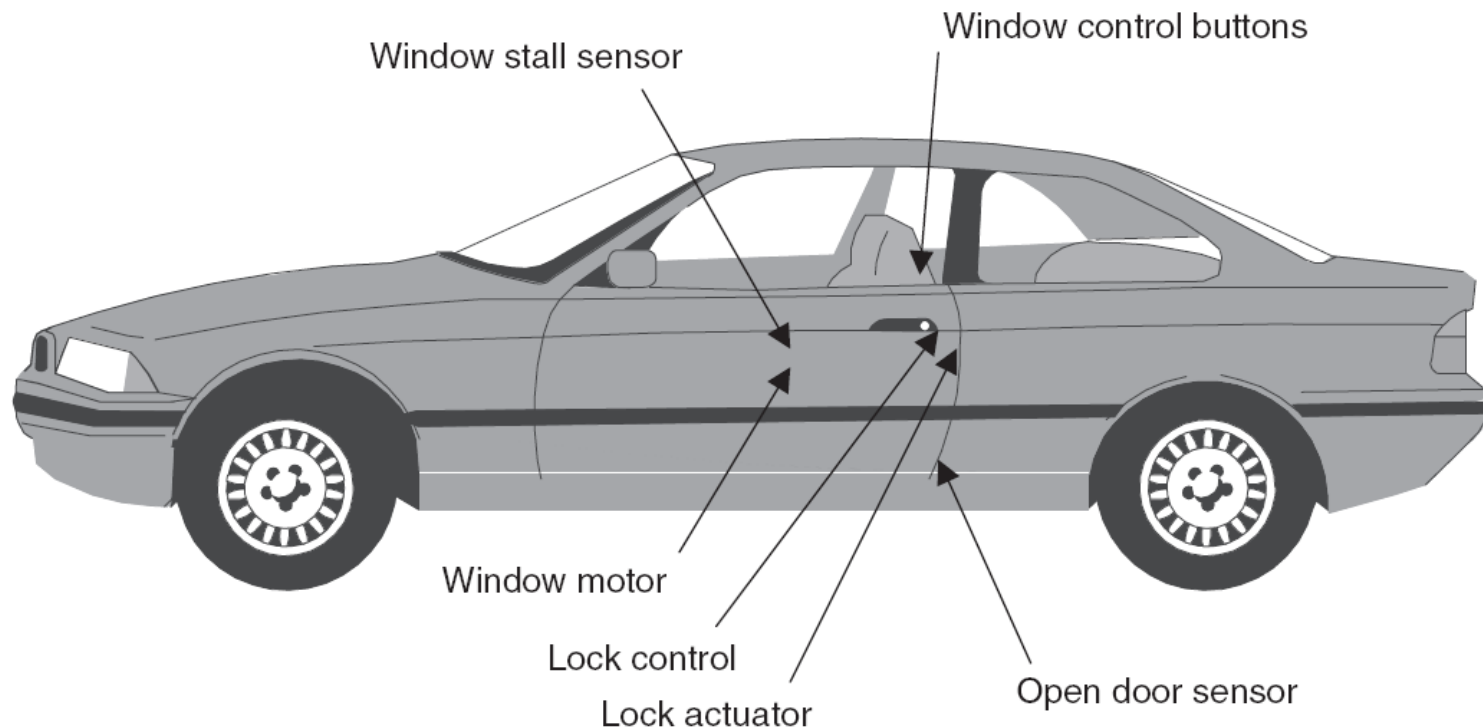# Embedded system Introduction

Definition

- An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts.

(wikipedia)

Embedded system Introduction

Example:

Embedded system used in Car Door

Embedded system Introduction

Application Area

- General Computing
  Video games, set-top boxes, wearable computer

- Control System
  Vehicle engine, nuclear power, fight control

- Signal Processing
  Radar, Sonar, video compression.

- Communication & Network
  Telephone system, router

Embedded system Introduction

Features:

- Embedded system is designed to perform some specific tasks.

- The program written for embedded system is called "firm-ware", and usually stored in persistence memory (rom/flash)

- The firm-ware can run with limited hardware resourced.

Table of contents

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Microprocessors and Microcontrollers

- The microprocessor is a processor on one silicon chip.

- The microcontrollers are used in embedded computing.

- The microcontroller is a microprocessor with added circuitry.

