جامعة المستقبل
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Microprocessor

Lecture 1
Concepts of Microprocessors, Microcomputer, Microcontroller: Organization of MP base system

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Overview

- The microprocessor is a general-purpose programming logic device.
- Understanding the microprocessor concepts is crucial in understanding the operation of digital computer.
- This lecture is an introduction to the basic concept of microprocessor architecture and operation
- The content of the lecture is divided into three sections:
  - microprocessor architecture,
  - programming and
  - interfacing input/output.
- The lecture is designed around the Intel 8-bit microprocessor (**8085**) and its **assembly language**

Learning Objectives

- At the end of the lecture, student should be:
  - Understand the fundamental operation of a microprocessor.
  - Grasp the basic concepts of microprocessor architecture and pin configuration.
  - Comprehend machine language programming.
  - Design and write programs using assembly language.
  - Understand the fundamentals of microprocessor input/output interfacing.

Introduction

- Most people think that computers are some kind of complicated device that is impossible to learn and infinitely intelligent, able to think better than a person.
  - **The reality is much simpler.**
- A computer can only do what the programmer has told it to do, in the form of **program**.
- **A program** is just a sequence of very simple commands that lead the computer to solve some problem.
- Once the program is written and debugged, the computer can execute the instructions very fast , and always do it the same, every time, without a mistake.

What is Microprocessor

- **A microprocessor** is the controlling unit of a microcomputer, fabricated on a small chip, capable of performing Arithmetic and Logic Unit (ALU) operations and communicating with other connected devices.
  - **It is designed to execute instructions and perform tasks within a computer system**.
    - **Example: A microprocessor in a smartphone executes instructions to run apps, handle touch inputs, and manage communication between hardware components like the screen, battery, and camera.**
  - Microprocessors contain both **combinational logic and sequential digital logic** and operate on numbers and symbols represented in the binary number system.
    - **Example: In a desktop computer, the microprocessor uses combinational logic for arithmetic operations (e.g., addition and multiplication) and sequential logic for maintaining order in tasks like running a game, processing inputs, or loading files.**
- Both microprocessors and microcontrollers are *ICs designed for real-time applications*, sharing many common features but also having significant differences.

What is Microprocessor

- **Microprocessor:**
  - An IC that contains only the CPU, providing processing power.
  - Example: **Intel Core i7 or AMD Ryzen processors** in laptops and desktop computers, which rely on external RAM, storage, and peripherals for functionality.
- **Microcontroller:**
  - An integrated circuit (IC) that includes a CPU, along with a fixed amount of RAM, ROM, and other peripherals, all embedded on a single chip.
  - Sometimes referred to as a mini-computer or a computer on a single chip.
  - Designed to perform specific tasks.
  - Example: **Arduino Uno**, which controls sensors and motors in a robot, or the microcontroller in a microwave that manages its timer, buttons, and heating elements.
- **Microcomputer:**
  - A small, relatively inexpensive computer with a microprocessor as its Central Processing Unit (CPU).
  - It includes a microprocessor, memory, and input/output (I/O) facilities.
  - Example: **Raspberry Pi**, a compact computer used for projects like home automation, media streaming, or coding education.

What is Microprocessor

- The **microprocessor** is a programmable integrated device with computing and decision-making capabilities similar to a computer's central processing unit (CPU).
  - **Example**: The Intel Core i5 in laptops helps run programs like games or browsers**.**
- **Being programmable** means the microprocessor can be instructed to perform specific tasks within its capabilities.
  - **Example**: In a washing machine, the microprocessor is programmed to handle different wash settings like "Quick Wash" or "Heavy Load."
- It is **a clock-driven semiconductor device** made up of electronic logic circuits.
  - **Example**: A smartphone chip, like the Snapdragon, uses a clock to open apps, stream videos, and make calls.
- Microprocessors are manufactured using either large-scale integration (**LSI**) or very-large-scale integration (**VLSI**) techniques.
  - **Example**: Chips like Apple's M1 are made with billions of circuits to make computers faster and more efficient.

