

Introduction

Memory units are the internal storage areas in computer. They are the locations which hold actual data and information either for short time temporarily or for long time permanently. The temporary memory is referred to as main memory and the permanent memory is called auxiliary memory. RAM and ROM are the main memory while secondary storage devices like hard disk, floppy disk, CDs, USB are the auxiliary memory.

Main Memory

- is the workspace for the computer's processor
- CPU needs to have millions of bytes of randomly accessed space where it can quickly read or write programs and data while they are being used.
- its storage is considered temporary because the data and programs will remain there only as long as the computer has electrical power or is not reset.

RAM (Random Access Memory)

- It is a volatile memory and holds data on a temporary basis
- When power is turned off its contents are erased.
- RAM holds programs and data which are currently being used.
- We can randomly (and quickly), directly access any location in memory.
- RAM is used to store:
 - Instruction awaiting to be obeyed
 - Instruction currently being obeyed
 - Data currently being processed
 - Data awaiting output.
- RAM can be assumed as the set of boxes, the boxes are numbered from zero upwards so that each box can be identified and located.
- Each bit of semi-conductor memory is represented by a single cell which may be regarded as Microscopic electronic circuits with two distinguishable stages used to represent 0 and 1.

Types of RAM

DRAM and SRAM

DRAM (Dynamic RAM)

- It is dense, meaning that we can pack a lot of bits into a very small chip and it is inexpensive which makes it affordable for large amount of memory.
- DRAM gets its name from the fact that it must be refreshed frequently. (The term refreshing means recharging the RAM chips with electricity.)
- DRAM chips must be recharged many times each second or they will lose their contents.
- The memory cells in a DRAM chip are tiny capacitors that retain a charge to indicate a bit.
- DRAM must be constantly refreshed or the electrical charges in the individual memory capacitors will drain and the data will be lost.
- The charge slowly leaks from the cells and has to be topped up constantly called "Refreshing".

SRAM (Static RAM)

- It does not need the periodic refresh rates like DRAM.
- Due to design of SRAM, not only are refresh rates unnecessary but SRAM is much faster than DRAM.
- Transistors are used instead of capacitors in SRAM.
- Transistors do not lose their charge.
- SRAM is much faster but lower in density and more expensive.
- The lower in density means that SRAM chips are both physically larger and store many less bits overall.
- Much more expensive than DRAM.

ROM (Read Only Memory)

- is a non-volatile type of memory that can permanently or semi permanently hold data
- is called ROM because it is either impossible or needs a special device to write to.
- contents or data in ROM will remain even if power is turned off.
- is an ideal place to put the computer's startup instructions that is, the software that are required to boot the system (are called firmware)
- otherwise the processor would have no program in memory to execute when it is powered on.

Types of ROM

- PROM
- EPROM
- EEPROM

PROM (Programmable Read Only Memory)

- It is blank when new and must be programmed with whatever data is necessary
- They are technically preloaded with binary 1s.
- 1MB ROM chip would come with about 1 million bit locations each containing 1.
- A blank PROM can be programmed, using a special machine called ROM programmer or ROM burner.
- Each binary 1 bit can be thought of as a fuse that is in fact (unburned).
- Most chips run on 5 volts but when we program a PROM we place a higher voltage normally 12 volts at various addresses with the chip
- The higher voltage actually blows or burns the fuses at the location we desire thus turning any given 1 into 0.
- PROM chips are often called OTP i.e. One Time Programmable chips because we cannot convert a 0 back into a 1.
- That is they can be programmed once and never erased.

EPROM (Erasable PROM)

- PROM that is erasable.
- EPROM is erased by the exposure to intense UV (Ultra Violet) light.

- UV light erases the chip by causing a chemical reaction that essentially melts the fuse back together, thus any binary 0s in the chip become 1s and the chip is restored to new condition with binary 1s in all location.

EEPROM (Electrically Erasable PROM)

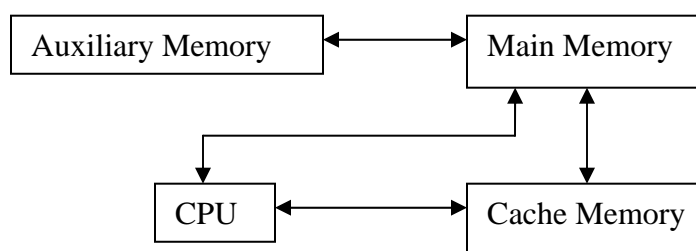
- Can be erased with electrical signals instead of UV light.
- Also known as Flash ROM.
- Are characterized by their capability to be erased and reprogrammed directly in the circuit board in which they are installed with no special equipment required.
- By using EEPROM it is possible to erase and reprogram the ROM in a computer without removing the chip from the System.

