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About the Book

Almost every element of 21st-century living is impacted by technology, from communication through security to transportation efficiency as well as safety to food availability, access to financial services, healthcare, sociability, but also productivity. These days, all it takes is a few mouse clicks to get the information you want. Pull out your phone, PC, or even your smart home assistant to get the answer. Fitness gadgets have also become more popular as a new technological trend.

A vast variety of technical innovations have helped us use our spare time, from video as well as computer games to the smart TVs. Even today, going to the movies doesn't have to take place in a movie theatre. In the same way that we use computers to read, we use digital platforms to view movies. There is a shift in an entertainment industry toward total digitalization thanks to online streaming platforms as well as mobile apps.

Computers, virtual reality, augmented reality, as well as e-learning have showed us how to cross the limitations of time and location. Today, one individual in India may study from Harvard or MIT, even from the comfort of their own home, thanks to the online educational systems. This Book is based on fundamental knowledge of such computer technology aspects that brings wide changes to our living style. This Book is completed with six chapters in which first chapter introduces the very basics of computer and the next chapter will give information about its organization & architecture. Third and fourth chapters focuses on the computer memory and about input & output media. Last two chapters explain you about the operating systems.

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FIRST EDITION

FUNDAMENTALS OF INFORMATION TECHNOLOGY

Dr. Sunil Kumari
Dr. Navin Prakash
Dr Arvind Kumar Shukla
Dr. Suryabhan Pratap Singh

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by

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Preface

Computers have a profound impact on society. They've turned us into their pawns. Whether it's the ticket desk, the microwave, or your automobile, we expect them to be there. To pursue one's job objectives and operate successfully and efficiently, one must have at least the basic understanding of computer abilities. For now and tomorrow's fast-changing computing world, computer literacy is both a need and a voice.

It's an integral part of modern society. Everything it touches, from our everyday lives to the globe at large, is impacted, both positively and negatively. In today's world, it's normal to see new technology advancements. An example is internet & smartphones. We can only progress as a species if we keep coming up with new ideas. Misuse of technology, on the other hand, has been related to the mental health problems, attention deficit disorder, and worries about personal privacy.

Using the keyboard to enter text or do mathematical computations is the extent of most people's computer knowledge. This, however, is insufficient. It is necessary to have a basic understanding of the components and operation of computers. We're spending more and more of our time online. While being able to do anything and everything online has made our lives easier, it has also put

us at risk. AI, machine learning, including intelligent data have increased connection in internet of things. Pushing the boundaries of internet of things, even more gadgets are being linked to the internet. As new technologies as well as new products incorporating network technologies emerge, the Internet of things would continue to expand.

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CHAPTER 1
Computer Basics

1.1. Introduction

A computer is the device which converts raw data into useful knowledge. The computer is the machine which can do calculations. Modern computers, on the other hand, are far more versatile. One of the primary functions of the computer is to store as well as process information entered into it, and then output the results in the proper format.

Numerical computations were the primary function of first computers. It wasn't long before people recognised that the computers were capable of performing a wide range of the information-processing tasks. Weather forecasting has been improved by their ability to process enormous volumes of the data. Decisions concerning routing phone calls over the network as well as controlling mechanical devices such as autos, nuclear reactors, but also robotic surgical equipment have been made because of their ability to process information quickly.

Computers have theoretical as well as practical constraints. For instance, a logical structure of the computer is an instance of the undecidable claim whose truth can't really

be established by a particular set of criteria. It's called the "halting issue" because there's no general algorithmic approach to recognize these assertions, therefore computers asked to find the truth of them would keep going endlessly unless forcefully paused.

Many more restrictions are due to limits placed on us by current technological developments. Unlike our brains, that can process information in the linear fashion instead of in bits and bytes, computers struggle to recognize spatial patterns, making it difficult for them to discriminate between the human faces, for example. Computers also have a hard time when it comes to interacting with people using natural language. For the general-purpose natural language algorithms, it's been difficult to provide meaningful information since so much common knowledge as well as context is required in everyday human conversation.

The computer's capabilities may also be used to characterize it. It is possible for the computer to take, save, interpret, as well as retrieve data and also print the results in a variety of formats. An important feature of the computer is that it is very fast and accurate.

It doesn't matter how big or little your computer is; it can still execute the same fundamental five tasks regardless of its configuration. Here they are:

1. It receives input in the form of data or instructions
2. It serves as a data repository,

3. In accordance with the needs of the user,
4. It produces output as a consequence of its operations, and
5. It is responsible for all of the computer's functions.

Input: Entering data as well as instructions into the computer system is referred to as "input".

Control Unit (CU): The 'Control Unit' is responsible for overseeing the intake, output, processing, as well as storage of data. To begin to cease it, receiving data, to store it, and so on. It handles entire computer's internal functions in the step-by-step manner.

Memory Unit: Data as well as instructions are stored on the computer.

Arithmetic Logic Unit (ALU): The ALU performs multiplication, addition, subtraction, division, logic, as well as comparison operations.

In order to get usable information, one must go through this procedure in order to produce outcomes from the data. The computer system's ALU & CU are together referred to as the central processor unit (CPU).You can think of the computer's CPU as its brain.

1.1.1. Characteristics of Computers

1. Speed: – Obviously, computers are very efficient. Calculations which would normally take us hours to finish are completed in a matter of seconds. Astoundingly, a

computer could execute up to one million (1,000,000) instructions in a second.

As a result, we measure computer speed in microseconds or nanoseconds. This gives you an idea of how quickly the computer is able to do its job.

Figure 1.1 Characteristics of Computers[*]

2. Accuracy: – All calculations made by the computer are done with same degree of precision. Computer design

[*] https://ecomputernotes.com/fundamental/introduction-to-computer/what-are-characteristic-of-a-computer

dictated accuracy level to be 7. It is human mistake that causes computer malfunctions**.**

3. Diligence: – Nobody gets weary of working on the computer since it doesn't have any of those issues. Hour after hour may pass without the single mistake being produced. A computer can execute millions of computations with same level of precision. Because of this, it is able to outperform humans in regular tasks.

4. Versatility: It's a euphemism for the ability to accomplish a variety of tasks. Payroll slips might well be prepared on a computer. In the future, you might use it to track inventories or to create utility bills, for example.

5. Power of Remembering: – Storage space on the computer is limitless since it is a machine. You could save and retrieve any data for as long as you need it for, for as many years as you like. The computer's storage capacity and how it has been backed up are totally up to the user.

6. No IQ: – It is impossible for a computer to do any task without user's input. It executes instructions at breakneck pace and with pinpoint precision. It's up to you to select what you wish to accomplish and how you want it to be done. Computers, on the other hand, are not able to make their own decisions in the same way that you can.

7. No Feeling: – It lacks emotions, flavor, knowledge, as well as experience. As a result, even after working for

extended periods, this doesn't get fatigued. No distinction is made in terms of who may utilize it.

8. Storage: – A vast quantity of data may be stored in computer's built-in memory. Secondary storage devices, like floppy discs, may also be used to store the data outside of the computer.

1.2. Evolution of Computers

Whenever it comes to the computers in a form of the personal desktop PCs, laptops, as well as tablets, it's hard to recall a period when they weren't there. However, computers in their current form are just a few decades old. Modern computers have had the largest but also most significant impact on civilization, despite the fact that the computers have theoretically been in existence since abacus some 5000 years ago.

In year 1944, the world's first full-sized digital computer was created. This computer, known as Mark I, weighed five tones and was exclusively used for computations. Though small and lacking in power, the very first of many computers which would kick off and expand subsequent generations of the computer development was the significant moment in history.

Hardware as well as software interact to perform all of the functions of the computer. The history of the personal computer may be traced back many decades. There are, however, five distinct generations of the computers. As

computers get ever more powerful as well as dynamic, they become more compact and affordable, but also more efficient, dynamic, and booming as a result of these improvements.

1.3. Generations of Computers

When you were born, a modern computer began to take form. The development of computer began in 16th century. Many modifications were made to the original computer, all for a better. Speed, precision, scalability, and affordability have all increased over time, enabling it to push the boundaries of the traditional desktop computer. This lengthy time span is neatly separated into successive stages known as the computer generations to make things easier to understand:

1.3.1. First Generation (1940 to 1956): Vacuum Tubes

The "first generation of computers" looked nothing like the computers we use today. A very huge computer was produced between 1940 & 1956, the earliest of its kind. At the time, computers' internal workings were crude. In the early days of computing, vacuum tubes as well as magnetic drums were used as memory as well as switches, respectively. Because of their immense heat output and big size, the vacuum tubes were the major contributor to the machines' enormous heat output. Overheating was a common problem with such computers, in spite of use of huge cooling systems. Machine language, the programming

language utilized in the first generation of computers, is the very simple programming language.

1.3.2. Second Generation (1956 to 1963): Transistors

Transistors replaced vacuum tubes in 2nd generation of computers (from the year 1956 to 1963). They were able to reduce their energy use and create less heat as a result. Computers from second generation were substantially faster than those from the first generation. Additionally, the computers themselves shrank in size as well. Core memory was also created for the transistor computers that utilized it in conjunction with magnetic storage.

1.3.3. Third Generation (1964 to Early 1970s): Integrated Circuits

In the decade from the year1964 to 1971, the introduction of the integrated circuits significantly increased the speed of the computers. There were vast numbers of the transistors, or the integrated circuits, crammed onto silicon chips. As a result, computers became not only faster but also shorter, stronger, and more affordable. Rather than punch cards as well as printouts, computers were now able to be interacted with by humans through keyboards and screens.

1.3.4. Fourth Generation (Early 1970s to Till Date): Microprocessors

The most significant changes happened between 1971 and 2010. Manufacturers were able to insert millions of the transistors on one circuit chip at this period of time.

Monolithic integrated circuit technology was the name given to this approach. The Intel 4004 chip, the very first commercially available microprocessor, also was announced at the same time. Personal computers were born out of this innovation. To begin with, personal computers like the Altair 8800 were sold as kits that needed assembly, making them more accessible to the wider audience. A new generation of home computers including Commodore Pet, Apple II, as well as the very first IBM computer began to appear in late 1970s and early 1980s. In early 1990s, personal computers as well as the capacity to build networks would pave the way for the Internet. Already in the 4th generation, tiny computers, such as laptops as well as handheld devices, were developed. That same period saw the development of what is now known as the "graphical user interface (GUI). As a result of these advancements, computer memory as well as storage also saw a rise in capacity and performance.

1.3.5. Fifth Generation (Present and Beyond): Artificial Intelligence

Even more powerful and quicker computer technology will be available in future. The advancement of the computer technology is ongoing. There are several ways that the technology is moving towards the future of the computer development, and the 5th generation of the computing has yet to be identified. Nanotechnologies, artificial intelligence, and quantum computing, for example, all have active research programmes.

1.4. Classification of Computers

The term "classification of computers" refers to the process of dividing computers into different groups depending on the characteristics of the job they do. Computers may also come in a variety of sizes, capacities, and types.

1.4.1. Microcomputers

The central processing unit (CPU) of the microcomputer is the compact, low-cost microprocessor. One printed circuit board houses a CPU, memory, and a small amount of I/O. Mainframes as well as minicomputers, which came before them, were more bigger, more difficult to maintain, and also more costly. They laid the groundwork for microcomputers and other smart devices we use on the daily basis today.

Eg: Smartwatches, Tablets.

1.4.2. Minicomputers

When such computers first appeared in market in mid-1960s, they were marketed at a significantly lower price than mainframes, which were meant for calculating and also record-keeping. They eventually grew popular for home use as a result of evolution.

When transistors as well as the core memory technologies made it possible for computers to be smaller and more affordable, the term "microcomputer" was coined to characterise them.

The new word, "MINICOMPUTERS," was developed to describe these smaller computers, which typically fit in a single rack cabinet.

Eg: PC, Personal Laptop etc.

1.4.3. Mainframes

Some people refer to this type of computer as "big iron." It is generally employed by big corporations for the bulk data processing like statistics, population counts, or transactions. Such systems have the higher processing capacity in comparison to the most other computer types, and also mainframe architectures have evolved continuously over time.

Eg: System z9, IBM z Series & System z10 servers.

1.4.4. Supercomputers

The most powerful computer systems are known as supercomputers. A "general-purpose computer" (GPC) can't compete with the processing power of the supercomputer. The supercomputer's real performance is generally measured in FLOPS rather than MIPS. Linux is the operating system of choice for all of world's fastest five hundred supercomputers. Efforts are being made in countries like China, the United States, the European Union, Taiwan, as well as Japan to develop ever faster, more powerful, and much more advanced supercomputers.

Quantum physics, climate research, weather forecasting, oil and gas scouting, molecular modelling, and also the physical simulations are just a few of the many domains in which supercomputers contribute significantly in computing. As well as Cryptanalysis has always relied on supercomputers, and this has been true throughout history.

Jaguar, PARAM, and the Roadrunner, for instance.

1.5. The Computer System

All the pieces of the puzzle work together to produce the desired outcome in computer system. Despite the fact that each of its components serves a distinct function, they all work together to provide the end result desired by the user.

Figure 1.2 Computer Systems*

*https://www.tutorialspoint.com/basics_of_computer_science/basics_of_computer_science_system.htm

Components of Computer System

Let's take a look at some of the most fundamental parts of the computer system.

Hardware

The "computer system's hardware" consists of all of its physical components. A computer's hardware includes all of the components that make up the computer's operating system.

A list of the hardware components, each of which performs a particular task, is shown below:

- **Monitor** − The outcome is shown in a visual form.
- **CPU** − The "Central Processing Unit" (CPU) is the part of computer which is in charge of both processing and sending data.
- **Motherboard** − It is primarily responsible for establishing and transmitting the communication among components.
- **RAM** − Presently running applications and temporary data are both stored in the "Random Access Memory"(RAM).
- **Hard Disk Drive** − I In other words, it's a long-term memory device.
- **Floppy Disk Drive** − It has fallen out of favour in recent years.
- **Optical disks** − Also, it is capable of storing information. DVD, CD, etc. are examples of this.

Software

When software is introduced to the computer system, hardware components are able to work. The term "software" refers to a set of instructions that may be run by a computer's operating system.

Unlike hardware, the software is the non-physical component of the computer system.

Types of Software

Programs may be categorized according to their core characteristics and functioning−

- Operating Systems (OS)
- Application Software (AS)
- E-accessibility Software

Let's now take a closer look at software components.

Operating System

When the computer is turned on, this software assists to load fundamental application.

The three most popular operating systems are Mac OS X, Windows, and Linux.

Application Software

Application software refers to software that may be utilised on the operating system that has already been installed. The

Office suite, Internet browser, and antivirus software are just a few notable instances of the application software.

E-accessibility Software

Additional features for users are provided by "E-accessibility software components, including such−

- Voice recognition software
- Magnifying tool
- Screen reader
- Video games
- On-screen keyboard
- Learning software, etc.

Human ware

When hardware as well as software are combined to create Human ware, the end result is the device which is as easy to use as feasible for the average person. Development of the human ware often starts with identifying the computer's possible users, as well as what they want and also need, prior to constructing the infrastructure.

1.5.1. Components of a Computer System

It is possible to program the computer to receive data (input), process it, and create the result (output). The computer system consists of the computer and any associated hardware or software. The CPU, memory, I/O devices, as well as storage devices make up the bulk of the computer system. All of such components work

together to produce the intended result. There are many different shapes as well as sizes of computers. Desktop, tablet, laptop, and smartphone computers are all examples of this kind of device. Figure 1.3 depicts the computer system's schematic diagram. Those directed lines depict flow of the data as well as the signal between the many components of the system.

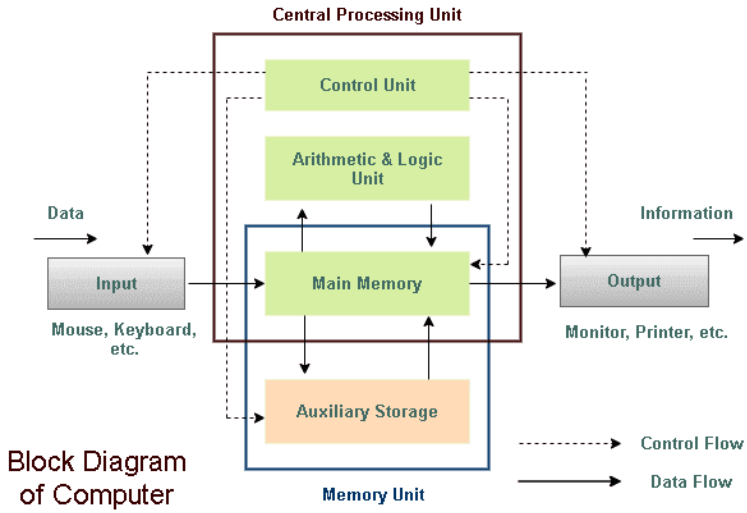

Figure 1.3 Components of a Computer System[*]

Central Processing Unit (CPU)

The processor, microprocessor or central processor is another name for the Central Processing Unit. It performs all of the computer's essential activities. It accepts

[*]https://www.tutorialsmate.com/2020/04/block-diagram-of-computer.html

commands from both the hardware as well as the running software and responds appropriately. It keeps track of all critical programmes, such as operating systems as well as the application software. Input as well as output devices may also interact with one another thanks to CPU. Because of these characteristics, the CPU is frequently referred to as computer's brain.

The CPU is placed or put into motherboard's CPU socket. It also has the heat sink, which absorbs and dissipates heat to keep the CPU cool and running smoothly.

A CPU is made up of three parts in most cases:

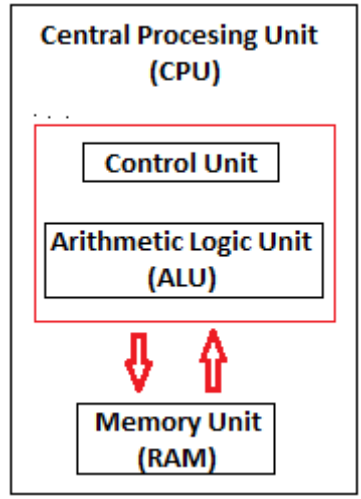

*Figure 1.4 Block diagram of CPU**

- ALU (Arithmetic Logic Unit)
- Control Unit

*https://www.javatpoint.com/central-processing-unit

- Memory or Storage Unit

Control Unit: It is control unit's circuitry that uses electrical impulses to command computer system to execute previously saved instructions. It reads instructions from memory, decodes them, and afterwards executes them. As a result, it directs and organizes the operation of all the computer components. The major function of Control Unit is to manage and also control the flow of data throughout the processor. It does not participate in the data processing or storage.

ALU: The arithmetic logic unit executes both arithmetic as well as logical tasks. Addition, multiplication, subtraction, division, as well as comparisons are all arithmetic functions. Identifying, comparing, as well as combining data are the most common logical functions. More than 1 ALU may be found in a single CPU. ALUs may also be used to keep track of timers that assist the computer operate.

Memory or Storage Unit/ Registers: "Random access memory" is the name given to this kind of memory. It saves data, programmes, and the intermediate as well as final outputs of the processing temporarily. As a result, it serves as the temporary storage location for data that is needed to operate the computer.

Output Device

The output device shows the outcome of computer's

processing of the raw data supplied by the input device. There are many output devices which show output in a variety of formats, including text, photos, audio , hard copies, and videos.

Monitor

A monitor seems to be the computer's display device or screen. It is the primary output device which shows processed data or the information in a form of text, graphics, audios, or videos.

1.5.2. Computer Working

The computer's fundamental function is performed in a section of machine which humans can't see, the control center, which translates data input into information output. The central processing unit (CPU), a very complicated and vast piece of electrical circuitry which executes recorded programme instructions, is a control centre.

Powering on the computer

When you initially turn on a computer, it sends the signal to a computer power supply that converts AC ("alternating current") to DC ("direct current"). This power provides the right quantity of voltage as well as electricity to the computer as well as its components.

*Figure 1.5 Powering on the computer**

When a computer as well as its components have enough power and also power supply reports no problems, it sends the signal to motherboard as well as the computer processor. While this is going on, a processor clears any residual data from the memory registers as well as assigns F000 hexadecimal value to CPU program counter. This number indicates to CPU that it really is ready to process instructions in "basic input/output system" at this point.

BIOS and the POST

The computer starts "power-on self-test" when it first looked at BIOS. This procedure ensures that all of the required components are present and working correctly. If a computer fails any of these checks, it will experience an abnormal POST. The beep code which differs from the

*https://www.computerhope.com/issues/ch001263.htm

typical 1 or 2 two beeps is known as the irregular POST. The irregular POST, for instance, might produce no sounds or a mix of beeps to indicate a reason of failure.

If the machine passes the POST, the very first 64 bytes of the memory in CMOS chip are examined. Even though the computer is shut off, CMOS ("Complementary Metal Oxide Semiconductor") battery keeps this chip alive. This chip stores data like the system time & date, as well as the information on all of the computer's hardware.

The POST begins evaluating as well as comparing system settings with what has been loaded in computer on loading CMOS information. It loads the fundamental device drivers as well as the interrupt handlers for devices like the hard disc, mouse, keyboard, and floppy drive if no problems are identified. These fundamental drivers enable the CPU to connect with such hardware devices, allowing the machine to continue booting.

Next, the POST checks the real-time clock (RTC) or system timer and the system bus to make sure both are working. Your display adapter will show an image after POST has finished loading the memory it contains.

It then examines memory location 0000:0472 to verify whether the cold boot is being performed. If BIOS detects 1234h, it understands this is the reboot as well as skips the rest of POST.

BIOS detects the cold boot when 1234h is not there and performs extra POST procedures. Afterwards, it performs a test on the computer's installed RAM simply writing data to every chip. At startup, the RAM was counted and shown in this manner.

Ultimately, signals are sent to computer's optical drive as well as hard drive through POST for testing and evaluation purposes. In the event that all discs pass POST, the computer will begin loading operating system.

Loading the operating system

The boot procedure begins after the machine has passed a POST test. The loading of an operating system as well as all of its related system files is responsibility of this operation.

A boot sector of hard drive is examined first by bootstrap loader that receives control from the BIOS. In CMOS configuration, if you don't have hard drive listed as the first boot option, this might attempt to boot from first media you plug in (For example "DVD" or "flash drive").

The Windows 10 Bootmgr may be seen on boot sector in just this instance. There is still some code that has to be found on hard disc. A Windows splash screen is shown, as well as Windows registry is loaded. Windows starts loading operating system's low-level applications into the memory after loading registry. In order for Windows to connect with computer's key hardware and the other

operating applications, it needs several of the programmes that come pre-installed.

Plug as well as play, PCI, as well as ISA devices usually loaded once the registry and also first basic hardware devices have been loaded. It is only after this that almost all of devices have been loaded that Windows goes on to additional drivers which have been installed on a computer.

After all of the previous processes have been completed, Windows will begin loading any extra services that are needed.

Hardware devices communicating with the computer

There should be some kind of communication between hardware and CPU once operating system has been installed on machine. Interrupt requests are used to communicate between hardware devices. Interrupt controller delivers request to CPU to pause what it does to process the new hardware request to interrupt the controller. Everything the CPU is doing is placed on hold and saved in the memory stack as the address. Consequently, when the present work is done, that task will continue.

1.6. Applications of Computers

Every aspect of our lives is influenced by computers. People use them all over the place in their own homes, at their

workplaces, in the research facilities, in hospitals, in government buildings, and even in entertainment industry.

Home

There are a variety of reasons why computers are utilized in the house, including online bill paying, social networking, playing games, home tutoring, and internet access. They give e-mail as a means of communication. Workers in corporations may benefit from the flexibility of working from home if they so want with their aid. Students can access online instructional resources because to the widespread use of computers.

Medical Field

Hospitals utilize computers to keep track of patients' medical histories, diagnoses, X-rays, and more. Robotic surgical instruments are increasingly being used by surgeons to undertake delicate procedures as well as remotely carry out surgery. In addition to entertainment, virtual reality may be utilized for training reasons. It also aids in monitoring of the baby in the pregnancy.

Entertainment

When it comes to gaming, listening music, or watching movies on the internet, computers are a great resource. The use of MIDI ("Musical Instrument Digital Interface") instruments in entertainment business considerably enhances the ability of musicians to record music using fake

instruments. Full-screen TVs may receive video feeds from PCs. There are excellent photo editors on the market.

Industry

The use of computers is widespread in a wide range of professions, from inventory management to the product design to the interior design to the video conferencing. Various items may now be sold in the rural or interior locations that were previously unreachable thanks to the power of the online marketing. The use of the computers in stock market has allowed an unprecedented degree of engagement from a broad cross-section of society.

Education

Online lectures, online exams, e-books, and online coaching are just some of the ways computers are being utilized in the education industry. Audiovisual aids in the education may be used more effectively with the assistance of these devices.

Government

There is a lot of data processing, the citizen database, as well as paperless environments in the government sector thanks to computers. To a large extent, computers have been instrumental in helping the military to design and launch missiles and satellites as well as to conduct space missions.

Banking

To maintain client information and perform activities like cash withdrawals and deposits through automated teller machines, banks rely on computers. Automated banking systems have greatly decreased human mistakes and costs.

Business

Computers have become an integral part of the modern workplace. Transaction processing is primary goal of company that includes dealings with the suppliers, workers, and consumers. Such transactions may be simplified and made more precise using computers. Investment, sales as well as the other factors of a firm may be analyzed utilizing computers.

