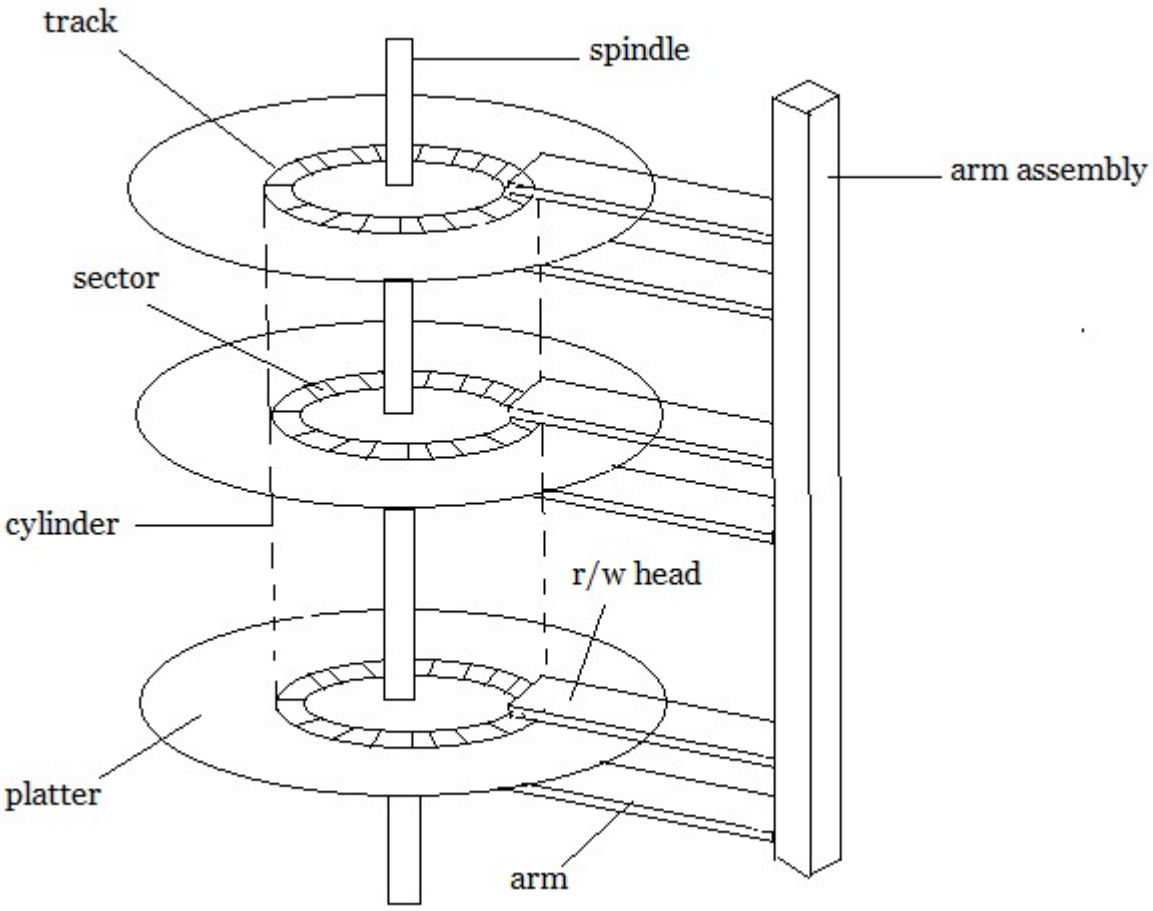


Storage capacity :

Storage capacity of a disk system= number of recording surfaces * number of tracks per surface * Number of sectors per track * Number of bytes per sector.

Access Mechanism : To access the piece of data from the disk, we need to specify its disk address, which is comprised of sector number, track number/cylinder number, and surface number (when multiple disk platter are used). Once the address is obtained the arm assembly along with disk rotation and r/w head completes the read/write operation.