Microprocessor

- A typical microprocessor (MPU) has **three** main parts:

  1. **The Program Counter (PC)** keeps track of which command is to be executed next.
     - **Example: In a calculator app, the Program Counter ensures the microprocessor follows the correct steps to perform an addition after you press “+” and input numbers.**
  2. **The Memory** stores the commands that need to be executed.
     - **Example: When you open a web browser, the memory holds the instructions needed to load and display the website.**
  3. **The Input/Output (I/O)** handles transferring data to and from the outside world (devices connected to the microprocessor).
     - **Example: When typing on a keyboard, the input sends the keypresses to the microprocessor, and the output sends the characters to appear on the screen.**

Microprocessor

- The microprocessor communicates using binary numbers (0 and 1), which are called **bits**.
  - **Example**: **When you press a key on your keyboard, the computer processes it as a combination of 0s and 1s, like "01000001" for the letter 'A'.**
- Each microprocessor has a fixed set of instructions in binary form called machine language.
  - **Example**: **A command like "add two numbers" is represented as a binary instruction (e.g., "110010") that the microprocessor understands.**
- Humans find it hard to work directly with 0s and 1s.
  - **Example**: **Instead of writing "110010" to perform an addition, it's much easier for a programmer to use a simplified name or symbol.**
- The binary instructions are given short, readable names called **mnemonics**, which form the assembly language for a microprocessor.
  - **Example**: **In assembly language, the instruction to add two numbers is written as ADD instead of a binary sequence, making it easier for programmers to work with.**

Microprocessor

- A typical programmable machine consists of four components:
  - Microprocessor – Memory – Input – Output
- These components work together or interact to perform a given task, forming a system.
- The physical components of the system are called **hardware**.
- A set of instructions written for the microprocessor to perform a task is called a **program**.
- A group of programs is referred to as **software**.
- **Example Task:** Writing a document!
  - Microprocessor: **Executes the program instructions** to open the word processing software and process the text.
  - Memory: **Stores the program**, the text you type, and temporary files as you work.
  - Input: **You use the keyboard** to type text into the document.
  - Output: **The screen displays** the text you’re writing, and a printer might output a physical copy once you're done.

Microprocessor

- Microprocessor applications are classified into two categories:
  - Reprogrammable Systems
  - Embedded Systems
- Reprogrammable Systems (e.g., *microcomputers*):
  - **Used for computing and data processing.**
  - Include:
    - **General-purpose microprocessors capable of handling large data.**
    - **Mass storage devices like disks and CD-ROMs.**
    - **Peripherals such as printers.**
    - **Example: Personal Computer (PC).**
- **Embedded Systems:**
  - **The microprocessor is part of a final product and cannot be reprogrammed by the end user.**
  - Examples include:
    - **Copying machine. Washing machine. Air conditioner. Other household or industrial devices.**