Microcontroller overview

- **Definition**

  MCU is integrated electronic computing device that includes three major components on a single chip:

  - Microprocessor

  - Memory

  - I/O ports
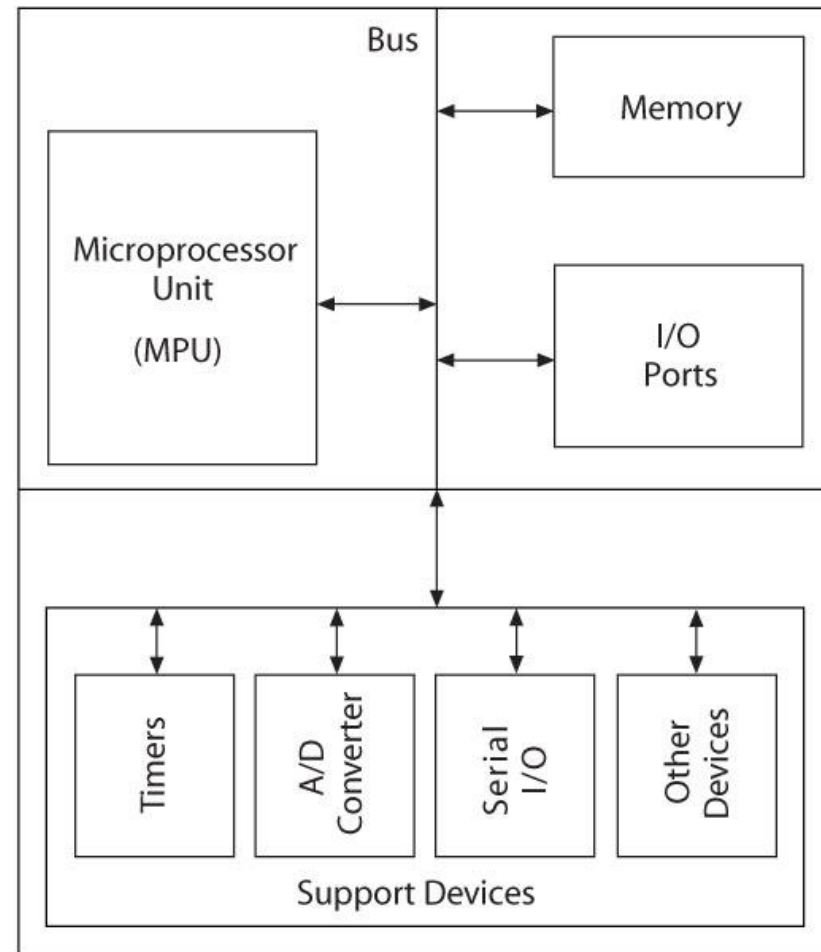
Microprocessor overview

- ## Definition

  The microprocessor is a multipurpose, programmable device that accepts digital data as input, processes it according to instructions stored in its memory, and provides results as output.
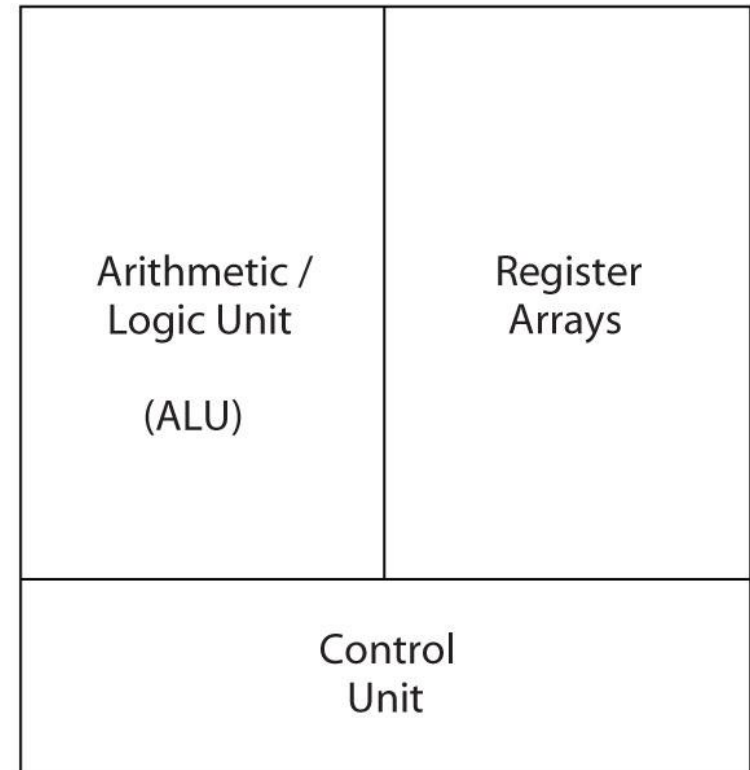
  (Wiki)

Arithmetic / Logic Unit (ALU)	Register Arrays
Control Unit	

Table of contents

Microprocessor architecture

- Communicates with Memory and I/O using the System Bus:

Address bus

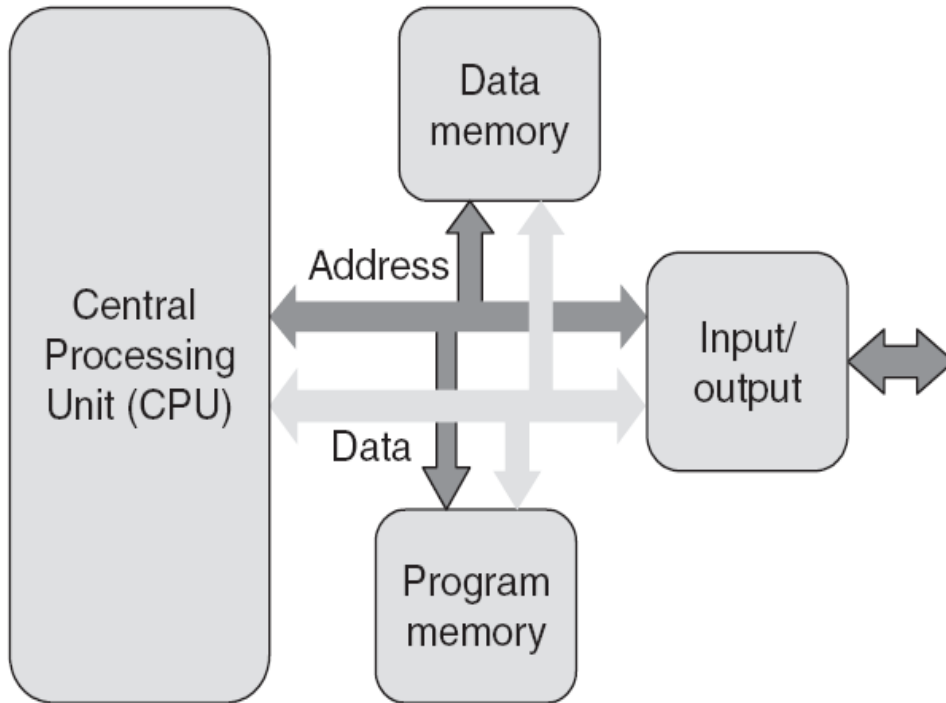- Unidirectional
- Memory and I/O Addresses

Data bus

- Bidirectional
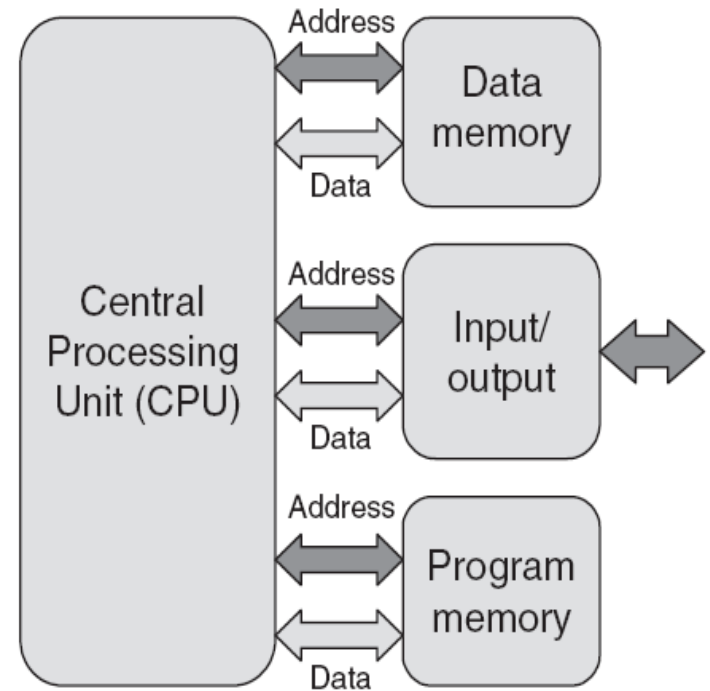- Transfers Binary Data and Instructions