Access Time : Data access time is the interval between the computer makes a request for transfer of data from a disk system to primary memory and the time this operation completes. A disk stores information from the beginning of a sector and reads information always from the beginning of a track. Hence disk access time depends upon following 3 parameters.

1. Seek Time: The time required to position the read/write heads on a specific track/ cylinder is called seek time. Seek time varies depending on the position of access arms assembly when a read/write command is received. Average seek time is between 10 to 100 milliseconds.

2. Latency: It is the time required to rotate the specified sector under the read/write head. Latency is also known as rotational delay. The value of latency depends upon the distance of the specified sector from the initial position of the head on the specified track. It also depends upon the disk rotation speed which varies between 300 rpm to 7200 rpm. Average latency varies between 5 to 80 millisecond.

3. Transfer Rate : Transfer rate is the rate at which a computer read/write data from/to a disk into memory. Once the disk drive positions the read/write head on a specified sector, it read/writes data at a speed determined by the rotational speed of the disk.

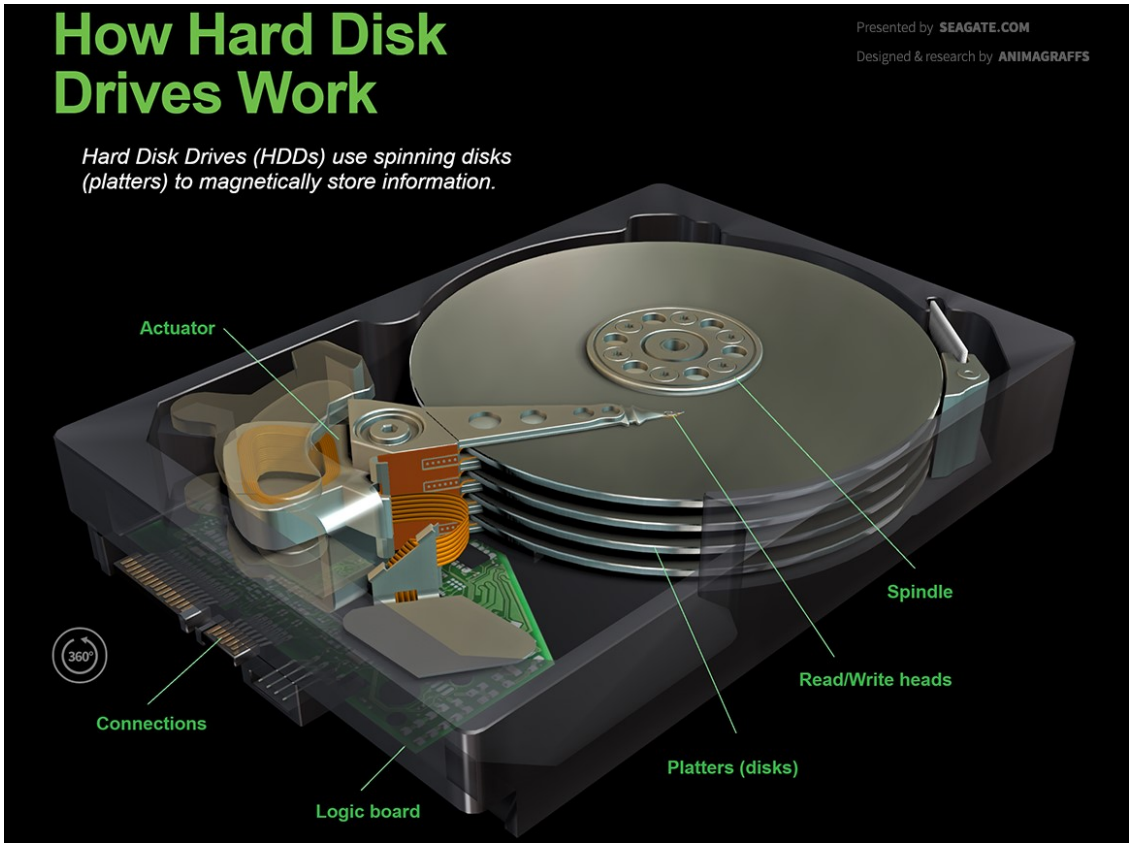
Advantages of Magnetic Disks

1. Magnetic disks support direct access mechanism for data storage. It makes them suitable for most of the application.
2. Magnetic disks have high data recording density and cost per bit is low.
3. Data access time in magnetic disks is superior to magnetic tape.
4. Size of magnetic disks is compact and magnetic disks such as zip disks, floppy disks are easily portable.
5. Magnetic disks are used for both online and offline storage.