A Simple Program

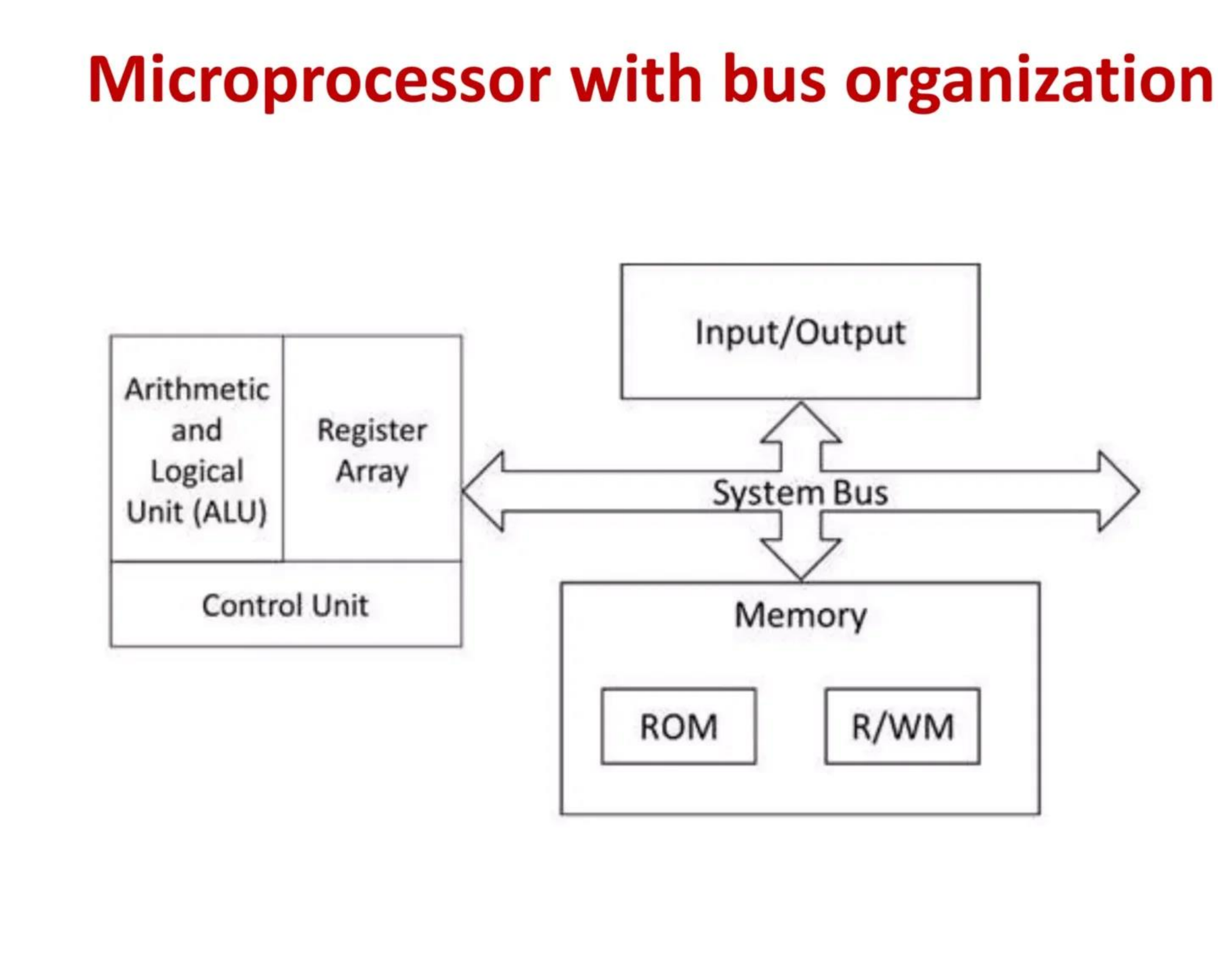
- A **program** is a sequence of simple commands or instructions.
- **Real-world example: Crossing a busy street:**
  - **Step 1: Walk up to the traffic lights and stop.**
  - **Step 2: Look at the traffic light.**
  - **Step 3: Is your light green?**
  - **Step 4: If the light is red, go to Step 2. (Otherwise, continue to Step 5.)**
  - **Step 5: Look to the left.**
  - **Step 6: Are there cars still passing by?**
  - **Step 7: If yes, go to Step 5. (Otherwise, continue to Step 8.)**
  - **Step 8: Look to the right.**
  - **Step 9: Are there cars still passing by? (There shouldn’t be any by now, but you never know!)**
  - **Step 10: If yes, go to Step 8. (Otherwise, continue to Step 11.)**
  - **Step 11: Proceed across the street, carefully!**

Evolution of Microprocessors

- **First Generation (4-bit Microprocessors):**
  - Introduced by Intel in 1971-1972 with the Intel 4004, capable of basic arithmetic, logic, and instruction execution.
- **Second Generation (8-bit Microprocessors):**
  - Introduced by Intel in 1973 with the Intel 8008, followed by the enhanced Intel 8088.
- **Third Generation (16-bit Microprocessors):**
  - Released in 1978, including Intel 8086, Zilog Z8000, and Intel 80286, capable of 16-bit operations.
- **Fourth Generation (32-bit Microprocessors):**
  - Notable example: Intel 80386, a widely used 32-bit processor.
- **Fifth Generation (64-bit Microprocessors):**
  - Since 1995, 64-bit processors like Intel’s Pentium Pro enabled multiple CPUs in a single processor.

Organization of a Microprocessor-Based System

- **Microprocessor:**
  - Reads instructions from memory.
  - Communicates with all peripherals (memory and I/O) using the system bus.
  - Controls the timing of information flow.
  - Performs the computing tasks specified in a program.
- **Memory:**
  - Stores binary information, called instructions and data.
  - Provides instructions and data to the microprocessor on request.
  - Stores results and data for the microprocessor.
- **Input Device:**
  - Enters data and instructions under the control of a program.
- **Output Device:**
  - Accepts data from the microprocessor as specified in a program.
- **Bus:**
  - Carries bits between the microprocessor, memory, and I/O devices.



Microprocessor with bus organization

THANK YOU ☺