Training

Using computer-based training to teach staff may save a company money while also enhancing employee performance. Virtual meetings may save time and money since participants might be located in different parts of the world.

Arts

Dancing, photography, the arts, as well as culture all rely heavily on the computers. Animated sequences may capture the fluidity of dancing in real time. Using the computer, photos may be digitized.

Science and Engineering

Dynamic processes in science as well as engineering being stimulated by the high-performance computers. There are several uses for supercomputers in the field of Research & development. Computers can generate topographic imagery. To better comprehend earthquakes, scientists utilise computers to map and analyse data.

CHAPTER 2
Computer Organization and Architecture

Information about the internal workings, structure, and also the implementation of the computers may be found in the Computer Organization as well as Architecture.

As opposed to this, Organization establishes system structure, ensuring that entire tools in the library are put to good use.

2.1. Central Processing Unit

All of computer's functions are carried out by its central processor unit. The CAD ("Computer-Aided Design") system's CPU is basically its brain. One ALU, one CONTROL UNIT, and several REGISTERS make up this system. The processor is the common shorthand for the central processing unit. As per program, the ALU executes logic, arithmetic, as well as related operations.

In addition to ALU activities, the control unit also oversees data transfer inside the CPU as well as throughout the external interfaces, as well as the flow of the data as well as control signals. The CPU's internal registers are the high-speed memory storage units. Certain

registers may be accessed by programmer directly through the machine's instruction set because they are "user-visible." Various other registers are reserved only for use by the central processing unit.

Types of CPU:

As a general rule, Intel as well as AMD ("Advanced Micro Devices") are the two main manufacturers of CPUs. There are a plethora of the CPU types available on market today. CPUs may be broadly classified as follows:

Single Core CPU: In 1970s, single-core CPU was the most common form of the computer processor. It uses a single core to do a variety of tasks. This means that the CPU could only execute one application simultaneously before switching to another set of the data streams. As a result, multitasking isn't recommended due to the decreased performance that results from running many programmes at the same time. Clock speed is primary determinant of such processors' performance. Smartphones, for example, continue to make use of this chip technology in their designs.

Dual Core CPU: An Integrated Circuit (IC) with the Dual Core CPU has two processing cores . It is quicker than the single-core processors and much more capable of multitasking than the single-core processors since they are connected together to function as the unit rather than individually.

Quad Core CPU: Two dual-core processors are built onto a single integrated circuit (IC) in just this CPU type. There are four separate cores in the quad-core processor, which is a kind of semiconductor. CPU instructions are read and executed by such cores. This allows the cores to execute several instructions concurrently, increasing overall performance for applications that may benefit from parallel processing.

In the quad-core CPU, four separate processing units may function simultaneously on the single chip. Because numerous cores may be integrated into one CPU, a greater level of performance could be achieved without increasing a clock speed. However, only if computer's software supports the multiprocessing will the performance improve. In the multiprocessing software, rather than utilising single processor at a time, the processing burden is divided amongst many.

2.1.1. Arithmetic Logic Unit

ALU stands for the "arithmetic logic unit" that conducts arithmetic as well as logic operations in a central processor unit. As last component to execute computations in a processor, this integrated circuit is also termed as the integer unit (IU). Adding, shifting, subtracting, and Boolean comparison are among the many operations it is capable of doing in the realm of mathematics and logic (XOR, AND, OR, & NOT operations).

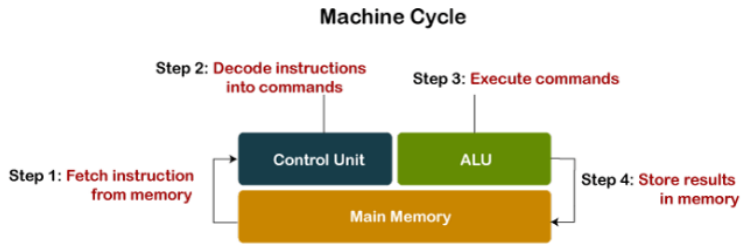

*Figure 2.1 Arithmetic Logic Unit**

Mathematical operations as well as bitwise transformations may also be performed on the binary numbers. It is possible to decompose arithmetic logic unit into the two parts: AU & LU (Arithmetic Unit and Logical unit, respectively). The ALU's operands as well as code inform it what operations to do based on data it receives. The ALU sends an information to computer's memory after it has finished processing an input

ALU performs the following tasks:

- **Logical Operations:** NOR, AND, NOT, NAND, XOR, and a slew of additional logical operations are available.
- **Bit-Shifting Operations:** Multiplying a number of the places in which the bits are moved to right or left is primary function of this function.
- **Arithmetic Operations:** However, this is about bit addition as well as subtraction, not multiplication as well as division. Performing operations like multiplication and also division, on the other hand,

*https://www.javatpoint.com/what-is-alu

is more time consuming and expensive. Subtraction as well as addition may be employed as a replacement for the multiplication in case when multiplication is not possible.

2.1.2. Registers

The computer's registers are the special kind of memory which can be accessed instantly by the central processing unit (CPU) and then used to retain, retrieve, and transmit data as well as instructions. Processor registers refer to the registers utilized by CPU.

A command, the storage location, or any other data might well be stored in the processor register (like the bit sequence or the individual characters).

Computers require the memory address register as well as the processor registers to manipulate data. After current instruction has been executed, the memory location in a register is utilised to compute the following instruction's address.

2.1.3. Control Unit

It is this component's job to take the information a user provides and turn it into the signals the CPU can utilise to carry out its operations.The primary memory, arithmetic as well as logic unit (ALU), input as well as the output devices, and also the instructions which are transmitted to CPU of the computer are all controlled and directed by the motherboard. Using the processor's main memory, it

retrieves the instructions and sends them to instruction register, that stores register contents.

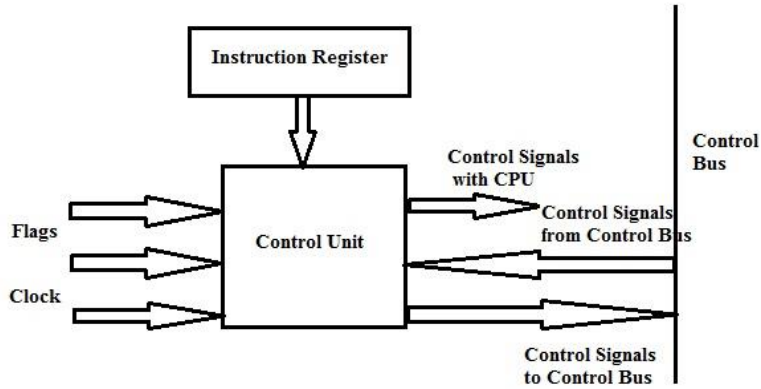

Figure 2.2Control Unit Block Diagram[*]

Programming instructions are given to the processor by means of the control unit, which transforms input signals into the control signals. The computer's processor is in charge of directing the computer's actions. All but a few processors need the internal control unit, such as a CPU or a GPU.

2.1.4. System Bus

A bus consists of a number of interconnected cables. Buses connect the computer's components. A source element may output data to bus, which can then transmit it to the other element. The bus then provides this information to destination element. Buses, rather than the direct

*https://www.elprocus.com/what-is-control-unit-components-its-design/

connections in between each pair of the devices, become even more effective as the complexity of the computer system increases.

Use of the circuit board is reduced by using buses instead of a large number of the direct connections. The number of pins on CPU chip may be reduced as a result. The diagram shows the 3-buses in system. The address bus is located on the highest bus. The memory address is needed whenever the CPU wants to access the data or the instructions from or write to memory.

The memory bus receives the address from address bus and utilises it to locate the memory location that is appropriate. In addition, each I/O device, such as a monitor, keyboard, or disc drive, has the unique address.

The CPU uses address bus to find I/O device's address. Using bus address, every device may determine if it is being used by CPU.

The data bus facilitates the transfer of information. A memory address is initially produced on address bus by the CPU whenever retrieving data from the memory. As a result, the CPU is able to access the data on data bus from the memory. As a result of this, CPU outputs the memory address firstly into the address bus, and then sends data to a data bus as well.

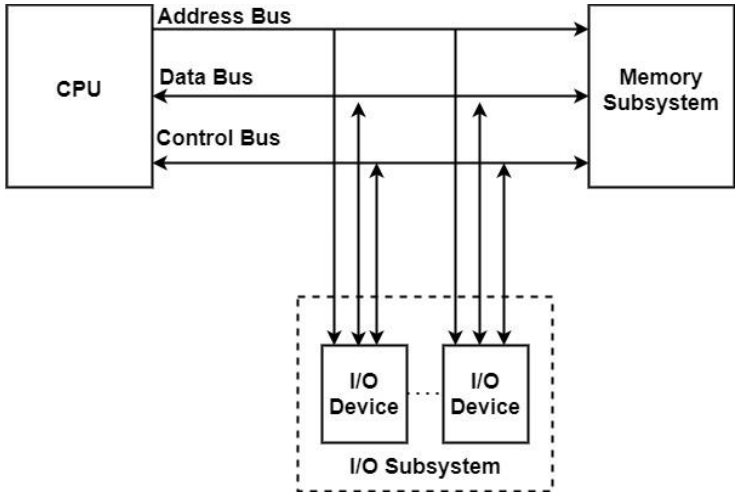

Figure 2.3 System Bus[*]

2.1.5. Main Memory Unit

In the computer system, a main memory serves as the core storage unit. Storage space for programmes as well as data utilised during run time activities may be found in this big and quick memory.

Semiconductor integrated circuits are the principal memory technology. The primary memory's integrated circuits are divided into the two major groups.

1. "Random Access Memory" -integrated circuit chips
2. "Read Only Memory" - integrated circuit chips

A second kind of integrated circuit chip is a ROM (Read Only Memory).

*https://www.tutorialspoint.com/what-is-system-buses

Electrical charges are used to capacitors to display the binary information in a dynamic RAM. MOS transistors are used to incorporate capacitors onto the device. On comparison to static RAM, dynamic RAM uses less power as well as offers more storage space in the single memory chip. Static as well as dynamic modes of operation are available for RAM- "integrated circuit chips". Flip-flops are basic components of the static RAM, which stores the binary information. Volatile information is data that can be accessed only when the system is powered up. In comparison to the dynamic RAM, static RAM is simpler to utilize and also takes less time to complete read as well as write operations. Electrical charges are used to capacitors to display the binary information in a dynamic RAM. MOS transistors are used to incorporate the capacitors onto the device. On comparison to the static RAM, dynamic RAM uses less power and offers more storage space in the single memory chip.

2.1.6. Cache Memory

Cache Memory is the kind of the high-speed memory that is used to store frequently used data. With the high-speed CPU, it may be utilized for synchronization and speed. Cache memory is more expensive than the main memory or disc memory, but it is more cost-effective than the CPU registers. Between RAM as well as CPU, cache memory serves as a quick stopgap. It stores data as well as instructions which are often requested such that CPU may access them right away.

Data from a main memory may be accessed more quickly thanks to cache memory. Data from the frequently used the main memory regions are cached and stored in the smaller, quicker memory. In the CPU, there are a number of separate caches that hold instructions as well as data.

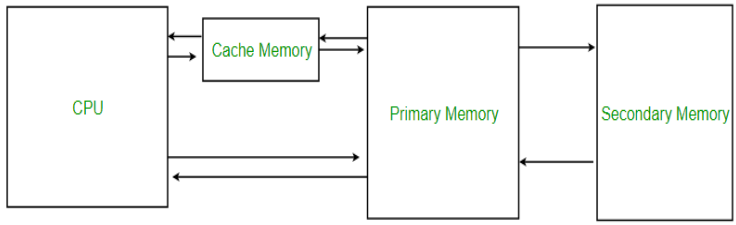

Figure 2.4 Cache Memory represented in the block diagram*

Applications of the Cache Memory –

1. Cache memory could often hold a fair number of the blocks at a time, although this amount is minimal when compared to a total number of the blocks in a main memory.
2. The mapping function specifies the relationship between a main memory blocks as well as those in a cache.

2.2. Communication among Various Units

An input unit collects data, a central processing unit (CPU)

*https://www.geeksforgeeks.org/cache-memory-in-computer-organization/

analyses it, as well as an output unit sends it out again. A single bus connects all of such gadgets together.

The computer's bus is the channel for transmitting data or the information in a form of the electric impulses through a group of the conducting wires. Address, Data, as well as Control Buses are all forms of the bus. The diagram depicts how several functional components are linked together.

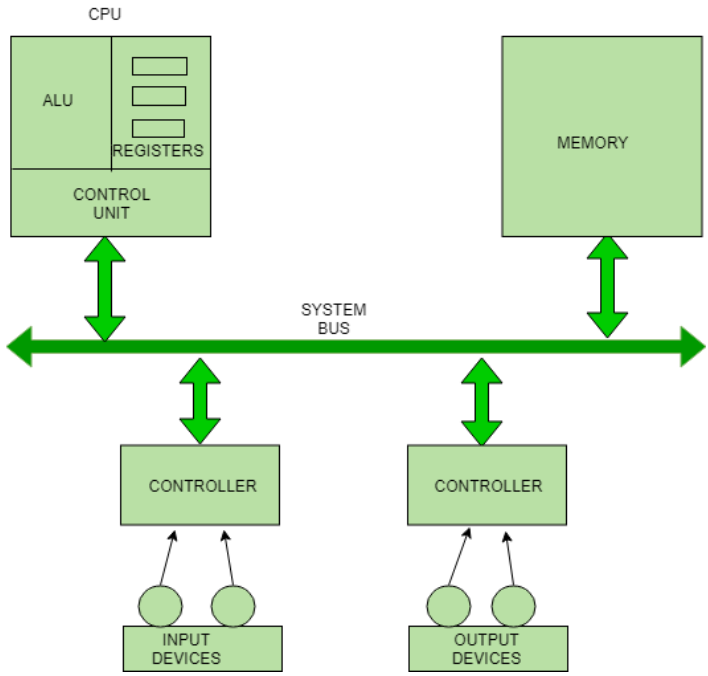

Figure 2.5 Communication among Various Units*

The data or the instruction's address is sent through address bus. Both data bus as well as control bus

*https://www.geeksforgeeks.org/functional-components-of-a-computer/

transport data back and forth between various components. It is via system bus which data is sent to and from the central processing unit (CPU), main memory, and other I/O devices. The controller circuit, that aids in the management of numerous input or output devices connected to computer, connects input or output devices to a system bus.

2.2.1. Processor to Memory Communication

"Memory Data Register" (MDR) & "Memory Address Register" (MAR) are two parts of "Central Processing Unit". The data that moves back and forth between the CPU as well as memory is stored in Memory Data Register. The location of next instruction being executed is stored in Program Counter, the special CPU register. For each memory address, CPU's Arithmetic as well as Logic unit stores it in Memory Address Register.

In the computer, the bus is the group of cables that facilitates communication among the device's many components. Addressing the memory location is done by using the address bus. Using the decoder, the digital circuit, word may be pinpointed to a particular memory region. It is linked to address bus that gives instruction's address. To carry data in between memory as well as the CPU, the data bus is needed the bidirectional data bus as well as a one-way address bus. Both read as well as write the operations are controlled by the control bus. Data is fetched from memory and sent MDR during the read operation. When

employing 1 or 0, the single control line may conduct two different actions, such as Read/Write. This transfer of data takes place during the write operation. Figure 2.6 depicts this structure.

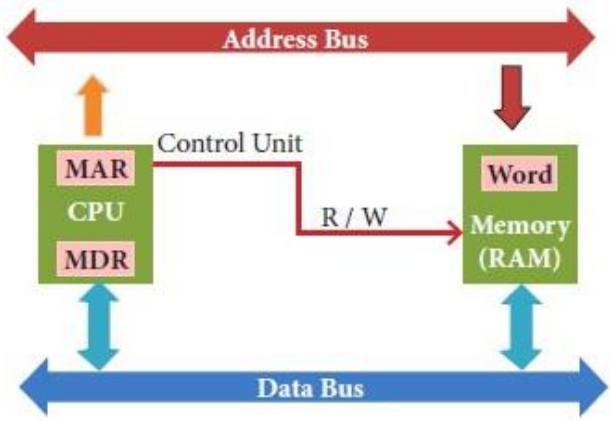

*Figure 2.6 Bus Connectivity between CPU & Memory**

2.2.2. Processor—I/O Devices Communication

The interface unit is used to establish communication in between the computer's Input/Output devices and its CPU. Input devices send data to a processor, while the processor sends data to the output device in the computer system.

While data is being transferred from Input/Output devices, the following processes are taken.

*https://img.brainkart.com/article/article-Data-communication-b-2Kz.png

While data is being transferred from Input/Output devices, the following processes are taken:

1. Bytes of data are sent one at time by input devices that connect to the data bus.
2. Data valid signals are sent over devices control bus, indicating that the data is accessible on a data bus, and are sent to a data register.
3. A flog bit of very same register in interface unit now contains the data that was previously held in a data register.
4. The interface unit's data registers will now receive an Input/output read signal from the CPU.
5. When data register has finished placing data on data bus, computer system's CPU receives the data.

Data is sent to the output devices through a series of steps:

1. The interface unit's data register usually connected to digital bus, which the CPU uses to send data.
2. The CPU also uses devices address bus to store the addresses of output devices.
3. In order to write data to register, CPU issues an Input/output write signal after putting the address as well as data on their proper buses.
4. As soon as data is received, the interface unit sends the data-accepted signal via a control bus.
5. Once the data has been transferred from data register, it is sent to output devices through a data bus.

6. The output devices then receives the data and transmit the signal to CPU to acknowledge it.

2.3. Instruction Format

Operands are used in conjunction with the set of the operation codes to accomplish tasks. Bits in the instruction may be designed in accordance with instruction format. The operands, opcode, and the addressing mode are all included.

8-bit character length is used as a guide for determining instruction length. Opcode, operand as well as the address modes all have multiple bits allocated to them when instruction length is permanently set.

The following factors may be taken into account when interpreting instruction's bit allocation function: −

- Number of the "addressing modes"
- Number of the "operands"
- Number of the "CPU registers"
- Number of the "register sets"
- Number of the "address lines"

The graphic depicted IA-32 instruction format generally. Microprocessors manufactured by Intel use the "IA-32 instruction format". The opcode field, the addressing mode field, the displacement field, and the immediate field are all included in the instruction format, which has the four fields altogether.

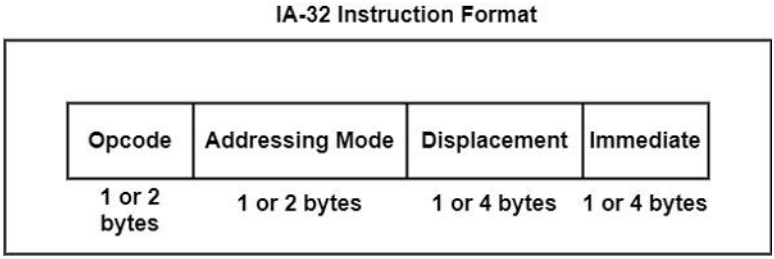

*Figure 2.7IA-32 instruction format**

One or two bytes make up the opcode field. Additionally, addressing mode field has 1 or 2 bytes. It only takes one byte to construct the operand's effective address in addressing mode field when there is only single register used to do so.

The displacement field comes immediately after addressing mode field. If a displacement value is used to calculate the effective address for the memory operand, subsequently one or even four bytes are encoded. One or even four bytes may be used to represent an instantaneous operand, depending on how many bytes are available in operand field.

2.4. Instruction Cycle

The fundamental cycle of computer system is retrieval of instruction from the memory, decoding of instruction, and execution of instruction. Fetch-Execute-Cycle is another name for it. The RAM of computer system is where all of instructions being executed. The CPU is in charge of carrying out the command. Data and instructions are initially retrieved from a main memory and stored in

*https://www.tutorialspoint.com/what-are-instruction-formats

a temporary memory, called as the registers, by the processor system. A fetch cycle is name given to this phase. The CPU decodes fetched instruction once it has been retrieved from memory. The decoding phase is name given to this stage.

The CPU has set of the instructions that includes everyone in predetermined list. Data processing occurs at the end of instruction cycle. In this step, the instruction is executed as well as result is saved in the different register. After "fetch-decode-execute cycle", CPU reset itself for the next instruction cycle to begin. The central processing unit is believed to be the fundamental operating cycle that is performed in RAM as well as executes the command. When the computer starts up and also then shuts down, it's in CPU repeatedly. As soon as the first instruction cycle is finished, the very next instruction cycle is started. Parallel execution of instructions is possible in today's central processing units.

In instruction cycle, there are fundamentally five steps, as shown in the following diagram:

1. Instructions retrieved from the memory.
2. Figure out the instruction next.
3. Reads "effective address" from the memory.
4. Instructions execution.

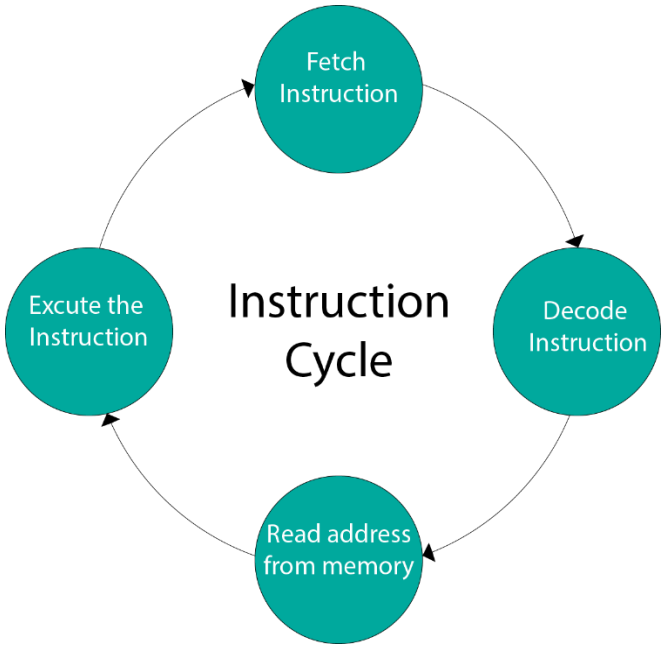

*Figure 2.8 Instruction Cycle**

2.5. Instruction Set

Instruction sets are sets of the machine language directives for the central processing units (CPUs). The instruction set is the subset of total number of the instructions that may be used by a computer's processor to improve its performance in a given circumstance.

The following is a list of the numerous instruction sets:

*https://www.javatpoint.com/instruction-cycle

- **Complex instruction set computer.** Microprogramming is added to CISC processors in order to allow instructions to be implemented as short programmes. Fast memory is used to store as well as update the programmable instructions. In CISC instruction sets, there are even more instructions than in any other form of the instruction set. When the single command is sent, the computer may do numerous activities, such as loading and unloading memory.
- **Reduced instruction set computer.** Computer with a smaller set of instructions. Control is the hard-wired in the RISC architecture. While it doesn't need microcode, the basic instruction set is much larger than before. The instruction set underlying RISC processors is similarly smaller and also more compact, and it has a defined format. In order to run quicker and even more effectively, RISC processors are built.
- **Enhancement instruction sets.** Instructions for enhancing performance. As a result of their frequent appearance in CPU advertising, certain instructions types are more recognised to the general public. The "166-megahertz Intel Pentium" with the "MultiMedia Extensions" (MMX) technologies are only one instance of this. It was released in 1996 and advertised as having improved "Intel CPU multimedia" performance. The MMX instruction set refers to a broader collection of features.

2.5.1. CISC Architecture

"Complex Instruction Set Computer " is the acronym for CISC. The use of CISC processors made it possible to lower the amount of memory required by reducing the complexity of the code. The single instruction in the CISC processor is capable of several "low-level operations". The CISC commands are brief yet 'complicated' as a result of this.

If a programme or piece of software is becoming simplified, then underlying hardware should keep up but also be able to handle the more difficult jobs. As a result, CISC processors have more complicated internal components. Here, you can see the block diagram of "CISC architecture":

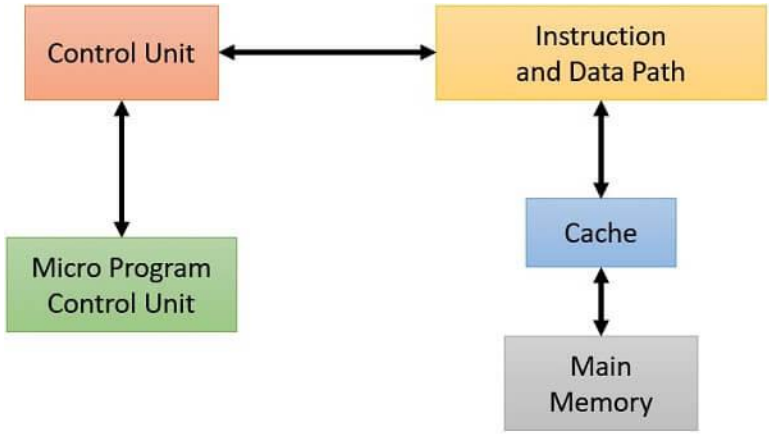

*Figure 2.9 CISC architecture**

In order to reduce the size of a programme, the CISC processor's major goal is to reduce the number of

*https://binaryterms.com/cisc-processors.html

the instructions in the programme. A complicated instruction is created by 'embedding parts of the lower-level instructions'. When the instruction is decoded, it creates a series of microinstructions that may be executed later.