Limitations of Magnetic Disks

1. The use of magnetic disks for sequential access is less efficient in comparison to magnetic tape.
2. It is difficult to maintain security of information stored on magnetic disks.
3. To recover data from a crashed magnetic disks is very difficult.

Types of Magnetic Disks: Hard disk, Floppy Disk



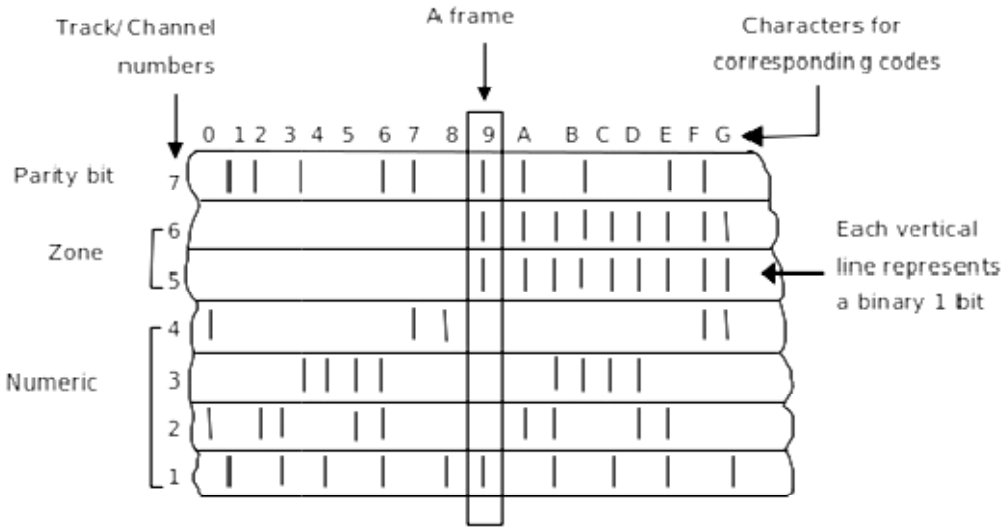
Parts of Hard disk

Magnetic Tapes : magnetic tape is most common sequential access secondary storage device. It is mostly used as a backup storage for data stored on online storage devices such as hard disk.

Storage Organization

Magnetic tapes are logically divided into vertical and horizontal sections. Vertical sections are called frames whereas horizontal sections are called Channels or Tracks. Older tapes had 7 tracks and they used 6-bit BCD (binary coded decimal) codes for data storage, remaining 1 bit act as parity bit which is used for error detection. Most of the modern tapes have 9 tracks and use 8-bit EBCDIC (Extended Binary coded decimal Interchange code) remaining 1 bit here also act as parity bit.

Parity : Parity refers to the condition to check whether two (or more) things are equal to each other or not. In computing even/odd parity bit is used for the purpose of error detection.



Illustrates the concepts of frames, tracks, parity bit, and character-by-character data storage

A magnetic tape is a continuous medium, which record data serially. There is no addressing. Records are separated by inter record gaps (IRG). The tape record IRGs automatically as it writes data on tape. Each IRG is about 0.5 inches. While reading data from a moving tape, a tape drive stops tape movement when it encounters an IRG. The tape remains stationary during the processing of IRG and then moves again to read the next record.