FLASH MEMORY

- Special types of EEPROM that can be erased and reprogrammed in blocks instead of 1 byte at a time.
- Many modern computers have their BIOS stored on a flash memory chip so that it can be easily updated if necessary.
- Also popular in modems because it enables the modem manufacturers to support new protocols as they become standardized.

CACHE MEMORY

- Moving data between RAM and the CPU's register is one of the most time consuming operations a CPU must perform, simply RAM is much slower than the CPU.
- The cache memory is placed between CPU and main memory.
- It is a semiconductor memory similar to RAM except that it is extremely fast compared to normal memory.
- It is a special and high speed memory used to increase the speed of processing by making current program and data available to the CPU at a rapid rate.
- Cache memory is used in computer systems to compensate for the speed difference between main memory access time and processor logic.
- It stores instruction code and data, which are to be currently executed by the CPU.
- It is used to reduce the average access time for instructions and data which are normally stored in the main memory.



- The modern 32-bit and 64-bit microprocessors operate at a very high speed.

- The memory matching with high – speed microprocessor must be very fast. But very fast memory is very expensive.
- If a fast microprocessor operates with conventional main memory it has to operate with several wait state, this will reduce the speed of the computer.
- A high speed cache memory is used to supply currently needed instructions and data to CPU.
- The main memory stores programs and data which is to be processed by the CPU.
- The currently needed instructions and data of the program are loaded into the cache from the main memory.
- The technique of accessing a cache memory differs from that of the main memory.
- To access main memory the CPU sends an address to it, in response of this the memory sends data contained at the specified memory address.
- On the other hand cache memory used parallel searching of data.
- It first compares the incoming address to the address present in the cache, if the address matches it is said that a “hit” has occurred then the corresponding data is read by the CPU.
- If the address does not match, it is said that a “miss” has occurred when a miss occurs, data is read from the main memory but it also loads a copy of the data to the cache memory so that when the CPU needs the same data or address, it finds it in the cache memory i.e. hit occurs and saves the time needed to load the data from the memory.
- Usually hit ratio is above 90%.
- The hit ratio is defined as the ratio of the number of hits to the total number of read requests sent to the cache by the CPU.
- Cache memory is placed at two or three levels they are called first level cache (L1), second level cache (L2) and third level cache (L3).
- Some microprocessor contains L1, L2, and L3 within the microprocessor.
- Cache within the microprocessor is called internal cache
- Cache outside the processor is called external cache.
- L1 → up to 256 KB built-in
- L2 → 2 MB
- Use of cache memory let the processor work in its actual speed

Introduction

Auxiliary storage device, also known as secondary memory is the supplementary memory to the main memory. It is permanent in nature retains its contents when the computer is switched off. It can be used to hold data and programs for future reference and they function as a back up storage media as well. Back ups assist to recover data in cases of accidental erasure, virus infiltration or major system crashes. They are not directly connected to the processor and hence the access time is slower than that of the main memory. The content in it must first be copied into the primary storage RAM for the CPU to process. The most common types of auxiliary storage devices are magnetic tape, hard disks, floppy disks, optical disks etc.

Auxiliary devices can be categorized into two types based on the data access.

1. Sequential Access
2. Random Access

Sequential Access	Random Access
Data are accessed sequentially step by step.	Data can be accessed randomly on any location.
Data access time is more as to read a particular piece of data all the data preceding it must be read.	Data access time is less as data on any location can be accessed directly.
Reading data sequentially involves a lower number of seek operations than does random reading; sequential reads deliver a higher rate of throughput	Random reads deliver a lower rate of throughput
Eg. Magnetic Tape, Tape drive	e.g. Magnetic Disks, Floppy Disk, Optical Disk

Magnetic Tape

- is a medium for magnetic recording generally consisting of a thin magnetizable coating on a long and narrow strip of plastic.
- originally developed in Germany, based on the concept of magnetic wire recording.
- device that stores computer data on magnetic tape can be called a tape drive, a tape unit, or a streamer.
- are sequential access device and are slower in performance as their data access time is more.
- are cheap and allow massive amounts (Kbs to Gbs) of data to be stored in computers for long periods of time.
- Modern magnetic tapes for hard disk backup come in cassette form. These are called cartridge tapes
- DAT (Digital Audio Tape) is the latest addition to the magnetic tape, the tape length is 60 or 90 meters, capacity up to 4 GB and data transfer rate 366 KB/sec

Uses

Magnetic tapes are often used to make a copy of hard discs for back-up reasons. This is automatically done overnight on the KLB network and the tapes are kept in a safe place away from the server.