2.5.2. RISC Architecture

"Reduced Instruction Set Computer" is the abbreviation for the word. Based on basic commands, it is a quick CPU design strategy.

These are simplified instructions. Achieving even the tiniest of objectives is the goal of every lesson. It's easier to write complicated instructions in such machine since instruction sets are small and straightforward. Complicated tasks may be completed in the single operation by stringing together instructions of comparable length. A single machine cycle completes the majority of instructions. RISC computers benefit greatly from the adoption of this pipelining approach.

A Smaller Number of Instructions It is the microprocessor intended to do a limited number of tasks simultaneously. Such chips use fewer transistors because of the smaller instructions they use, which reduces the cost of both designing and manufacturing the transistors.

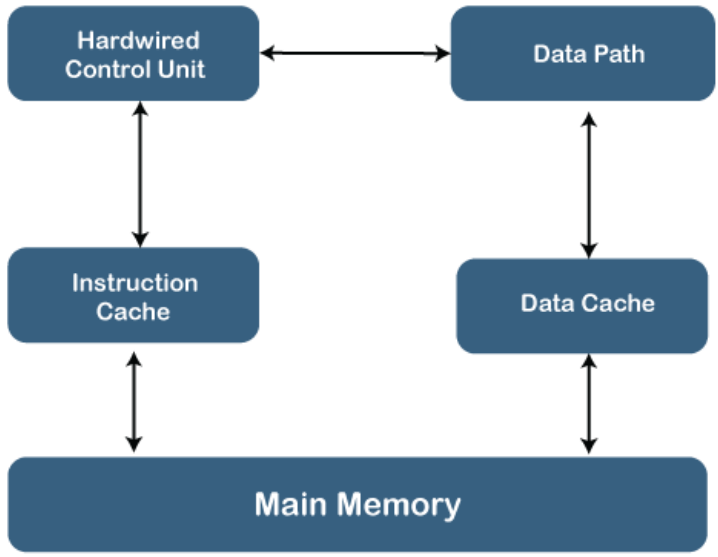

Figure 2.10 RISC Architecture[*]

2.5.3. Comparing the RISC with CISC

RISC	CISC
It is the computer with a "reduced instruction set".	It stands for Complex Instruction Set Computer.
It focuses on software in order to improve the instruction set's efficiency.	It places an emphasis on hardware in order to make instruction set run as efficiently as possible.
The RISC Processor uses it as a fixed unit of the programming.	CISC processor's microprogramming unit.
To save the instruction, you'll need numerous register sets.	For storing the instruction, you'll need the single set of registers.

*https://www.javatpoint.com/risc-vs-cisc

The decoding of instructions is straightforward in RISC.	The decoding of instructions is quite difficult in CISC.
In RISC, pipeline has straightforward applications.	In CISC, it's tough to put the pipeline to good use.
In order to speed up the execution of instructions, it employs just a small amount of instructions.	It has a significant number of the instructions which take longer to execute.
When a program interacts with another program's registers, LOAD and STORE are used independently.	When a program talks to another program's memory, it employs LOAD as well as STORE instructions.
Memory registers in RISC have more transistors.	Complex instructions may be stored in the CISC transistors.
RISC's runtime is very fast.	CISC takes longer to complete.
High-end applications such as telecommunications, image processing, and video processing may all benefit from RISC architecture.	Home automation, security systems, and the like may benefit from the CISC design.
Fixed-format instructions are provided.	It provides instructions in the variety of formats.
In order to run on a RISC processor, a program must take up more memory.	The memory footprint of a program developed on CISC architecture is less.
Power Architecture, AVR, Alpha, SPARC, as	VAX, Motorola 68000 series, AMD,

well as ARM are all examples of RISC.	System/360, and Intel x86 CPUs are all instances of CISC.

2.6. Inside a Computer

2.6.1. Motherboard

One of the computer's most important components is its "motherboard." CPU, RAM, hard disc and the optical drive connectors, expansion cards which manage video as well as audio, and also the connections to the computer's ports are all housed on the thin plate . Every component of computer is linked to motherboard in some way.

Figure 2.11Motherboard*

*https://fossbytes.com/whats-inside-my-computer-different-components-of-a-computer/

2.6.2. Central processing unit (CPU) or processor

The motherboard of a computer contains central processing unit (CPU), which is sometimes known as processor. What it does is carry out orders, which is why it is frequently referred to as the computer's brain. As soon as you launch a programme, you're giving instructions to your computer's central processing unit .

In most cases, the CPU is the two-inch ceramic square with the silicon chip embedded in middle. A thumbnail-sized chip is most common size. As the heat sink, a metal device which absorbs the heat from CPU, sits over motherboard's CPU socket.

Megahertz (MHz), or millions of the instructions per second; as well as gigahertz (GHz), or billions of the instructions per second, are the units used to measure the processor's speed. Instructions may be executed more rapidly with the faster processor. It is, however, not merely processor's speed that determines the computer's performance.

2.6.3. Power supply unit

The "computer's power supply unit" transforms the electricity coming from wall socket into the form that the computer needs. It provides electricity to a motherboard and the other components through the network of wires.

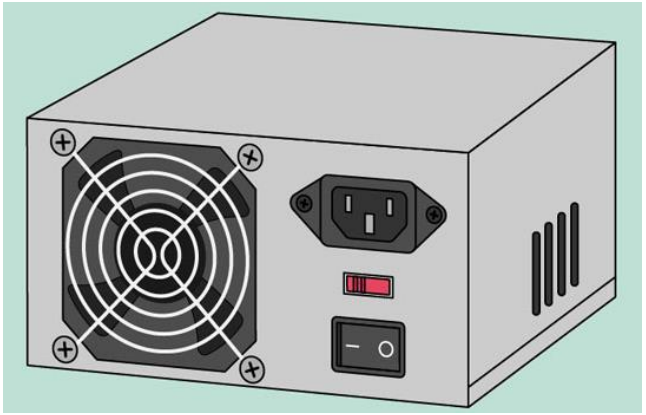

*Figure 2.12Power supply unit**

2.6.4. Ports and Interfaces

I/O sockets on a motherboard of the computer link to ports as well as interfaces on machine's back panel. The ports as well as interfaces allow external devices to be plugged in. The following is a list of the many port types:

Serial Port: To connect the external devices, which are often present on older PCs.

Parallel Port: It connects printers available on older systems.

USB Ports: It is possible to attach external devices such as cameras as well as scanners to computer through USB ports.

USB 3.0: To link computers and the other electronic devices, USB 3.0 is the third major version of standard. The

*https://edu.gcfglobal.org/en/computerbasics/inside-a-computer/1/

maximum data transmission rate for USB 3.0 devices is 5 Gigabytes per second. Additionally, USB 3.1 as well as USB 3.2 have been made available to the public.

High Definition Multimedia Interface (HDMI)

Uncompressed video as well as the audio data may be sent from the video controller to the suitable display device such as a "computer monitor" or "LCD projector".

2.6.5. Expansion Cards

The expansion card is the computer card or board that adds new features and functions. It is plugged into the computer's motherboard expansion slot. To interact with motherboard, expansion cards include edge connectors which are attached to edge of card.

There are a wide variety of expansion cards, includes sound cards, network cards, video graphics cards, and more. Expansion cards are utilised to improve the performance of the game's unique feature. In order to improve the visual quality on the computer, video graphics cards, for instance, are utilized.

2.6.6. Ribbon Cables

When many small-grade cables are arranged in parallel, the result is a thin, flat ribbon cable. Ribbon cables are so named because they have a broad flat profile and resemble the piece of ribbon when the cores are placed side by side. Internal peripherals, like as disc drives and their

corresponding drive controllers, often necessitate the usage of numerous data buses, which is where this sort of connection comes in.

Multiple-planar cables are another name for ribbon cables. Expanding a computer's capabilities is done by installing an expansion card. An expansion card is inserted into motherboard's expansion slot. Expansion cards includes edge connections connected to card's edge for communication with motherboard.

Sound, network, but also video graphics cards are just some of many types of the expansion cards available. Expanding the game's distinctive characteristic is a primary goal of expansion cards. Video graphics cards, for example, are used to enhance computer's visual quality.

2.6.7. Memory Chips

To put it simply, the memory chip is the integrated circuit which contains millions of the capacitors as well as the transistors which are capable of storing and processing data. “Random access memory “and "read-only memory" are two types of memory that may be used on the memory chip.

RAM

RAM stands for random-access memory. When your computer does a computation, it saves the results in RAM until they are required.

*Figure 2.13 RAM**

When the computer is switched off, the "short-term memory" is erased. Whether you're working on the manuscript or the spreadsheet, you'll want to save the work often to prevent losing it. Data is written to hard disc whenever you save the file, which provides long-term storage.

Megabytes (MB) and gigabytes (GB) are terms used to describe the size of RAM (GB). Memory (RAM) is a measure of how many tasks your computer can perform at once. As several apps are running at the same time, your computer might just get slow. Since this is case, several individuals purchase more RAM in order to boost the speed of their laptops.

*https://fossbytes.com/whats-inside-my-computer-different-components-of-a-computer/

ROM

Figure 2.14 ROM[*]

Read-only memory (ROM) is a kind of memory device which usually permanently retains data. Along with the "random access memory", it serves as the computer's main memory unit. Only the programmes and also data saved on it could be read, and nothing can be written to it. The only words which may be read are those that are the permanently recorded in the device.

At time of the ROM fabrication, manufacturer loads the programmes into ROM. ROM content cannot be edited after this, that means you cannot rewrite, rewrite, or wipe its content. ROM content cannot be altered after this Certain ROMs, on the other hand, allow for data modification.

2.6.8. Storage Devices

Hard drive

A computer's software, papers, and the other data reside on

*https://www.javatpoint.com/rom

hard drive. A hard drive is the long-term storage, so even if you shut down computer or disconnect it, a data is still there.

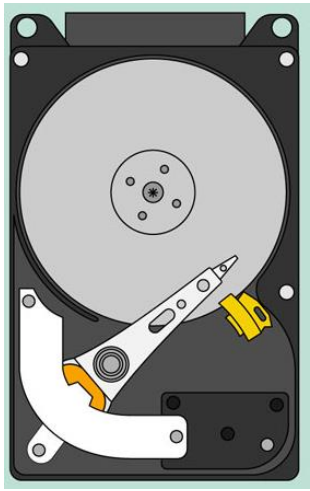

*Figure 2.15 Hard drive**

A few of data on hard drive is transferred to RAM whenever you execute an application or open the file. When you save the file, a copy of the data is made and stored on your computer's hard drive. Computers with quicker hard drives can start as well as load applications much more quickly.

Solid state drives

Large volumes of data may be stored non-volatilely on the solid state discs.

*https://www.computerscience.gcse.guru/theory/storage-devices

They utilise NAND flash memory, which have the benefit of having no mechanical moving components and, as a result, instant access to stored data

Figure 2.16 Solid state drives*

The performance of solid-state drives is superior to that of conventional hard disc drives, but the cost of these drives is much higher.

As a result of the higher cost, most storage capacity are expressed in the gigabytes.

Portable versions are also available for those who don't want to install them on their computer.

2.7. Data Representation in Computers

The following are some possible visual representations of data:

*https://www.computerscience.gcse.guru/theory/storage-devices

Data

In the digital age, data may take many forms, including numerical values, text strings, musical notes, and even the hue of an image. The way we stores, processes, and transfer data is referred to as the data representation. The data may be stored digitally on a variety of devices, including computers, cellphones, and tablets. In order to deal with the stored data, the electronic circuitry is employed.

Digitization

Photographs, music, numbers, and text may all be converted to the digital data via the process of the digitization. These kinds of the data are manipulated using electronic equipment. There were four stages to digital revolution, beginning with large, costly computers as well as moving to today's digital world. Small and affordable gadgets are proliferating all over the planet.

Binary Digits

Binary digits or bits, that are 0 and 1, represents the digital data. The lowest unit of information in the computer is binary digit. In this case, it has a value that is either true or false. True or false would be indicated by 1 and 0 respectively. Files that are used to gather data from storage devices like flash drives, CDs and DVDs are known as digital files.

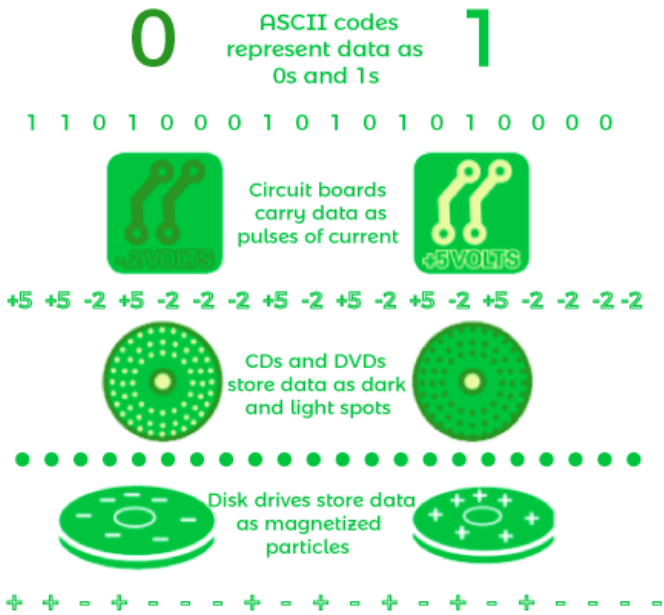

*Figure 2.17 Data representation in the form of Binary Digits**

It is possible to express number in following manner:

Numeric Data

We can conduct arithmetic operations on the numeric data because it contains numbers. Using the binary number system, the digital devices are able to store and display numerical data. Only digits 0 & 1 may be used to represents binary number system. There aren't any other

*https://www.javatpoint.com/data-representation-in-computer-organization

numbers in system that are quite like 2. The binary code for number 2 is 10.

Representing Text

It is possible to represent a piece of text in following ways:

Character Data

Symbols, characters, and digits could be used to construct character data, but they cannot be utilised in computations. Utilizing character data, we may create name, hair colour, our address, and other personal information. Textual data is the most common kind of the character data. For example, we may explain our father's and mother's names using the written word.

Digital Devices

A variety of the codes are used to represents character data on the digital devices, including the Unicode, ASCII, and others. When written out in its complete name, ASCII stands for American Standard Code for Interchange of Information". It's the character encoding standard for the electronic communication that's based on UTF-8. ASCII code may represent text via telecommunications equipment, computers, as well as a slew of the other devices. The ASCII code requires 7 bits for every character, with each bit representing a distinct character. The ASCII code for letter "A" in uppercase is "1000001".

Extended ASCII

It's possible to think of Extended ASCII as the "superset" of ASCII. Every character in the "ASCII" set is represented by 7 bits, however each character in “Extended ASCII" set is represented by 8 bits 7 bits of "ASCII characters" and a single more character are included in expanded ASCII. There are only 128 distinct characters in ASCII, however Extended ASCII has the ability to encode 256 different characters. The "Extended ASCII code" for letter A in uppercase is "0100000".

Unicode

"Universal character encoding standard" is another name for Unicode. Unicode is a standard for encoding and decoding characters in electronic documents such as text files, web pages, and the other types of media. With the aid of Unicode, we could now represents characters from all across world, rather than just the fundamental English characters that ASCII could represents.

The ASCII code can encode 128 characters, but 16-bit Unicode code can encode around 65,000 characters. Every character in the ASCII code is represented by a single bit, but Unicode allows for up to four bytes per character. UTF-8 as well as UTF-16 are two of the most regularly used Unicode encodings. Unicode 8 (UTF-8) is an example of the variable-length coding system. It is also most common character encoding employed on the Internet today. The

default encoding for several software products is UTF-8, as well.

Representing Bits and Bytes

To represents bits & bytes, the following representations are possible:

Bits and Bytes

Bits are really smallest unit of the data or information in the digital communication or the computers. Because it lacks the binary digit, it could only take on one of two values: 0 or 1. Bits may be represented in several ways, such as "0 or 1", "- or +", "false or true", "off or on", "no or yes". Bits & bytes are widely used to indicate "network access speed" as well as "storage capacity" in several technologies. A lowercase b is often used to denote the bit.

Bits are organised into units called bytes for the purpose of carrying out instructions and storing data. The byte is the eight-bit unit that is often abbreviated as the capital B. An eight-bit value is equivalent to 32 bits, but an eight-bit value for an eight-byte value equals 80 bits.

2.7.1. Types of Number System

The term "number system" refers to a method for representing and manipulating numeric data. The decimal number system seems to be the most widely used. Some more common number systems includes: octal, binary, and hexadecimal number systems.

Decimal Number System

In the decimal number system, there are ten digits from zero to nine. In other words, these ten digits may be used to represents any number. Positional values may be found in the decimal system.

10^5	10^4	10^3	10^2	10^1	10^0

Binary Number System

Using the two-state system (on & off) is the most straightforward method of changing instructions via electric impulses. It's easy to confuse "on" with "off" because of the way they are expressed numerically. Binary number system refers to the number system that uses just digits 0 &1.

In addition to binary, there is also the term "bit" to describe each individual binary digit. Every digit in this power-of-two-based binary number system also has the value expressed in the powers of two.

2^5	2^4	2^3	2^2	2^1	2^0

Octal Number System

Zero, one, two, three, four, five, six, seven are the eight digits of the octal number system. This is an example of an octal number system, which uses powers of 8 to indicate the numerical value of every digit−

8^5	8^4	8^3	8^2	8^1	8^0

Hexadecimal Number System

Zero through nine, and A through F, are the 16 symbols of the octal number system, which includes a total of 16 symbols. The positional value system, the hexadecimal digits are represented by their values expressed in the powers of 16, as can be seen in the example below −

16^5	16^4	16^3	16^2	16^1	16^0

2.7.2. Conversion between Number Bases

It is possible to translate numbers through one base to the other in the variety of ways. Here, we'll show you how to use the following−

Decimal to Other Base System

Steps are as follows

1. Subtract the "new base's value" from the "decimal number" you want to convert.
2. Use the last digit from Step 1 as "new base number's rightmost" digit.
3. Divide the preceding divide's quotient by "new base".
4. The residual from Step 3 should be recorded as next digit (towards the left) of "new base number".

Step 3: When the quotient is zero, repeating the Steps 3 & 4 till the quotient is zero.

The "most significant digit"(MSD) of a "new base number" will be the final remaining residual.

Other Base System to Decimal System

Steps are as follows

1. Each digit's location in column must be determined (it depends on position of the digit and also base of a number system).
2. Multiply "column values" by digits in relevant columns to get the final values.
3. Calculate sum of the goods from step -2. The total will be decimal equivalent of the number.

Other Base System to Non-Decimal System

Steps are as follows

1. An original number should be converted to the decimal number.
2. Decimal number produced from this process may now be converted to a corresponding base number.

Shortcut method - Binary to Octal

Steps are as follows

1. Divide "binary digits" into the three groups (begining from the right).

2. Each set of the three binary digits should be converted to a single octal digit.

Shortcut method - Octal to Binary

Steps are as follows

1. Each octal digit should be converted to a three-digit binary integer (the "octal digits" might be treated as “decimal' for such conversion).
2. A single binary number made up of the three digits of every one of the ensuing groupings of binary numbers.

Shortcut method - Binary to Hexadecimal

Steps are as follows

1. The binary digits may be divided into the four categories (beginning from the right).
2. Use the hexadecimal symbol for each set of the four binary digits.

Shortcut method - Hexadecimal to Binary

Steps are as follows

1. A four-digit binary integer for every hexadecimal digit (hexadecimal digits might be treated as the decimal for such conversion).
2. All binary groups (each with four digits) should be combined into the single binary number.

2.8. Coding Schemes

Coding is the Standard that instructs the computer of user that character corresponds to what byte set. If "coding scheme" used is not specified, the computer may read a particular byte as the different character than the intended.

As an example, consider the following: In ASCII, 0x6B is translated as the letter 'k', whereas in EBCDIC, it is read as character.

The most widely used coding method is known as ASCII "American Standard Code for Information Interchange". In the year 1963, the "American Standards Association" introduced ASCII as ASA X3.4-1963, the first version of the standard. 7-bit representations of 128 characters, ranging from "0x00 to 0x7f", are provided.

Using the ASCII Character Set-

Characters	Decimal	Hexadecimal
0-9	48-57	30-39
A-Z	65-90	41-5A
a-z	97-122	61-7A

Other specialized letters and punctuation occupy the remaining hexadecimal space.

- **UTF-32 (Unicode Transformation Format 32-bit):** It uses four bytes to represent each character in UTF-32. As the fixed-length system, every character is represented by the 4-byte value. All Unicode's 1, 064, 112, code points were represented in this way.

Eventually, this method was supplanted by more efficient ones because of its huge space needs.

- **UTF-16(Unicode Transformation Format 16-bit):** To encode characters, UTF-32 use either two or four bytes. Unicode's 1, 064, 112,code points may be represented using it.
- **UTF-8(Unicode Transformation Format 8-bit) :** At least one byte is required for every character to be encoded with UTF-8, that was introduced in the year 1993. It is capable of representing every single Unicode code point.

  The first 128 characters of "UTF-8", from "0x00 to 0x7f", are identical to ASCII. Therefore, this UTF scheme is the compatible with ASCII in the opposite direction.

  An encoding method that uses either 1, 2, 3, or 4 bytes to represents the character is called the "variable length encoding".

  When two or even more consecutive bytes represents the same character or two distinct characters, the first few bits of every byte serve as indicators.

- **ISCII(Indian Script Code for Information Interchange) :** Several Indian scripts may employ this coding technique, making it universally applicable. It's an 8-bit design. There are no "ISCII-specific characters" in "first 128 ASCII characters"; only the following 128 bits are dedicated to encoding them.

CHAPTER 3
Computer Memory and Storage

3.1. Introduction

An essential part of every computer system's hardware and software is the computer's RAM (random access memory). When data as well as output results are processed, they are saved in this location. Storage might be needed for a short time, immediately, or for a long time at all. When we talk about the computer memory, we're referring to electronic storage space where the CPU can access data as well as instructions fast.

Main and also the auxiliary memory are two types of computer memory. During the execution of a programme, data as well as instructions are stored in the main memory, whereas data and programmes not presently in use are stored in the auxiliary memory, which offers the long-term storage.

Using computer technology, data is preserved in the data storage device and may be retrieved at any time. Temporary or long-term data storage is possible with the use of the computer's storage mechanism.

Users may store a wide range of material, from films and papers to raw data, on the storage devices like flash drives as well as hard discs, which are essential to the most digital devices.

Many people refer to the data storage as the electronic or computer data storage.

As one of the most important parts of the computer, storage is divided into various categories, but the two most common ones are hard drives and optical drives:

- **Volatile Storage (Memory):** To store or retain data, requires a constant source of power. Temporary storage for the data and the application workloads is provided by this device. Cache memory as well as random access memory are two instances of the non storage.
- **Non-Volatile Storage:** The ability to save digital data even if the device is turned off or does not receive any electrical power. Permanent data storage that requires I/O activities is often accomplished using this technique, which is also referred to as the secondary storage. Optical discs, hard drives, and USB flash drives are all types of the volatile storage.

3.1.1. Memory Representation

Input, intermediate results, output, and instructions are all stored in computer's memory. Memory is made up of

binary digits, or bits. The single binary digit, such as 0 or 1, is what we refer to as bit. Data is represented by bits, the smallest possible representational unit in computers. But the computer treats data as a collection of bits. The byte is a collection of eight bits. The smallest unit of data which the computer can handle is the byte. A single byte may represents 256 distinct symbols since it can hold 28 different bit combinations, — for example 256 different bit combinations. "00000000" to "11111111" is the range of possible bit combinations in the byte. A word may be formed from a collection of bytes. A word may be made up of two, four, or eight bytes, depending on the context.

1 bit = 0 or 1
1 Byte (B) = 8 bits
1 Kilobyte (KB) = 2^{10} = 1024 bytes
1 Megabyte (MB) = 2^{20} = 1024KB
1 Gigabyte (GB) = 2^{30} = 1024 MB = 1024 *1024 KB
1 Terabyte (TB) = 2^{40} = 1024 GB = 1024 * 1024 *1024 KB

3.2. Memory Hierarchy

Digital computers require memory units to store programmes and data, which is why they are so important.

There are two basic types of memory units: read-only and write-only:

1. Main Memory refers to the memory which communicates directly with the central processing

unit. RAM is the common abbreviation for "random-access memory".

2. Auxiliary Memory is the name given to memory units which offer additional storage. For example, magnetic discs and also the magnetic tapes are two of the most often utilised supplementary memory options.

All of the computer system's possible storage devices, from slow but large-capacity auxiliary memory to quicker main memory, fall under the umbrella term "memory hierarchy."

An example memory hierarchy is shown in the following figure.