Storage capacity:

Storage capacity of a tape= Data recording density * length

Data recording density is measured as dpi (dots per inch). In older tapes data recording density was 800 dpi whereas modern tapes has 77000 dpi.

Data Transfer Rate :

Data transfer rate = tape speed * data recording density

Advantages of Magnetic Tapes

1. Storage capacity of magnetic tapes is very high.
2. Cost per bit of Storage is very low in magnetic tapes.
3. Magnetic tape reels and cartridges are easily portable because of their compact size and lightweight.

Limitations of magnetic tape:

1. Magnetic tapes are not suitable for storage of data that need to be accessed randomly.
2. We must store magnetic tapes in dust free environment because specks of dust cause tape-reading errors.

Magnetic tape in use

Optical Disks

An optical – disk storage system consists of a metallic or plastic disk coated with a highly reflective material. Optical disks are also known as laser disks or optical laser disks because they use laser beam technology for data read/write.

Storage Organization

Unlike magnetic disks having several concentric tracks and optical disk has one long track starting at the outer edge and spiraling inward to the center. Spiral track is ideal for reading large blocks of sequential data such as audio or video. It however, causes lower random access of data than in case of concentric tracks used by magnetic disks.

Spiral track organization divides the spiral track of an optical disk into equal length sectors regardless of the position of a sector from the center. All the sectors being of equal length enables data packing at maximum density over the entire disk. However, it also requires a more complicated drive mechanism because the rotational speed of the disk must vary inversely with the radius. That is the drive must slow down the disk's rotation speed to read/write data from/to sectors towards the periphery of the disk, and speed it up to read/write data from/to sectors towards the center of the disk.

Storage capacity:

Optical disks comes in various sizes ranging between 12.0 inch to 3.0 inch diameter, the most common one is 5.25 inch diameter with capacity of 650 Megabytes.

Storage capacity of an optical disk= Number of sectors * Number of Bytes per sector

5.25 inch optical disk typically has 330000 sectors each of 2352 bytes, making its storage capacity equal to $330000*2352= 776*10^6$ Bytes= 776 MB , this is unformatted capacity, formatted capacity is 650 MB.

Access Mechanism

An optical disk drive uses laser beam technology for reading/writing of data form/to an optical disk surface. It has two laser beam sources. It uses one laser beam (of greater intensity) to write data by etching microscopic pits on the disk surface and another low intensity laser beam to red data from disk surface. While writing data it turns the beam ON and OFF corresponding to the data to be written 1 or 0. To read data it focuses the less powerful beam on disk surface. This beam is strongly reflected by coated surface known as land and weekly reflected by the burnt surface called pits, which produce a pattern of ON and OFF reflections, which are converted by sensor into signals of binary 1 and 0.

Access Time:

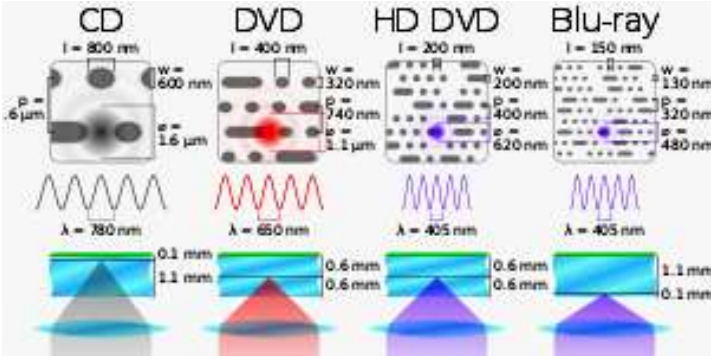
1. Sectors of an optical disk are on a continuous spiral track. This results in slower random access than in concentric track organization.
2. Each sector has the same length regardless of its position therefore the disk speed has to vary according to the radius of the read/write sector. Slower at periphery and faster towards the center of the disk.
3. Optical disks are prone to scratches, dust, sticky print etc. while handling. This cause the read mechanism to employ error correction mechanisms.
4. The entire read/write assembly is not a sealed unit. Therefore disk cannot be rotated at a very fast speed. It may damage the disk and other parts.

