Date:
Page no.

Unit-4 Computer organization and Stored Program Concept

Ques What is stored program concept? who has given it? Explain with diagram.

According to this concept, the data and instructions are stored in memory first before their execution in the program.

This concept was given by Von-Neumann

It is called Von Neumann Architecture.

ENIAC - Electronic Numerical Integrator And Calculator.

EDVAC - Electronic Discrete Variable Automatic Computer.

UNIVAC - Universal Automatic Computer.

These are the examples of stored program concept.

The block diagram of Von neumann architecture system is shown below

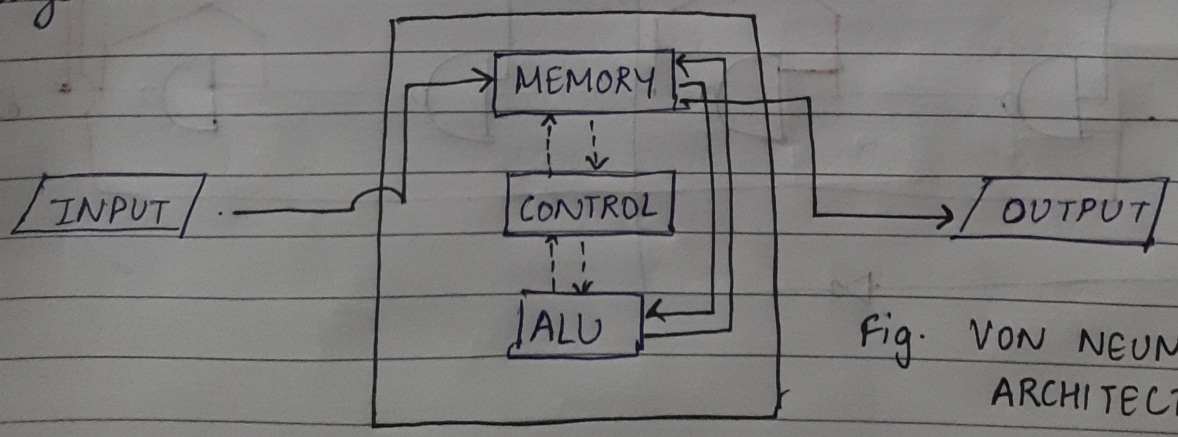


Fig. VON NEUMANN ARCHITECTURE

The Main components of the VNA model are:

(1) Input. It is used to enter the data into the computer.
The early input devices were- Keyboard and Punched card.

(2) Output It is used to produce the result. The main output device of early time was. VDU (Monitor) ie. Visual Display Unit.

(3) Memory It is the main storage device which stores our data and instructions. Once data is stored in memory, it is available to all the units of the computer system at any times.

Then there is no need to enter the data again and again and this has the main logic/concept of Von- Neumann architecture.

(4) Control Unit It is like the brain of a human being. It controls all the operations performed inside the computer.

(5) Arithmetic & Logic Unit It is known as ALU. It perform all the mathematical operations as well as logical (if, then, else comparison) calculations. It directly receives data from Memory Unit and process it and sends back and result to the memory unit.

Date :
Page no.

Computer Architecture is a functional description of the design implementation and requirements of different components of a computer. It mainly deals with the functional behaviour of a computer system and covers the "what to do" part. It gives the functional description of requirements, design and implementation of the different parts of a computer system.

Computer organization provides information about the linking of different operational attributes of the computer system. It refers to the ways in which the hardware components of a computer system are arranged and interconnected. It implements the provided computer architecture and covers the "how to do" part.

Ques Flynn classification (Define)

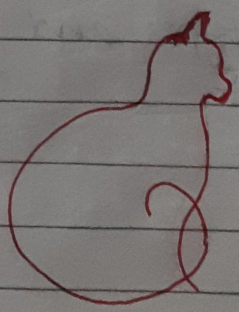
The architecture of all computers can be divided into 4 classification. This is known as flynn classification

1. SISD Single Instruction Single Data
2. SIMD Single Instruction Multiple Data
3. MISD Multiple Instruction Single Data
4. MIMD Multiple Instruction Multiple Data.

