Microprocessor

كلية التربية للعلوم الصرفة/ ابن الهيثم

المرحلة الثانية

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Introduction to Computer

- A computer is an electronic device, operating under the control of instructions stored in its own memory that can accept data (input), process the data according to specified rules, produce information (output), and store the information for future use.

Computer Components

Any kind of computers consists of **Software** and **Hardware**:

- **Software:** Software is a generic term for organized collections of computer data and instructions, often broken into two major categories: system software that provides the basic non-task-specific functions of the computer, and application software which is used by users to accomplish specific tasks.
- **Hardware:** Computer hardware is the collection of physical elements that constitutes a computer system. Computer hardware refers to the physical parts or components of a computer such as the monitor, mouse, keyboard, etc. all of which are physical objects that can be touched.

Basic Components of a computer

1. Central Processing Unit (CPU)
2. Read Only Memory (ROM)
3. Random Access Memory (RAM)
4. Input / Output ports
5. Bus System

1. Central Processing Unit (CPU)

- A CPU is brain of a computer. It is responsible for all functions and processes. Regarding computing power, the CPU is the most important element of a computer system.

The CPU is comprised of three main parts:

A. Arithmetic Logic Unit (ALU)
B. Control Unit (CU)
C. Registers

The main three parts of CPU:

A. **Arithmetic Logic Unit (ALU):** Executes all arithmetic and logical operations. Arithmetic calculations like as addition, subtraction, multiplication and division. Logical operation like compare numbers, letters, or special characters

B. **Control Unit (CU):** controls and co-ordinates computer components.

- Read the code for the next instruction to be executed.
- Increment the program counter so it points to the next instruction.
- Read whatever data the instruction requires from cells in memory.
- Provide the necessary data to an ALU or register.
- If the instruction requires an ALU or specialized hardware to complete, instruct the hardware to perform the requested operation.

C. **Registers:** they are a temporary storage memory that is built into CPU. Registers are performed their tasks quickly. All computers required these registers to manipulate data, and store memory addressing.

The CU deals with several special-purpose registers and their functions:

- **Program counter (PC):** The PC holds the address of the next instruction to be executed.
- **Instruction register (IR):** The IR holds the actual instruction being executed currently by the computer.
- **Memory address register (MAR):** The MAR holds the address of a memory location.
- **Memory data register (MDR):** The MDR holds a data value that is being stored to or retrieved from the memory location currently addressed by the memory address register.
- **Status register (SR):** The SR indicates the results of an arithmetic and logic unit operation. For example: carry, overflow, negative.

The Fetch-Execute Cycle

- Depending on the complexity of each operation (i.e., task), the computer may take two or more machine cycles in order to complete the task.

A machine cycle consists of both fetch and execution cycles:

- **In the fetch cycle**, the CU brings the program instruction from the memory, decodes it (i.e., translates the instruction into commands), and then sends the data to the ALU for execution.
- **In the execution cycle**, the ALU performs an operation and then sends the result to the memory for temporary storage.