Advantages:

1. Cost per bit of storage is very low.
2. Ideal for storage of large block of sequential data such as audio or video.
3. Optical disks have data storage capacity of 30 years.
4. Due to compact size and light weight. They are easy to handle and carry.

Limitations

1. Data access speed of optical disks is slower than magnetic disk.
2. Optical disks need more complicated drive system due to single continuous track.
3. It is prone to scratches, dust, sticky prints etc. while handling.



Various types of optical disks and representation of data storage technology used in them

CPU (Central Processing Unit)

CPU is the heart and brain of a computer. CPU is the hardware within a computer that carries out the instructions of a computer program by performing the basic arithmetical, logical, control and input/output operations of the system. The term has been in use in the computer industry at least

since the early 1960s. The form, design, and implementation of CPUs have changed over the course of their history, but their fundamental operation remains much the same.

CPU operation is determined by the instruction it executes, collection of these instructions that a CPU can execute forms its instruction set. An instruction is represented as sequence of bits, which has two parts opcode and operands. Opcode indicates the operation to be performed, the nature of operands (data or address) and mode (register or memory),

A computer can have more than one CPU; this is called multiprocessing. All modern CPUs are microprocessors, meaning contained on a single chip. Some integrated circuits (ICs) can contain multiple CPUs on a single chip; those ICs are called multi-core processors.

ALU (Arithmetic Logic Unit)

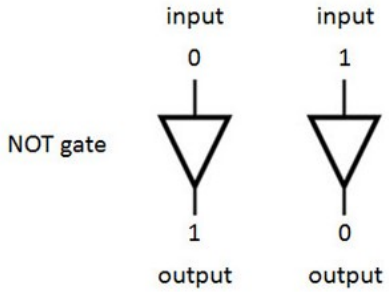
An arithmetic logic unit (ALU) is a digital circuit used to perform arithmetic and logic operations. It represents the fundamental building block of the central processing unit (CPU) of a computer. Modern CPUs contain very powerful and complex ALUs. Most of the operations of a CPU are performed by one or more ALUs, which load data from input registers. A register is a small amount of storage available as part of a CPU. The control unit tells the ALU what operation to perform on what data and the ALU stores the result in an output register. The control unit moves the data between these registers, the ALU, and memory.

An ALU performs basic arithmetic and logic operations. Examples of arithmetic operations are addition, subtraction, multiplication, and division. Examples of logic operations are comparisons of values such as NOT, AND, and OR.

All information in a computer is stored and manipulated in the form of **binary numbers**, i.e. 0 and 1. **Transistor** switches are used to manipulate binary numbers since there are only two possible states of a switch: open or closed. An open transistor, through which there is no current, represents a 0. A closed transistor, through which there is a current, represents a 1.

Operations can be accomplished by connecting multiple transistors. One transistor can be used to control a second one - in effect, turning the transistor switch on or off depending on the state of the second transistor. This is referred to as a **gate** because the arrangement can be used to allow or stop a current.

The simplest type of operation is a NOT gate. This uses only a single transistor. It uses a single input and produces a single output, which is always the opposite of the input. This figure shows the logic of the NOT gate



Memory Registers

Registers are memories located within the Central Processing Unit (CPU). They are few in number (there are rarely more than 64 registers) and also small in size, typically a register is less than 64 bits in size. The contents of a register can be read or written very quickly however, often an order of magnitude faster than main memory and several orders of magnitude faster than disk memory. Different kinds of register are found within the CPU. General Purpose Registers are available for general use by the programmer. Unless the context implies otherwise we'll use the term "Register" to refer to a General Purpose Register within the CPU. Most modern CPU's have between 16 and 64 General Purpose Registers. Special Purpose Registers have special uses and

are either nonprogrammable and internal to the CPU or accessed with special instructions by the programmer. Examples of such registers include:

1. Program Control Register (PC) : It holds the address of the next instruction to be executed. Normally the instruction are stored in consecutive memory locations (in the main memory) and executed in sequence until it encounter a branch instruction.