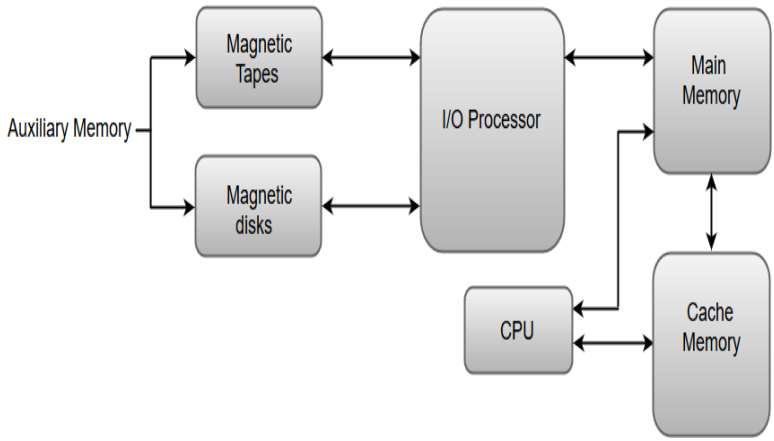

Figure 3.1 Memory Hierarchy*

* https://www.javatpoint.com/coa-memory-hierarchy

Auxiliary Memory

The computer's auxiliary memory is indeed the cheapest, largest, and the slowest-access storage available. Programs as well as data may be stored in the auxiliary memory for the long-term storage or when they are not needed right away. Magnetic tapes as well as magnetic discs are most frequent supplemental memory types.

The writing, rewriting, and accessing of data on the magnetic disc are all accomplished via the application of magnetization. Examples include hard drives, zip discs, as well as floppy discs.

For archiving, gathering, as well as backup of many types of the data, magnetic tape is the ideal media.

Main Memory

"Random Access Memory" is the common name for computer system's primary memory. An I/O processor connects this memory to the CPU and other peripheral devices.

When not in use, applications may be moved to auxiliary memory, freeing up main memory space for more important data and programmes.

Cache Memory

Cache memory is used to save frequently used data from the main memory such that processor may access it more

quickly. Cache memory is the first place the CPU looks when it needs to access the data from the main memory. Data is read from the fast memory if it is already stored in a cache memory. Alternatively, the CPU transfers to main memory to get the necessary data.

I/O Processor

For the most part, an I/O Processor handles the data transfers in between auxiliary and principal storage devices.

3.3. Random Access Memory

"Random Access Memory" is full name of RAM. Whenever the PC or the laptop's power supply is turned off, information saved in this kind of memory is erased. The BIOS may provide access to the data stored in the RAM. It is often referred to as the primary memory, cache memory, temporary memory, or volatile memory of computer system.

RAM may be a single chip put on a motherboard or the collection of the chips mounted on the tiny board and linked to motherboard via a ribbon cable. A computer's primary memory. As contrast to the other memories, like the "hard disc drive" (HDD), "solid-state drive" (SSD), "optical drive", etc., it is quicker to write to as well as read from.

*Figure 3.2 Random Access Memory**

3.3.1. Types of RAM

RAM is "volatile," meaning that data stored within is erased when computer is shut down or if power goes off. As a result, UPSs are often utilized as a form of redundancy in the computer systems. RAM is modest in both physical size as well as data storage capacity.

RAM is of two types −

1. **Static RAM (SRAM)**

While power is being provided, the memory keeps its contents. This is known as "static." Moreover, when power goes off, the data is gone. They employ the 6-transistor

*https://www.tutorialspoint.com/computer_fundamentals/computer_ram.htm

matrix as well as no capacitors in their SRAM chips. SRAM does not need to be updated on the regular basis since transistors don't require electricity to avoid leakage.

Because SRAM requires more chips to store same amount of data as DRAM, it is more expensive to produce. Therefore, SRAM is employed as the cache memory due to its high access speed.

Features of “Static RAM”

- Long life
- Refreshing isn't necessary.
- It is very Fast
- Also work as “cache memory”
- Large in size
- IT is costly
- It consume high power

2. Dynamic RAM (DRAM)

Likewise SRAM, data in DRAM has to be constantly updated. In order to do this, the refresh circuit is used to perform hundreds of data rewrites each second on memory. Because it is tiny and inexpensive, DRAM is the most often utilised kind of computer memory. There are two components in every DRAM memory cell: a capacitance as well as a transistor.

DRAM's features are described here.

- Data retention is short
- Requires constant recharging.

- Compared to SRAM, it is slower.
- It works as RAM
- Size is small
- Not too much costly
- It consume less power.

3.4. Read Only Memory

"Read-Only Memory" is referred to as ROM. It is the non-volatile memory which is utilized to store data that is critical to operation of the system. We could only access the programmes as well as the data stored in "read-only memory" since that's what its name implies. In addition, it serves as the computer's main memory. The electronic fuse that may be configured for a particular piece of the information is included in this device. Data saved in the binary form in ROM. Permanent memory is another term for it.

ROM's advantages include the following:

- Non-volatile memory is referred to as ROM.
- ROM data is indestructible.
- We could only read the data and programmes that are stored on it.
- On the ROM, data and applications are saved in the binary format.
- The computer's boot procedure makes use of it.

3.4.1. Types of ROM

Now, we'll go through each sort of ROM individually:

1. MROM ("Masked read-only memory"): There is no doubt in our minds that ROM is as ancient as the semiconductor technology. With transistor switches connecting word as well as bit lines, "MROM" was the first programmable read-only memory . Physically coded ROM data can only be programmed during manufacturing process. It wasn't too costly, really.

2. PROM ("Programmable read-only memory"): The PROM is the kind of digital storage device. In this ROM type, the fuse or the anti-fuse locks every bit in place. It is impossible to alter or delete the information that is stored in it. Firmware and microcode are examples of low-level applications that employ this kind of code.

3. EPROM ("Erasable programmable read-only memory"): Reprogrammable PROM, often known as EPROM or EROM, is a form of EPROM. By using ultraviolet light on an EPROM, data may be deleted as well as reprogrammed. It can only be reprogrammed so far. Microcontrollers utilized EPROM before EEPROM as well as flash memory became commonplace.

4. EEPROM ("Electrically erasable programmable read-only memory"): It could be programmed as well as wiped electronically, as its name suggests. About ten thousand times may this ROM be deleted and reprogrammed. In the

range of 4-10 microseconds, the EEPROM is erased and reprogrammed. Microcontrollers as well as keyless systems rely on it.

3.5. RAM, ROM and CPU Interaction

Since memory bus connects RAM directly to CPU, CPU may retrieve data stored in the RAM relatively quickly. However, in most cases, ROM data can't really be modified. The "computer's ROM memory" includes only enough commands to get it up and running when it is first turned on.

There are ROM chips on a motherboard of the computer. To store programmes, computers may also include supplementary ROM chips. When it comes to ROM's placement, it's up to motherboard's manufacturer since they need to discover an available area on their motherboard which could be linked to CPU through the "controller chip".

You have RAM as well as ROM in the computer. RAM stands for "random access memory", while ROM stands for "read-only memory". RAM stands for random-access memory, and it's where you keep the things you're working on while you're on the go. Computer programmes are stored in ROM, or read-only memory, which is a kind of the non-volatile memory.

Having a lot of RAM helps the CPU finish its responsibilities. RAM is like nails in the nail gun's barrel.

Memory is used by the CPU while it performs tasks and executes apps.

3.6. Types of Secondary Storage Devices

Whether internal or external, the secondary storage device is the non-volatile storage device. In order to save data indefinitely, it is necessary to have the storage device other than the main storage. The "auxiliary storage device", "backup storage", or "tier 2 storage" is the supplemental storage device. An operating system, applications, device drivers, and ordinary user data are all stored on such devices, which are also known as disc drives.

You may choose between fixed as well as removable second-storage options for your files here.

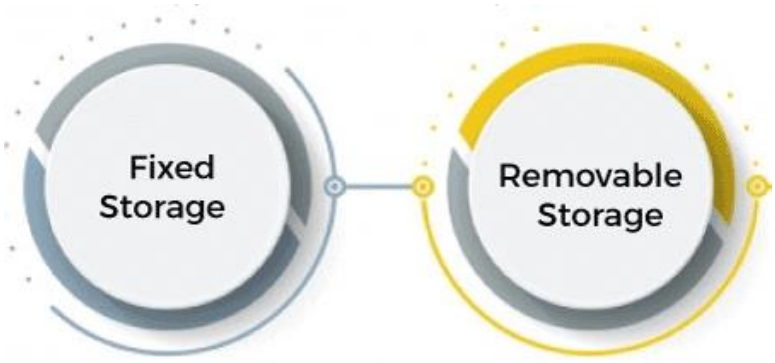

Figure 3.3 Types of Secondary Storage Devices*

*https://www.javatpoint.com/secondary-storage-devices-in-computer-organization

Removable or the fixed media might be used for secondary storage material hard disc drives, optical drives, and optical drives are all examples of the fixed storage media. Removable storage media is the storage medium which is portable and may be transported outside computer.

1. Fixed Storage

Data may be stored on the computer system's fixed storage device. These are most often known as the hard drives or fixed disc drives.

There is no such thing as the "fixed storage device". To perform repairs, maintenance, or upgrading work, they might be taken out of system. Engineers are required to open up computer systems to provide the physical access, and this can't be done without an appropriate toolbox. Generally, this can't be done without the engineer.

When it comes to computers and data, most of the time it's saved in some kind of built-in storage. Types of the fixed storage that we provide include the following:

- “Internal flash memory”
- “solid-state disk” units
- “Hard disk drives”

2. Removable Storage

The "computer system's removable storage" is the "external media device" used to store the data. Removable Disks" or "External Drives" are often referred to as these. It is possible

to remove the storage device from the computer while it is still in use as the "removable storage". DVDs, CDs, USB drives, Blu-ray disc drives, and diskettes are all instances of the external devices. The ability to move data between computers is greatly facilitated by the usage of the removable storage.

Because of their high data transmission rates, detachable discs in storage systems are an attractive alternative to "storage area networks" (SANs). The following are the several kinds of portable storage we offer:

- Optical discs (CDs, Blu-ray discs, DVDs,)
- Floppy disks
- Memory cards
- Disk packs
- Magnetic tapes
- Paper storage (punched cards, punched tapes,)

3.7. Magnetic Tape

Different types of data may be stored on magnetic tape. Comparatively speaking, it is an analogue solution as opposed to more modern storage medium like solid state discs (SSDs). For many years, magnetic tape was the primary means of storing audio as well as binary data, and it is still used in certain systems today.

With the advent of the digital image as well as audiovisual material storage, the magnetic tape systems have become more rare in the recent years.

Several of the bigger and simpler mainframe computers which existed before to latest personal computers employed magnetic tape.

Magnetic tape vaulting for storing of tangible records is an old-school method of using the magnetic tape which is still in use. These specialists back up the digital data on the magnetic tape in order to protect it in the case of a natural catastrophe or other emergency situation.

Figure 3.4Magnetic tape*

3.7.1. Magnetic Tape Organization

These include magnetic tape, magnetic discs, as well as the magnetic drums. Magnetic memory is used in such memories.

Magnetic tape can only store data on one side of ribbon. Sequential memory is made up of the thin plastic ribbon

*https://www.geeksforgeeks.org/magnetic-tape-memory/

covered with magnetic oxide that is used to store the data. It takes more time to read and write data since sequential access is used. Using the magnetic tape drive for both writing as well as reading data makes it very dependable.

The storage capacity ranges from "100 MB" to "200 GB", and also the ribbon's width ranges from "4mm" to "1 Inch".

3.7.2. Advantages of Magnetic Tapes

Low Cost

The data storage media which doesn't need power while it is stored has the very cheap operational cost when compared to the expenses of energy, air conditioning, as well as the power facility equipment.

Since the cost of the cartridge is less than the cost of an HDD per GB of the capacity, more cartridges means a cheaper cost per GB.

Optimal for Long-term Storage

Magnetic tape, on the other hand, has indeed been demonstrated in an expedited assessment test to sustain its performance for more than three decades.

Furthermore, the magnetic tape is regarded as the ideal medium for the long-term storage due to its reduced failure as well as error rates and superior dependability compared to hard discs.

Secure and Safe

Blackouts, theft, hacking, and other data leakage incidents occur across the globe. For magnetic tape, BCP, that stores the data offline, seems to be the best option since it has a lesser likelihood of such incidents.

Offline storage and portability make it ideal for distant data storage in the event of a catastrophe or other unforeseen event.

High Capacity

Magnetic tape's recording density also is rising, in contrast to hard discs, whose "recording density" has already hit its limit; the next-generation technologies have indeed been proven. As a result, additional gains in storage capacity may be envisaged by making tape thinner as well as longer. LTO12, that offers the greatest capacity per cartridge among current magnetic tape solutions, has so far been included in future roadmap.

3.7.3. Disadvantages of Magnetic Tapes

- The life expectancy of the magnetic tape is 15 years. Over time, the quality of data decreases.
- For the sake of being able to read data saved on older tape technology, this tape is required.
- Tape may be damaged if kept near the magnetic field or powerful speaker.
- Magnet tap is in direct contact with the recording heads, creating friction as well as wear.

- It is necessary to acquire and also set up specialized equipment for capturing and also storing data. Only a certain piece of equipment is capable of reading the data.
- In comparison to magnetic discs, it is sluggish.
- It is inflexible, making it difficult to make changes to the database.
- Tape reading problems may occur if corrosive gases and chemicals are present.
- Use parity bits, which makes it harder to retrieve data if little mistake occurs.
- Since data can't be retrieved in the random order, this format isn't appropriate.
- To record as well as read data on just this tape, a unique piece of the equipment is required.
- Age, heat, or even the Earth's magnetic field may cause tape's magnetic data to be damaged or erased over time.

3.8. Magnetic Disk

This sort of the secondary memory is the flat disc coated with the magnetic material that may keep data. It serves as a repository for a wide range of software and data. 1 represents information that has been polarized in one way, and vice versa. The number zero denotes the direction.

There is a drawback of using magnetic discs instead of RAM since they are less costly and could store more data, but data access rate is slower than with the main memory. Changing

or erasing data on a magnetic disc is simple. Data may also be accessed at random using this method.

Figure 3.5 Magnetic Disk[*]

3.8.1. Storage Organization of a Magnetic Disk

The magnetic disc is the most prevalent kind of physical storage medium for data. There are really many revolving platters in the disc. In a similar way as the audio cassette recorder, the electromagnetic recording heads are used to read and write to the platters. For every surface, there is the single head, and they all move in unison. It spins at around "3600 rpm", with heads hovering only a few micrometers above a surface of the disc. With capacities ranging from "500MB" to "9GB"and the price range between £20-$3000, modern workstation drives are becoming more affordable.

*https://www.geeksforgeeks.org/magnetic-disk-memory/

Tracks are laid out in concentric circles on the platter's surface. Sectors separate every track. The transfer unit in between the disc and main memory is indeed block of an information contained in a single sector. It is up to operating system to decide where every file's blocks should be put.

The amount of time it takes to go to a certain block includes:

- It's time to shift gears and start looking in the proper direction.
- Latency - the time required for sector to get around to head.
- Time required for the actual transmission of data, known as "block transfer time".

Everything here happens in a matter of milliseconds, not microseconds. As you can see, the search time as well as latency are clearly dependent on where the necessary block is in relation to where the heads are now situated. Putting all of the file's blocks solely on a single track helps keep access times as well as latencies to a minimum. Similarly, if you have a huge file, it's best to keep it all on one disc. There are slew of more positioning strategies (like placing the heavily used files on middle tracks such that an "average seek time" is reduced). In most cases, it is not feasible to put the blocks efficiently since files vary widely in size as well as may do so dynamically.

3.8.2. Accessing Data from Magnetic Disk

Retrieving Information from the Magnetic Disk—

Seek Time

Tracks are selected and head is positioned accordingly for data to be read or recorded. The seek time is amount of time it takes to move read or write head to requested track.

Latency Time

Reading/Writing begins when the head is on correct path and is waiting for the sector to come beneath it (disk being moving at the high speed). The time it takes for a particular sector to come under the read/write control is known as latency.

Data Transfer Rate

The data must be written to or read from a disc once the read or write head has been positioned correctly on correct track as well as sector. Data transfer rate is a rate about which data being written or retrieved from a disc.

Access Time

A disk's access time is calculated as the total of seek time, latency time, but also the data transfer time.

- ✓ Storage space on a hard drive is expressed in gigabytes (GB)

- ✓ Multiple discs stacked on top of each other provide large amounts of storage. A cylinder is made up of the same tracks on all of the discs. Each disc has the read/write head that works in tandem with the other heads on the disc.
- ✓ Both sides of a disc may contain tracks as well as sectors. The term "double-sided disc" refers to one such disc.

3.9. Types of Magnetic Disks

All magnetic discs have a circular platter shape. They come in the variety of shapes, sizes, and materials, including metal as well as plastic. Magnetic discs currently come in a wide variety of shapes and sizes due to such distinctions. All of them, though, may be categorized into the two major categories-floppy discs. While hard discs are often stored in cartridges or other "contamination-free containers", floppy discs are enclosed in plastic sleeves or cases that protect the individual discs. Hard discs may be further divided into Zip/ Bernoulli discs, disc packs, & Winchester discs based on packaging they come in.

3.9.1. Floppy Disk

It is also called as floppy diskette, the floppy disc, or the floppy diskette, and it is a kind of storage medium which reads the data storage information. One of the earliest forms of the hardware storage by IBM, which might read and write the portable device, was exceedingly costly.

*Figure 3.6 Floppy Disk**

As a CD-ROM, they were "8 inches" in diameter when they were initially created, and users couldn't write to them. The first version of this disc could only hold 80KB of data, while subsequent models could store up to 800KB. USB as well as network file transmission have displaced floppy discs, however such discs are now obsolete.

Types of Floppy Disk

Many floppy disc drives have come and gone throughout the years since they were no longer in use.

8-inch Drive

The "8-inch floppy disc" was originally employed as the read-only format in early 1970s, but it soon evolved into

*https://www.javatpoint.com/what-is-a-floppy-disk

a format which could both read as well as write. Only because of its outward appearance was it given the eponymous floppy drive brand name.

5 ¼ -Inch Drive

A "5 ¼-inch floppy disk drive", popular on PCs in 1980s, was manufactured and extensively used. Computers using floppy disc drives in early 1990s might hold data between "360 kilobytes“ and "1.2 gigabytes" at the time. Data could be written to both the sides of certain 5¼-inch floppy drives, and data could also be modified. Manufacturers of the floppy discs started to produce "double-sided drives" after that.

3 ½ -Inch Drive

A 3 ½-inch floppy disc drive which really can store 1.44 megabytes on the high-density disc as well as 730 kilobytes on the double-density disc has also been developed. Earlier versions of Windows, including Windows 3.0, required the usage of many discs to complete the installation process.

Zip Drive

The zip drive was launched by Iomega in mid-1990s. Due to its availability as a peripheral, the zip drives were popular way to expand the existing system. As a result of its high price, the zip drive was not widely used since it was too expensive.

3.9.2. Hard Disk

The fixed disc or the hard drive is another name for a hard disc. Data is also said to be stored on a hard magnetic disc. In the drive unit, it's found. An external hard drive is the "non-volatile storage device" which comprises platters as well as magnetic discs which rotate at the high speeds. It is non-volatile if the data is retained even after the machine has been shut down.

It's a part of our computer systems, and we've got it. The computer's hard disc is housed in the drive unit and consists of platters encased in an airtight enclosure.

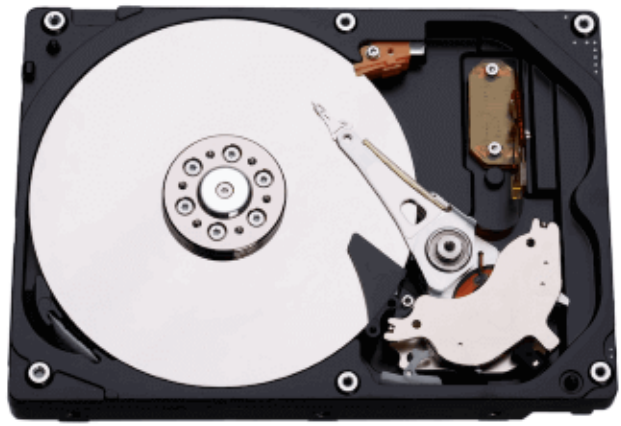

Figure 3.7Hard Disk[*]

The read/write actuator arm, a read/write head, a head actuator, a spindle, as well as the platter make up the bulk of its construction. A circuit board (also known as the disc

*https://www.javatpoint.com/hard-disk-definition-and-function

controller or interface board) is located on back of the hard drive. In this way, the computer and hard drive may exchange data.

Secondary storage, the hard drive, is meant to keep data safe for the long term. To put it another way, the "secondary storage devices" have a lot more storage space than the main storage devices do. When we turn off our computer, the information on our hard drive is still there. The computer's hard drive contains a variety of data, including the operating system as well as installed applications.

3.9.3. Zip Disk

Magnetic disc storage technology Iomega created in mid-1990s is known as the Zip drive. In its early days, it was popular because it was cheaper than the hard drives and it could hold more data than the floppy disc. The "Zip drive" was able to transport data quickly and reliably, and it was also quite durable. The Zip drive as well as Zip disc were quickly rendered obsolete by the introduction of competing technology like USB drives.

Use the drive with at least the very same capacity as Zip discs you intend to use. Low-capacity media could be read by drives with the higher capacity. The Iomega software cannot execute the "long" (thorough) format on a "100 MB"disc because "250 MB" drive writes to "100 MB" discs significantly more slowly than the "100 MB" drive. Iomega's software has an edge over Windows since it has ability to the format "100MB" discs with a little greater capacity using

the extended format. There is no difference in the size of a 250 MB disc when it is formatted in either direction Read-only supports for "100 MB" discs is available on the "750 MB" drive.

3.9.4. Advantages of Magnetic Disks

- Our valuable time is saved thanks to such magnetic discs, which process data as well as information at an immense rate
- Almost all of the data saved in such devices may be accessed at any time.
- They are regarded to be the greatest "secondary storage devices “since they are less expensive and lower in weight.
- Magnetic discs are better suited for a broad variety of applications since they provide for immediate access to the data.
- Because of its random access characteristic, magnetic discs are often used in collaborative projects and software where numerous people may work on the same project at the same time.
- Data may be stored on or off-line using magnetic drives. A floppy disc or Zip drive is often used as a supplemental storage medium for offline backups.
- High-end Winchester discs are utilized in the "personal computers" where software and apps are enjoyed by users.

- They're so popular now because of their large storage capacities and ability to store enormous quantities of data.
- There is a great amount of data that can be stored in a little amount of space, and also the ability to save and remove data at any time.
- Lightweight and compact, they could hold a lot of data in little amount of space.
- Because of their small size and low weight, they may be moved from one area to another with ease. To transfer data between computers, they're also utilized.
- Because these magnetic discs are impervious to changes in temperature as well as humidity, they are much less likely to suffer data corruption than a competing technology.

3.9.5. Disadvantages of Magnetic Disks

- They should be kept in a clean, dry place.
- Because of the ease of access, it is possible for users to accidentally delete important data.
- A magnetic disc is pricier than the magnetic tape.
- Disks from Winchester Magnetic discs, although more portable than magnetic tapes, aren't quite as light.
- Magnetic disc security measures can't be as readily maintained as distributed as well as "shared network security" features.

3.10. Optical Disk

Electronic data storage medium, also known as an "optical media", "optical disc", "optical storage storage media", "Optical disc drive", and "disc drives". It reads but also it writes data through the optical storage methods as well as technology. The portable as well as auxiliary storage device known as the optical disc was invented in late 1960s. The very first optical disc, created by "James T. Russell", can store data in form of "micron-sized light "as well as "dark dots".

3.10.1. Storage Organization of Optical Disk

More data could be stored on the optical disc, and it has the longer lifetime than the previous generation of magnetic storage mediums. Computers need the "CD writer" or "DVD writer drive" to read as well as write to "CDs" and "DVDs", and the Blu-ray drive to read and write. On read as well as write data to magneto-optic drives, discs, like CD-R as well as DVD-R drives, are employed.

Storage capacity has risen with the advent of the new generation of the optical media. The maximum data storage capacity of a CD is 700 MB, but a DVD can hold 8.4 GB of data. It's possible to store up to 50 GB of data on a single Blu-ray disc. In comparison to floppy disc storage medium, that can hold up to 1.44 MB of the data, such storage capacity is by far most convenient.

3.10.2. Access Mechanism of Optical Disk

The 0s as well as 1s in the binary computer code are represented by small markings formed in disc's plastic layer. Based on a size of a file, etchings may number in the tens of billions of etchings. Optical discs may store vast amounts of data despite their little blemishes in plastic. Spiral-wound etchings are used to wrap around optical disc to accommodate the high file sizes. In the figure3.7, we could see that every spiral of the information originates at an inner border of a disc. When data is stored this manner, users may access files they want without having to open any of the others.

Spiraling from disc's center to its edges, optical disc stores data in the spiral-like manner. Access to data files contained on a disc is now direct, removing need to open any unnecessary files beforehand.

Reflective metal is next layer that surrounds a plastic layer. This layer's primary purpose is to enable laser light to bounce off disc's surface as well as return to the detector.

Data contained in a plastic layer is finally decoded and decoded when disc reflects a laser beam back to a laser.

The detector can tell "0s & 1s" from each other since they reflect differently in light. “Optical disc data" is protected by the last polycarbonate layer on outside surface. This layer protects an "optical disc's memory" against typical injuries. As fragile as it may be, the disc's outer covering cannot effectively shield it from heavy impact or to prevent ridges from wearing down over time.