Computer Architecture	Computer organization
① Architecture describes what the comp does	The organization describes how it does it.
② It deals with the functional behaviour of computer systems	It deals with a structural relationship.
③ It indicates its hardware	It indicates its performance.
④ As a programmer, you can view architecture as a series of instructions, addressing modes and registers.	The implementation of the architecture is called organization.
⑤ For designing a computer, its architecture is fixed first	For designing a computer, an organization is decided after its architecture.
⑥ Computer architecture comprises of logical functions such as instruction sets, registers, data types and addressing modes.	Comp organization of physical units like circuit diagrams, peripherals and adders. [logic logic gates, combinational circuits, sequential circuits]

Date :
Page no.

(7) There are no errors in computer architecture	Errors are possible in comp organization
(8) The different architectural categories found in our computer system are as follows: a) Van-neumann arch. b) Harvard arch. c) Instruction set arch. d) Micro arch. e) System design	CPU organization is classified into 3 categories based on the number of address fields: a) organization of a single accumulator. b) organization of general registers c) Stack organization.
(9) It makes the computer's hardware visible	It offers details on how well the computer performs.
(10) Architecture coordinates the hardware and software of the system	Computer organization handles the segments of the network in a system.

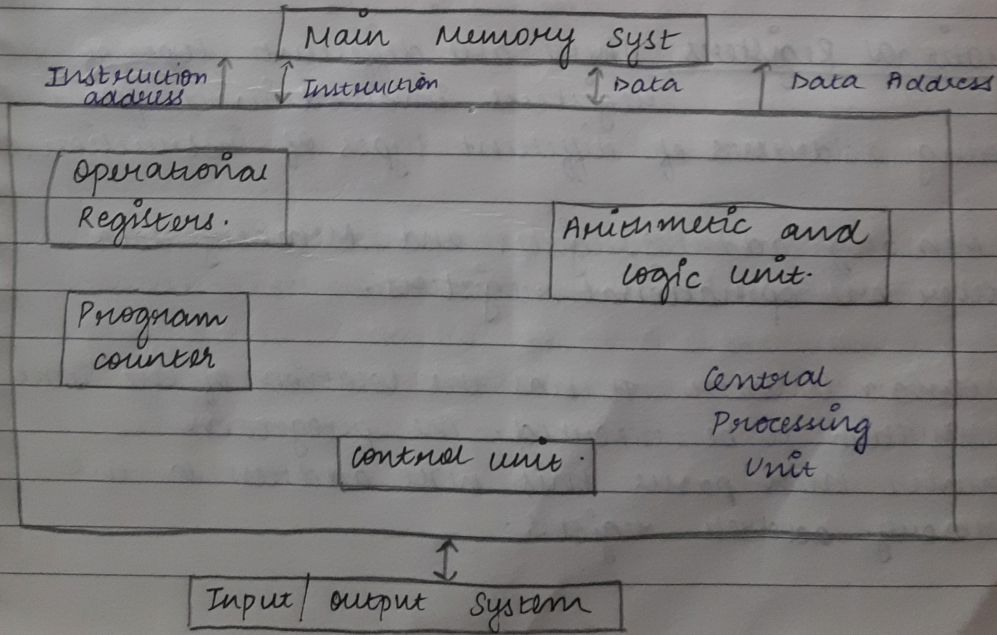


Harvard Architecture

In a normal comp that follows Von Neumann arch, instructions and data both are stored in the same memory. So, same buses are used to fetch instructions and data. This means that CPU cannot do both together (read the instructions and read/write data)

Harvard Architecture is the comp arch that contains seperate storage and seperate buses (signal path) for instructions and data. It was basically developed to ~~bottleneck~~ overcome the bottleneck of Von-neumann's architecture.

The main adv. of having seperate buses for instruction and data is that the CPU can access instructions and read/write data at the same time.



Date :
Page no.

BUSES Buses are used as signal pathways. In Harvard arch, there are seperate buses for both instructions and data.

Types of Buses

1. **Data Buses** They carry data among the main memory system, processor and I/O devices.

2. **Data Address Bus** It carries the address of data from the processor to the main memory system

3. **Instruction Bus** It carries instructions among the main memory system, processor and I/O devices

4. **Instruction Adress Bus** It carries the address of instruction from the processor to the main memory system.

Operational Registers There are different types of registers involved in it for storing addresses of different types of instructions.

The Memory address register and Memory data register are operational registers.

① **Program Counter** It has the location of the next instruction to be executed. The program counter then passes this next address to the memory address register.

