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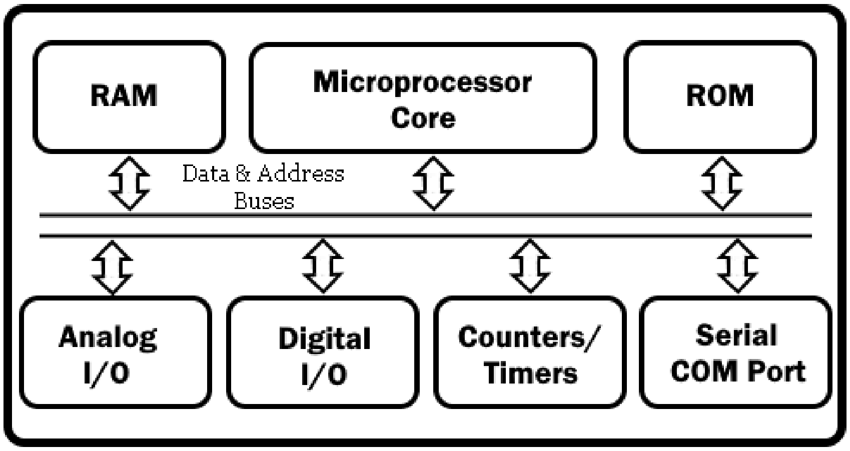
Contents:

Microprocessor and Microcontrollers:

- ✓ Difference between Microprocessor and Microcontrollers
- ✓ What is architecture
- ✓ Comparison between Harvard architecture Von Neumann architecture

Microcontroller:

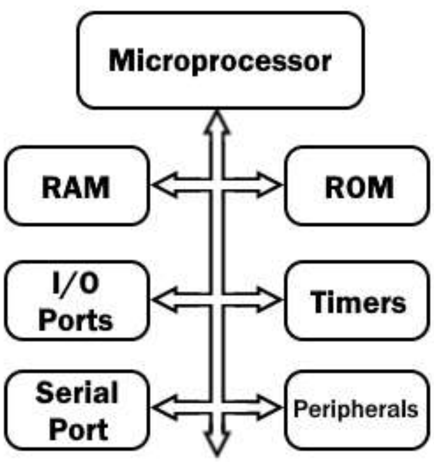
A microcontroller is a mini-computer on a single semiconductor IC (integrated circuit) chip. It is a complete computer and has all the essential components needed on a single chip such as the processing unit, ROM, RAM, I/O ports, serial ports and Timers, etc. It does not need external components to perform a task which makes it a perfect candidate for embedded and compact devices in industries. Most common series of the microcontroller are PIC, 8051, AVR, etc.



Microcontroller

Microprocessor:

A microprocessor is an IC that has only CPU (Central processing unit) without other necessary components inside the (IC) packaging. Its packaging does not contain RAM, ROM and other components required to perform a task. That is why it needs external components to complete a task.



General Purpose Microprocessor Based System

Due to this reason, the devices made from microprocessors are bulkier and power consuming but they have up-gradable memory and high processing capacity for performing complex tasks such as games, website and software development, etc. it functions are unlimited.

Difference between Microcontroller and Microprocessor.

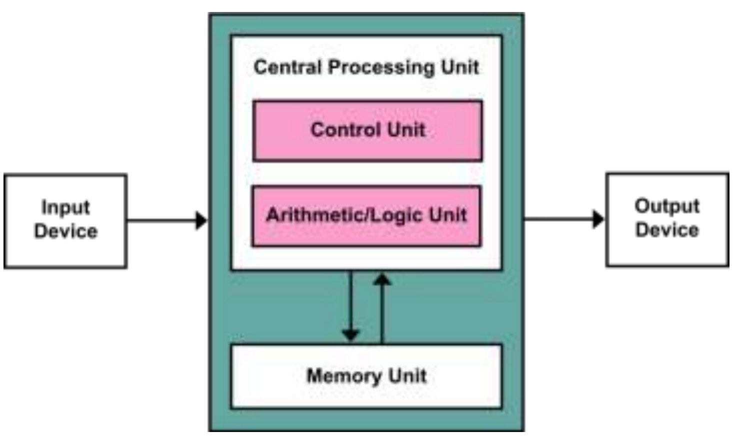
Microcontroller	Microprocessor
It is a mini-computer capable of performing a task on its own. Examples: 8051, 8951 etc.	It is the central processing unit of the computer. Examples: 8085, 8086 etc.
It has necessary peripherals inside the chip like RAM, ROM, etc that is why it is called SoC (system on chip). The functional units are registers, CU, ALU, RAM, ROM, IO Ports, DAC, ADC, Counters and Timers.	It needs external RAM, ROM to perform a task. The functional units are registers, CU and ALU etc.
It is used in the embedded system and specific applications.	It is used in computers as it is the brain of a computer.
It is used in compact devices because it does not need external components.	It needs external components thus the devices made it are bulkier.
Due to a few numbers of external components, the power consumption is very low. Thus it can be powered using batteries.	The external components require extra power to perform. Thus they are not suitable to run on batteries.
It has an internal fixed amount of memory that cannot be upgraded.	The external memory is upgradeable and can be easily varied to meet the task.
Due to on-chip flash and memory, they are fast in loading the program and instructions. Hence fast execution at startup.	Due to external memory, the programs take some time to load which makes it relatively slow.
The microcontroller also has a power-saving system for the idle condition that decreases the power consumption	The microprocessors do not have the power-saving function, they consume energy in idle condition.
Its processing speed is 8Mhz to 50Mhz.	While the microprocessor processing speed is

