Chapter One

Introduction to Microprocessor, Microcomputer

Introduction to microprocessor

The microprocessor is sometimes referred to as the 'brain' of the personal computer, and is responsible for the processing of the instructions which make up computer software. It houses the central processing unit, commonly referred to as the CPU, and as such is a crucially important part of the home PC.

The world's first microprocessor, the Intel 4004, was a 4-bit microprocessor–programmable controller on a chip. It addressed a mere 4096, 4-bit-wide memory locations. (A **bit** is a binary digit with a value of one or zero. A 4-bit-wide memory location is often called a **nibble**.) The 4004 instruction set contained only 45 instructions.

The 4-bit microprocessor debuted in early video game systems and small microprocessor-based control systems. One such early video game, a shuffleboard game, was produced by Bailey. The main problems with this early microprocessor were its ***speed***, ***word width***, and ***memory size***. The evolution of the 4-bit microprocessor ended when Intel released the 4040, an updated version of the earlier 4004. The 4040 operated at a higher speed, although it lacked improvements in word width and memory size. The 4-bit microprocessor still survives in low-end applications such as microwave ovens and small control systems and is still available from some microprocessor manufacturers. Most calculators are still based on 4-bit microprocessors that process 4-bit BCD (**binary-coded decimal**) codes.

Later in 1971, realizing that the microprocessor was a commercially viable product, Intel Corporation released the 8008—an extended 8-bit version of the 4004 microprocessor. The 8008 addressed an expanded memory size (16K bytes) and contained additional instructions (a total of 48) that provided an opportunity for its application in more advanced systems. (A **byte** is generally an 8-bit-wide binary number and a **K** is 1024. Often, memory size is specified in K

bytes.) As engineers developed more demanding uses for the 8008 microprocessor, they discovered that its somewhat small memory size, slow speed, and instruction set limited its usefulness. Intel recognized these limitations and introduced the 8080 microprocessor in 1973—the first of the modem 8-bit microprocessors.
Soon, other companies began to introduce their own versions of the 8-bit microprocessor.

Introduction to Microcontroller Architecture

Computer Architecture

Is the conceptual design and fundamental operational structure of a computer system. It is a blueprint and functional description of requirement and design implementations for the various parts of a compute, focusing largely on the way by which the CPU performs internally and accesses addresses in memory.

A computer system is a set of tools that can aid people in performing data processing tasks and in solving computational problems. Some of these tools consist of mechanical hardware and electronic circuits. These are the computer itself and its peripheral equipment such as terminal, printers, disk storage devices, and communications equipment. Other tools are software- the computer programs. These programs knit everything together and make it possible for the user to get down to business working on his problem, without having to learn the complicated but irrelevant details of exactly how the computer system works.

Computer Hardware

Hardware is equipment involved in the function of a computer. Computer hardware consists of the components that can be physically handled. The function of these components is typically divided into four main categories, there are: Central Processing Unit (CPU), Memory Unit, Input/Output (I/O) Units, and system interconnection (Busses) that provide the communication among the CPU, main memory, and I/O. The basic components of computer hardware shown in figure (1.1).

