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Computer Graphics Part -1

Computer Graphic Part-1

Content:

INTRODUCTION

It is a rapidly evolving field. Until the past two decades, graphics was mainly the realm of artists. Now, computer graphics has touched the lives of not only artists and engineers, but also the common man in various ways.

By graphics we will refer to any sketch, drawing special artwork or other material to pictorially depict an object or process or otherwise convey information, as a supplement to or instead of written descriptions. The sketch may be cartoon or landscape building, electrical network or of the human anatomy. It may be just a few regular lines or 2D or 3D drawing. The graphics may also include text in various sizes and shapes.

In computer graphics, pictures or graphics objects are displayed as a collection of individual picture elements called **pixels (picture element).** The pixel is the smallest addressable screen element. It is the tiny piece of the display screen which we can control. The control is attained by setting the intensity and color of the pixel which compose the screen.

COMPONENTS OF COMPUTER GRAPHICS

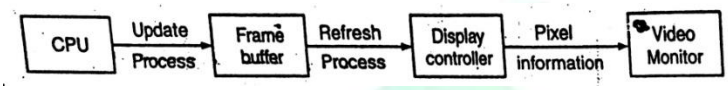
Interactive computer graphics consists of three components such as

Digital memory buffer

TV monitor

Display controller

Using these components, we are able to see the output on the screen in the form of pixels.



a. Digital Memory Buffer (Frame Buffer)

This is place where images or picture are stored as an array (matrix of 0 and 1, 0 represents darkness and 1 represents image or picture).

Frame buffer is the **Video RAM** (V-RAM) that is used to hold or map the image displayed on the screen. The sum of memory need to hold the image depends primarily on the resolution of the screen image and also the color depth used per pixel. The formula to compute how much vide memory is required at a given resolution and bit depth is quite simple.

$$\text{Me} = 1 + \frac{nx}{1!} + \frac{n(n-1)x^2}{2!} + \cdots \text{Memory is MB}$$

$$= \frac{X - resolution \times Y - resolution \times Bits\ per\ pixel}{8 \times 1024 \times 1024}$$

frame buffer is implemented using rotating random access semiconductor memory. However frame buffer also can be implemented using shift registers.

b. TV Monitor

It helps us to view the display and they make use of CRT (Cathode Ray Tube)

c. **Display Controller**

It is an interface between digital memory buffer and TV monitor. The main function of this is to pass the contents of frame buffer to the monitor.

APPLICATION OF COMPUTER GRAPHICS

Today, computer graphics is used in a variety of fields ranging from routine everyday activities to very specialized area in widely different fields, including business, industry and engineers medicine, government work, education and training, advertising research art and entertainment and communication in general. Some of the major application areas are listed below

1. Computer Aided Design/Drafting (CAD and CADD)
2. Presentation graphics
3. Entertainment
4. Computer Aided Learning (CAL)
5. Computer Art
6. Graphical user Interface (GUI)
7. Medical applications
8. Geographical information systems (GIS)

Computer aided Design/Drafting (CAD and CADD)

A major use of computer graphics is in design process, particularly for engineering applications such as building and other structural design, mechanical and industrial design as well as the design of manufacturing processes, including that of automobiles and aircraft, ships and spacecraft and many other products.

For some design applications, objects are first displayed in a **wire frame outline from** that shows the overall shape and internal features of objects. Wireframe shows allow designees to quickly see the effects of interactive adjustments to design shapes.

It packages range from 2D vector-based drafting systems to 3D solid and surface modellers. Latest CAD packages can regularly allow rotations in three dimensions, allowing viewing of a designed object from any desired angle, even from the inside looking out. Few CAD software is capable of dynamic mathematical modelling, in which case it may be marketed as CADD (*computer- aided design and drafting).*

Presentation Graphics

Here "Presentation", refers to the act of presenting important points of a topic to

a. The audience for a lecture
b. Potential customers for a new product or service etc.

The presentation of data in a condensed, visual, convenient from has always been an aid to understanding and promoting any idea. Graphics become a vital part of presenting idea and promoting organizations even in non-business endeavors such as at academic seminars or for an proposals for new construction and so on. Computer graphics has raised such presentations to an art form by making the visuals attractive and colorful without the special artistic skills through slides, transparencies, printout on paper video displays and animation.