thus it cannot be used for complex tasks.	above 1Ghz. It can perform complex tasks.
The MCU can support upto 720p High-definition video.	It can support above 720p high-definition video.
It can support USB 2.0 with max speed of 480 Mbits/sec	While it can support USB 3.0 with 5 Gbits/sec speed.
The MCU is application-specific i.e. it is designed for performing a single specific task.	It is designed to perform complex and complicated tasks to utilize its high memory.
It is cheap and having low power consumption thus they are perfect for cost-effective, battery-operated electronics.	It is expensive and power-consuming having high processing speed thus they are perfect for high performance of complex tasks.

These two processor architectures can be classified by how they use memory.

Von-Neumann architecture

In a Von-Neumann architecture, the same memory and bus are used to store both data and instructions that run the program. Since you cannot access program memory and data memory simultaneously, the Von Neumann architecture is susceptible to bottlenecks and system performance is affected.



Von Neumann architecture defined by……

A standard design of computer system (released 1945-51) in which there is a control unit, arithmetic logic unit (ALU), a memory unit (all within CPU) and input/output devices. These entities are connected over a series of busses.

♣ There is only one data bus which is used for both instruction fetches and data transfer from the memory which also is used for storage of both instructions and data.

♣ Data/instructions can pass in half duplex (scheduled/one at a time) mode from to and from CPU

♣ Also called stored program concept.

♣ The memory is addressed linearly; that is, there is a single sequential numerical address for each memory location.

♣ Memory is split into small cells of equal sizes each with address numbers (i.e. same word size used for all memory).

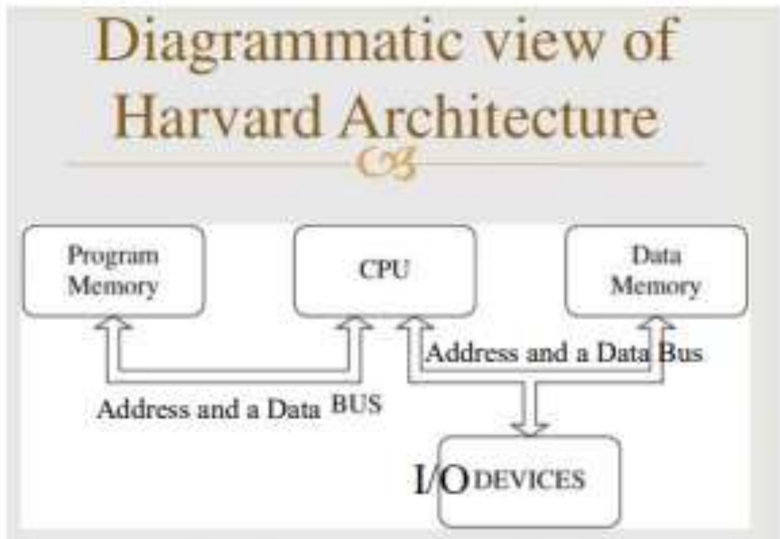
♣ Program instructions are executed in the order in which they appear in the memory, the sequence of instructions can only be changed by unconditional/conditional jump instructions.