Advantages

Magnetic tape is relatively cheap and tape cassettes can store very large quantities of data (typically 26 GB).

Disadvantages

Accessing data is very slow and you cannot go directly to an item of data on the tape as you can with a disc. It is necessary to start at the beginning of the tape and search for the data as the tape goes past the heads (serial access).

Winchester Disk

- The term Winchester comes from an early type of disk drive developed by IBM that stored 30 MB and had a 30-millisecond access time; so its inventor named it a Winchester in honor of the 30-caliber rifle of the same name.
- They have the same technology of the modern day hard disk with less speed and capacity

Magnetic Disk

- Diskette drive and hard disk drives are the most commonly used storage devices.

Hard Disk	Floppy Disk
1. They are the mass storage device with enormous capacity to store data.	1. They have limited storage capacity upto 1.44 MB.
2. Data access time is less.	2. Data access time is more.
3. Relatively expensive	3. Relatively cheap
4. Are fixed disk and usually built into the computer	4. Are portable.
5. They last long	5. They have a short life.

Hard Disk

- Mass storage random access device that can store GBs of data. As of July 2008, the highest capacity HDDs are 1.5 TB.
- A typical mobile HDD spins at 5,400 rpm, with 7,200 rpm models available for a slight price premium
- The fastest “enterprise” HDDs spin at 10,000 or 15,000 rpm, and can achieve sequential media transfer speeds above 1.6 Gbit/s and a sustained transfer rate up to 125 MBytes/second. Drives running at 10,000 or 15,000 rpm use smaller platters because of air drag and therefore generally have lower capacity than the highest capacity desktop drives.
- Data is stored by magnetizing the surface of flat, circular plates called platters which have a surface that can be magnetized. They constantly rotate at very high speed. A read/write head floats on a cushion of air a fraction of a millimeter above the surface of the disc. The drive is inside a sealed unit because even a speck of dust could cause the heads to crash.
- Programs and data are held on the disc in blocks formed by tracks and sectors. These are created when the hard disc is first formatted and this must take place before the disc can be used. Disc are usually supplied pre-formatted.

Uses:

- The hard disc is usually the main backing storage media for a typical computer or server.

Advantages:

- Stores and retrieves data much faster than a floppy disk or CD-ROM
- Very fast access to data as data seek time is less.
- Data can be read directly from any part of the hard disk. The access speed is about 1000 KB per second.
- Usually fixed inside the computer so cannot get mislaid.
- Cheap on a cost per megabyte compared to other storage media.

Disadvantages:

- Hard disks eventually fail which stops the computer from working.
- Regular 'head' crashes can damage the surface of the disk, leading to loss of data in that sector.
- The disk is fixed inside the computer and cannot easily be transferred to another computer.

Floppy Disk

- A floppy disk is an obsolescent data storage medium that is composed of a disk of thin, flexible magnetic storage medium encased in a square or rectangular plastic shell.
- Floppy disks are read and written by a floppy disk drive
- Invented by IBM, floppy disks in 8-inch, 5¼-inch, and the newest and most common 3½-inch formats enjoyed many years as a popular and ubiquitous form of data storage and exchange, from the mid-1970s to the late 1990s. They have now been superseded by flash and optical storage devices.

Uses:

- Moving files between computers that are not connected through network or communication hardware
- Loading new programs onto a system
- Keeping a back-up of small files.

Advantages:

- They are very cheap to buy and floppy disk drives are very common.

Disadvantages:

- They are easily physically damaged if unprotected and magnetic fields can damage the data.
- They are relatively slow to access because floppy disk rotates far more slowly than hard disks. The access speed is about 36 KB per second.

Two types of Floppy Disk

- 8" inch disk →
- 5.25" inch disk → mini floppy
- 3.5" inch disk → micro floppy
- Also depends upon the density of the disk
 - Density of the disk is measure of the capacity of the disk surface: the higher the density the more closely the iron – oxide particles are placed and the more data the disk can store.
 - Double Density (DD)
 - High Density (HD)
 - Extra High Density (ED)

Disk Capacity Determination

Disk capacity = NT x NS x NB x S
NT → No. of Tracks per surface
NS → No. of Sectors per tracks
NB → No. of Bytes per sectors – 512 bytes
S → No. of Sides

Disk	Type	Tracks	Sectors/Tracks	Sectors	Bytes/Sectors	Total bytes	KB	MB
5.25"	DD	40	9	750	512	368640	360	.36
5.25"	HD	80	15	2400	512	122800	1200	1.2
3.5"	DD	80	9	140	512	737280	720	.7
3.5"	HD	80	18	2880	512	1474560	1440	1.44
3.5"	ED	80	36	5760	512	2949150	2880	2.88

Example:

5.25" DSDD Capacity = NT x NS x NB x S = 40 x 9 x 512 x 2 = 368640 bytes = 360 KB	3.5" DSHD Capacity = NT x NS x NB x S = 80 x 18 x 512 x 2 = 1474560 bytes = 1440 KB = 1.44 MB
--	---

Optical Disk

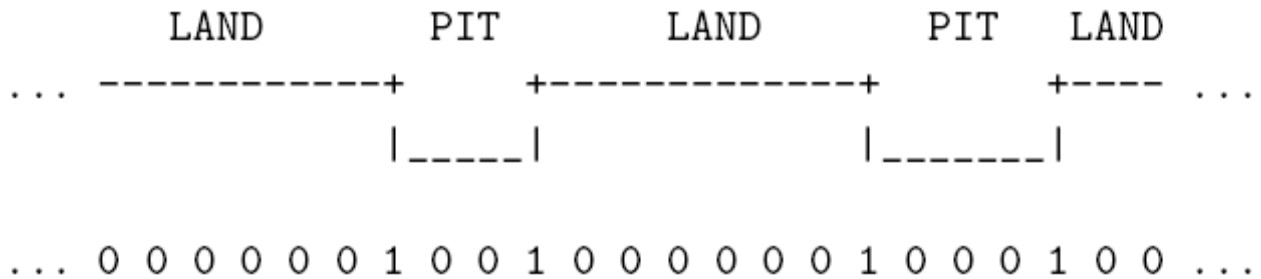
- Alternatives to magnetic storage systems.
- Most widely used type of optical storage medium is the compact disk (CD), CD – ROM, DVD – ROM, CD – Recordable, CD – Rewritable
- These devices fall into the category of optical storage because they store data on a reflective surface. So it can be read by a beam of laser light.
- A laser uses a concentrated, narrow beam of light, focused and directed with lenses, prisms and mirrors.
- The light focus of the laser beam is possible because all the light is the same wavelength.

CD-ROM (Compact Disk Read Only Memory)

- Is read only optical storage medium
- They are capable of holding above 700MB of data , 74 minutes of audio or video
- Accessing data from a CD-ROM is quite a bit faster than floppy disk but considerably slower than a modern hard disk
- The disk is made of a polycarbonate wafer, 120mm in diameter and 12mm thick with a 15 mm hole in the center.
- The wafer is coated with metallic film, usually an aluminum alloy.
- The aluminum film is the portion of the disk that the CD-ROM drive reads for information.
- The aluminum film is covered by a plastics polycarbonate coating that protects the underlying data.
- CD-ROM is single sided.
- Data is laid out on a CD-ROM disk in a long, continuous spiral that starts at the outer edge and winds inward to the center.
- Data are stored in the form of lands which are flat area on the metal surface and pits, which are depressions or hollows.
- Land reflects the laser light into the sensor (indicating a data bit of 1)
- Pit scatter light (indicating a data bit of 0)
- Reading the information back is a matter of reflecting a lower – powered laser off the aluminum film.
- A receiver or light receptor notes where light is strongly reflected or when it is absent or defused.

Chapter 7: Auxiliary Storage Devices

- Diffused or absent light is caused by the pits made that is called land.
- Data transfer rate is around 150 KBps , 300KBps now a days 7800KBps



WORM (Write Once Read Many)

- is a data storage technology that allows information to be written to a disk a single time and prevents the drive from erasing the data.
- The discs are intentionally not rewritable, because they are especially intended to store data that the user does not want to erase accidentally.
- Because of this feature, WORM devices have long been used for the archival purposes of organizations such as government agencies or large enterprises.
- The discs have varied in size from 5.25 to 14 inches wide, in varying formats ranging from 140MB to more than 3 GB.

EO disks (Erasable Optical Disks)

- Data in EO disks can be erased and loaded with new data just like the magnetic disk
- eg. CD RW, DVD RW, Magneto Optical Disk

Magneto Optical Disk

- Incorporates the combined features of magnetic disk and CD-ROMs
- They can be read and written into and are portable as well.
- Storage capacity more than 200 megabytes
- Data access speed is faster than floppies and CD-ROMs but not as fast as hard disks

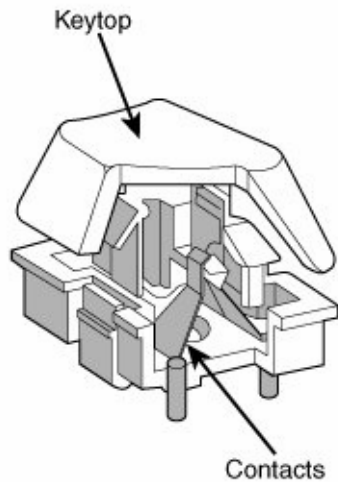
Introduction

- are the hardware parts that accept data and instructions from the user
- It enables you to input information and commands into the computers.
- convert input data and instructions into suitable binary form (such as ASCII) which can be accepted by the computer.
- The commonly used input devices are keyboard, mouse, scanner, light pen, graphic tablet, joystick, trackball, touch screen, microphone, digital tablets etc.