Entertainment

Computer graphics methods are used in marketing music videos, games, cartoon movies, television shows etc. The graphics scenes are showed by themselves and sometimes graphics objects are combined with the actors and live scenes.

Computer-Aided Learning (CAL)

Computer-generated models of physical financial and economic systems are used as educational aids. Needless to say, computer graphic tools such as Microsoft Power Point are very heavily used in teaching seminar and conference

presentations on almost very subject at every level. The nature of the computer graphics is a vital component of the teaching learning process.

Computer Act

Computer graphics process are used in both fine art and commercial art applications. The ability to create any shape and play with any color that one can imagine through the medium of the computer has given the artist a wonderful palate and paintbrush for use on an unlimited canvas.

Graphical User Interface (GUI)

One cannot use any package of recent times without observing the many graphic items present and available on the screen to guide the user. Most software developed today must have a GUI for user friendly and interactive operation.

A vital component is window manager that allows a user to display multiple-window areas. Every window can carry a different process that can contain graphical or non-graphical displays.

Medical Applications

Computer graphics has become a powerful tool of diagnosis and treatment in the hands of doctors. Two-dimension images of cross-sections of the human body or specific organs are product by a CAT (Computerized Axial Tomography) scan. Tomography is a technique of X-ray photography (CT) and position emission tomography (PET) use projection methods to reconstruct cross sections from digital data. These techniques are also used to monitor internal function and show cross sections during surgery.

Geographical information systems (GIS)

It refers simply to a recent technique for the assembly, integration, tabular and graphic databases about natural and man-made features and facilities for purpose of better understanding more efficient analysis and faster decision making.

IMAGE PROCESSING

Difference between Image processing and Computer Graphics

Process used in computer graphics and image processing overlap, the two areas are concerned with fundamentally different operations. Computer is used to create a picture. Image processing applies techniques to update or interpret existing pictures such as photographs

Two principal applications of image processing are:-

a. Improving picture quality.
b. Machine perception of visual information, as used in robotics.

To appeal methods, we first digitize a photograph and other pictures into an image file. Then digital methods can be applied to modify picture parts, to enhance color or to improve the quality of shading.

A revolutionary development in this field is interactive image processing in which human input via graphical interaction techniques and menus assists to regulate various sub processes while transaction of images are displayed on the screen. For example scanned in images or photographs are electronically enhanced by touching, cropping and combining with other images, some application of digital image processing are:

a. Medical image processing
b. Face detection
c. Microscopic image processing
d. Pattern detection etc.

GRAPHICS PRIMITIVES

DISPLAY DEVICES

The important part in a PC is to display system. The systems where the graphics are rendered in the console screen of the computer. It is responsible for graphic display. It may be attached with a PC to display character, picture and video output. Some of the common types of display systems are

a. Raster scan display
b. Random scan displays
c. Direct view storage tube
d. Flat panel displays

The display systems are often referred to as Video Monitor or Video Display unit. The most common video monitor that normally comes with a PC is the Raster Scan type. However, every display system has three parts:

i. **Display adapter,** that creates and hold the image information.
ii. **Monitor**, which display that information.
iii. **Cable**, that carries the image data between display adapter and the monitor.

The display devices are also known as *output devices.* The most commonly used output device in a graphics system is video monitor and the operation of most video monitors is based on the Cathode-Ray Tube (CRT) design.

CATHODE RAY TUBE (CRT)

The simplest version of a cathode ray tube consists of a gas-filled glass tube in which two metal plates, one negatively changes (the cathode) and the other positively charged (the anode), have been place. When a very large voltage is placed across the electrodes, the neutral gas inside the tube will ionize into conducting plasma, and a current will flow as elections travel from the cathode to the other side.

It is a type of analog display device. They are special, electronic vacuum tubes that use focused electron beams to display images. Through tubes of this type are used for many purposes. They are famous for their use in such things as televisions, oscilloscopes, computer and radar displays, and automated teller machines. They are used in video game equipment.