♣ All instructions/data is in binary form

Figure 2: The Harvard architecture has a separate bus for signals and storage.
(Image: Wikimedia Commons)

Harvard Architecture

The Harvard architecture stores machine instructions and data in separate memory units that are connected by different busses. In this case, there are at least two memory address spaces to work with, so there is a memory register for machine instructions and another memory register for data. Computers designed with the Harvard architecture are able to run a program and access data independently, and therefore simultaneously. Harvard architecture has a strict separation between data and code. Thus, Harvard architecture is more complicated but separate pipelines remove the bottleneck that Von Neumann creates.



The key features…..

1. The two different memories can have different characteristics: for example, in embedded systems, instructions may be held in read-only memory while data may require read-write memory.

2. In some systems, there is much more instruction memory than data memory, so a larger word size is used for instructions.

3. The instruction address bus may be wider than the data bus.

Embedded systems include special-purpose devices built into devices often operating in real-time, such as those used in navigation systems, traffic lights, aircraft control systems and simulators.

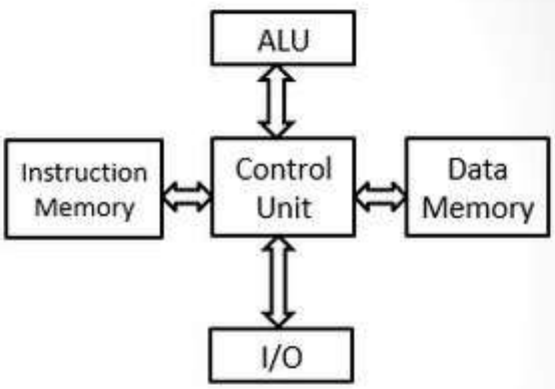
Harvard architecture can be faster than Von Neumann architecture because data and instructions can be fetched in parallel instead of competing on the same bus.

Difference between Von Neumann and Harvard Architecture:

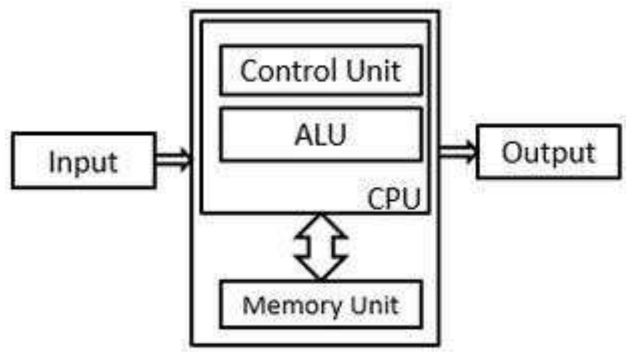
Architecture of a micro computer or a micro controller refers to the arrangement of the CPU with respect of the RAM and ROM. Hence, the Von-Neuman and Harvard architecture are the two ways through which the micro controller can have its arrangement of the CPU with RAM and ROM.

Difference between Von Neumann and Harvard Architecture

<table>
<tr><th>Point of Comparison</th><th>Harvard Architecture</th><th>Von Neumann Architecture</th></tr>
<tr><td>Arrangement</td><td>In Harvard architecture, the CPU is connected with both the data memory (RAM) and program memory (ROM), separately.



Harvard Model</td><td>In Von-Neumann architecture, there is no separate data and program memory. Instead, a single memory connection is given to the CPU.



Von Neumann Model</td></tr>
<tr><td>Hardware requirements</td><td>It requires more hardware since it will be requiring separate data and address bus for each memory.</td><td>In contrast to the Harvard architecture, this requires less hardware since only a common memory needs to be reached.</td></tr>
<tr><td>Space requirements</td><td>This requires more space.</td><td>Von-Neumann Architecture requires less space.</td></tr>
<tr><td>Speed of</td><td>Speed of execution is faster because</td><td>Speed of execution is slower since it</td></tr>
</table>

execution	the processor fetches data and instructions simultaneously .	cannot fetch the data and instructions at the same time.
Space usage	It results in wastage of space since if the space is left in the data memory then the instructions memory cannot use the space of the data memory and vice-versa.	Space is not wasted because the space of the data memory can be utilized by the instructions memory and vice-versa.
Controllin g	Controlling becomes complex since data and instructions are to be fetched simultaneously.	Controlling becomes simpler since either data or instructions are to be fetched at a time.

The above given difference between the Harvard and Von Neumann architecture is very helpful in getting a clear understanding of the difference between the two types of architecture.