(2) Arithmetic and Logic Unit. It is the part of the CPU that operates all the calculations needed. It performs addition, subtraction, comparison, logical operations, bit shifting operations, and various Arithmetic operations

(3) Control Unit. It is the part of the CPU that operates all processor control signals. It controls all the input and output devices and also controls the movement of instructions and data within the system.

(4) Input/output System. Input devices are used to read data into main memory with the help of CPU input instruction. The info from a comp as output is given through output devices. The comp gives the results of computation with the help of output devices.

Features

- Seperate Memory Spaces: In Harvard architecture, there are seperate memory spaces for instructions and data. This seperation ensures that the processor can access both the instruction and data memories simultaneously, allowing for faster and more efficient data retrieval.

- **Fixed instruction length** - In Harvard arch, instructions are typically of fixed length, which simplifies the instruction fetch process and allows for faster instruction processing.

- **Parallel Instruction and Data Access** Since Harvard arch seperates the memory spaces for instruction and data, the processor can access both memory spaces simultaneously, allowing for parallel instruction and data processing.

- **More efficient memory usage** Harvard arch allows for more efficient use of memory as the data and instruction memories can be optimized independently, which can lead to better performance.

- **Suitable for embedded systems** - Harvard arch is commonly used in embedded systems because it provides fast and efficient access to both instructions and data, which is critical in real-time applications.

- **Limited flexibility** The seperate memory spaces in Harvard arch limit the flexibility of the processor to perform certain tasks, such as modifying instructions at run-time. This is because modifying instructions requires access to the instruction memory, which is seperate from the data memory.

Date :
Page no.

Advantages of Harvard Architecture

Harvard arch has 2 seperate buses for instruction and data. Hence, the CPU can access instructions and read/write data at the same time. This is the major advantage of Harvard architecture.

In practice, Modified Harvard Arch is used where we have 2 seperate caches (data and instructions).

- **Fast and efficient data access** Since Harvard arch has seperate memory spaces for instructions and data, it allows for parallel and simultaneous access to both memory spaces, which leads to faster and more efficient data access.

- **Better Performance** The use of fixed instruction length, parallel processing, and optimized memory usage in Harvard arch can lead to improved performance and faster execution of instructions.

- **Suitable for real-time applications** Harvard arch is commonly used in embedded systems and other real-time applications where speed and efficiency are critical.

Date :
Page no.

- **Security** : The seperation of instruction and data memory spaces can also provide a degree of security against certain types of attacks, such as buffer overflow attacks.

Disadvantages of Harvard Architecture.

- **Complexity** The use of seperate memory spaces for instruction and data in Harvard arch adds to the complexity of the processor design and can increase the cost of manufacturing.

- **Limited Flexibility** Harvard arch has limited flexibility in terms of modifying instructions at runtime because instructions and data are stored in seperate memory spaces. This can make certain types of programming more difficult or impossible to implement.

- **Higher Memory Requirements** : Harvard arch requires more memory than von-neumann arch, which can lead to higher costs and power consumption.

- **Code Size Limitations** Fixed instruction length in Harvard arch can limit the size of code that can be executed, making it unsuitable for some applications with larger code bases.

RISC and CISC

Date :
Page no.

Reduced Instruction Set Architecture (RISC)

The main idea behind this is to make hardware simpler by using an instruction set composed of a few basic steps for loading, evaluating, and storing operations just like a load command will load data, a store ~~dor~~ command will store the data.

Complex Instruction Set Architecture (CISC)

The main idea is that a single instruction will do all loading, evaluating, and storing operations just like a multiplications command will do stuff like loading data, evaluating and storing it, hence its complex.

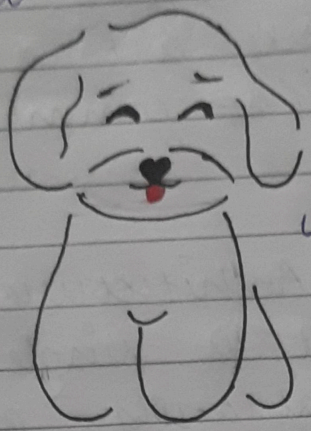
Both approaches try to increase the CPU performance

RISC: reduce the cycles per instruction at the cost of the number of instructions per program.