2. Memory Address Register (MAR) : It holds the address of the active memory location. It is loaded from the program control register when the system reads an instruction from memory.

3. Memory Buffer Register (MBR) : It holds the contents of the accessed read/ write memory word.

4. Accumulator Register (A) : It stores the data on which the system has to operate , intermediate results and results of the operations performed.

5. Instruction Register (I): It holds the current instruction under execution. As soon as the instruction is stored in the register, its operation and instruction parts are separated. The system send the address part to the MAR register and instruction part is send to the CU for decoding and interpretation. CU then generated and sends the command for the appropriate unit to carry out the specified operation.

6. I/O register (I/O): These registers are used to communicate with I/O devices. Input devices send their information to the input registers

Although Register Size (the size of the Register bit-group) tends to vary according to register type, the Word Size of an Architecture is often (but not always!) defined by the Size of the General Purpose Registers. In contrast to Main memory and disk memory, registers are addressed directly by specific instructions or by encoding a register number within a computer instruction. At the programming (assembly) language level of the CPU, registers are normally specified with special identifiers (e.g. R0, R1, R7, SP, PC)

The contents of a register are lost if power to the CPU is turned off, so registers are unsuitable for holding long-term information or information that is needed for retention after a power-shutdown or failure. Registers are however, the fastest memories, and if exploited can result in programs that execute very quickly.

Input-Output Devices

Input device

Input device is a device through which data and instruction are entered into computer system. An input devices converts the data and instructions into binary form that computer can understand. This transformation is performed by “Input interface”.

The data entered through input device can be some text, some graphical image or symbol, sound etc, depending on the form of the raw data the various input devices are available.

Basic Function Performed by Input unit of a computer system -

1. It accepts the instruction and data from the user.
2. It converts these instruction and data in computer acceptable form.

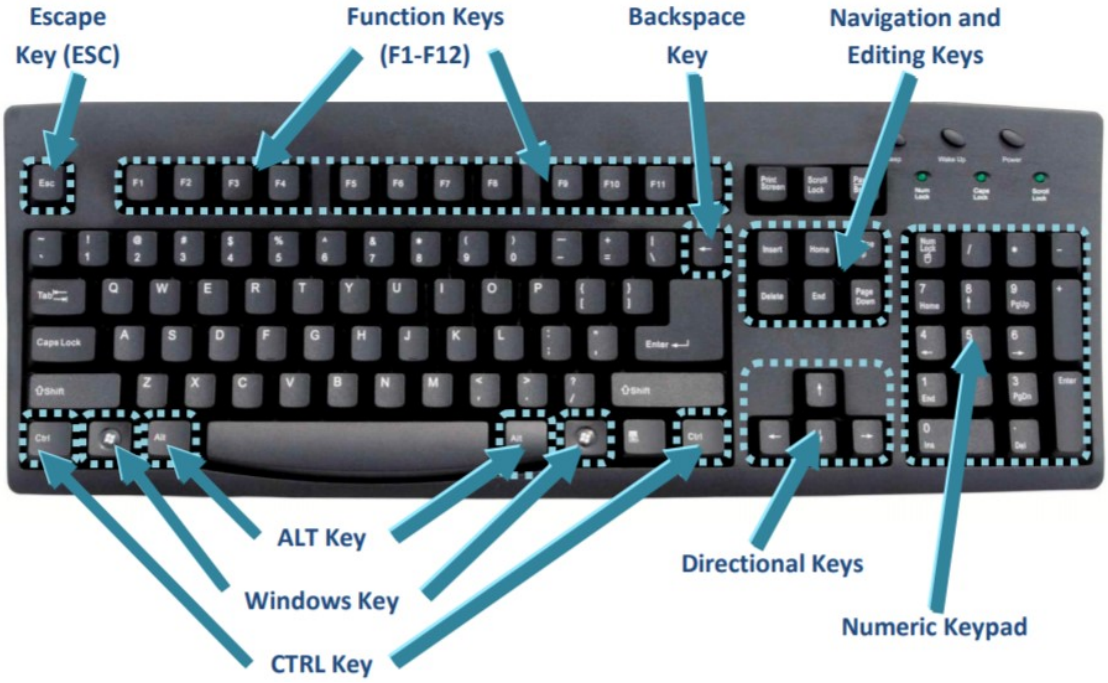
3. It supplies the converted instruction and data to the computer system for further processing.