Control lines

- Read and Write timing signals

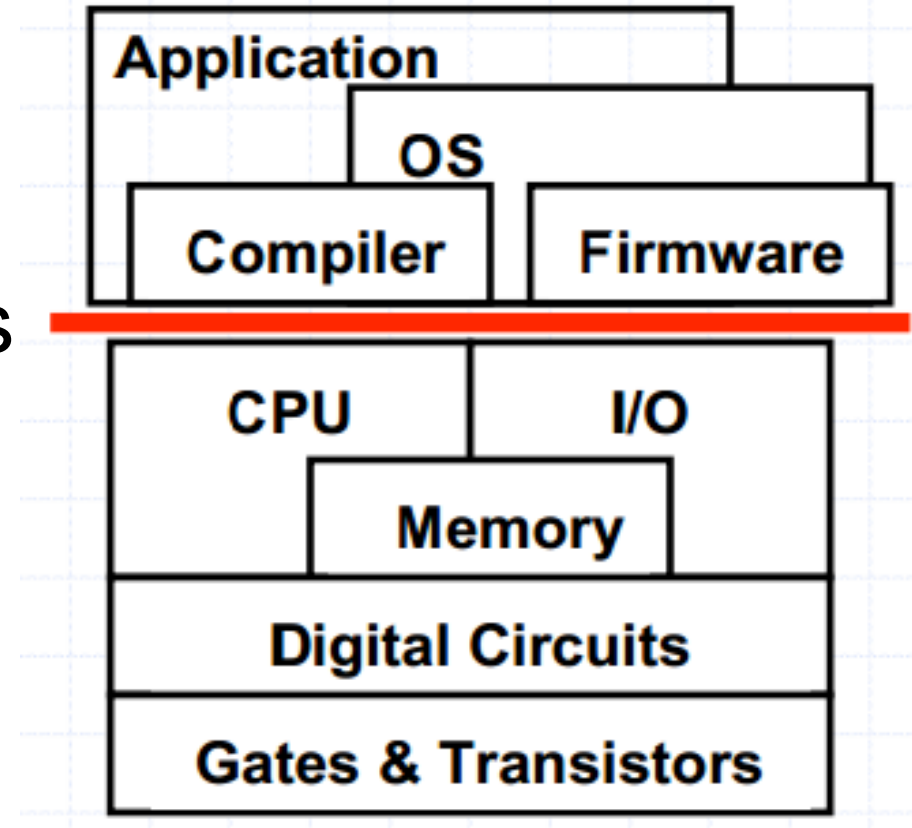# Microprocessor architecture

Von Neumann

Harvard

Table of contents

Instruction Set Architecture

How to talk to computers

Instruction Set Architecture

- **Definition**

  ISA is the part of the computer architecture related to programming, including the native data types, instructions, registers, addressing modes, memory architecture, interrupt and exception handling, and external I/O.

  (wiki)

How to design ISA

1. **Operations**
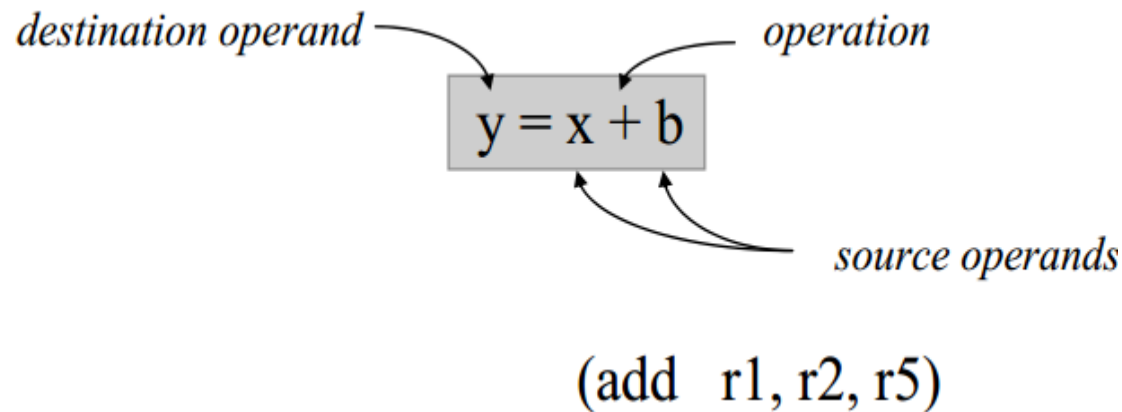   - how many
    - which ones
2. **Operands**
    - how many
    - location
    - types
    - how to specify
3. **Instruction format**
    - size
    - how many formats

destination operand → operation →

$$y = x + b$$

← source operands

(add r1, r2, r5)

CISC & RISC

CISC

- Fewer instructions to execute a given task than RISC

- Programs for CISC take less storage space than programs for RISC

- Arithmetic or other instructions may read their operand from memory and could write the result in memory

RISC

- Simpler instructions, faster execution speeds per instruction

- Cheaper to implement

- Load/Store architecture – only load and store are used to access the external memory

Summary

- An embedded system is a product that has one or more computers embedded within it.

- The embedded computer is usually a microcontroller: a microprocessor adapted for embedded control applications.

- There are two kinds of microprocessor architectures: Harvard & Von Neumann

- The ISA serves as the boundary between software and hardware

Question & Answer

Thanks for attention !

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