1.1 INTRODUCTION

The microprocessor is one of the most important components of a digital computer. It acts as a brain of a computer system. Computers are of two types: analog computers and digital computers. A digital computer makes processing of digital signals or numbers while analog computer processes analog signals (Continuous quantity) A digital computer is a programmable machine. Its main component is: CPU (Central Processing Unit), memory, input device and output device.

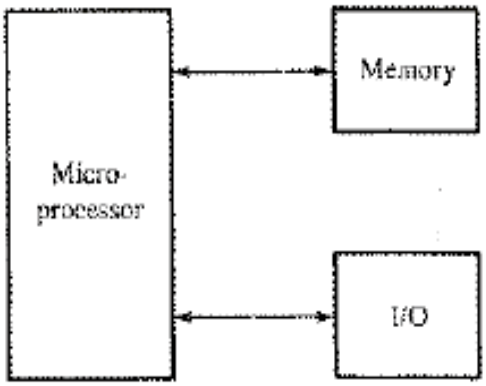

Figure 1.1.1 A Programmable machine

[Source: "Microprocessor Architecture Programming and Application" by R.S. Gaonkar, page-4]

The CPU executes instructions given by the programmer. The input device is used to feed programs and data to the computer. The memory is storage device. It stores programs, data and result. The output device displays or prints programs, data and/or results according to the instruction given to the computer.

"A microprocessor is a multipurpose, programmable, clock driven, register- based electronic device that reads binary instructions from storage device called memory, accepts binary data as input and processes data according to those instructions, and provides results as output."

The physical component digital computer system or programmable machine are called hardware. A set of instructions written for microprocessor to perform a task is called a program, and group of programs is called software.

The microprocessor operates in binary digits, 0 and 1, also known as bits. Each microprocessor recognizes and processes a group of bits called the word, and microprocessors are classified according to their word length.

Word Length of a Microprocessor:

The word length of microcomputer or microprocessor is given as "n-bit" where, n= 4, 8, 16, 32 or 64. An 8-bit microprocessor can process 8-bit data at a time. Its ALU (Arithmetic Logic Unit) is of 8 bit, its general purpose registers which holds data for processing, are 8-bit. Similarly, a 16-bit processor handles 16-bit data at a time and its ALU, general purpose registers, are of 16 bits. A processor of longer word length is more powerful and can process data at faster speed.

History of microprocessor:

The first microprocessor INTEL 4004, a 4-bit PMOS microprocessor was introduced in the year 1971 by Intel Corporation, U.S.A. after this a 4-bit microprocessor Intel404, an enhanced version of Intel 4004 was developed. Many other companies also developed 4-bit microprocessor.

In 1972, Intel introduced the first 8- bit microprocessor, Intel 8008 which also uses PMOS technology. The microprocessor using PMOS technology were slow and not compatible with TTL logic. In 1976 Intel developed an improved version of 8-bit NMOS microprocessor, Intel 8085 which uses only one +5V.

Microprocessor	Year of introduction	Word length (bit)	Memory addressing capacity	Pins	Clock	Remarks
4004	1971	4	1 KB	16	750 KHz	First microprocessor
8085	1976	8	64 KB	40	3-6 MHz	Popular 8- bit microprocessor
8086	1978	16	1 MB	40	5-10 MHz	Popular 8- bit microprocessor
8088	1980	8/16	1 MB	40	5-8 MHz	Widely used in PC/XT
80286	1982	16	16 MB real, 4 GB virtual	68	6-12.5 MHz	Widely used in PC/AT
Pentium	1993	32	4 GB real, 32-bit address & 64-bit data bus	237 PGA	60-200 MHz	Contains 2 ALUs
Pentium Pro	1995	32	64 GB real, 36-bit address bus	387 PGA	150-200 MHz	It is data flow processor
Itanium	2001	64	64 address lines	423 PGA	733 MHz-1.5 GHz	64-bit (Explicitily Parallel Instruction Computing) Processor

A Microprocessor-Based System

From the above description, we can draw the following block diagram to represent a microprocessor-based system as shown