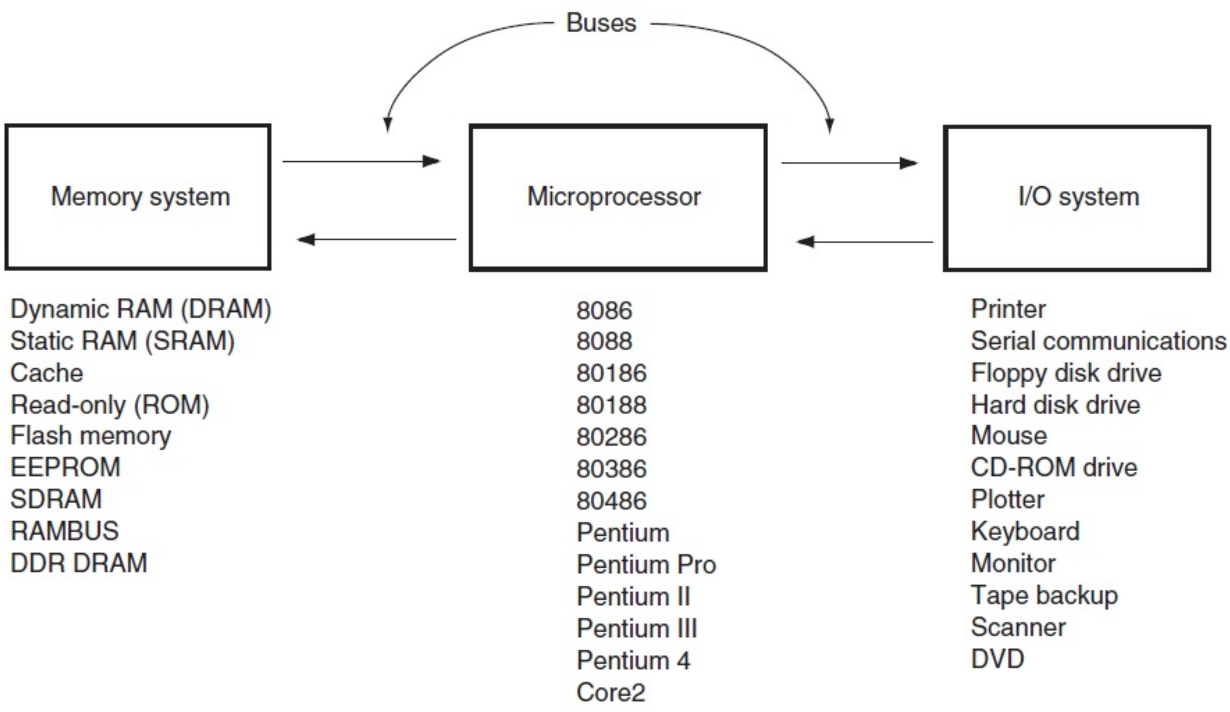

Fig. (1.1) ***The Block Diagram of a Microprocessor-based Computer System***

1. CPU Structure

This section, using a simplified model of a central processing unit as an example, takes you through the role of each of the major constituent parts of the CPU. It also looks more closely at each part, and examines how they are constructed and how they perform their role within the microprocessor. As there are a great many variations in architecture between the different kinds of CPU, we shall begin a looking at a simplified model of the structure. The model to be used is a good basis on which to build your knowledge of the workings of a microprocessor. The simplified model consists of three parts, which are:

- Arithmetic & Logic Unit (ALU)

  The part of the central processing unit that deals with operations such as addition, subtraction, and multiplication of integers and Boolean operations. It receives control signals from the control unit telling it to carry out these operations.

- Control Unit (CU)

  This controls the movement of instructions in and out of the processor, and also controls the operation of the ALU. It consists of a decoder, control logic circuits, and a clock to ensure everything happens at the correct time. It is also responsible for performing the instruction execution cycle

- Register Array

  This is a small amount of internal memory that is used for the quick storage and retrieval of data and instructions. All processors include some common registers used for specific functions, namely the program counter, instruction register, accumulator, memory address register and stack pointer.

2. Memory Unit

The computer memory is a temporary storage area. It holds the data and instructions that the Central Processing Unit (CPU) needs. Before a program can be run, the program is loaded from some storage medium into the memory. This allows the CPU direct access to the program. Memory is like the page of a notebook with space for a fixed number of binary numbers on each line.

The memory unit usually described by its **size** which represents the number of locations in the memory and its wordlength which specify the capacity in bits for each location in the memory. These two parametrs affected by the number of address bus and data bus of the microprocessor. A general memory structure shown in figure (1.2).

For example, we have a maximum number of address lines connected to a memory from the CPU is **8** and the maximum number of data lines that the memory can deal with is **16** so

$n = 8$

$m = 16$

Type of memory = $2^n \times m$

$= 2^8 \times 16$

$= 256 \times 16$

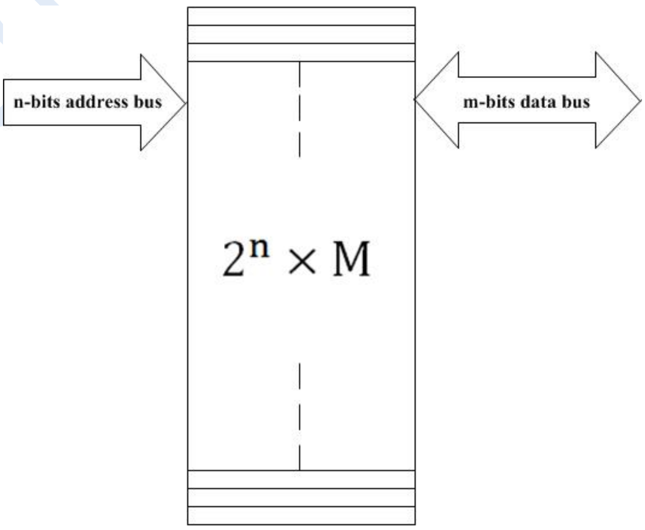

Fig. (1.2) ***Memory Structure***

3. Input / Output (I/O) Unit

Input / output refers to the complementary tasks of gathering data for the microprocessor to work with and making the results available to the user through a device such as the display, disk drive, or printer. The keyboard and the mouse are input devices that make information available to the computer; the display and printer are output devices with which the computer makes its results available to the user. The Hard Disk is both an input and an output device because it can either provide stored information or store the data after processing.