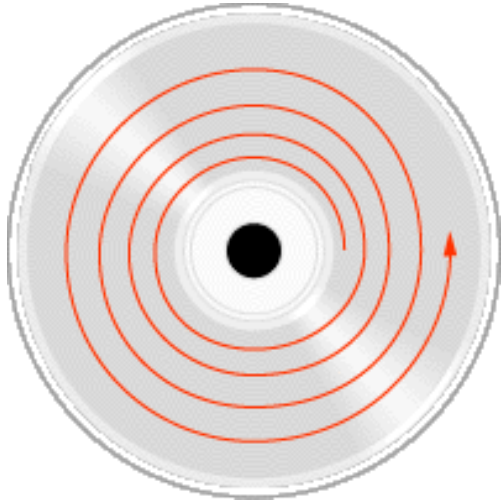

*Figure 3.8 Optical Disk**

3.11. Types of Optical Disks

"Increased storage capacity" and quicker read/write times are two benefits of optical drives, which were introduced to

*https://www.findlight.net/blog/2018/05/30/optical-storage/

market in 1980s as "disk-based drives". Optical media come in a variety of forms, as follows:

3.11.1. Compact Disk

"Compact disc read-only memory", or "CD-ROM", was the first disc to be used in drives of most recent PCs. Compact Disk Filing System CDs are populated by CD-ROM devices with the data formatted according to ISO 9660. Most CD-ROM drives in the computers operate at a reduced pace to decrease noise and promote stability, and if a drive has read problems, it only speeds up for bigger data files. In contrast, the most recent CD-ROM drives are capable of reading at 60 revolutions per second.

Figure 3.9 Compact disc*

*https://www.javatpoint.com/cd

Data is stored on CDs so that it may be read at a later time. Software program that can be transferred to a laptop or desktop computer may be stored on a compact disc. Windows files might be installed on the computer from the CD. Additionally, the CD's saved files may be transferred to the other computers, allowing you to generate a complete backup of entire data.

3.11.2. Digital Versatile Disk

Figure 3.10Digital Versatile Disc*

"Digital Versatile Disc" is the acronym for DVD. It is frequently referred to as a DVC. To store large amounts of data, such as high-quality films and movies, it uses the digital optical disc. Operating system files are also stored here. In 1995, , Sony, Philips , Toshiba, as well as

*https://www.javatpoint.com/dvd-full-form

Panasonic collaborated to develop the technology. More storage capacity than the CDs and the ability to play on a wide range of devices such as DVD players make DVDs an ideal medium for storing and distributing multimedia content.

3.11.3. Blu-ray Disk

Like CD as well as DVD, Blu-ray is the kind of the optical disc. It was designed to store as well as play back massive volumes of the "high-definition (HD) video". With 700 MB on a CD, DVDs can contain 4.7GB, as well as Blu-ray discs could carry up to 25GB of data, the single disc could hold. Even the double-sided, "dual-layer DVD" could only contain 17 GB of data. “50 GB" of data may be stored on the dual-layer Blu-ray disc. A four-hour HDTV marathon is covered in that amount of time.

Since "Blu-ray discs" employ blue lasers, they can carry more data than typical optical media. The laser is really blue-violet, but "Blu-ray" is simpler to say than the "Blu-violet-ray," which is more difficult to pronounce. A wavelength of “blue-violet laser" is shorter than that of “red laser", which is often utilized in CDs as well as DVDs ("405nm" compared to "650nm"). As a result, a disc the same size as “CD" or "DVD" may store substantially more data since the laser could concentrate on the smaller region. They anticipate "Blu-ray devices" to replace VCRs (“videocassette recorders”) as well as "DVD recorders" as more people switch to HDTV, according to advocates of the technology.

*Figure 3.11 Blu-ray Disk**

3.11.4. Advantages of Optical Disks

The optical disc has a number of advantages, including the following:

Cost

Optical discs are manufactured using just polymers and metal foils that reduces their manufacturing costs. Since several computers come with the optical disc drive, customers may save money by buying optical discs in bulk, and they could also save money by purchasing optical disc drives separately.

Durability

Optoelectronic discs are more durable than both volatile as well as non-memory. In the event of a power outage, there

*https://simple.wikipedia.org/wiki/Blu-ray_Disc

is no risk of data loss or wear. As a result, it's capable of running for an extended period of time. However, it is vulnerable to physical damage, particularly scratching as well as heat, so it is not the long-term investment.

Simplicity

A process of backing up data is made simpler by the use of the optical drives. The data to be burned must be put within a drive symbol. Users may also quickly create the backup of their data by simply selecting "Burn Disk".

Stability

Unlike magnetic discs, optical discs are well-protected from the electromagnetic fields as well as the other environmental influences, resulting in exceptionally high levels of stability.

Portability

Optical discs are very portable, but they are also somewhat huge. The fact that they could fit into bags and the other compact things means that they may be used on a variety of computers as well as devices and taken just about everywhere.

3.11.5. Disadvantages of Optical Disks

Many benefits, but also some drawbacks are detailed below:

Security

When employing optical discs for backup, they must be protected from hands of criminals. Optical disc theft might be far more damaging if it is successful. As a result, it might be less secure, and its size makes it more vulnerable to theft as well as loss.

Reliability

Although flash drives may be damaged by any plastic enclosures, the optical discs they contain cannot. As a result of their propensity for scratching discs, they render them illegible. The data on the optical disc can no longer be retrieved.

Capacity

Optical discs have a high per-gigabyte/terabyte cost when compared to the other types of the storage devices. This is also the case when compared to any other storage medium. An optical disk's maximum storage capacity is "4.7 GB", excluding Blu-ray disc.

Duplication

An optical disc cannot be easily copied like the USB flash drive. Burning necessitates the use of the separate software as well as hardware. Several third-party tools are also available for such purpose. Microsoft's latest operating system, Windows 10, includes writing tools.

User Friendliness

However, its production costs are quite cheap, thus it isn't ideal as a backup. Networks as well as online backups for the services need large sums of money. As a result, if the optical drive is regularly replaced, it is considered to have high failure rate.

3.12. Magneto-optical Storage Devices

*Figure 3.12 The 130 mm 2.6GB magneto-optical disc**

This kind of disc is called the magneto-optical disc because it uses both magnetic disc as well as optical technologies to rewrite data. Except for its bigger size, it is quite similar to the magnetic diskette. Flash drives as well as DVD/CD drives, that are less costly and have superior writing time as well as reliability than the magneto-optical discs, are

*https://en.wikipedia.org/wiki/Magneto-optical_drive

rapidly replacing magneto-optical disc manufacturing and usage. In addition to being known as MO drives, the magneto-optical discs are also referred as MO discs.

3.12.1. Basics of MO Recording

It's called "magneto-optical recording", and it's a way to store and retrieve data using lasers. Using a magnet, a driving laser warms the "magnetic surface" to the "high enough temperature" to allow for more accurate data writing. When reading data from disc, a lower-intensity laser is used.

3.13. Universal Serial Bus

It's a widely accepted industry standard for cables, connectors, and protocols for connecting, connecting, and powering the peripheral devices as well as computers through "Universal Serial Bus". The USB standard has gone through three generations:

1. USB 1.x

2. USB 2.0

3. USB 3.x

There have been several improvements and additions to USB 2.0. As of 1996, "USB Implementer Forum" is in charge of maintaining USB standard, which was first introduced in that year.

Devices includes digital pointing devices & video cameras all be connected to a computer via USB. However, USB-enabled gadgets, such as portable media players, printers, disc drives, as well as the network adaptors for the personal computers, quickly became ubiquitous. The serial port as well as parallel port have mostly been phased out in favor of this interface, which can be found on almost any device. Other kinds of the portable device battery chargers have been supplanted by USB connector-based ones.

3.13.1. Pen Drive

*Figure 3.13Pen drives**

The USB flash drive, or the pen drive, is the data storage device that may be taken anywhere. Pen drives have supplanted old-school floppy drives as one of the most common means of storing data among modern customers.

*https://www.techwalla.com/articles/definition-of-a-pen-drive

Learners, professionals, academics, and independent IT consultants may easily carry the pen drive since it is small, lightweight, and convenient. Currently available "8GB" and "32GB" pen drives may be utilized to store the graphics-heavy documents, photographs, audio files, as well as video clips.

The following is a list of some of the many benefits of using a pen drive

- The size of a pen drive is quite compact.
- The weight of a pen drive is quite low
- A pen drive's data transmission speed is impressive.
- It is the "Portable Storage Device".
- The bootable media is a pen drive.
- Pen drives come in a variety of sizes nowadays.
- Any form of data may be permanently stored on the pen drive.
- It is now possible to save data on the pen drive that ranges from "64 MB" to "128 GB".
- When compared to CDs and DVDs, pen drives are more durable and scratch-resistant.

3.13.2. External Hard Disk Drive

Using the USB cable or the wireless connection, the external hard drive may be linked to the computer. When the computer's internal drive is nearing or has reached its maximum memory capacity, users often turn to the external hard drive for storage. When it comes to storing large amounts of data, these devices are better option than

the flash drive since they have more storage space. "Removable hard drives" are another term for "external hard drives".

*Figure 3.14External Hard Disk Drive**

The following are some of the benefits of using the external hard drive:

1- Portable, plug-and-play external hard drives may be used anywhere. Any computer having a "USB" or "FireWire"port may make use of it as the storage device.

2- An external hard disc may be used as the backup drive in an emergency. It's important to have a backup in case your hard disc fails, whether it's for business or personal use.

*https://www.indiamart.com/proddetail/external-hard-disk-drive-20640258912.html

3- Macs with the slower internal drives might benefit from using an external hard drive as their primary storage device.

3.14. Memory Stick

Sony introduced the Memory Stick portable card in end of 1998. In the world of computers, memory sticks and the USB flash drives have had a big impact. In addition to memory stick, there are many other popular "external storage devices", like TF cards, Micro SD cards and memory pens.

The memory stick has two primary functions: (store files for temporary and also share the data with the other computer users). Windows File Manager is required to access files stored on the "USB memory stick" when it appears in computer's notification area.

Pin insertion types such as the compact flash are available on memory sticks . By inserting the "USB memory stick" into the "USB port", you may transfer images from the computer to the memory stick.

Because of this, it may be used with a wide range of devices, including electrical readers, digital cameras, and the mobile phones. The USB adapter or PC with an inbuilt card reader are the only ways to use it on a non-USB device.

*Figure 3.15 Memory Stick**

3.15. Mass Storage Devices

The term "mass storage device" refers to any storage device which allows huge volumes of data to be stored and moved between PCs, servers, and other IT environments. It is possible to connect an MSD to a computer from both the inside and outside of computer.

Mass storage devices may be considered too as additional storage devices, or "auxiliary storage." “USB mass storage devices" are often referred to as "external hard drives" in this context.

Memory storage devices are mainly concerned with devices which have a long-term storing capacity. Using a data transmission interface like USB, SCSI (“Small Computer System Interface”), or Ethernet, MSD is linked to computer

*https://www.collinsdictionary.com/dictionary/english/memory-stick

or server (for the "storage area networks"). Hard disc drives, hard discs,optical drives, with RAID (redundant array of independent disks) as well as USB storage devices are few of the most prevalent MSDs. There are already MSD devices available that can give anything from few gig to petabytes of storage. Unlike internal MSDs, external MSDs are very easy to uninstall and reinstall on another computer.

CHAPTER 4
Input Output Media

Input as well as output devices are two of the most fundamental computer components discussed in this chapter. Before any processing can take place, data as well as instructions must be entered into computer system via input devices. Machine-readable data is translated into human language via output devices. Input devices such as keyboards, mice, scanners, joysticks, as well as optical scanners are covered in this chapter. Various kinds of printers as well as plotters have indeed been used to study the functioning of all such input devices as well as output devices, including printers & plotters.

4.1. Introduction

IO devices, or input/output devices, are any pieces of hardware which enable an operator or the other systems to communicate with the computer. They are also known as I/O ports. I/O devices are able to provide as well as receive data from and to the computer.

Hardware which can accept, output, or process data falls under the category of the input/output (I/O) device. It

accepts data as input, delivers it to the computer as a storage output, and also receives data from a computer.

4.1.1. Importance of Input/Output Devices

You need input devices to interface with the computer and to contribute fresh information to system.

It's not possible to change the bug fixes, settings, or the other user experiences of a machine that doesn't have the input device.

Data entry on a computer will be impossible without some kind of input device (For example document, command, picture, etc.).

Computer input as well as output devices are simple to understand in terms of their role in computer system. Input or output devices are sometimes known as the peripherals because they house the computer's CPU as well as memory.

You need input devices to interface with the computer and to contribute fresh information to system. If the computer doesn't even have the input device, for example, this would run on its own, but no changes may be made to its settings, bug patches, or the other user experiences.

4.2. Types of Input Devices

The keyboard as well as mouse are common examples of the direct input devices, whereas scanners and microphones are examples of the indirect input devices that

users utilize to enter data into the computer after making observations with them. It is popular to use the touchpad instead of the mouse on the smart phone or the laptop.

4.2.1. Keyboard

A keyboard is among the most frequent and widely used methods of entering data and instructions into a computer's memory. Keyboards continue to be the main input device in most residential and business computer environments despite a plethora of alternative options.

Figure 4.1 Keyboard*

Smaller and lighter, the laptop keyboard makes the computer smarter. To enter data and make selections, mobile devices such as smartphones as well as tablets rely on the "on-screen keyboard".

*https://medium.com/@tryeducationtypes/what-is-an-input-device-types-of-input-devices-a2ac2431637e

USB or Bluetooth are used to connect keyboard to computer. There are a few more keys on keyboard that may be used to do other operations, but the overall layout is similar to the typewriter. For the Windows and the internet, you can now have keyboards with "84" to "108" keys.

Typing Keys

A-Z as well as 0-9 are included in this set of keys. The configuration provided by such keys is quite similar to that of the typewriter.

Numeric Keypad

To input numbers as well as move the cursor, numeric keypad has the set of 17 keys. The layout of such keys is similar to most other calculators as well as adding machines.

Function Keys

A keyboard's function keys are located in the row at very top of a keyboard. Every key on the keyboard has defined function as well as a corresponding function key label.

Control Keys

Using 4 arrow keys, the user may manipulate the cursor as well as the screen's layout. Home, Insert, Alternate (alt), End, Page Up/Down, Delete, Control (ctrl), as well as Escape (esc) are all part of the keyboard's control scheme .

Special Purpose Keys

The Enter, Caps Lock, Space bar, Shift, Num Lock, Tab, as well as Print Screen keys on the keyboard are all dedicated to certain functions.

Types of keyboards: Depending on where you live and what language you speak, several keyboards may be available. The following is a list of certain of the most prevalent keyboards:

i) QWERTY Keyboard:

Figure 4.2 QWERTY Keyboard[*]

That is the most prevalent kind of computer keyboard in use today. You may even find it in nations where Latin-based alphabet doesn't exist since it's so well-known. As a result of its widespread usage, certain people believe it is only sort of keyboard which can be used with the computers.

ii) AZERTY Keyboard:

In France, this keyboard is widely accepted as the norm. Developed in the France, it is mostly used in France as well

[**] https://www.javatpoint.com/input-devices

as the other European nations as an alternate to standard QWERTY layout. There are a few nations who have produced their own AZERTY keyboards.

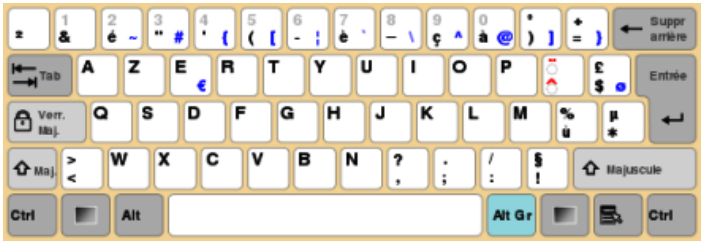

Figure 4.3 AZERTY Keyboard

The very first six letters of it's own name are drawn from keyboard's upper left row. In the QWERTY keyboard, the "A" & "Z" keys are swapped for the "Q"& "W" keys. In addition, M key is situated to left of L key on an AZERTY keyboard.

For example, it places more emphasis on accents that are necessary when writing the European languages such as French on "AZERTY keyboard" rather than the "QWERTY keyboard", for example.

iii) DVORAK Keyboard:

Typing speed may be increased by limiting finger movement when using this sort of layout. To facilitate typing, the most commonly utilized letters are arranged in a single row.

Figure 4.4 DVORAK Keyboard[*]

4.2.2. Pointing Devices

It is the input device that has a pointer on it. A pointer or cursor may be moved around the screen with this. The following are some other applications for it:

1. Sending instructions to computer over a network.
2. Choosing from a list of options on a display.
3. Choosing commands from the menu of available options.

The following are the most significant pointing devices:

Mouse

Among pointing input devices, the mouse is by far the most popular. In addition to controlling cursor on a screen, the mouse may also be used to communicate with a computer. A wired or wireless connection is used to connect computer's mouse to it. One wheel and two or three buttons are located on top of mouse. In order to execute

[**] https://www.javatpoint.com/input-devices

various actions, such buttons may either be clicked or double tapped.

Figure 4.5 Mouse*

The two most prevalent mouse kinds are as follows:

1. **Mechanical Mouse:** The bottom of it has the little ball on it. As mouse is rolled across het flat surface, a ball spins. This flat surface is most often provided by the rectangular rubber pad (called as the "mouse pad"). The cursor on a screen travels in a same way as mouse is rolling over flat surface.
2. **Optical Mouse:** There's no bottom-bound ball in this thing. When the mouse moves, it is detected by laser

*https://www.logitech.com/en-in/products/mice/m190-wireless-mouse.910-005913.html

technology. It is becoming a standard feature on personal computers, as well.

Trackball

*Figure 4.6 Trackball**

Like the mouse, it may be used to do a variety of tasks. It features a ball that can be rolled up and down on its top. To move a pointer on a screen, a ball is rolled or turned with palm or fingers. The trackball, such as mouse, contains buttons that may be used to communicate with computer. Laptops often come with the trackball. Its hands are firmly planted on the keyboard. An additional input device is really available.

Touch Pad/Track Pad

The "pressure-sensitive pointing device", the Touch Pad, is available. It is similar to the trackball in that it is the fixed

*https://old.amu.ac.in/emp/studym/99992263.pdf

device with no moving elements. Moving the mouse pointer across the screen is accomplished by sliding the fingertip over tiny, and flat surface.

*Figure 4.7 Touch Pad**

Pointing Stick

Pointing sticks are devices that respond to the pressure of the user's hand. It resembles an eraser in appearance. In between the keys of the keyboard, it is on a computer screen, it's being used to move mouse cursor around. Pushing a pointing stick in one way causes the on-screen pointer to move in that direction as well. "Laptop computers" often use a pointer "stick input device".

Joystick

*https://old.amu.ac.in/emp/studym/99992263.pdf

*Figure 4.8 Joystick**

Hand-held stick with the vertical handle. A foundation is provided for a stick. A pointer on a screen is controlled by stick that is held in user's hand. Activating specific event or action is done by pressing joystick's button. Video games mostly employ the joystick as the control device. It's also found in a number of CAD systems.

Touch Screen

Using the touch screen is the unique kind of display. Touching a screen with a user's fingertip provides direct input to a computer. Sensors inside a computer's screen are used to detect touch of the finger in the most touch screen PCs. ATMs often employ touch screens. Restaurants, department shops, supermarkets, and other businesses also employ touch screen devices.

*https://old.amu.ac.in/emp/studym/99992263.pdf

*Figure 4.9 Touch screen**

Light Pen

A light pen is the pointing input device that may be held in one's hand. It's an input device that detects light. The "light-sensitive element" is found at tip of a pen. The button is also included in this gadget. Touching a screen with a pen provides direct input to a computer. When a user touches screen with a pen, a display screen is detected or sensed by the pen. To choose an item on a display screen, user aims light pen at it and pushes a button. Engineers as well as graphic artists are the most common users of the Light Pen.

Figure 4.10 Light pen†

*https://old.amu.ac.in/emp/studym/99992263.pdf
†https://old.amu.ac.in/emp/studym/99992263.pdf

Digitizer or Graphics

When creating new photos or tracing over existing ones, the Tablet Digitizer is the useful tool. It's a tool for sketching pictures, animations, maps, graphics, and technical diagrams by hand on the computer screen. Data or signatures typed on such tablets might well be captured. Stylus or puck are used to enter data on a rectangular board, flat. Each square on a board corresponds to a certain spot on computer screen. Stylus has the appearance of the pen. For sketching pictures on the graphics screen or the digitizer, it's utilized. Puck like the little mouse. Cursor is another name for puck. A crosshairs on a puck make it ideal for tracing.

*Figure 4.11 Digitizer**

4.2.3. Speech Recognition

Speak-to-text, commonly referred to as ASR("Automatic Speech Recognition"), the computer speech recognition, or simply "speech recognition," allows the computer software to convert human voice into text. Sophisticated speech recognition concentrates on a translation of spoken words

*https://old.amu.ac.in/emp/studym/99992263.pdf

into text, whereas voice recognition identifies the unique voice of each user.

Using a computer software or equipment, the person's spoken words may be recognized and processed to produce text that can be read on the screen or monitor. In its early phases, this technology relied on the small lexicon of everyday expressions.

It is now possible for software to distinguish between distinct accents and also languages with greater precision because to advances in a software and also the technology. Despite the advances in voice recognition, more work has to be done.

One of the most common phrases used to describe speech recognition is "voice recognition." The two, on the other hand, are distinct. It is possible to use the speech recognition to decipher what a person has just spoken. It is possible to identify the person's voice using speech recognition, the biometric technique.

The doctor may utilize voice recognition to dictate the medical transcription reports, while the speech recognition could be utilized to execute voice searches. A succession of the voice-activated prompts might well be familiar if you've ever called "internet service provider" for help. To make sure you get to the proper department, the contact center utilizes voice recognition software.

Additionally, the greatest solutions enable enterprises to tailor a technology to their unique needs, from language

and subtleties of the speech to the brand identification. For instance:

- **Language weighting:** Improve accuracy by focusing on words which are used often, rather than keywords which are already in a basic vocabulary.
- **Speaker labeling:** The multi-participant discussion should include the transcription which the cites or tags the contributions of every speaker.
- **Acoustics training:** Take care of acoustical aspects of a company. Train system to adjust to different speaking styles as well as acoustic conditions (such as those seen in call centers such as voice pitch, volume as well as pace.
- **Profanity filtering:** Sanitize voice output by using filters to recognize certain words or the phrases.

4.2.4. Digital Camera

Using the digital camera, you may capture images and save them as digital data on the memory card. Digital cameras, as opposed to analogue ones, that record the light intensity as well as color using film chemicals exposed to light, employ the digital optical components and turn that information into the pixel data. Several digital cameras have the ability to capture video in addition to shooting static images.

*Figure 4.12 Digital Camera**

Digital cameras have a number of benefits over film cameras, including the following.

LCD screen

A LCD screen on the digital camera's back enables users to quickly see their photographs and movies. When it comes to framing your photos, using the LCD screen might be a lot simpler.

Storage

In comparison to a point-and-shoot, the digital camera could hold thousands of images rather than only 36.

*https://www.computerhope.com/jargon/d/digicame.htm#:~:text=A%20digital%20camera%20is%20a,converts%20it%20into%20pixel%20data.

Picture development

Digital camera images may be produced in the same way as traditional film images, except rather than developing whole roll of film, you could choose which images to develop.

Size

Unlike an SLR, the digital camera doesn't need film storage, therefore it may be readily carried in the pocket or handbag.

It's possible to buy the digital camera of any size, with a wide range of the features and pricing:

- **Compact digital camera:** Portable, simple to operate, and light in weight, but with poor image quality. Flashlight built-in. JPEG files are the most used format for storing images. Also referred to as the point-and-shoot camera.
- **Digital single lens reflex camera (DSLR):** The design is focused on SLR camera. Reflection of light from a lens via the optical viewfinder in the exclusive viewing system.
- **Bridge camera**: Incorporates several DSLR-like capabilities. Similar to the compact digital cameras, it has the fixed lens and a tiny sensor. Image framing is made possible via the live preview.
- **Mirrorless interchangeable lens camera (MILC**): This system combines high-quality DSLR sensors

with professional zoom lenses. The MILC was launched in 2008, as well as its ergonomic design makes it easy and small.

- **Line scan camera system**: Supports mechanisms for focusing and often incorporates the line scan sensor chip. Capture photos of moving materials in the industrial applications.
- **Integrated camera**: Integrated with a variety of electronic devices, such as cell phones, PDAs, and computers.

4.2.5. Webcam

When the webcam is connected to the computer, it captures video. Also referred as the webcam, it is capable of taking still images as well as video. Real-time video transmission is made possible by installing software on the computer which comes with such cameras. Even though it can record HD video, video quality isn't as good as it may be compared to the other cameras.

As the input device, the webcam takes photographs that may be saved as the digital files. Images are sent to the server on the computer which processes them. Then, the images may be sent from a server to a hosting page. When it comes to webcams, USB and FireWire ports are the most common methods of connecting them to computer. Included are features such as:

- For video telephony, the webcams are less expensive than other types of cameras because of the reduced manufacturing costs.
- While most portable cameras have a higher maximum resolution, webcams have a lower maximum resolution than the most computers.