Keyboard

- Is the most common way to enter text and data into a computer
- Standard layout is basically like old typewriter keyboard (called a QWERTY keyboard)
- The most commonly used keyboards are
 - 101 – Key enhanced keyboard, 104 – key windows keyboard.
 - 82 – Key Apple standard keyboard and 108- key Apple extended keyboard.
 - It contains alphabets (A to Z or a to z), digits (0 to 9), special characters (!, @, #, \$, %, ^, &, *, <, >, ? etc) and some control keys.
- There are five key groups:
 - **Alphanumeric keys**
 - Letters of the alphabets
 - Numbers and symbols
 - Caps lock, tab, backspace and enter key do special functions but they are part of the alphanumeric key group.
 - **Modifier Key group**
 - Modify what happens when you press another key
 - Shift changes letter keys to upper case
 - Shift makes the number keys produce special symbols
 - Ctrl and alt used in combination with other keys change what that key does
 - **Numeric Key Pad**
 - Looks like a calculator keyboard
 - Used to enter numbers and operation symbols
 - Num lock forces keypad to enter numbers which is the normal default.
 - **Function Keys**
 - Middle of top row
 - Labeled F1 to F12
 - Could be assigned specific commands by the current application or operating system (or software dependent)
 - **Cursor Movement keys**
 - Direct movement of on-screen cursor
 - Up, down, left and right arrow
 - Other keys are insert, home, page up, delete , end and page down
- Special purpose keys are in addition to the five key group are found on keyboards specifically designed for windows operating system
- Start key or windows key

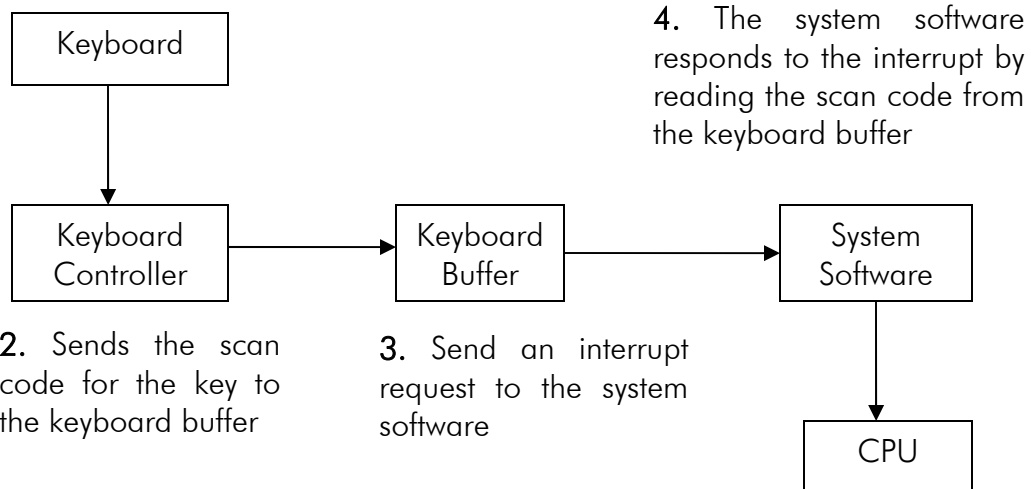
When a key is pressed an electronic signal is produced which is detected by an electronic circuit called keyboard encoder or controller.



The function of an encoder is to detect which key has been pressed and to send a binary code (corresponding to the pressed key) to the computer. The binary code may be an ASCII, EBCDIC or HEX code depending upon the computer.

How the computer accepts input from the keyboard?