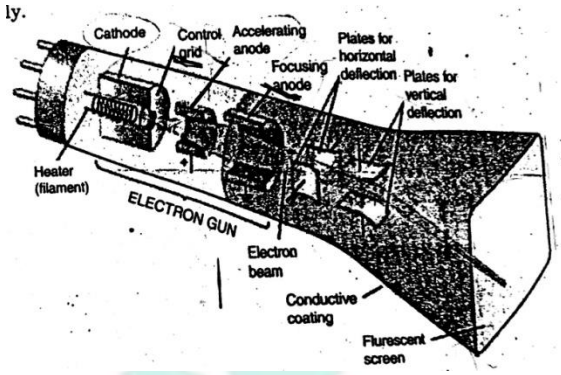
It has cathode or negatively charged terminal. In this, terminal is heated filament, much like the filament seen in a light bulb. The filament contained inside a vacuum with a glass tube. Inside the tube, a beam of electrons is allowed to flow from the filament into the vacuum. The flow of the electrons is natural, not forced.

When used inside a television set, a CRT's electrons are concentrated in a light beam by positively charged terminal, called an anode. An accelerating anode is then use to speed up the movement of the electrons. These fast-moving electrons fly through the tube's vacuum hitting the phosphor-coated screen and making it glow.

They are found in oscilloscopes, and similar devices are used in TV picture tubes and computer displays. The name goes back to the early 1900s. Cathode-ray tubes use an electron bean; before the basic nature of the beam was understood,

it was called cathode ray because it originated from the cathode (negative electrode) of a vacuum.

Below figure is a schematic diagram of the principle elements of a cathode-ray tube. The interior of the tube is a very good vacume, with a pressure of around 0.01 Pa (10-7 atm) or less. At any greater pressure, collisions of electrons with air molecules would scatter the electron beam excessively.



The cathode, at the left end in the figure, is raised to a high temperature by the heater, and electrons evaporate from the surface of the cathode. The accelerating anode, with a small hole at its center, is maintained at a high potential V_1, of the order of 1 to 20 kV, relative to the cathode. This potential difference gives rise to an electric field directed from right to left in the region between the accelerating anode and the cathode. Elections passing through the hole in the anode from an arrow beam and travel with constant horizontal velocity from the anode to the fluorescent screen. The area where the electrons strike the screen glows brightly. The control grid regulates the number of electrons that reach the anode and hence the brightness of the grid regulates the number of electrons that reach the anode and hence the brightness of the spot on the screen. The focusing anode ensures that electrons leaving the cathode in slightly different directions are focused down to a narrow beam and all arrive at the same spot on the screen. The assembly of cathode, control grid, focusing anode, and accelerating electrode is called *electron gun.*

The beam of electrons passes between two pairs of deflection plates. An electric field between the second pair divert them vertically. If no diverting fields are present, the electrons travel in a straight line from the hole in the accelerating anode to the center of the screen, where they produce a bright spot.

The electron gun fixed at the base plate of the CRT focuses electron beam on the CRT plate which is coated with phosphor bronze. The electron beam form the gun sequentially scans every pixel of the raster. In the process the beam hits a pixel and the phosphor dot of the pixel gets excited. As the electron beam moves to the immediate next dot, the currently excited dot starts emitting light energy in order to come back to its original static state. As the light emitted by the phosphor fades very rapidly, some method is needed for maintaining the screen picture. One way to keep the phosphor glowing is to redrawn the picture repeatedly by quickly directing the electron beam back over the same points. This type of display is a refresh CRT.

THE BEAM-PENETRATION, CTR

The normal CTR can generate images of only single colour due to limitations of its phosphor. A colour CRT device uses a multilayer phosphor and achieves clolour control by modulating a normally constant parameter, namely the beam accelerating potential. The screen is coated with a layer of green phosphor over which a layer of red phosphor is deposited. When a low potential electron beam strikes the screen only there red phosphor is excited thus producing a red trace. A higher velocity beam will penetrate into the green phosphor increasing the green component of the light output.

By varying the beam potential different combinations of red and green light can produce a limited range of colour such as orange, yellow etc. the speed of the electrons, and hence the screen colour at any point, is controlled by the beam-

acceleration voltage. Beam penetration has been an inexpensive way to produce colour in random-scan monitors, but only four colours are possible and quality of pictures is not a good as with other methods.

Advantages: The biggest advantage is that it is at half cost of shadow mask and its resolution is better.