4. System Busses

A set of wires carry data communication between the major components of the computer, including the microprocessor. Not all of the communication that uses the bus involves the CPU, although naturally the examples used in this tutorial will centre on such instances.

The system bus consists of three different groups of wiring, called the data bus, control bus and address bus. These all have seperate responsibilities and characteristics, which can be outlined as follows:

1. **Control Bus**

   The control bus carries the signals relating to the control and co-ordination of the various activities across the computer, which can be sent from the control unit within the CPU. Different architectures result in differing number of lines of wire within the control bus, as each line is used to perform a specific task. For instance, different, specific lines are used for each of read, write and reset requests.

2. **Data Bus**

   This is used for the exchange of data between the processor, memory and peripherals, and is bi-directional so that it allows data flow in both directions along the wires. Again, the number of wires used in the data bus (sometimes known as the 'width') can differ. Each wire is used for the transfer of signals corresponding to a single bit of binary data. As such, a greater width allows greater amounts of data to be transferred at the same time.

3. **Address Bus**

   The address bus contains the connections between the microprocessor and memory that carry the signals relating to the addresses which the CPU is processing at that time, such as the locations that the CPU is reading from or writing to. The width of the address bus corresponds to the maximum addressing capacity of the bus, or the largest address within memory that the bus can work with. The addresses are transferred in binary format, with each line of the address bus carrying a single binary digit. Therefore the maximum address capacity is equal to two to the power of the number of lines present $\left(2^{\text{number of lines}}\right)$.

Figure (1.3) represents the block diagram of a computer system with different types of busses.

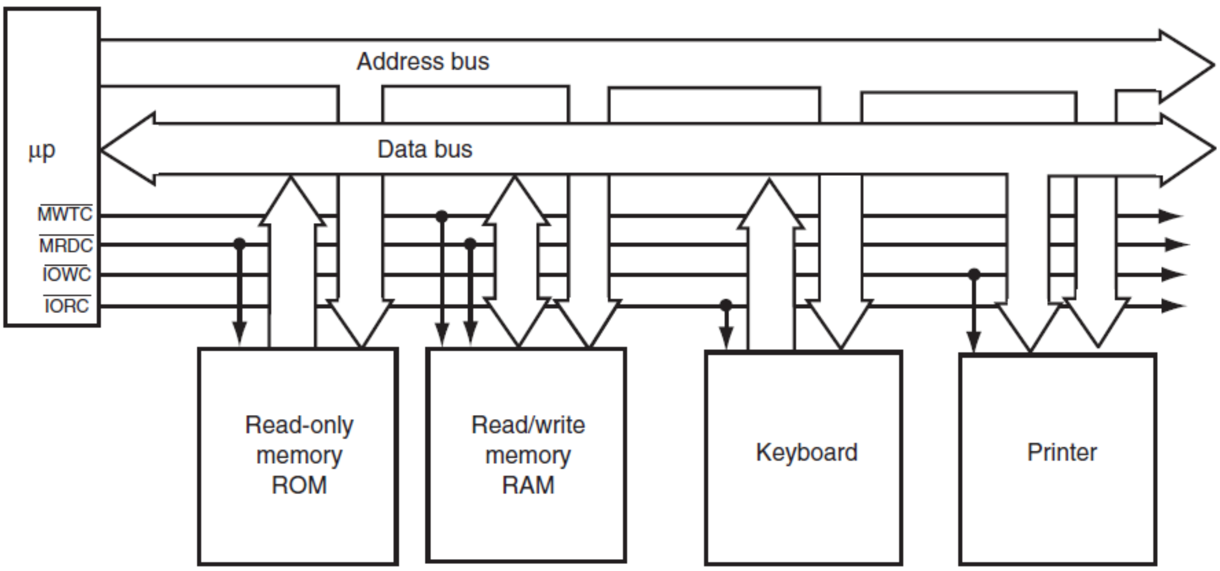

Fig. (1.3) ***The Block Diagram of a Computer Showing the Address, Data, and Control Bus Structure***

Table 1.1 lists some of the intel Microprocessors showing its address and data bus size and the maximum amount of addressable memory.

Microprocessor	**Data Bus(bits)**	**Address Bus(bits)**	**Memory Size (byte)**
8085	**8**	**16**	**64 k**
8088	**8**	**20**	**1 M**
8086	**16**	**20**	**1 M**
80186	**16**	**20**	**1 M**
80286	**16**	**24**	**16 M**
80386	**32**	**32**	**4 G**
80486	**32**	**32**	**4 G**
Pentium	**64**	**32**	**4 G**
Pentium II	**64**	**36**	**64 G**
Pentium III	**64**	**36**	**64 G**

Table (1.1) Some of Intel Microprocessors