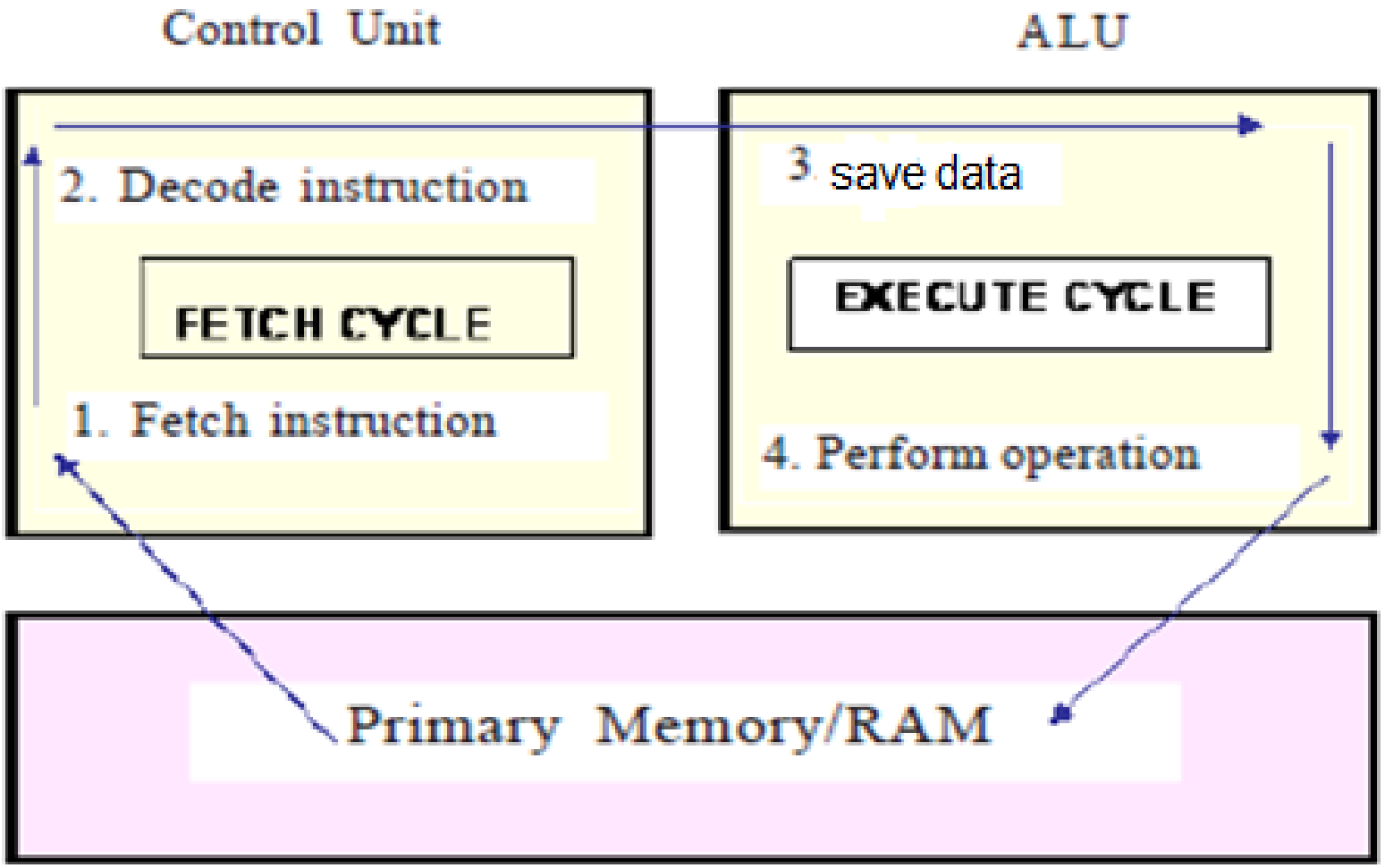

Fig. 1 Fetch and Execution Cycle

Evolution of Microprocessors

We can categorize the microprocessor according to the generations or according to the size of the microprocessor:

1) **First Generation (4-bit Microprocessors):** The first generation microprocessors were introduced in the year 1971-1972 by Intel Corporation. It was named Intel 4004 since it was a 4-bit processor. It was a processor on a single chip. It could perform simple arithmetic and logical operations such as addition, subtraction, Boolean OR and Boolean AND.
2) **Second Generation (8-bit Microprocessor):** The second generation microprocessors were introduced in 1973 again by Intel. It was a first 8 - bit microprocessor which could perform arithmetic and logic operations on 8-bit words. It was Intel 8008, and another improved version was Intel 8088.

Evolution of Microprocessors

3) **Third Generation (16 - bit Microprocessor):** The third generation microprocessors, introduced in 1978 were represented by Intel's 8086, Zilog Z800 and 80286, which were 16 - bit processors with a performance like minicomputers.

4) **Fourth Generation (32 - bit Microprocessors):** Several different companies introduced the 32-bit microprocessors, but the most popular one is the Intel 80386.