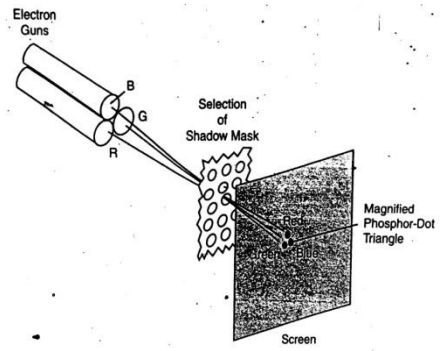
Disadvantage: the main problem arises at the time of switching colours, when the beam-accelerating potential needs to be changed by significant amounts in order to prevent smear and flicker of the image. The hardware of the software must be designed to introduce adequate delays between colour changes, so that there is time for voltage to settle. So biggest disadvantage is that change of colour takes time which doesn't suit interactive graphics at all.

To prevent frequent delays and consequent flicker all the red elements of the picture should be displayed first, then the accelerating potential can be changed to display toe tallow elements and so on through all the different colours.

SHADOW MASK CRT

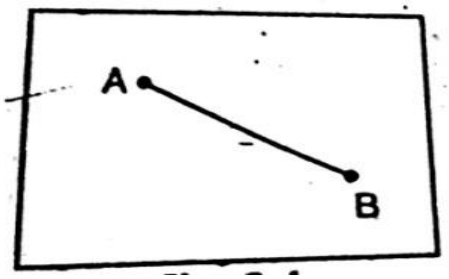
The process are used in raster-scan systems (including colour TV) because they produce a much wider range of colour than the beam penetration method. It has three phosphor colour dots at each pixel position. One phosphor dot emits a red light, another emits a green light, and the third emits a blue light. The CRT has three electron guns, one for each colour dot, and a shadow-mask grid just behind the phosphor coated screen. The stream of electrons produced by the CRT's cathode reaches the phosphor-coated faceplate; it encounters the shadow mask, a sheet of metal engraved with a pattern of holes. The mask is positioned in the glass funnel of the CRT during manufacture and the phosphor is coated on the screen so the screen so that electrons coming from the red, green and blue gun positions only land on the appropriate phosphor.

Stray electrons strike it and are absorbed by it, generating a great deal of heat, which in turn causes the metal to expand. To allow flatter CRT's to be made, the metal most commonly used now for shadow masks is **invar, an alloy of iron and nickel.** The metal dimensions when heat is applied. In reality, its dimensions are not completely invariable and the buildup of heat in a shadow mask can let to a form of distortion known as *doming,* where the center of the mask bulges towards the faceplate slightly.



RAINDOM SCAN DISPLAY (MONITORS)

The original CRT, developed in the late 50's and early 60's created charts and pictures line by line on the tube surface in any (random) order or direction given, in a vectorial fashion. The electron beam was moved along the particular direction and for the particular length of the line is specified. For this reason the type of device was known as vector calligraphic or stroke. For example we want a line connecting point A with point B on the vector graphics display, we simply drive the beam deflection circuitry, which will cause beam to go directly from point A to B.



If we want to move the beam from point A to point B without showing a line between points, we can blank the beam as we move. It thus random scan display generates the image by drawing a set of random straight lines much in the same way one might move a pencil over a piece of draw an image-drawing strokes from one point o another, one line at a time.

There are of course no bit planes containing mapped pixel values in vector system. The display buffer memory contains a set of line drawing commands along with end point coordinates in a display list or display list or display program created by a graphics package. The display processing unit (DPU) executes each command during every refresh cycle and feeds the vector generator with digital x, y and Δx, Δy values. The vector generator converts the digital signals into equivalent analog deflection voltages. This causes the electron beam to move to the start point or from the start point to the end point of a line or vector. Therefore, the beam sweep does not follow any fixed pattern, the direction is arbitrary as dictated by the display commands.

RASTER SCAN DISPLAYS (MONITORS)

It is a synonym for "matrix" therefore a raster scan CRT scans a matrix with electron beam. In a raster-scan system, the electron beam is wept across the screen, one row at a time from top to bottom. As the electron beam moves across each row, the beam intensity turned on and off to create a pattern of illuminated spots. Picture definition contained in a memory area called the refresh buffer or frame buffer. It carry the group of intensity values for all the screen points. The stored intensity values are retrieved from frame buffer and displayed on the screen one row (beam line) at a time. Every screen point is referred to as a pixel. Every pixel on the screen can be specified by its row and column number. Thus by specifying row and column number we can specify the pixel position on the screen.