Some of the commonly input devices used are:-

1. Keyboard
2. Mouse
3. Joy stick
4. Track ball
5. Touch screen
6. Light Pen
7. Digitizer
8. Scanner
9. Speech Recognition Devices

1. Keyboard

Keyboard is an input device for entering data and instructions into a computer. Data is entered into the computer by pressing set of keys available with this device. The most popular keyboard used today is the 101-keys QWERTY keyboard but multimedia keyboard is also available which contains more than 101 keys.



Keyboard keys are arranged in 6 groups such as:

1. Alphanumeric keys: - The alphanumeric keys are the collection of alphabets A-Z, numerals from 0-9 and punctuation marks that are arranged the same way on almost every keyboard.

2. Numeric keys: - It is usually located on right side of keyboard and appears like a non-scientific calculator with ten digits (0-9) and arithmetic operators.

3. Function keys: - The Function keys numbered from F1 to F12 are usually arranged in a first row at top of keyboard. Each function key performs different function depending upon the current application being run by user.

4. Cursor movement keys: - These keys allows user to change the position of the cursor on the screen. Cursor movement keys move cursor up, down, left and right.

5. Special purpose keys: - These keys perform special function i.e. insert, delete, print screen.

6. Modifier keys: - These keys are used in conjunction with other keys. Modifier keys include keys such as Alt (Alternate), Shift and Ctrl (Control).

2. Mouse

Mouse is a pointing device that controls the position of the cursor on a computer screen without using keyboard. It is called pointing device because it is used to point and select option on screen. There are two or more depression switched on the top of mouse.

Types of Mouse: -

1) Mechanical mouse
It has rubber or metal ball on its underside that can roll in all directions. Mechanical sensors within mouse detect the direction the ball is rolling and move the screen pointer accordingly.
2) Optomechanical mouse
It is same as a mechanical mouse but it uses optical sensor to detect motion of the ball.
3) Optical mouse
It uses a laser to detect the mouse's movement. It respond more quickly and precisely than mechanical and Optomechanical mouse, but is more expensive.

Three simple techniques to use mouse: -

1) Clicking: - To click on something with the mouse means, to move the pointer to the item on the screen and to press and release the mouse button once.
2) Double clicking: - To double click on item means, to move the pointer to the item on the screen and to press and release the mouse button twice with quick succession.
3) Dragging: - To drag an item, user position the mouse cursor over the item, the press the mouse button and hold it down as you move mouse.

3. Joy stick

It is also a pointing device which is used to move cursor position on a monitor screen. It consists of a lever which moves in all directions and controls the movement of pointer. Lever is having spherical ball at its base. When the lever steers the cursor moved in the respective direction. Potentiometers are used to sense the movements. On most of joystick a button at top is provided to select the option.

E.g. It is commonly used with computer games, flight simulators and for controlling robots.

4. Track ball

Track ball is pointing device that works like an upside down mouse. The only difference is that the ball in case of the track ball is placed on the top along with the button of the trackball. The movement of cursor is controlled by movement of ball by the fingers.Trackball is most commonly used in notebook or laptop instead of a mouse.