5) **Fifth Generation (64 - bit Microprocessors):** From 1995 to now we are in the fifth generation. After 80856, Intel came out with a new processor namely Pentium processor followed by Pentium Pro CPU, which allows multiple CPUs in a single system to achieve multiprocessing. Other improved 64-bit processors are Celeron, Dual, Quad, Octa Core processors.

RAM

- RAM is a memory scheme within the computer system responsible for storing data on a temporary basis, so that it can be promptly accessed by the processor as and when needed. It is volatile in nature, which means that data will be erased once supply to the storage device is turned off.
- RAM stores data randomly and the processor accesses these data randomly from the RAM storage.
- RAM is considered "random access" because you can access any memory cell directly if you know the row and column that intersect at that cell.

Memory Write Operation

Three basic steps are needed in order the CPU to perform a write operation into a specified memory location:

1. The word to be stored into the memory location is first loaded by the CPU into a specified register, called the memory data register (MDR).
2. The address of the location into which the word is to be stored is loaded by the CPU into a specified register, called the memory address register (MAR).
3. A signal, called write, is issued by the CPU indicating that the word stored in the MDR is to be stored in the memory location whose address in loaded in the MAR.

Memory Read Operation

Three basic steps are needed in order to perform a memory read operation:

1. The address of the location from which the word is to be read is loaded into the MAR.
2. A signal, called read, is issued by the CPU indicating that the word whose address is in the MAR is to be read into the MDR.
3. After some time, corresponding to the memory delay in reading the specified word, the required word will be loaded by the memory into the MDR ready for use by the CPU.

ROM

- ROM is a permanent form of storage.
- ROM stays active regardless of whether power supply to it is turned on or off.
- ROM devices do not allow data stored on them to be modified.

Input /Output Devices

- Input device is any peripheral (piece of computer hardware equipment to provide data and control signals to an information processing system such as a computer).
- Input device Translate data from form that humans understand to one that the computer can work with. Most common are keyboard and mouse.
- Output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) which converts the electronically generated information into human-readable form.
- I/O Devices are connected to the system bus through **I/O controller** (interface) – which acts as interface between the **system bus** and **I/O devices**.

There are two main reasons for using I/O controllers

1. I/O devices exhibit different characteristics and if these devices are connected directly, the CPU would have to understand and respond appropriately to each I/O device. This would cause the CPU to spend a lot of time interacting with I/O devices and spend less time executing user programs.
2. The amount of electrical power used to send signals on the system bus is very low. This means that the cable connecting the I/O device has to be very short (a few centimeters at most). I/O controllers typically contain driver hardware to send current over long cable that connects I/O devices.

Bus System

- A Bus is a common communications pathway used to carry information between the various elements of a computer system

- The term BUS refers to a group of wires or conduction tracks on a printed circuit board (PCB) though which binary information is transferred from one part of the microcomputer to another

- The individual subsystems of the digital computer are connected through an interconnecting BUS system.

There are three main bus groups:

1) Address Bus
2) Data Bus
3) Control Bus

1) Address Bus

- The address bus consists of 16, 20, 24, or more parallel signal lines. On these lines the CPU sends out the address of the memory location that is to be written to or read from.
- The number of address lines determines the number of memory locations that the CPU can address. If the CPU has N address lines then it can directly address 2N memory locations.
- The 8086 microprocessor has 20 bit address bus, therefore it can address a maximum of 1M byte of memory location with an address ranged from (00000)H-(FFFFF)H

2) Data Bus

- The data bus consists of 8, 16, 32 or more parallel signal lines. As indicated by the double-ended arrows on the data bus line, the data bus lines are bi-directional.
- This means that the CPU can read data in on these lines from memory or from a port as well as send data out on these lines to memory location or to a port.
- Many devices in a system will have their outputs connected to the data bus, but the outputs of only one device at a time will be enabled.

3) Control Bus

- The control bus consists of 4-10 parallel signal lines.
- The CPU sends out signals on the control bus to enable the outputs of addressed memory devices or port devices.
- Typical control bus signals are memory read, memory write, I/O read, and I/O writer.