CISC: The CISC approach attempts to minimize the number of instructions per program but at the cost of an increase in the number of cycles per instruction

$$\text{CPU Time} = \frac{\text{Seconds}}{\text{Program}} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Cycle}}{\text{Instr}^n} \times \frac{\text{Seconds}}{\text{Cycle}}$$

Earlier when programming was done using assembly language, a need was felt to make instructions to do more tasks because programming in assembly was tedious and error-prone due to which CISC architecture evolved but with the increase of high-level language dependency on assembly reduced RISC architecture prevailed



Characteristics of RISC
- Simple instructions, hence simple instruction decoding
- Instr" come undersize of one word
- Instr" takes a single clock cycle to get executed
- More general-purpose registers
- Simple addressing modes
- Fewer data types
- A pipeline can be achieved

Characteristics of CISC
- Complex instr", hence complex instr" decoding
- Instr's are larger than one-word size
- Instr" may take more than a single clock cycle to get executed.
- Less number of general purpose registers as operations get performed in memory itself
- Complex addressing modes
- More data types

RISC	CISC
(1) Focus on software	Focus on hardware
(2) Use only hardwired control unit	Use both hardwired and microprogrammed control unit
(3) Transistors are used for more registers	Transistors are used for storing complex instr"s.
(4) Fixed size instr"s	Variable sized instr"s
(5) Can perform only register to register Arithmetic operations	Can perform REG to REG or REG to MEM or MEM to MEM.
(6) Requires more number of registers	Requires less number of registers.
(7) Code size is large	Code size is small
(8) An instruction executed in a single clock cycle	Instr" takes more than one clock cycle
(9) An instr" fit in one word	Instr"s are larger than the size of one word
(10) Simple and limited addressing modes	Complex and more addressing modes.

Date :
Page no.

(11) RISC is Reduced Instr" cycle	CISC is complex Instr" cycle
(12) The number of instr"s are less as compared to CISC	The number of instr"s are more compared to RISC
(13) It consumes low power	It consumes more/high power.
(14) It is highly pipelined	It is less pipelined.
(15) RISC requires more RAM	CISC requires less RAM
(16) Addressing modes are less here	Addressing modes are more.

☆ RISC

Advantages

Simpler Instr"s : RISC processors use a smaller set of simpler instr"s, which makes them easier to decode and execute quickly. This results in faster processing times

Faster Execution : Because RISC processors have a simpler instr" set, they can execute instr" faster than CISC processors

Lower power consumption : RISC processors consumes less power than CISC processors, making them ideal for portable devices

Disadvantages

More instr"s required : RISC processors require more instr"s to perform complex tasks than CISC processors

Increased Memory usage : RISC processors requires more memory to store the additional instr"s needed to perform complex tasks.

Higher cost : Developing and manufacturing RISC processors can be more expensive than CISC processors

☆ CISC

Advantages

Reduced code size : CISC processors use complex instr"s that can perform multiple operations, reducing the amount of code needed to perform a task.

More memory efficient : Because CISC instr"s are more complex, they require fewer instr"s to perform complex tasks, which can result in more memory-efficient code

Widely used : CISC processors have been in use for a longer time than RISC processors, so they have a larger user base and more available software

Disadvantages

Slower execution: CISC processors take longer to execute instr^n's because they have more complex instr^n's and need more time to decode them.

More complex Design: CISC processors have more complex instr^n sets, which make them difficult to design and manufacture

Higher power consumption: CISC processors consume more power than RISC processors because of their more complex instr^n sets

Stored Program Concept: [VON NEUMANN ARCHITECTURE]

The term Storage Program Control concept refers to the storage of instr^n's in computer memory to enable it to perform a variety of tasks in sequence or intermittently.

The idea was introduced in the late 1400s by John Von Neumann who proposed that a program be electronically stored in the binary format in a memory device so that instructions could be modified by the computer as determined by intermediate computational results.

ENIAC Electronic Numerical Integrator and Computer) was the first computing designed in the early 1940s. It was based on Stored Program concept in which machine use memory for processing data.

FLYNN ARCHITECTURE MJ Flynn proposed a classification for the organization of a computer system by the number of instructions and data items that are manipulated simultaneously.

The sequence of instructions read from memory constitutes an instruction stream.

The operations performed on the data in the processor constitute a data stream.