1. Key is pressed on the keyboard

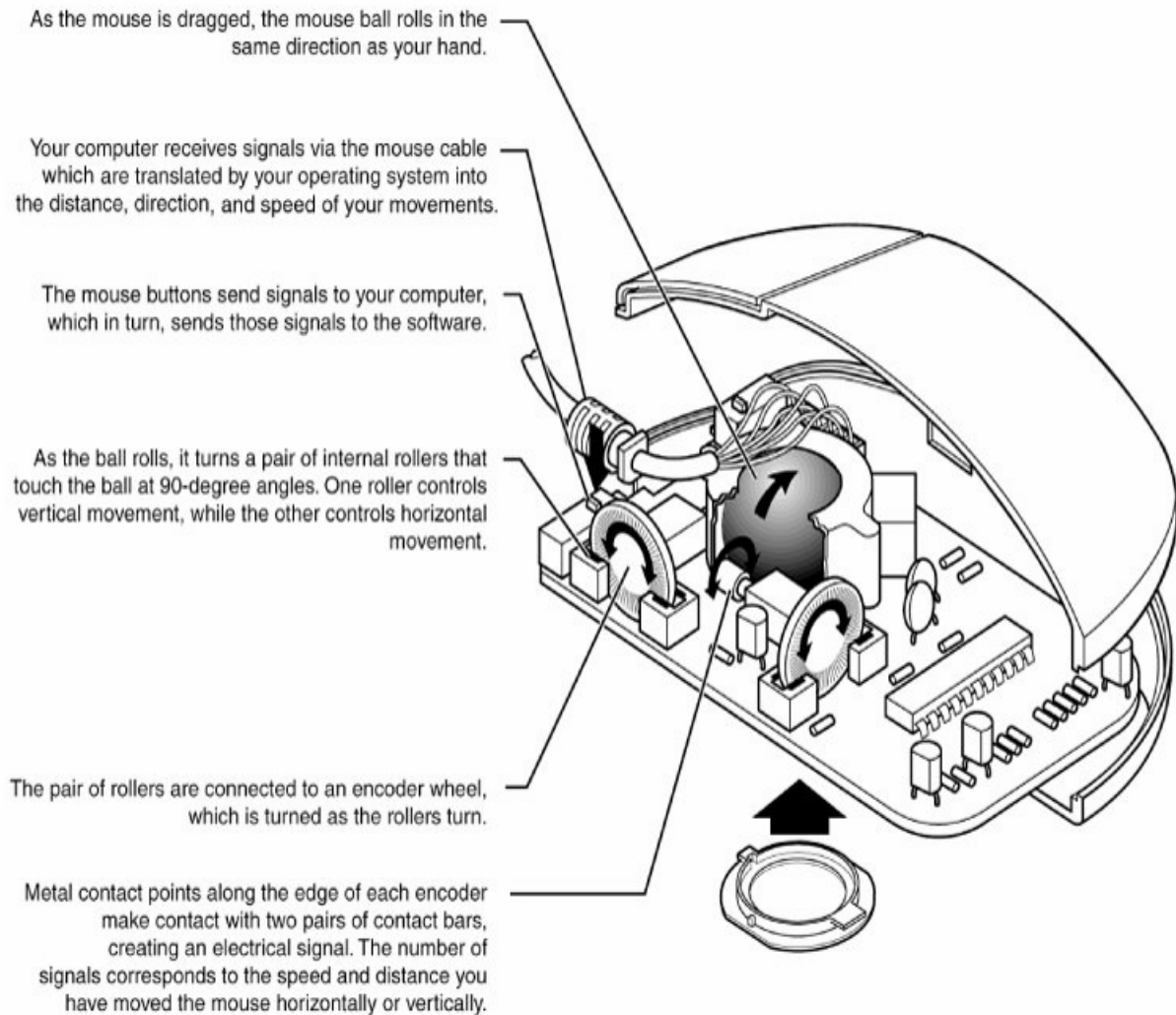


Mouse

- Is a small hand held devices used to position the cursor on the screen
- Is a kind of pointing device
- Is an input device that rolls around on a flat surface and controls the pointer
- Pointer is an on-screen object, usually an arrow, that is used to select text; access menus; and interact with programs, files or data that appear on the screen.

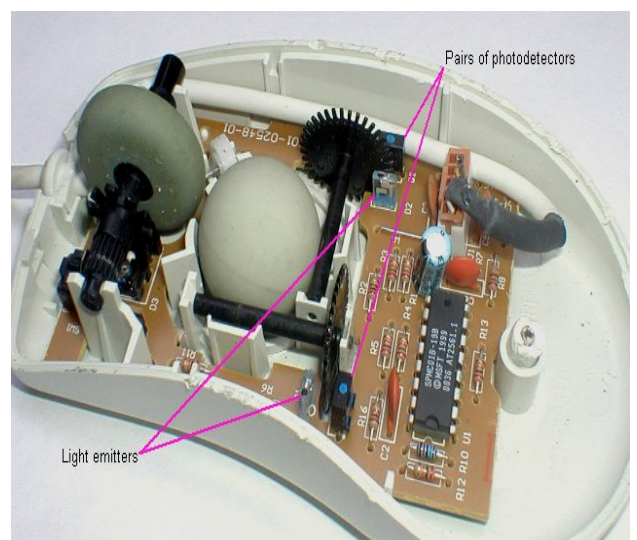
Mouse Actions:

- Clicking – move pointer to item and click left button one time.
- Double – clicking – move pointer to item and click left button two times quickly.
- Dragging – position mouse over item, click and hold left button as you move the mouse.
- Right Click – move pointer to item and click one time with right button



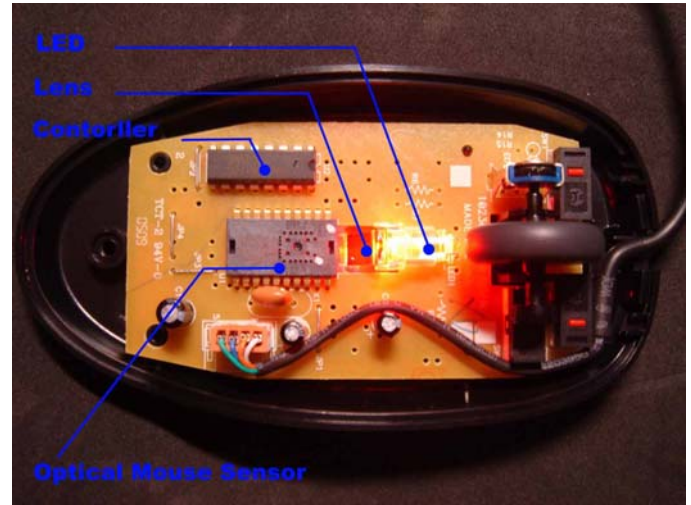
Mechanical Mouse

- a mouse that operates by mechanical means
- a rubber ball rolls as the mouse is moved across a tabletop or mouse pad, and the rubber ball turns vertical and horizontal wheels inside the mouse.
- The wheels, called encoders, have tiny metal contact points on their rims, which touch a contact bar as they turn. The contact bar sends electrical signals to the computer. The location of the mouse is established by how many times the contact points have touched the bars, the direction in which the wheels are turning, and the ratio between the number of signals from the vertical and horizontal encoders. The mechanical mouse is different from the optical mouse, which uses a beam of light to tell where it is.



Optical Mouse

- Introduced in 1999, actually uses a tiny camera to take thousands of pictures every second.
- Is able to work on almost any surface without a mouse pad
- Most optical mice use a small, red light – emitting diode (LED) that bounces light off that surface onto a complementary metal – oxide semiconductor (CMOS) sensor
- In addition to LED, a recent innovation are laser-based optical mice that detect more surface details compared to LED technology
- The result is the ability to use a laser – based optical mouse on even more surface than an LED mouse



Optical mouse has several benefits over track-ball mouse

- o No moving parts means less wear and a lower chance of failure
- o There's no way for dirt to get inside the mouse and interface with the tracking sensors
- o Don't require a special surface such as a mouse pad.

Track Ball

- A trackball is a pointing device consisting of a ball housed in a socket containing sensors to detect rotation of the ball about two axes—like an upside-down mouse with an exposed protruding ball.
- The user rolls the ball with the thumb, fingers, or the palm of the hand to move a cursor.
- Before the advent of the touchpad, small trackballs were common on portable computers, where there may be no desk space on which to run a mouse.
- The trackball was invented by Tom Cranston and Fred Longstaff as part of the Royal Canadian Navy's DATAR system in 1952
- The advantage of track balls over a mouse is that it remains stationary and does not require more space.



Joystick

- Is also a pointing device
- Used to move the cursor position on the screen
- Has spherical ball at its lower end as well as its upper end
- The lower spherical ball moves in a socket
- The joystick can be moved right or left, forward or backward
- The electric circuitry inside the joystick detects and measure the displacement of the joystick from its central position
- Buttons mounted on the stick or elsewhere on the joystick can be pressed to execute commands.
- Mainly used to play games.



Digitizing Tablet

- is an input device that enables a user to enter drawings and sketches into a computer.
- consists of an electronic tablet and a cursor or pen
- A graphics tablet (or digitizing tablet, graphics pad, drawing tablet) is a computer input device that allows one to hand-draw images and graphics, similar to the way one draws images with a pencil and paper. These tablets may also be used to capture data of handwritten signatures.
- A graphics tablet (also called pen pad) consists of a flat surface upon which the user may "draw" an image using an attached stylus, a pen-like drawing apparatus.
- The image generally does not appear on the tablet itself but, rather, is displayed on the computer monitor. Some tablets however, come as a functioning secondary computer screen that you can interact with directly using the stylus.
- Some tablets are intended as a general replacement for a mouse as the primary pointing and navigation device for desktop computers.



Scanners

- is an input device that can read text or illustrations printed on paper and translate the information into a form that the computer can use.
- Using scanner drawings, graphs, photos, text can be stored for computer processing by passing an optical mechanism over the information stored.
- The core component of the scanner is the CCD array (charge couple device).