The capability of a raster-scan system to store intensity information for each screen point makes it will suited for the realistic display of scenes containing subtle shading and colour patterns.

DIFFERENCE BETWEEN RASTER AND RANDOM DISPLAYS

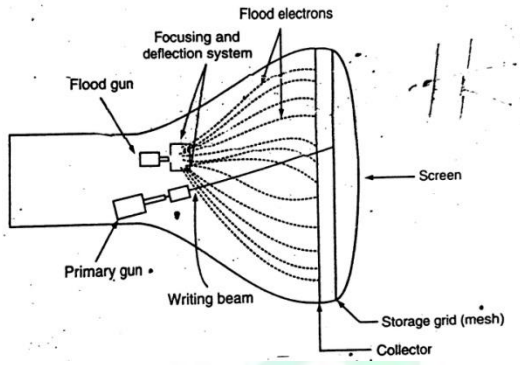
The difference between raster and random display is that raster display gives a realistic image. It generally have higher resolution than raster systems. It produce smooth line drawing because the CRT beam directly follows the line path. A raster system produces Jagged lines that are plotted as the point sets.

VECTOR SCAN DISPLAY	RASTER SCAN DISPLAY
1. It only draws lines and characters. 2. Don't use interlacing 3. It display the beam is moved between the end points of the graphics primitives 4. Higher resolution. 5. More expensive. 6. Uses monochrome or beam-penetration type. 7. It draws a continuous and smooth line. 8. Editing is easy. 9. Refresh rate depends directly on picture complexity. 10. Scan conversion is not required.	1. It has ability to display areas filled with solid colors or patterns. 2. Uses interlacing. 3. The beam is moved all over the screen one scan line at a time from top to bottom and then back to top. 4. Lower resolution. 5. Less expensive 6. Uses monochroma 7. It display mathematically smooth lines polygons and boundaries of curved primitives only by approximating then with pixel on the raster grid. 8. Editing is difficult. 9. Refresh rate independent of picture complexity. 10. Graphics primitives are specifics in terms of their end points and must be scan converted into their corresponding pixels in the frame buffer.

DIRECT-VIEW STORAGE TUBE

Both in the raster scan and random scan system the screen image is maintained (flicker free) by redrawing or refreshing the screen many times per second many times per second by cycling through the picture data stored in the refresh buffer.

A direct-view storage tube (DVST) gives the alternative method of maintaining the screen image. It uses the storage grid which stores the picture information as a charge distribution just behind the phosphor-coated screen. Figure shows the diagram of a DVST.



It consists of two electron guns:

a. Primary gun
b. Flood gun

A primary gun contains the picture pattern and flood gun keep the picture display.

There is no refresh buffer, the images are created by drawing vectors or line segments with a relatively slow-moving electron beam. The beam is planned not to produce directly on phosphor but on a fine wire mesh (called storage mesh) coated with dielectric and mounted just behind the screen. A pattern of positive charge is deposited on the grid, and this pattern is transferred to the phosphor coated screen by a continuous flood of electrons emanating from a separate flood gun.

The DVST contains also a second grid just behind the storage mesh, that is called **collector.** The main purpose of collector is to smooth out the follow of flood electrons. These electrons pass through the collector at short velocity and are attracted to the positively charged portions of the storage mesh but repelled

by the rest. Electrons not hold off by the storage mesh pass right through it and strike the phosphor.

In order to create the bright picture, energy of electrons can be controlled by maintaining the screen at high positive potential by means of voltage applied to him aluminium coating between the tube face and the phosphor.

Advantage of DVST

1. Refreshing of CRT is not required.
2. Because no refreshing required, complex pictures can be showed at very high resolution without flicker.
3. It has flat screen.

Disadvantage of DVST

1. They do not showed colors and are available with single level of line intensity.
2. Deleting needs removal of charge on the storage grid. Thus erasing and redrawing process takes several seconds.
3. Selective or part deleting of screen is not possible.
4. Delete screen produces unpleasant flash over the entire screen surface which prevents its use of dynamic graphics applications.
5. It has bad contrast as a result of the comparatively short accelerating potential applied to the flood electrons.
6. The presentation of DVST is some what inferior to the refresh CRT.