It's important to note that the computer's operating system and CPU have a major role in camera functionality. Custom coding, motion detection, and picture archiving are some of the more complex services they may provide. Besides that, webcams are also utilized for video streaming, social recording, and computer vision, and they are mostly employed for the security monitoring and also the videoconferencing.

Figure 4.13 Webcam*

*https://www.javatpoint.com/webcam

Features of webcam

The dimensions, shapes, features, and costs of webcams may all vary widely. Choosing best webcam depends on a number of factors, including the following:

1. Megapixels

When megapixels are merged, they create the visual picture from many tiny bits of colour. With higher megapixels, the webcam delivers a brighter, clearer picture. The quantity of megapixels used to be the concern, but it isn't any more. The majority of webcams now have decent picture quality. In spite of this, it is possible to get an excellent picture with webcams that have at least "320X240" or "640X480" pixels. To create "high definition" (HD) quality, a camera with "1280X720" pixels is regarded to be the best option.

2. Frame Rate

It's really the frame rate that determines how many pictures are shown each second, that controls the quality of the image and colour brightness. A suitable camera should have a frame rate of 30 frames per second at very least. Images might tremble as well as vibrate in case a frame rate is much less than 30 frames per second. For smoothest video and the highest quality moving picture, look for a webcam which records at 60 frames per second.

3. Lens Quality

The lens is the very first step in video production process. This means that you must ensure that a camera has right lens for your needs. The lens of a low-cost camera is made of plastic, whereas the lens of the high-end webcam is made of glass. Plastic lenses can't compare to the clarity of the glass lens. In addition, the glass lens is recommended for the professional video production since it is more suitable.

4. Autofocus

Autofocus is the function which works by automatically focusing the target as it moves around during the webcam session in the variety of situations. Inappropriate usage of this feature might slow down functionality while a camera is also taking its time to snap a picture.

5. Low Light Quality

Using your webcam in the low-light situations might have a negative effect on its picture quality. Right Light, invented by Logitech, may increase picture quality in nights or in the low-light circumstances in several of their webcams.

6. Resolution

Despite the fact that several webcams provide 720p as well as 1080p "high-definition quality", resolution is the crucial feature of images or movies. In addition, certain webcams can record video in 4K resolution, however these models

are more expensive. While 1.3MP as well as 2.0MP webcams aren't the highest-quality options, they may nevertheless capture decent images without going overboard with resolution.

4.2.6. Scanners

One of the most common uses for the scanner is to digitise physical media like images and papers. Using software tools, this transforms the papers into a form which can be read and edited on the computer system. A wide variety of scanners exist on a market, each of which has its own resolution.

Flatbed scanners, that are most often used to scan periodicals, pictures, and other documents, feature the flat scanning surface. It is also possible to scan books and also the other heavy items since most flatbed scanners feature a lift-up cover. Paper documents might only be scanned with the sheet-fed scanner. Despite the fact that the "sheet-fed scanners" can't scan books, certain versions incorporate an automated document feeder that lets you scan many pages in succession.

Types of Scanner

It is possible to utilise a variety of scanners with the computer for the variety of purposes. Here are a few examples:

Flatbed Scanners

Flatbed scanners are the most common form of the optical scanner, it scans documents on the flat surface and is the most often used. Using such scanners, you don't have to move a document, and they can capture every aspect of the page. There are many sizes of the flatbed scanners for regular paper and they are useful for the delicate materials such as documents that really are fragile, particularly historical photos as well as papers. Additionally, certain scanners are designed to save space on a desktop. If you're looking to save space on your desk, consider getting all-in-one printers and scanners.

Figure 4.14 Flatbed Scanners*

Sheetfed Scanners

Sheetfed scanners are scanners which enable just one sheet of paper to be scanned at a time. Compared to flatbed scanners, such scanners are shorter and have a lower resolution. They're excellent for scanning a lot of material at once. If you have the small quantity of space, such scanners

*https://www.javatpoint.com/what-is-scanner

are beneficial. At the workplace, they're used to scan documents, but in archives as well as libraries, they're more typically used to scan the books, and also they're constructed for scanning the loose sheets of the paper. Scanners with duplex capabilities, the duty cycle rating, handling capacity, and speed in terms of the paper weight as well as size are all included in such scanners

Figure 4.15 Sheetfed Scanners[*]

Handheld Scanner

Unlike flatbed scanners, which are often large and cumbersome, portable scanners are small and easy to use. When scanning, it is placed above the object. Flatback as well as sheetfed scanners only work if the document is inserted into scanner. In contrast, the paper to be scanned is moved over the portable scanner. It is able to save, change,

*https://www.javatpoint.com/what-is-scanner

forward, as well as email digitally since it scans the physical documents into a digital form. Because flatbed scanners take considerably more space, portable scanners are the most practical option when it comes to saving on desk space.

Figure 4.16 Handheld Scanner[*]

Drum Scanner

The "photomultiplier tube scanner" captures images at their greatest quality using the photomultiplier tube. Photomultiplier tubes are used instead of charge-coupled devices in this scanner. Flatbed scanners are typically equipped with charge-coupled devices. Drum scanners rely on photomultiplier tubes, which are light-sensitive vacuum tubes. The picture is put on the glass tube in a drum scanner. Photomultiplier tubes (PMTs) gather up the

*https://www.javatpoint.com/what-is-scanner

reflections of a beam of the light as it travels across the picture and analyses them.

Figure 4.17 Drum Scanner[*]

Higher than 10,000-dot-per-inch resolution is a hallmark of drum scanners that is why they're so popular. Moreover, they are less common than the flatbed scanners on the market owing to their high price and enormous size.

Photo Scanner

One of the most common types of optical scanners used for picture scanning. High-resolution and deep-color scans are provided by photo scanners. They're far more compact than standard scanners. In most cases, a picture scanner could scan "3x5-inch" or "4x6-inch" images at a greater quality than normal. High-end photo scanners could also scan the negatives as well as slides. You may be able to clean as well as restore old images using software which comes with

*https://www.javatpoint.com/what-is-scanner

certain photo scanners. The figure 4.14 depicts a photo scanner.

*Figure 4.18 Photo Scanner**

Film Scanner

The film scanner is the piece of equipment which scans film and then sends the digital images to the computer for storage. Printmaking intermediaries are not required for scanning. While flatbed scanners can scan in prints of any size, this scanner provides advantages over them, including the ability for a photographer to directly manipulate original picture on a film, conduct cropping as well as retouching on unaltered image on a film, and much more. Film grain as well as scratches may be removed and color reproduction from the film could be improved using specific software or hardware on various film scanners.

*https://www.javatpoint.com/what-is-scanner

*Figure 4.19 Film Scanner**

Portable Scanners

Figure 4.20 Portable Scanners†

Because they are lightweight and portable, the portable scanners are ideal for on-the-go use. If you have a PDA, you could even carry some of them in the pocket. They work well for scanning documents that include just text. In terms of the resolution, they are constrained. They also come with

*https://www.javatpoint.com/what-is-scanner
†https://www.javatpoint.com/what-is-scanner

the wireless connection option. The portable scanner with a cable is seen in the figure to the right.

These scanners can't do the high-resolution scanning for photos or other purposes. You no longer need the desktop computer to get your job done since several smartphones come with the variety of programmes which turn your phone into the scanner.

4.2.7. Optical Character Recognition

OCR is the technique used to transform images of text into digital files which can be read by computers. The image file may be saved to the computer when you scan anything like a form or the receipt. In order to search, edit, or count words in image file, you can't use the text editor. With OCR, you could, though, make the text document out of the picture and save the image's info as text.

Print media is a common source of information for the most businesses. There are a variety of business procedures that include paper invoices, scanned legal documents, forms, and printed contracts. Large amounts of documentation need a significant investment in terms of both time and physical space. Scanning the document into the image presents difficulties. The procedure requires human involvement and might be time consuming.

As a result of digitizing this information, the text is concealed inside the picture files that are created. Word processing software does not recognize text in photos in

a same way it does in the text documents. By turning text pictures into the text data which could be evaluated by certain other business tools, OCR technology addresses the issue. As a result of this data, you may do analyses as well as automate procedures in order to boost productivity.

Figure 4.21 Optical Character Recognition*

Depending on their usage as well as application, the data scientists categories various OCR technologies. As a starting point, here are some:

Simple optical character recognition software

Numerous distinct typeface and picture patterns may be used as the templates in the OCR engine. Pattern-matching algorithms are used by the OCR software for comparing

*https://www.openpr.com/news/2057056/optical-character-recognition-ocr-market-survey-report-2020

text pictures character by the character with data stored in the program. It is referred to as the "optical word recognition" if a system matches a text phrase by phrase. Since there are so many different fonts as well as the handwriting styles, it's impossible to capture and keep them all in the database using this technique.

Intelligent character recognition software

Using "intelligent character recognition" technology, modern OCR systems are able to read the text in a same manner that people do. Using the machine learning software, they are able to educate robots to act like people. Several layers of text analysis are performed using the machine learning system known as the "neural network". Various picture features, including curves, lines, intersecting points as well as loops, are analyzed, and the findings are combined to produce a final image. If you're looking for results quickly, ICR is an excellent option.

Intelligent word recognition

Rather than preprocessing photos into the characters like ICR does, "intelligent word recognition systems" use the same basic ideas as ICR.

Optical mark recognition

For example, a paper may be identified using a technique called "Optical Mark Recognition".

4.2.8. Optical Mark Recognition

It is the electronic approach for obtaining data from documents that are handled by humans by recognizing particular marks on document. Optically marked paper would reflects less light than the blank paper, hence optical mark identification requires a scanner to determine whether or not the paper is transmitting or reflecting light; as consequence, there will be less contrast in a reflection.

Optical mark identification, or the optical mark reading, is also referred as "Scantron".

- **OMR reader software**– To create, interpret, and assess optical markings that have already been highlighted on bubble sheets, this program is only focused on doing so.
- **OCR reader software**– This program is only capable of reading and evaluating written or printed content on sheets. When compared to OMR reader software, OCR reader software has a lower level of accuracy.
- **OMR and OCR reader software**– Both "OMR" & "OCR" patterns may be read by this sort of software, and it also has the ability to analyze them effectively.

Characteristics and functions of the OMR software:

It is capable of designing OMR sheets.-

When creating OMR sheets, designers may make use of software's built-in design tools as well as template options.

Such tools are simple to use and don't need any advanced technical knowledge or skill to utilise.

OMR sheets may be scanned and printed with this device-

You don't have to worry about printing and scanning the bubble sheets when you've finished creating them. An OMR scanner may be used in conjunction with a standard Flatbed/ADF MFP scanner to perform this task.

It contains a built-in anti-cheat capability-

The OMR software is combined with an AI component to ensure the proctored environment for OMR-based examinations as well as to make them completely anti-cheat. In the sheets, it may compare the repeat of incorrect responses to discover the possibility of cheating. In addition, certain software are able to supply randomized response options or questions that means that each applicant receives the unique answer sheet.

It's capable of reading OMR sheets with pinpoint precision-

After the OMR sheets have been printed and scanned, the last step is to read them. Reading OMR sheets is all about extracting data from them. The correctness of reading element is critical to the data's overall legitimacy.

When the data is evaluated, reports may be generated-

Another crucial OMR software feature is the ability to analyses the gathered data and provide it in a usable fashion. As a result, extensive comparing reports in the graphical as well as statistical forms are generated and utilized to provide feedback.

4.2.9. Magnetic-ink Character Recognition

"Magnetic ink character recognition" makes use of the magnetic ink to discern between different characters. Banks as well as the other companies that place a high value on safety rely heavily on this technology. Magnetic ink is used to print important papers like checks as well as vouchers. Magnetic ink may be printed on the laser printer using MICR toner.

Benefits of MICR

The following are few of the advantages of MICR:

- MICR data can be processed quickly and with fewer mistakes
- Cheque fraud has decreased since it is very hard to forge MICR papers.
- When compared to earlier OCR technology, it provides much more security since once characters have been printed, they cannot be manipulated.

- After several encounters with the non-magnetic inks, signatures, as well as stamps, MICR may still be read as plain as day.
- Even after rigorous treatment, MICR's reading accuracy is still very good.

4.2.10. Bar Code Reader

To read barcodes, scanners take a picture of the code and convert it into the sequence of numbers. Through a connected or wireless connection, scanner transmits data to the database. It is possible to scan the numerals as well as bars to see further information, like the product's price, number of items are in stock, description, and maybe an image of the product.

Typically, the barcode scanners have scanned barcodes that the general public is acquainted with. Barcodes that seem like a series of straight lines and empty spaces are known as 1D barcodes. Barcode scanners include a "quiet zone" for preventing them from taking up information which isn't relevant to scan. A blank region is considered to as a silent space since it does not transmit any scanning signals

In order to read as well as decode barcodes, camera-based scanners capture a picture of a barcode and do so at a lower cost. To prevent mistakes, omni-directional scanners use additional mirrors as well as lenses in their laser scanners. If barcode has been shredded or crumpled in any way, an omni-direction scanner could read it more quickly than the less powerful laser scanner.

Barcode scanner types

Barcode scanners come in a variety of form factors, each with its own set of features and benefits tailored to a particular industry, location, or use case:

- **Handheld** – Scanners that use barcodes are the most common. Corded as well as cordless variants are available.
- **Mobile computers** – An all-in-one solution that incorporates the best of both worlds. Cordless barcode scanners might be mistaken for this device.
- **Presentation** - Users may quickly and conveniently scan several things with this sort of the scanner. On-counter or the multi-plane scanners are also known.
- **In-counter** - Rather than being on top of the counter like the multi-plane presentation scanner, this scanner is built within one.
- **Fixed-mount** – Using sensors which are activated as goods pass in front of scanner, this hands-free scanner could read barcodes and do other tasks.
- **Wearable** – Scanning devices that are generally worn on an hand, arm, or finger are included below.

The advantages of a specialized barcode scanner:

There are several different kinds of barcode scanners, but the advantages they all have in common are enough to justify the cost of the specialized scanner over less expensive alternative. A scanner that is just used for scanning:

- **Integrates into your system**: When it comes to connecting smartphones to "point of sale" system, bluetooth adapters and perhaps drivers are probably required, since barcode scanners are nothing more than keyboards.
- **Has few software issues**: In general, barcode scanners do not even develop viruses and also don't require software upgrades, and they aren't interrupted by messages or phone calls from the other scanners.
- **Durability**: In general, barcode scanners have a long lifespan of trouble-free operation.
- **Functionality**: They could read codes fast and from the distance, so they don't have to deal with battery life or sluggish operating systems like the non-readers do.

4.3. Types of Output Devices

The output device is anything which receives data from the computer and then projects, prints, or reproduces it. The output might well be video, audio, physical copy – printed paper, for example – or any combination of the aforementioned. The output device translates computer data into a form that can be read by humans.

When we feed data into the computer, the computer conducts various operations on it, and then shows the results to user through the output device. You may get them as output devices:

4.3.1. Printers

The printer is the physical output device which may be used to print the document. Text files, images, or a mix of the two may all be used to create the document. To print papers, it receives user input from a computer or even other devices. The project report, for instance, requires the creation of the soft copy and printing using the printer.

*Figure 4.22 Printers**

Two types of printers exist: 2D & 3D printers, both of which are typical computer peripherals. Text and pictures are printed on paper using 2D printers, whereas three-dimensional actual things are printed using 3D printers.

4.3.2. Plotters

Vector images can only be printed using the plotter. Basically, it's the piece of the computer hardware which

*https://www.javatpoint.com/printers

translates computer orders into the paper line drawings. Automatic pens are used to draw the line over the screen. In contrast to typical printers, the plotter does not require toner to create numerous copies of a drawing. Alternatively, this may employ vector graphics files or instructions to generate the continuous lines. Aside from printing paper copies of the schematics, it is no longer frequently employed for the computer-aided design.

Figure 4.23 Plotters*

Plotters are often utilized in engineering tasks. Due to the fact that they may employ the continuous line, while traditional printers use dots that are tightly spaced. Drawing straight lines on a paper may be accomplished using a variety of plotters, each with their own unique set of tools. 3-D plotters (also known as "cutting plotters"), for

*https://www.javatpoint.com/what-is-a-plotter

instance, utilize blades to construct various diagrams or cut out the material based on the computer inputs. Plotters, on the other side, usually use the pen to draw the lines on a paper before they begin their work.

A plotter is situated in front of the flat surface which contains the item to be cut. Cutting pattern and measurements are sent to plotter by computer to produce a precise carving. Make many copies of each design by repeating the cutting procedure over and over again.

4.3.3. Computer Output Microfilm

Data held on the computers is transferred from the electronic medium to the microfilms as part of the process known as the "Computer Output Microfilm". It aids in the reduction of the paper reproduction for big companies with the goal of storage, broadcast, reading as well as printing. Anacomp, San Diego, Inc., CA, was the main vendor of the Computer Output Microfilm machines, offering and facilitating servicing and restoring companies.

Information relating to engineering has been widely archived using microfilm and punched cards systems.

Microfilm Attributes

- Microfilm in the 16 mm or 35 mm format, that is not usually punctured, is utilized in the motion picture industry standard.

- 35mm rolls are typically 30.48 m long, whereas 16mm rolls are often 100 ft long, 130 feet long, and 215 feet long.
- Large engineering drawings might take up to 600 or 800 images on single roll of 35 mm film, whereas 16 mm film can hold up to 2,400 images, depending on a format.
- Roll microfilm may be stored on the open reels or on the cassettes
- Xerographic copying is the common process in microfilm printers. On a drum, the pictures that must be printed are protruding in the coordinated fashion.

4.3.4. Monitor

"Video display unit" (VDU) are other terms for monitors, which may be defined as electronic output devices. Displays information created by the computer's visual card, including pictures, video, text, and graphics. Despite its resemblance to a television, it has a far greater resolution. On March 1, 1973, Xerox debuted Alto computer system that included world's first computer display.

The "fluorescent screen" & "Cathode Ray Tube" were used in construction of older monitors, making them heavy and huge in size, and so taking up more desk space. LEDs are extensively used to backlight flat-panel displays, which are now found in all modern monitors. It takes up less desk

space than outdated CRT screens with contemporary monitors.

Types of Monitors

The following are some examples of monitors and their many types:

1. **Cathode Ray Tube (CRT) Monitors**

*Figure 4.24 Cathode Ray Tube**

Early monitors employed this technology. The image shown on screen is generated by an electron beam. It includes the cannons that shoot the beam of the electrons into the screen. The screen is bombarded with electron beams at a high rate of speed. It is possible to create a wide range of colours by mixing the three primary colours of

*https://www.javatpoint.com/monitor

RGB (red, green, as well as blue). Flat Panel Monitors have replaced CRT monitors in the modern world.

2. Flat Panel Monitors

Figure 4.25 Flat Panel Monitors*

Such monitors are small and light, making them ideal for small spaces. Comparatively, they use less electricity than traditional CRT displays. Because they don't emit hazardous radiation, such monitors are more efficient. Compared to CRT displays, this kind costs more. PDAs, laptop PCs, and mobile phones all make use of flat-panel displays. Such monitors come in a variety of sizes, including 15," 17," 18," & 19." Using two sheets of glass, the flat-panel

*https://www.javatpoint.com/monitor

monitor's display is created. A chemical is contained inside such plates, and it may be triggered in the variety of ways.

3. Touch Screen Monitors

Figure 4.26 Touch Screen Monitors[*]

The term "input device" refers to these displays. Using the finger or stylus, rather than the mouse or keyboard, is possible. The event happens when the user touches a screen with their finger and is sent to controller for the processing. Users may interact with a computer by using such displays, which have images or text that aid in the process. Touching menus or icons on a screen is how users interact with the system.

*https://www.javatpoint.com/monitor

1. **LED Monitors**

Figure 4.27 LED Monitors*

The "light-emitting diode" (LED) displays computer monitor has the flat screen. It is low in weight and also has the relatively small depth. It employs the panel of the LEDs as its source of illumination. Presently, LED displays are used in a broad range of the electronic devices, including mobile phones, laptop screens, televisions, computer monitors as well as tablets.

1. **OLED Monitors**

In comparison to LCD displays, this revolutionary "flat light-emitting display technology" is more energy efficient, thinner, brighter, and offers superior refresh rates

*https://www.javatpoint.com/monitor

& contrast. A succession of the organic thin sheets are sandwiched between the two conductors. This kind of display does not need the backlight since it emits light. The new technology also gives the best picture quality ever seen in tablets as well as the high-end smartphones.

*Figure 4.28 OLED Monitors**

1. DLP Monitors

TI invented the digital light processing technology that goes by the name of DLP. It's a presenting tool that projects graphics from the computer monitor onto the large screen. LCD-based computer projection systems generated fading and unclear pictures prior to a development of a DLP. It uses the digital micro mirror device, a small mirror that is placed on unique kind of semiconductor, for DLP

*https://www.javatpoint.com/monitor

technology. As a result, it provides high-quality images that are also easily seen in a well-lit space.

*Figure 4.29 DLP Monitors**

1. TFT Monitors

The "thin-film transistor LCD flat panel display" is the subset of the "LCD flat panel display" family. 1 to 4 transistors control each pixel in TFT displays. Such transistors are used in the high-quality flat-panel LCDs. Even though TFT-based displays provide best resolution of any flat-panel method, they are prohibitively costly to produce. Transistor LCDs are referred to the active-matrix displays because they make use of TFT transistor technology. In comparison to earlier passive-matrix displays, the newer active-matrix displays have better quality.

*https://www.javatpoint.com/monitor

*Figure 4.30 TFT Monitors**

Plasma Screen Monitors

Plasma screens, such as LCD as well as LED TVs, are thin, flat-panel displays that may be hung on the wall. When compared to LCD panels, it has the brighter screen and is slimmer than CRT displays. In certain cases, it is referred to as "thin-panel" displays because it can show both digital computer input as well as analogue video signals. Because of their high contrast ratios as well as fast refresh rates but also broad viewing angles, the plasma screens help to eliminate video blur. In addition, it allows high-resolution images of up to "1920 x 1080" pixels.

Plasma screens have certain drawbacks, like the risk of the screen burn-in, higher power consumption, a decrease

*https://www.javatpoint.com/monitor

in the brightness with the time, and the potential to be heavier.

Figure 4.31 Plasma Screen Monitors[*]

4.3.5. Voice Response System

It is the computer interface that reacts to voice instructions rather than keyboard or mouse inputs, such as a virtual keyboard.

It is the kind of voice synthesis in which the pre-recorded words maintained in the database are concatenated to form whole phrases. Voice response systems, in contrast to text-to-speech, operate with a restricted vocabulary in situations where the words or phrases created conform strictly to the rigidly planned order of utterance.

VRS is appropriate for those who are visually impaired or have other physical limitations. In the absence of an

*https://www.javatpoint.com/monitor

ordinary keyboard or mouse, the ability to provide computer instructions may be life-altering for those with disabilities. Keeping track of things is also very crucial.

Data input might be voice-activated through the use of various software protocols. This eliminates the need for people to enter data with hands. VRS systems are used by many more individuals than they realize on a daily basis.

There is the electronic voice that greets callers whenever they phone a banking institution, the travel agency or catalogue firm, and asks them the question and waits for a response. A central computer converts callers' requests into precise actions based on what they confirm.

Voice response might be used to provide a full telephony experience in some circumstances. As a disadvantage, this sort of experience does not allow users to respond in a manner consistent with their own personal preferences. You can't expect to get the answer you're seeking if you ask the question which isn't on a list, so don't do it.

VRS systems are often used by financial organizations to prohibit unauthorized access to accounts and data. Such financial organizations' VRS systems are set up to only react to predetermined vocalizations as well as passwords.

"Virtual reality systems" have advanced to the point where users may activate and control software programmes using their voices. VRS systems may now be used to do everyday

home tasks, like turning on as well as off lights & fans, or shutting and also opening the garage door.

4.3.6. Projector

When it comes to projecting images to a big group of people, the projector is the output device which might be connected to the computer instead of the monitor or tv. You may use this device to project pictures from Blu-ray players or computers to big surfaces such as walls and screens. Many different types of the projectors are available and may be utilized in a variety of settings, including classrooms, home theatres, corporate training sessions, and more.

Types of Projector

One of the most prevalent kinds of projectors is LCD ("liquid crystal display") or DLP ("digital light processing"). Although CRT ("cathode ray tube") projectors were prominent in the early days of projectors, they have since faded in popularity. Because of its limited light output as well as enormous size, CRT projectors are really no longer used in current times.

Cathode Ray Tube (CRT)

At its heart lies a tiny and brilliant cathode ray tube, CRT projector that is also known as "Cathode Ray Tube projector" or "CRT projector". The picture is focused and expanded on the screen using a Lens placed in front of CRT face. Color CRT projectors initially appeared on market in early 1950s. Rather of using the single-color CRT, most

current CRT projectors make use of three different colours of CRT tubes as well as lenses to produce colour pictures. Below is an illustration of the CRT projector in action.

*Figure 4.32 Cathode Ray Tube**

Liquid Crystal Display (LCD)

"Liquid crystal displays" (LCDs) are utilised to create LCD projectors, which are often used in the business seminars as well as business presentations. They use transmissive technology as well as liquid crystal to show data, images, or videos. LCD projectors are more prominent than several alternatives because of their superior colour reproduction and lower manufacturing costs. This kind of the display panel is often used in the wide range of electronic devices, including mobile phones, handheld video games, desktop computers, laptops, and televisions. LCD technology's display is significantly thinner than that of CRT technology. The image below depicts what an LCD projector might be like.