Chapter 8: Input Devices

- CCD is the most common technology for image capturing in scanner. CCD is collection of tiny light sensitive diode which convert photos (light) into electrons (electrical charge)

Scanning process

- The document is placed on the glass plate
- The lamp is used to illuminate the document
- The entire mechanism (mirrors, lens, filter and CCD array) make up the scan head
- The scan head is moved slowly across the document by a belt that is attached to a stepper motor.
- The image of the document is reflected by an angled mirror to another mirror and then reflects the image onto a lens
- The lens focuses the image through a filter on the CCD array
- The lens splits the image into three smaller versions of the original (color filter R, G, B) onto a discrete section of CCD array.



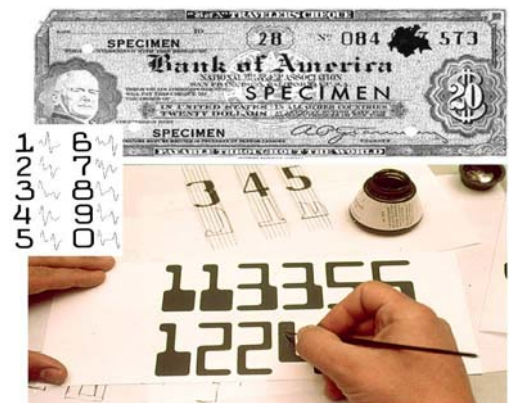
Digital Camera

- is an input device used to input digital images to a computer.
- takes video or still photographs, or both, digitally by recording images via an electronic image sensor.
- can do things film cameras cannot: displaying images on a screen immediately after they are recorded, storing thousands of images on a single small memory device, recording video with sound, and deleting images to free storage space.
- are incorporated into many devices ranging from PDAs and mobile phones (called camera phones) to vehicles. The Hubble Space Telescope and other astronomical devices are essentially specialized digital cameras.



Magnetic Ink Character Reader (MICR)

- allows the computer to recognize characters printed using magnetic ink.
- a character recognition technology adopted mainly by the banking industry to facilitate the processing of cheques.
- ATM cards use a similar technology to access account information and facilitate monetary transaction.



Optical Character Recognition (OCR)

- Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic translation of images of handwritten, typewritten or printed text (usually captured by a scanner) into machine-editable text.
- OCR is used for reading text from paper and translating the images into a form that the computer can manipulate (e.g. into ASCII code)
- Scans the documents and using the photo electric device converts the shape into electric signals.
- These patterns are then compared with the stored patterns of the characters which the reader can recognize
- If a match is found, the character scanned is identified otherwise the document may be rejected by the reader.

OMR (Optical Mark Reader)

- Can sense the presence of a pen or pencil mark
- It is widely used in scoring answers to multiple choice questions.

BCR (Bar Code Reader)

- is an electronic device for reading printed barcodes.
- consists of a light source, a lens and a photo conductor translating optical impulses into electrical ones.
- Is used to extract the information of any product, its description, date of manufacture and expiry and price.



Touch Screen

- is a display which can detect the presence and location of a touch within the display area.
- The term generally refers to touch or contact to the display of the device by a finger or hand.
- Touch screens can also sense other passive objects, such as a stylus.
- Until the early 1980s, most consumer touch screens could only sense one point of contact at a time, and few have had the capability to sense how hard one is touching. This is starting to change with the commercialization of multi-touch technology.
- The touch screen has two main attributes.
 - First, it enables one to interact with what is displayed directly on the screen, where it is displayed, rather than indirectly with a mouse or touchpad.



- Secondly, it lets one do so without requiring any intermediate device, again, such as a stylus that needs to be held in the hand. They also play a prominent role in the design of digital appliances such as the personal digital assistant (PDA), satellite navigation devices and mobile phones.

Touch Pad (Track Pad)

- is a pointing device consisting of specialized surface that can translate the motion and position of a user's fingers to a relative position on screen.
- They are a common feature of laptop computers and also used as a substitute for a computer mouse where desk space is scarce.
- Touch pads vary in size but are rarely made larger than 40 square centimeters (about 6 square inches). They can also be found on personal digital assistants (PDAs) and some portable media players.



Light Pen

- A light pen is a computer input device in the form of a light-sensitive wand used in conjunction with the computer's monitor.
- It allows the user to point to displayed objects, or draw on the screen, in a similar way to a touch screen but with greater positional accuracy.
- A light pen can work with any CRT-based display, but not with LCD screens (though Toshiba and Hitachi displayed a similar idea at the "Display 2006" show in Japan), projectors and other display devices.