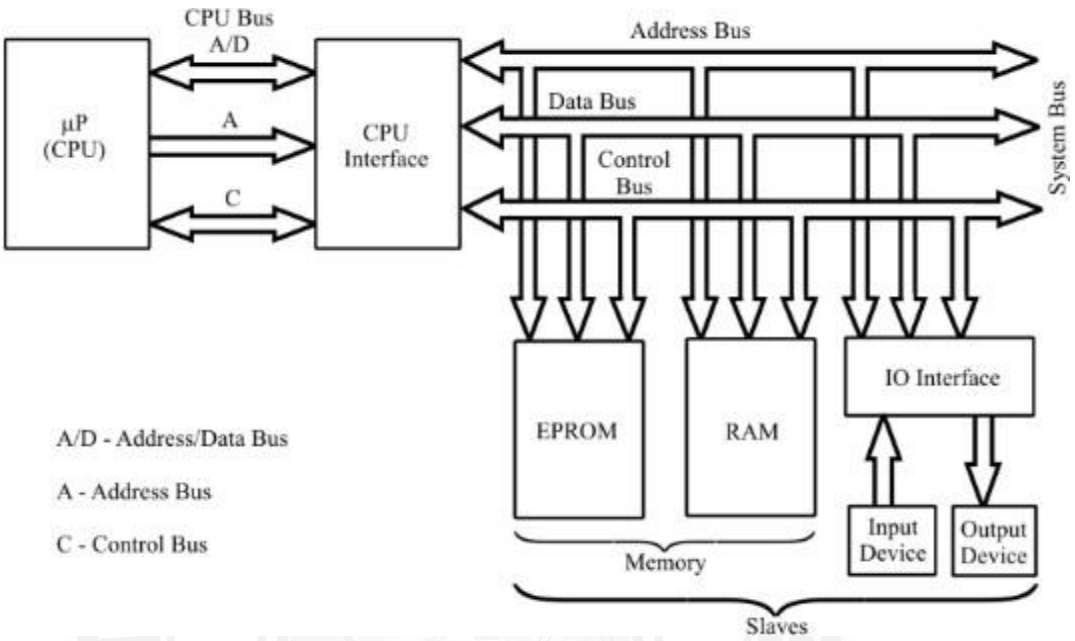

Figure 1.1.1 Microprocessor based system (organization of microcomputer)

[Source: "Microprocessor Architecture Programming and Application" by R.S. Gaonkar, page-6]

In this system, the microprocessor is the master and all other peripherals are slaves. The master controls all peripherals and initiates all operations. The buses are group of lines that carry data, address or control signals. The CPU interface is provided to demultiplex the multiplexed lines, to generate the chip select signals and additional control signals. The system bus has separate lines for each signal.

All the slaves in the system are connected to the same system bus. At any time, instant communication takes place between the master and one of the slaves. All the slaves have tristate logic and hence normally remain in high impedance state. The processor selects a slave by sending an address. When a slave is selected, it comes to the normal logic and communicates with the processor.

The EPROM memory is used to store permanent programs and data. The RAM memory is used to store temporary programs and data. The input device is used to enter program, data and to operate system. The output device is also used for examining the results. Since the speed of IO devices does not match with speed of microprocessor, an interface device is provided between system bus and IO device.

Central Processing Unit:

The CPU consists of ALU (Arithmetic and Logic Unit), Register unit and control unit. The CPU retrieves stored instructions and data word from memory; it also deposits processed data in memory.

a) ALU (Arithmetic and Logic Unit)

This section performs computing functions on data. These functions are arithmetic operations such as additions subtraction and logical operation such as AND, OR rotate etc. Result are stored either in registers or in memory or sent to output devices.

b) Register Unit:

It contains various register. The registers are used primarily to store data temporarily during the execution of a program. Some of the registers are accessible to the uses through instructions.

c) Control Unit:

It provides necessary timing & control signals necessary to all the operations in the microcomputer. It controls the flow of data between the processor and peripherals (input, output & memory). The control unit gets a clock which determines the speed of the processor.

There are three buses:

Address Bus:

It is a group of wires or lines that are used to transfer the addresses of Memory or I/O devices. It is unidirectional. In Intel 8085 microprocessor, Address bus was of 16 bits. This means that Microprocessor 8085 can transfer maximum 16-bit address which means it can address 65,536 different memory locations. This bus is multiplexed with 8-bit data bus. So the most significant bits (MSB) of address goes through Address bus (A7-A0) and LSB goes through multiplexed data bus (AD0-AD7).

Data Bus:

Data Bus is used to transfer data within Microprocessor and Memory/Input or Output devices. It is bidirectional as Microprocessor requires to send or receive data. The data bus also works as address bus when multiplexed with lower order address bus. Data bus is 8 Bits long. The word length of a processor depends on data bus, that's why Intel 8085 is called 8-bit Microprocessor because it have an 8 bit data bus.

Control Bus:

Microprocessor uses control bus to process data that is what to do with the selected memory location. Some control signals are Read, Write and Opcode fetch etc. Various operations are performed by microprocessor with the help of control bus. This is a dedicated bus, because all timing signals are generated according to control signal. The microprocessor is the master, which controls all the activities of the system. To perform a specific job or task, the microprocessor has to execute a program stored in memory. The program consists of a set of instructions stored in consecutive memory location. In order to execute the program, the microprocessor issues address and control signals, to fetch the instruction and data from memory one by one. After fetching each instruction, it decodes the instruction and carries out the task specified by the instruction.

Memory

To execute a program:

- The user enters its instructions in binary format into the memory.
- The microprocessor then reads these instructions and whatever data is needed from memory, executes the instructions and places the results either in memory or produces it on an output device.

The three cycle instruction execution model

- To execute a program, the microprocessor ―reads‖ each instruction from memory, ―interprets‖ it, then ―executes‖ it.
- To use the right names for the cycles
- The microprocessor fetches each instruction, decodes it, and then executes it. This sequence is continued until all instructions are performed.