*https://www.javatpoint.com/what-is-a-projector

Figure 4.33 Liquid Crystal Display[*]

Digital Light Processing (DLP)

Figure 4.34 Digital Light Processing[†]

DLP projectors may be one-chip or the three-chip and used for both front and rear projection. One-chip DLP projectors

*https://www.javatpoint.com/what-is-a-projector
†https://www.javatpoint.com/what-is-a-projector

could create up to 16 million colors, while three-chip versions could produce & over 35 trillion colors, making a projector capable of producing more realistic as well as natural imagery. There are front projectors that use it and TVs that use it, as well as the back projectors in businesses and schools. The DLP projector is seen in the picture below.

4.3.7. Electronic Whiteboard

The electronic whiteboard is the kind of whiteboard which is used in the schools and companies. It sends any data written on it to the computer or the group of computers, as needed. Digital elements on screen may be interacted with in real time, too.

*Figure 4.35Electronic whiteboard**

*https://www.computerhope.com/jargon/e/elecwb.htm

When it comes to meetings and conferences, e-white boarding has a number of important perks over conventional whiteboards. However, there are very few additional benefits to consider:

1. It's a whole new level of participation in meetings when they're used. The topic is engrossing the participants. Annotating, editing, sharing, and saving files is a cinch. Changes may be made in real time as well as audience comments can be accessed.
2. The spread of information is made easier. Everybody in the classrooms or workplace may use it.
3. Video, hyperlinked pages, as well as the other pictures that are constantly updated and annotated enhance the flow of information.
4. Connectivity through a mobile phone. With the right software as well as hardware, connecting the smartphone or the tablet to the electronic whiteboard is simple and quick, allowing for a wide variety of the data sharing options.

4.3.8. Headphone and Headset

Despite the fact that headsets as well as headphones are sometimes employed interchangeably, there are the few major distinctions in between the two.

Headphones: With the band which goes over wearer's ear, a little speakers may be placed over wearer's ears, allowing for a more comfortable listening experience. Cushions are

often positioned around speakers and then over ears to provide both comfort as well as sound isolation.

Figure 4.36 Headphones*

Headphones allow for a more in-your-face, or "immersive," audio experience. Transducers for the headphone use don't need to move a lot of air, thus they could produce a high-quality sound. But unlike speakers, sound is perceived in the headphones' plane as well as does not originate from either in front or behind the wearer.

Headset: A headset is the pair of the headphones with a microphone which is needed. The word "headset" usually implies that perhaps the microphone is put on the short boom to side, which might well be adjusted to the user's preference, however the inline microphone could also be used.

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*https://www.electronics-notes.com/articles/audio-video/earphones-headphones-headsets/basics-tutorial.php

Headsets are great for receptionists as well as call centres, wherein the user must hear caller well while avoiding excessive levels of the background noise, and also the caller must hear the clear voice. The use of headsets for Skype or comparable conversations may also be extremely helpful in reducing external noise and reducing echo, although contemporary phones can manage this quite well.

Figure 4.37 Headset[*]

4.4. Computer Terminals

Despite their relatively basic function, computer terminals are capable of receiving and transmitting information from the larger computer system. The monitor as well as keyboard set-up attached to the bigger computer via the network interface is among the most frequent types of the computer terminal. Handheld computers and specialized devices, like credit card readers as well as "point-of-sale terminals", are other sorts of the computer

*https://www.electronics-notes.com/articles/audio-video/earphones-headphones-headsets/basics-tutorial.php

terminals. Fully working computer systems could be used as terminals by employing terminal emulation software to access the bigger mainframe computer, thanks to the spread of the inexpensive computer hardware.

Text terminals

The text terminal, sometimes known as the "terminal," is the serial computer interface that allows users to input and view text. An array of the pre-selected formed characters is used to display information. Cathode-ray tubes (CRTs) are known as "video display units" (VDUs) when they are used in these devices.

Dumb terminals

The terminal is considered the dumb terminal if it can only process the limited amount of control codes (LF, CR, etc.), but it lacks the capacity to process specific escape sequences that really can execute functions like clearing the screen, clearing a line, or controlling a cursor location.

Graphical terminals

Along with text, graphical terminals might display graphics. "Vector-mode terminals" as well as "raster-mode terminals' are two types of the graphic terminals.

CHAPTER 5
Operating System

5.1. Introduction

The naive user could only understand the machine code in Computer System that is comprised of Hardware as well as software.

All the processes as well as resources within system need to be managed by a system that can operate as an intermediate.

It is the software that manages and operates a variety of computing devices, including computers, smartphones, supercomputers & web servers as well as automobiles and also the network towers. The operating system is responsible for removing the necessity of knowing the coding language in order to communicate with computer hardware. Graphical User interface "(GUI) layer that serves as a bridge between the user & the computer's physical components in addition, the operating system oversees the computer's software and also the way in which programmes are executed.

5.2. Operating System: Definition

"*An Operating System can be defined as an interface between user and hardware. It is responsible for the execution of all the processes, Resource Allocation, CPU management, File Management and many other tasks*."

5.3. Evolution of Operating System

Following is a timeline of the operating system's numerous iterations:

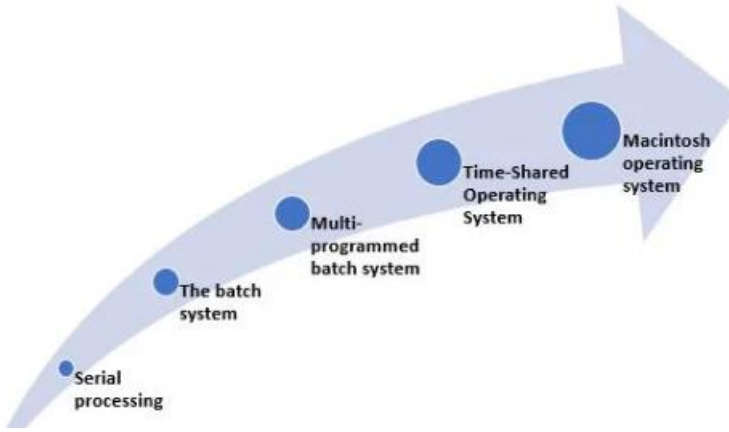

Figure 5.1 Timeline of the operating system*

1. Serial Processing

Without an operating system, it was developed by 1940s and 1950s programmers who integrated hardware components. Scheduling & setup time are really the main

*https://www.educba.com/evolution-of-operating-system/

issues here. Logging in as a user and wasting calculated time results in the machine time being wasted. Loading the compiler, saving the produced program, the source code, linking, as well as buffering all contribute to setup time. If an error happens at any point along the way, the procedure is reset.

2. The Batch System

It's a tool for increasing the efficiency with which computers are utilized and applied. Schedules and submissions of work were done using cards as well as tapes. Then, using "Job Control Language", it was successively run on monitors. The early computers utilised in batch operations produced a continuous stream of computer-generated work with no pauses or breaks. It is necessary to write the program on punch cards first, and then copy it to tape's processing unit. Once a task on a tape has been completed, the computer immediately moves on to the next one. It's the task of the professional operators to communicate with machine in which the jobs being dropped by the users, they retrieve them, and return to collect the results.

3. Multi-programmed Batch System

It is used to do multiple tasks that need to be kept in memory at the same time. The processor uses job scheduling to determine which software should be run next.

4. Time-Shared Operating System

To create alternative batch systems, this method was employed. Using computer's printing ports, a user may communicate directly with a computer. Few people used the computer at the same time, which meant that each task took only the fraction of a second to complete before moving on to next. A really fast server could handle a large number of concurrent requests by establishing an iteration where all of its resources are focused on each one. Computer systems are shared by a number of different programmes using Timesharing technologies.

5. Macintosh Operating System

It was built on decades of work on the graphical operating systems as well as applications for personal computers. Sutherland pioneer software sketchpad developed in year 1960 employing several characteristics of a modern "graphical user interface", but the hardware components cost millions of dollars which took up the room in the early 1960s.

The Macintosh became commercially as well as economically viable when a number of research holes were filled with a project involving massive computers as well as hardware improvements. Several research laboratories are still working on research prototypes like sketchpads. It paved the way for the development of future items.

5.4. Types of Operating Systems

Hard Real-Time System

These kinds of operating systems are employed by people tasked with completing crucial tasks within the set amount of time. Response times that are too long may be rejected by a system, which could result in the system failure. Hard real-time systems have limited or non-existent secondary storage, therefore data was kept in the ROM.

Soft Real-Time System

It is possible for the soft real-time system to absorb delays in software as well as hardware resources from operating system, making it more flexible as well as less restrictive. A vital job prioritizes less important activities in the soft real-time system, and this priority remains active until the work is completed. It is also possible to assign a time restriction to a given job that allows for acceptable brief delays in the completion of subsequent jobs. When it comes to things such as the reservation system or the computer audio or virtual reality, or video to name a few examples.

5.5. Functions of an Operating System

5.5.1. Process Management

In multiprogramming environment, the OS determines order in which programmes can access the processor as well

as how much processing time every process should have available. Process scheduling is the technical term for this.

In order to manage the CPU, the operating system performs the following tasks: −

- Monitors the progress of running processes.
- Traffic controller is the name given to the software that monitors the situation.
- CPU allocation and CPU de-allocation are handled by this.

5.5.2. Memory Management

A main memory is under the supervision of operating system. There are many bytes and words in the primary memory, and each one is allocated an address. It's the fast storage that could be immediately accessed by system's CPU. To run a program, it must first be loaded into the system's main memory.

For the memory management, the operating system performs the following actions: −

- Primary memory is tracked by this program.
- Memory addresses which have indeed been allotted and those which have yet to be used.
- The OS determines how long the process should run as well as order in which it is given access to the memory in the multiprogramming.

- It allocates memory to process whenever it get the requests from the process and deallocates memory whenever process has eliminated.

5.5.3. File Management

The directory structure of the file system makes it easier to find and use files. Other directories as well as files can be found in such directories.

For the file management, an operating system performs the following actions: −

- It takes account of everything from the location of data to the user access preferences and the current status of each file.
- The file system is the name given to these resources.

5.5.4. Device Management

Drivers in an operating system control how devices communicate with one another.

For the device management, an operating system performs the following tasks.

- It's important to keep track of entire devices that are linked to your computer.
- A software known as the "Input/Output controller" is designated by the operating system as being in charge of each individual device.

- When and for how long the process has access to the device is determined by this rule. Once the devices are allocated, they are de-allocated when they are no longer needed.

5.5.5. Security Management

The security of the operating system is critical. Operating systems are judged on their capacity to provide us with greater protection. The firewall is a common feature in the modern operating systems. The firewall is the security system which keeps track of each and every activity on a computer and, if it detects anything suspicious, blocks it.

5.6. User Interface

Interface design focuses on the visual aspects of software and electronic devices, such as the appearance and feel of the user interface. Designers strive to build user-friendly and enjoyable interfaces. The "graphical user interface" (GUI) is one example of a UI design. Other examples include "voice-controlled interfaces".

Users engage with designs through user interfaces. They are available in three different formats:

- **Graphical user interfaces (GUIs)** — Digital control panels allow users to interact with graphical representations. A graphical user interface is what you see on the screen when you sit down at your computer.

- **Voice-controlled interfaces (VUIs)—** These devices are controlled by user's voice. Siri on the iPhone as well as Alexa on Amazon devices, for example, are both virtual user interfaces (VUIs).
- **Gesture-based interfaces—** In "virtual reality" games, for example, users interact with 3D design settings by moving their bodies.

CHAPTER 6
Microsoft Windows XP

6.1. Introduction

By far the most popular and widely used operating system (OS) for personal computers, and media centres is Windows XP.

In August 2001, Windows XP was made available to manufacturers, and also in October 2001, it was made available to the general public.

Since Windows 95, Windows XP has been Microsoft's most significant operating system release. The number of the Windows system changes, including enhanced visual user interface quality and several capabilities for connectivity, optimising multimedia, and device management, are available in Windows XP, developed on improved reliability of Windows 2000 kernel.

According to Microsoft, the most popular Windows XP editions are:

- **Home Edition**: For the most part, domestic users
- **Professional Edition:** More complex functions are needed by power users as well as professionals.

- **Media Center Edition**: This version wasn't really made accessible to the general public; rather, it was made available only to computer makers for use in computers advertised as media center PCs.

6.2. Features of Windows XP

As an upgrade to Windows 2000, Windows XP was released. – On top of that, it was the replacement for Windows 95/98. When Windows XP was released, it came with a slew of improvements and additional capabilities over its predecessor. The following is the list of a few of Windows XP's most notable features:

Remote Deskto: Using a Remote Desktop Connection In order to use remote desktop connection capability, a user must have "Windows XP professional" OS installed.

Device Driver Rollback: This latest Windows XP feature allowed users to remove the device driver that had been installed. Device drivers which cause system instability could be uninstalled by users with ease.

Built-in CD burner: When Windows XP was released, it included a built-in CD burner. Users could now burn files straight from Windows Explorer, eliminating the need to install "CD" burning software.

Encrypted file system support multi-user: Windows XP Professional has this feature. Files as well as folders stored

on the encrypted file system can be accessed by numerous people at the same time.

Device support improvement: Improvements to Windows XP's device support include USB 2.0, gear based on the FireWire, Intel High Definition Audio, and scanners depending on the Windows Image Acquisition.

6.3. Starting Windows XP Professional

Whenever Windows XP won't start properly, you can use Safe Mode to diagnose and fix numerous critical issues. Here's how to get into Safe Mode on a computer.

1. **Press F8 Before the Splash Screen**

2. **To begin, turn your PC on or restart it.**

To access the "Windows Advanced Options menu", hit the F8 key just before t"Windows XP splash screen" shows, as shown in figure.

3. Choose a Safe Mode Option

By now you must be able to see “Windows Advanced Menu" screen. If not, you might well have skipped the tiny window of opportunity to press "F8" from "Step 1" and Windows might well be continuing to boot if it is able. "Step 1" should be retried after restarting your computer if this occurs.

Here, you have three options for entering in Safe Mode:

Safe Mode: In most cases, this really is the best option to select. This would load only minimum number of processes required to start the Windows.

Safe Mode with Networking: Windows networking functions can be enabled by selecting this option, which loads same processes as the Safe Mode. The internet or the local network can be accessed when troubleshooting using this.

Safe Mode with Command Prompt: The Command Prompt is still accessible in this version of Safe Mode, which loads a limited number of processes. It's a great option if you need to dig deeper into the problem. Look out "Windows XP Safe Mode" with Command Prompt for something little different.

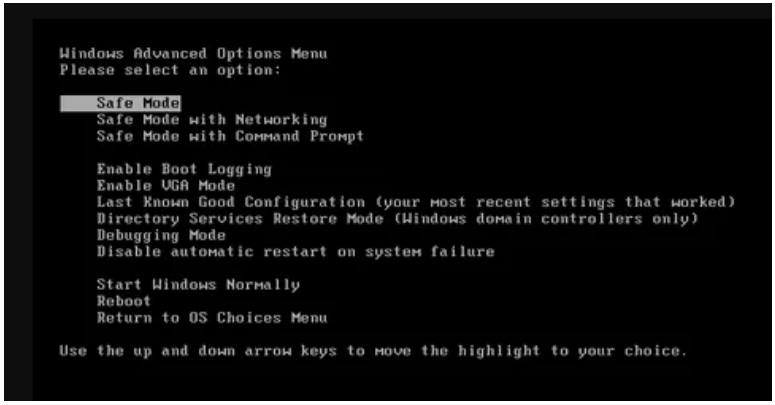

*Figure 6.1 Safe mode option on window**

4. **Select the Operating System to Start**

The Command Prompt is still accessible in this version of Safe Mode, which loads a limited number of processes. It's a great option if you need to dig deeper into the problem. Look out "Windows XP Safe Mode" with Command Prompt for something little different.

After selecting either Safe Mode or Safe Mode with the Networking, press "Enter" on the keyboard.

5. **Wait for Windows Files to Load**
6. System files that are required to execute Windows XP have now been loaded. The screen would show the name of every file that is being loaded.

*https://www.lifewire.com/how-to-start-windows-xp-in-safe-mode-2624542

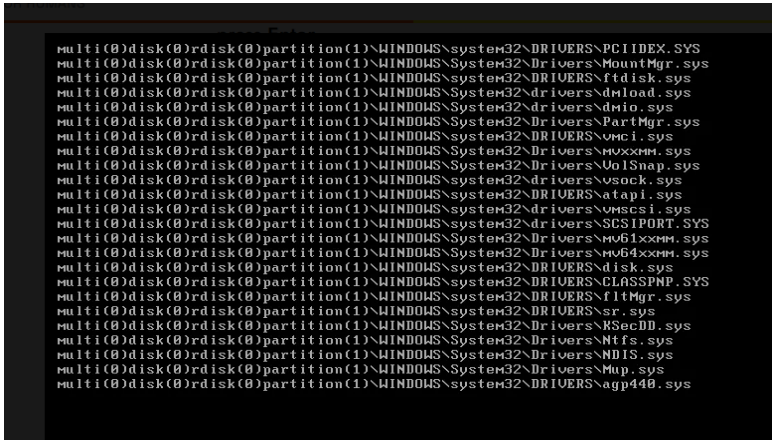

*Figure 6.2 Loading of window file**

7. Log In With an Administrator Account

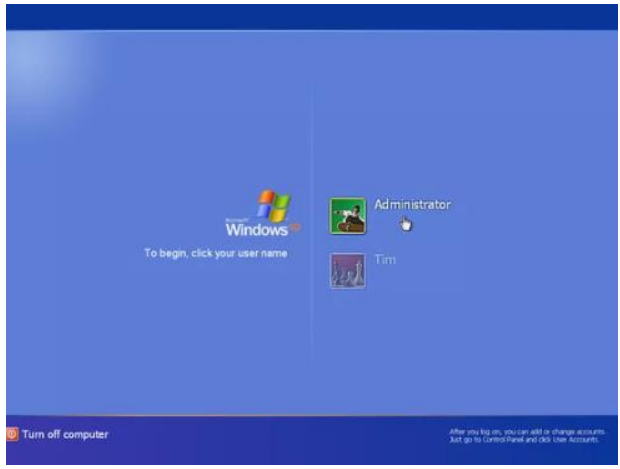

Figure 6.3 Log in with administrative account†

*https://www.lifewire.com/how-to-start-windows-xp-in-safe-mode-2624542

†https://www.lifewire.com/how-to-start-windows-xp-in-safe-mode-2624542

With the administrator account or an account with administrative rights, you can access Safe Mode.

8. Proceed to Windows XP Safe Mode

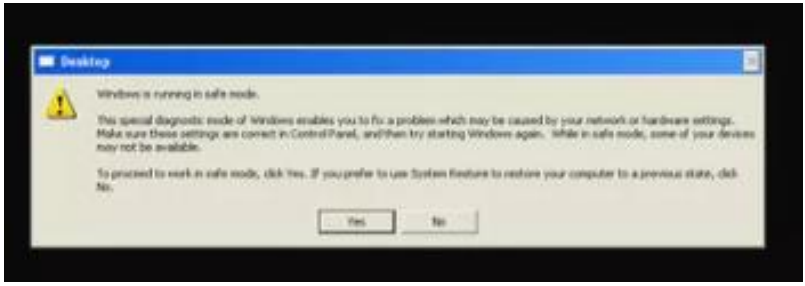

*Figure 6.4 Dialog box**

In order to enter in Safe Mode, pick Yes from the "Windows is running in safe mode" dialogue box as shown in figure 6.4.

Make Necessary Changes in Safe Mode

Restart a computer after making any necessary adjustments. After the restart, if there are no residual issues, computer should boot smoothly to Windows XP.

*https://www.lifewire.com/how-to-start-windows-xp-in-safe-mode-2624542

*Figure 6.5 Making changes in safe mode**

6.4. The Desktop

Figure 6.6 The Desktop View†

*https://www.lifewire.com/how-to-start-windows-xp-in-safe-mode-2624542

†https://www.javatpoint.com/what-is-a-desktop#:~:text=The%20desktop%20is%20a%20basic,top%20of%20a%20physical%20desk.

There are many various types of things that can be displayed on desktop of the personal computer. These include project folders and the reference sources as well as drawing and documenting tools and writing tools. On the computer which sits on top of the desk, this really is primary user interface. When the startup procedure is complete, desktop display is presented as the default display.

A desktop wallpaper and also the icons of files as well as the folders you've saved there are both displayed on desktop. The taskbar is the feature of "Windows operating system" and may be found at the bottom of screen. The Dock as well as a menu bar are located at bottom of a dock in Mac OS X. The desktop can be seen on either a Windows or a Macintosh computer if indeed a display screen isn't completely taken up by icons for programmes or files and folders.

Users could drag and drop items from desktop just like they would a folder. If you don't want to spend time searching through multiple directories, you can just use the desktop shortcuts. As a result, placing shortcuts to frequently used programmes, files, as well as folders on your desktop may prove useful.

6.4.1. Taskbar

Taskbar is a part of operating system that is positioned at bottom of a screen. You can use Start and the Start menu for locating but also launching programmes, or you can

view all currently running programmes. The Notification Area is located on right side of a taskbar and it allows you to monitor the exact date & time, as well as the running processes. All succeeding versions of Windows have included a taskbar since Microsoft Windows 95's introduction.

Figure 6.7Taskbar view in different windows*

*https://www.computerhope.com/jargon/t/taskbar.htm

Using this image, you can see how Windows taskbar has evolved over time. The taskbar in "Windows 95, 98, ME", and NT 4.0 looked exactly like the one in Windows 98, with the exception of the Quick Launch button. As a result of the changes made in" Windows Vista and 7", Microsoft renamed the Quick Launch as well as added Start Orb. The Start button was deleted from Windows 8 and later re-added in Windows 8.1. The new Cortana search box in Windows 10 is similar to the one in Windows 8.1. To make the taskbar more streamlined, Windows 11 moves the Start, Widget, Search, and the Pinned Program icons to a new location at the top of a bar.

The main components of the Windows 10 taskbar are listed in **figure**.

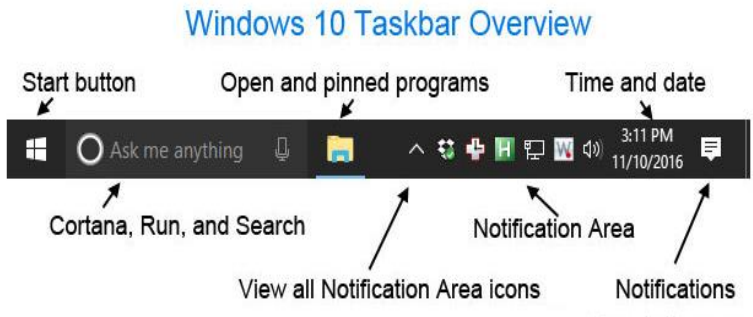

*Figure 6.8Components of Windows 10 taskbar**

6.4.2. Customizing Taskbar

Just the few mouse clicks away, the taskbar's latent

*https://www.computerhope.com/jargon/t/taskbar.htm

potential can be unleashed to the fullest extent. Take advantage of the taskbar by following these steps:

1. Right-click the taskbar as well as select Properties Taskbar from the context menu that appears. The Taskbar as well as Start Menu Properties dialogue box is displayed to you.

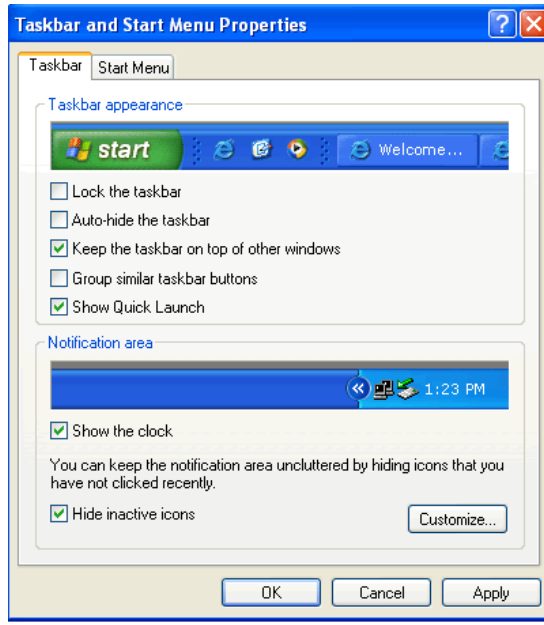

Figure 6.9Task Bar and start Menu properties option in Window XP*

2. To begin, uncheck the box next to Lock the Taskbar and then tick the following options:

*https://sourcedaddy.com/windows-xp/customizing-the-taskbar.html

As soon as you bring mouse down to screen's bottom, a taskbar is automatically hidden. If you don't have a super-high-definition display and can't live without taskbar at bottom of your screen, uncheck this option.

The taskbar should remain visible on top of the other windows if this option is enabled. When the taskbar rolls under the other windows, it doesn't make sense.

Check Make the Quick Launch toolbar visible so that you may take advantage of it, one of Windows' greatest (often hidden) assets.