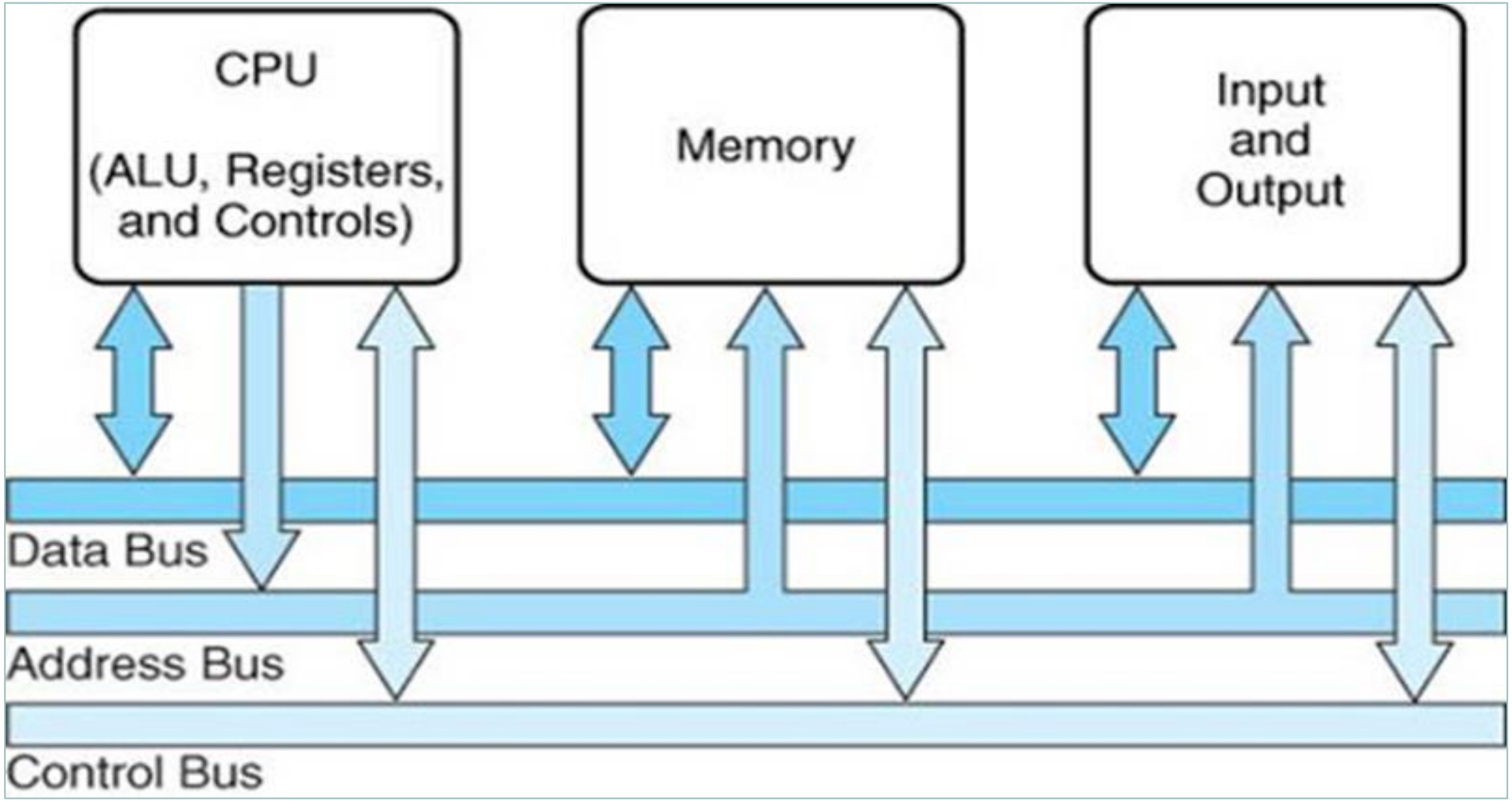

Fig. (2) System Bus in Computer