3. Once you've clicked OK, your taskbar will look like the one **figure** 6.10.

Figure 6.10 Taskbar*

6.4.3. Desktop Icons

Symbols are used to represent programmes, features, or files in a compact pictorial form. Depending on the icon, you can open a file or execute a certain operation by clicking or double-clicking on an icon. If you were to the double-click on the My Computer icon, for instance, Windows Explorer will be displayed for your consideration. Apple

*https://sourcedaddy.com/windows-xp/customizing-the-taskbar.html

mac OS X as well as Microsoft Windows both use icons as part of their graphical user interfaces. To aid in the identification of files, icons are used. An instance of "My Computer" icons from Microsoft Windows can be seen in image.

6.5. My Computer

My Computer is a tool that lets you rapidly view all of the files, folders, as well as drives on the computer, as well as how they are arranged. When your computer is linked to the network, My Computer shows any drives that have been mapped to it.

It is possible to open My Computer window by double-clicking My Computer icon on your desktop.

For example, A: represents a floppy drive, C: and D: indicate hard drives, and E: indicates a CD-ROM drive. It's possible that your drive letters are different. These objects' icons would also be displayed in this window.

There are also icons within folders. The Control Panel icon opens the Control Panel window. You use the icons in that window to configure your computer. For more information on using the Control Panel, see Lesson 14, "Using the Control Panel."

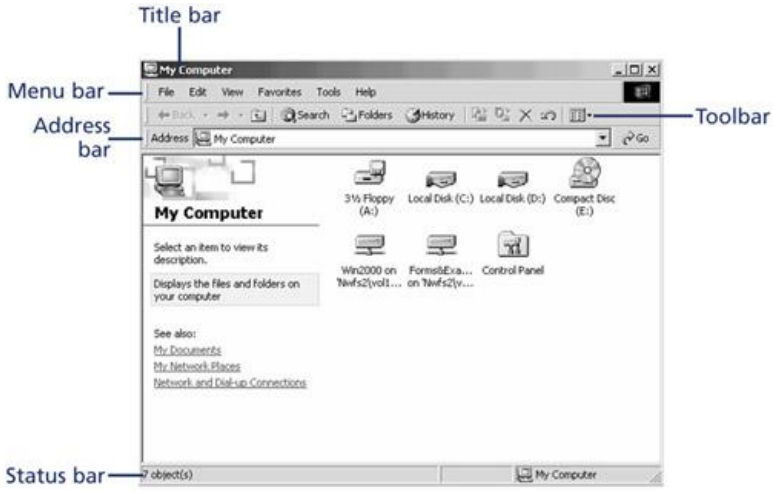

*Figure 6.11My Computer in Window XP**

6.6. Working with Files and Folders

For those who are unfamiliar, a file is the collection of connected information which you could find on somebody's desk or in their filing cabinet. Instances of file types on the computer includes spreadsheets, text documents, digital photos, and even music files. As an instance, each photo you capture with the digital camera or each song on CD may be saved as the separate file. Some points to know more:

- Icons are used to symbolize files on computer. File types can be quickly discerned just by looking at their icons.

*https://www.informit.com/articles/article.aspx?p=411736&seqNum=65

- The appearance of an icon reveals the type of file it symbolizes.
- A folder is nothing more than a place to store files.
- In order to find a certain document, you will have to sift through a mountain of paper files.
- In the very same way, folders on computer are organized.
- Files and folders can be stored in folders, as well.
- The term "subfolder" refers to the subfolder within the folder. You could have as many subfolders as you like, and each one can have as many files as well as subfolders as you want.

Search for a file

The number of files you have as well as how they're organised may necessitate an extensive search for each one. Use a search box to find files quickly and easily.

Every window has the search box at top. Click or press on the search box and begin typing in your search word to begin searching within a folder. Filtering current view depending on text entered in the search field. If your search phrase matches file's tags, name, or the other properties, or even content inside the document, file will be presented as the search result.

Create a new folder

- Organizing your files is made easier with the use of folders. Create sub-folders within the sub-folders.

- After selecting the Home tab, select new folder.

Print a document

However, it's ideal to open a file you would like to print in app, and then use that app's instruction to print it. Print choices can be checked and changed from here if necessary. Press "Ctrl+P" if you can't locate the print option in app you're using.

Create or delete a file

To create the new file, most people use an app. If you want to write a letter, for instance, you could use the word-processing program. Most apps by default keep files in popular directories such as Pictures as well as Music, making it easier to locate the files when you need them again in the future.

Keep your PC clutter-free by getting rid of unnecessary files when they're no longer needed by deleting them. To delete the file, locate it and also then pick it out of the list. Select the Home tab, then select Delete to remove the item from your list.

Open an existing file

Double-tap or double-click the file to open it. In most cases, the software you utilized to "create" or "edit" a file would open a file. As an instance, you can open the text file in word processor. A file can be opened by selecting it, then

tapping or swiping down to pick it, then tapping or swiping down to select it, and then selecting the app to open it in.

6.6.1. Recycle Bin

Removed files are temporarily retained in a Recycle Bin until they are permanently deleted by Windows. Users of Windows operating systems dating back to Windows 95 can use this tool to restore accidentally deleted files. As long as the files are not destroyed by user and are still in a Recycle Bin, they really aren't permanently gone from hard disc. You can also restore files from Recycle Bin to their original location.

When data is accidentally erased, the Recycle Bin comes in handy. When you delete the file from a computer, it is actually saved in a recycle bin folder and not erased from a system. You can't restore the file that's been deleted from a Recycle Bin since it won't be moved to recycling bin. You can also use keyboard shortcut "Shift + delete" to avoid files from being deleted from a recycle bin.

"Recycle Bin Tasks" can be found in left sidebar of window, though. Right-clicking recycle bin icon opens a menu of options, including Restore all items and Empty Recycle Bin, among other choices. Recycle bin files would be permanently erased if you select “Empty Recycle Bin" option. Selecting "Restore all things" will return every file to its original location on the hard drive. In addition, if you only want to restore the certain set of files, you could do this by selecting them one by one.

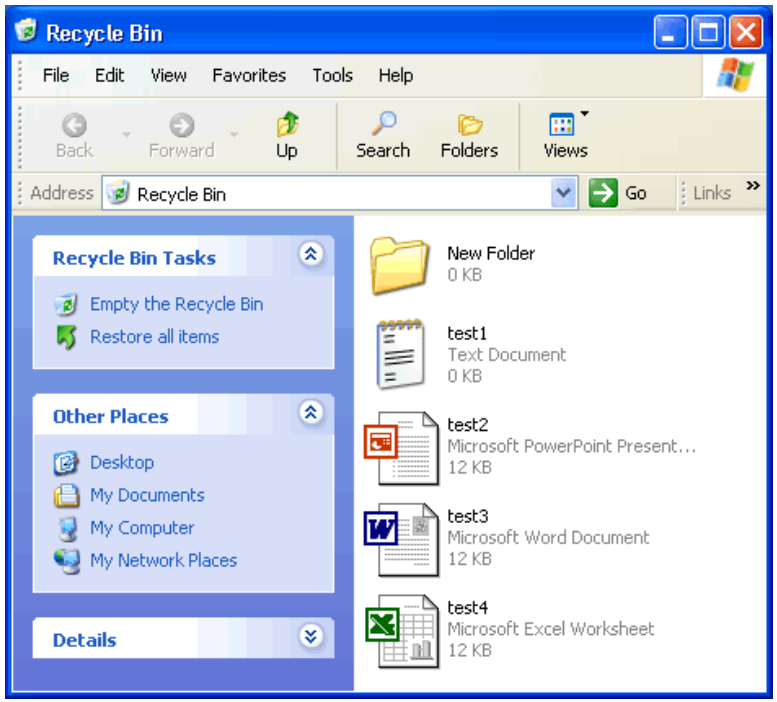

*Figure 6.12 Recycle Bin**

6.7. Windows Explorer

File management in "Windows" is simplified with the help of "Microsoft Windows Explorer". File Explorer was originally known as "Windows Explorer" until it was retitled in Windows 95. The computer user uses Window or File Explorer utility every time he or she looks for a particular file or folder on their system.

*https://edu.gcfglobal.org/en/windowsxp/what-is-the-recycle-bin/1/

Accessing files and folders on the connected disc is made simpler with the help of the file management program. Context-sensitive actions, like those available when the file is chosen in “Windows/File Explorer interface", allow users to quickly perform various operations on selected file. Open, share, paste, explore, copy, cut, move, and delete whole folders are also options. To move the files across directories, you may either search for them or drag them into a new location.

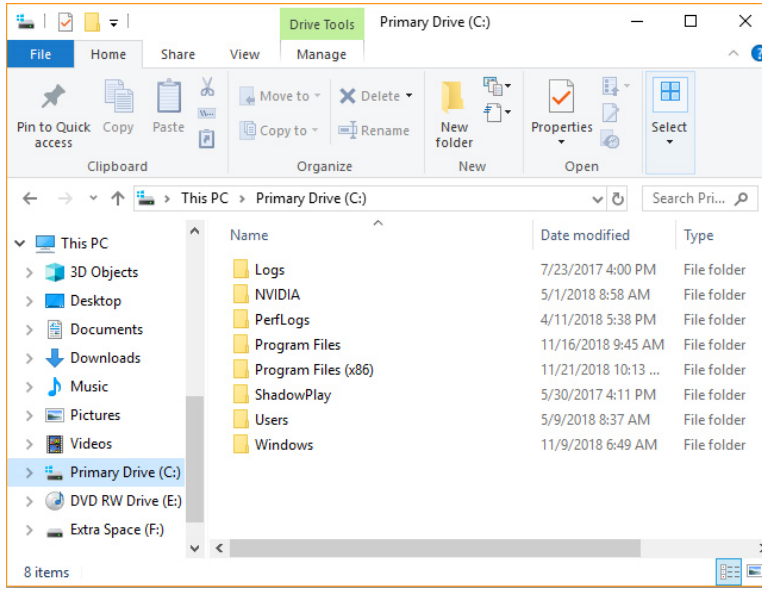

*Figure 6.13 Windows Explorer**

File as well as folder information could be displayed in a variety of ways in Windows/File Explorer, includes thumbnail picture arrays, lists, icons, and details (including

*https://www.computerhope.com/jargon/e/explorer.htm

name, type, size, time, date and the other information). The user's preferences as well as the type of the content being examined determine display format to be used. There are many different ways to display folders, such as thumbnails for images and videos, or a complete list for papers, depending on the content.

6.8. Windows Help and Support Centre

It's not your typical help file; Help as well as Support Center seems more like the web site with advice on how to use various parts of Windows XP, how to solve issues, and how to keep your machine up to date and expand its capabilities.

Figure 6.14 Help & Support Center in Window[*]

*https://www.oreilly.com/library/view/windows-xp-in/0596002491/re99.html

Help & Support Center has some basic troubleshooting content, but the majority of it focuses on the most common issues (such as, if you really couldn't print, check to see if the printer is on and filled with the paper). In addition, if you're connected to a network, you can also search the Microsoft's Knowledge Base, a vast repository of knowledge on anything from common inquiries to bug reports to compatibility lists.

6.9. Searching in Windows XP

In order to locate files or directories on your computer, follow these instructions:

1. Click on "**Start -> Search -> For Files or Folders"**.

Figure 6.15 Start button on Window XP*

*https://kb.wisc.edu/helpdesk/page.php?id=33877

2. Next, Click on "**All files and folders"** on left pane of a "search result window".

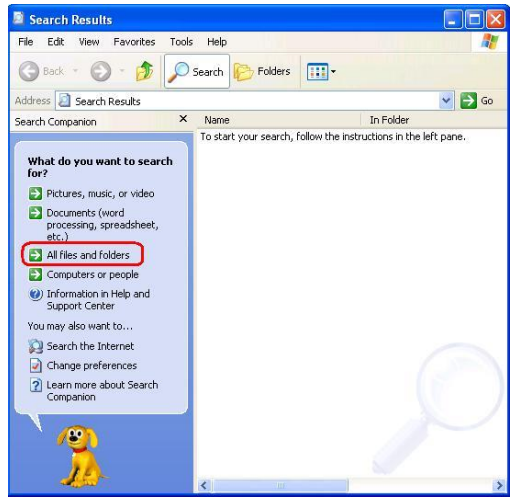

Figure 6.16All files and folders option in search result page in Window XP*

3. Type or select any or entire search criteria's.

Note:

- If you're unsure of the actual file name, put an asterisk after it. An engine*.doc file generates all word documents with the file names which begin "engine"
  (For example engine, engineering, engineer,etc).
- Asterisk is sometimes used to locate all the files of the particular type that share a same attribute. *.doc would generate all the Word files, for instance.

*https://kb.wisc.edu/helpdesk/page.php?id=33877

- Select "Search" from the drop-down menu.
- If you're still unable to locate the file you need, click on "More advanced options" to see if that helps.
- Disable searching for hidden "files “and”folders"
- 4. Click **Search**

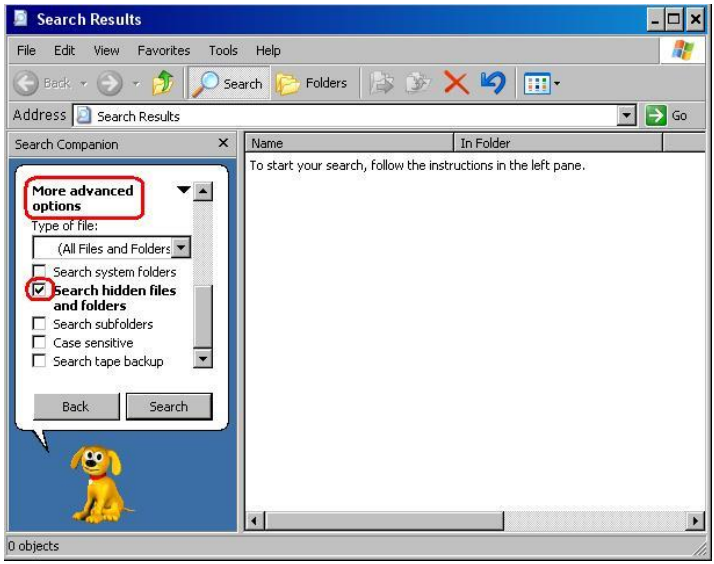

*Figure 6.17 Search result page in windowXP**

6.10. System Utilities in Windows XP

Various startup-related options can be selectively enabled or disabled using System Configuration Utility. However, because it is developed for a previous version of Windows, it is of limited use on Windows XP. But there are a few possibilities that you won't find anywhere else:

*https://kb.wisc.edu/helpdesk/page.php?id=33877

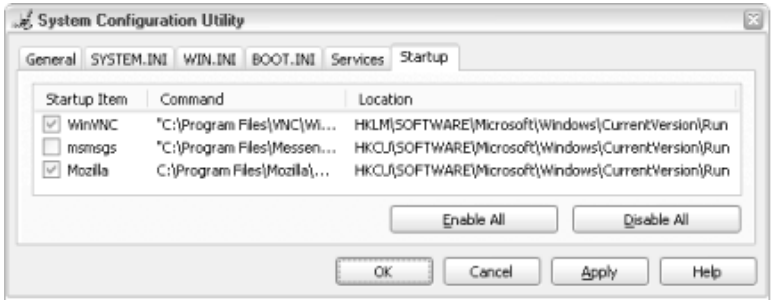

*Figure 6.18 System Utilities in Windows XP**

6.11. Control Panel

There are several settings under the Control Panel, which may be found on Windows desktops as well as laptops. Controlling practically every aspect of your computer's operation is made simple with this tool. This includes anything from the keyboard as well as mouse functions to the passwords and also the users on your network to the desktop backdrops and the desktop sounds to application installation and the removal.

You can access the Control Panel by clicking on the following links:

- **Use search**. You can search for location or task by entering a keyword or phrase in a search box. When you type "sound" in a search bar, you'll get a list of system sound, sound card, and taskbar volume settings.

*https://www.oreilly.com/library/view/windows-xp-in/0596009003/re186.html

- **Browse**. Programs, System & Security, and Ease of Access are all instances of categories that can be explored using the Control Panel. To see the list of all the Control Panel items, select either "Large icons" or "Small icons" from the View by drop-down menu.

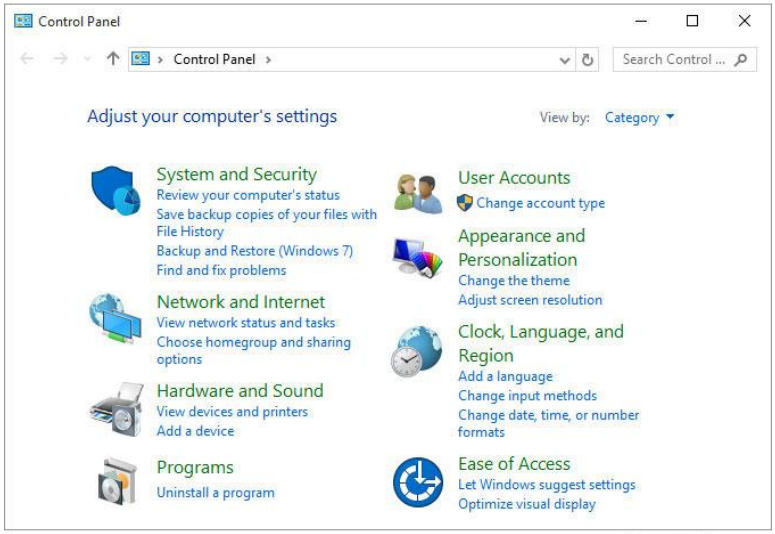

*Figure 6.19 Window 10 Control panel**

6.12. Windows Accessories

There are several useful tools in Window Accessories group that can be customized to meet our specific requirements. Many tools are available in "Window Accessories Group" so that we could use Simple Type. Although there

*https://www.computerhope.com/jargon/c/controlp.htm

are several tools in "Window Accessories Group", the following are among the most significant ones.

Character Map:-

"Character Map Window Accessories" has the feature that lets you see which "font key" or "key combination" has been assigned to it. There are a plethora of keys and fonts here that aren't found on the standard keyboard. We could improve our writing with the support of others.

“Start button→ All program→ Window accessories→ Character Map”

Calculator:-

Window Accessories has an arithmetic as well as scientific calculator that we use frequently. Calculators are presented on screen as well as can be used with the mouse, allowing us to conveniently perform the mathematical sums. Windows system relies heavily on this program.

“Start button→ All program→ Window accessories→ calculator”

Note Pad:-

An extension (.txt) of file created within Note Pad indicates that there is the limit to amount of text which can be entered into this text editor; hence, we are limited to a certain amount of text. This is must-have for Windows accessory developers.

"Start button→ All programs→ Window accessories→ notepad"

Word Pad:-

In addition to being a text editor, Word Pad also is known as Word Processor. With the ability to adjust text size and set date & time, this is a useful feature of Windows Accessories.

"Start button→ All program→ Window accessories→ word pad"

Remote Desktop Connection:-

A connection to a remote computer a person sitting far away could control our computer via a remote connection, thus we can link from one computer to the other and obtain any help or aid anyone, in this, we can connect through one computer to the other and get any help or help anybody.

"Start button→ All program→ Window accessories→ remote desktop connection"

Paint:-

Window Accessories' Paint Tool is an essential tool for creating images such as maps, sketches, and other visual representations. With the aid of a variety of equipment, we may achieve a high-quality painting.

“Start button→ All program→ Window accessories→ paint”

Math input panel:-

An input panel for math can be found in a set of window decorations. Windows 7 introduced a new math input panel. Mathematical digits can be generated from any word or letter. A's' on”Friends-math input panel", for instance, would result in a '5'. The "Math input panel" allows for the creation of any word using a mouse.

“Start button→ All program→ Window accessories→ Math input panel”

Snipping Tool:-

Using Snipping tool, we may take "Screen shorts" of any screen objects, just like we used to do on phone. Snipping tool is also the important Window Accessories feature.

“Start button→ All program→ Window accessories→ snipping tool”

Disk cleanup:-

When we use disc cleanup, we may remove items such as junk files and cookies from PC, which improves its efficiency.

“Start button→ All program→ Window accessories→ System tool→ disk cleanup”

Disk defragment:-

Disk defragment is the window add-on that can be used to defragment and organize files and folders on a computer's hard drive to free up disc space.

“Start button→ All program→ Window accessories→ System tool→ defragment”

6.12.1. Calculator

Adding, subtracting, multiplying, and dividing are all examples of math functions that can be performed by a calculator. First electronic calculator was created in 1957 by "Casio Computer Company". Because of this, calculators have come in different sizes and also are incorporated into most operating systems on the smartphones, computers, as well as tablets. The Calculator program, which comes with every version of Windows, is depicted in the figure.

A numeric keypad on the computer can be used to input numbers into the calculator. Press "Num Lock key" if your numeric keypad isn't working. The numbers above a top row of keys on laptops and computers without the numeric keypad could be utilised.

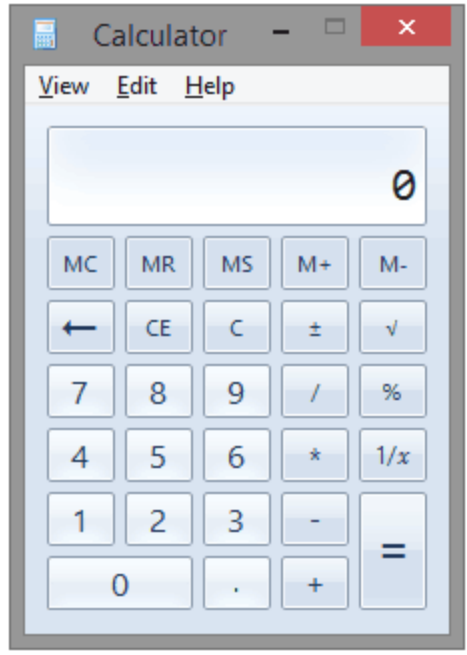

*Figure 6.20 Calculator**

6.12.2. Notepad

Microsoft Windows comes pre-installed with Notepad, the text editor that lets you ”create", "open", and "read" plain text files. Notepad won't be able to open a file with specific formatting or that isn't the plaintext file. Here is a short sample of what Notepad might look like when it is operating.

*https://www.computerhope.com/jargon/c/calc.htm

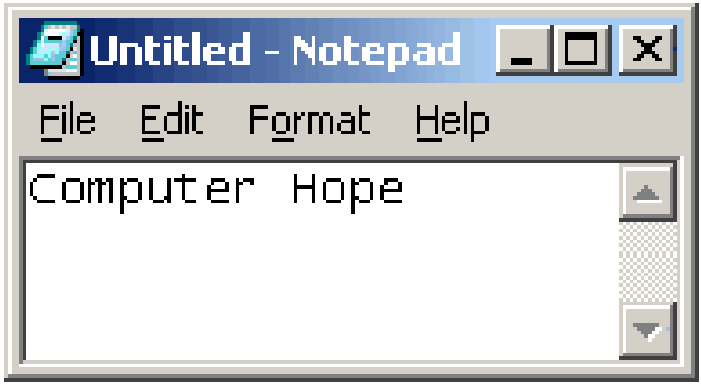

***Figure 6.21** Notepad**

6.12.3. Paint

An easy-to-use tool that lets you make simple graphics on your computer is Microsoft Paint. Since the beginning of Windows, every new release has come with a copy of Paint. Basic drawing as well as painting tools, such as colored and also the black-and-white stencils as well as cured-line tools, are included in Paint.

Users can also open other image files in the Microsoft Paint. For instance, you can "create", "open", "view", and "edit" .dib, .bmp, .jpg ,.tiff,.gif,..png, as well as .ico files with the current version of the Microsoft Paint. To view photographs stored on the computer, you'd have to use software other than Microsoft Paint.

*https://www.addintools.com/documents/others/how-to-take-screen-shots.html

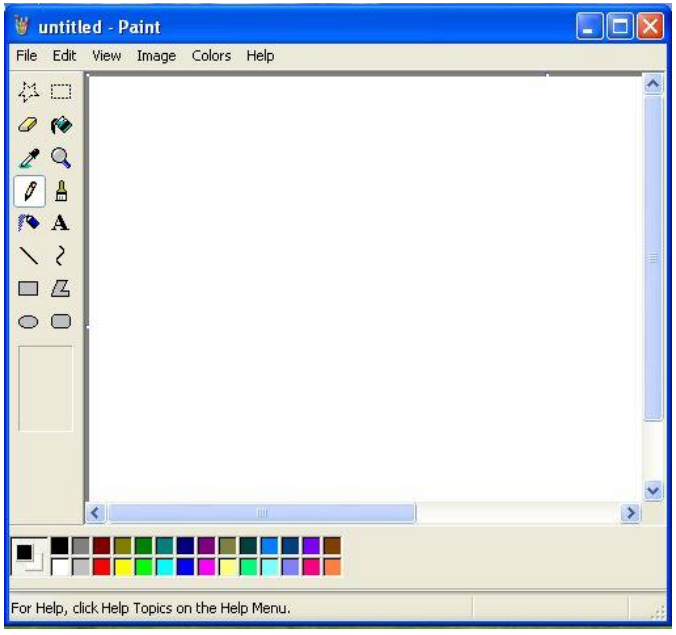

*Figure 6.22 Paint**

*https://www.addintools.com/documents/others/how-to-take-screen-shots.html