FLAT-PANEL DISPLAY

A number display methods are in use that is designed to reduce the depth of the CRT display caused by the length of the tube. These devices are known as *flat panel displays.* These types of flat panel displays commonly in use with

computer systems are **liquid crystal displays (LCD's), gas plasma displays (GPD's) and electroluminescent display (ELDs).**

The screen of flat panel displays made up of pairs of electrodes. Every pair of electrodes is used to generate one picture element.

It refers to a class of video devices that have reduced volume, weight and power requirements compared to a CRT. They are thinner than CRT and we can hang them on walls or wear them on our wrists. Current uses of these are in small TV monitors, calculators, laptop computers etc. there are two types of flat panel displays:

a. Emissive displays
b. Non-emissive displays

Emissive displays: It displays (emitters) are devices that convert electrical energy into light. Plasma panels, light emitting diodes are examples of displays.

Non-emissive displays: It displays optical outcome to translate sunlight or light from few other source into graphics pattern. The important example of it is to flat-panel display is a liquid crystal device (LCD).

LIQUID-CRYSTAL DISPLAY (LCD)

They are commonly used in small systems such a s calculators and portable laptop computers. It produce a picture by passing polarized light from the surroundings or from an internal light source through a liquid-crystal material that can be aligned to either block or transmit the light.

They were first discovered in the late 19th century by the Austrain botanist, Fredrich Reintzer, and the term "liquid crystal" itself was coined shortly afterwards by German physicist, Otto Lehmann.

They are almost transparent substances, exhibiting the properties of both solid and liquid matter.

It uses an electron gun to bombard electrons over a glass tube coated with phosphor, which glows when struck by the electron beam. While in LCDs, liquid crystals sandwiched between thin polarized sheets are used. This setup allows LCDs to be sleeker and less heavier than CRT. They consume 1/3rd of the power of CRT. They also emit lesser front of their PCs, then it's better to use LCD monitors. There is one small drawback in LCD monitors. The viewing angle of most LCD monitors is only 160^{o}, so if we try to view the monitor from the sides, we may not be able to see anything.

INTERACTIVE DEVICES

KEYBOARD

It is primary input device for entering text and numbers. It is simple device consists of about 100 keys each of which sends different codes to the CPU. It was one of the first peripheral to be used with PCs, and it is still the most common. T hey are designed for the input of text and characters and also to control the operation of a computer.

Standard keyboards

The number of keyboard differs from the original standard of 101 keys to the 104 key windows keyboards. There are five pars of standard keyboard:

a. The alphanumeric keys
b. The numeric keypad
c. The function keys
d. Modifier keys
e. Cursor movement key

THE MOUSE

It functions as a pointing devices by detecting two-dimensional motion relative to its supporting surface can be used only with GUI (Graphical user interface) based operating system, e.g. Windows.

It is a small pointer-held box used to position the screen cursor. Another process for detecting mouse motion is with an optical sensor. It is moved over a special mouse pad that has a grid of horizontal and vertical lines. The optical sensor detects movement across the lines in the grid.

So types of mouse based on mechanism

1. Mechanical mouse
2. Optical mouse

It offers two main benefits. It lets us position the cursor anywhere on the screen quickly without using the cursor movement keys. We simply move the pointer to the on screen position we want and press the mouser button, the cursors appears at that position. Second, instead of forcing us to type or issue commands from the keyboard, the mouse-based operating systems let us choose commands fro easy to use menus and dialog box.

TRACKBALLS AND SPACEBALLS

It is a pointing device that works like an upside-down mouse. As the name implies, a trackball is a ball that can be rotated with the fingers or palm of the hand to produce screen cursor movement. The potentiometers attached to the trackball are used to measure the amount and direction of rotation. Because we do not move the whole device, a trackball requires less space than a mouse. Trackballs gained popularity with the advent of laptop computers, which typically

are used on laps or on small work surfaces that have no space for a mouse. Trackballs comes in different models.

It is a two dimensional positioning device whereas space ball provides six degree of freedom. Unlike the trackball, a space ball does not actually move. Strain gauges measure the amount of pressure applied to the space ball to provide input for spatial positioning and orientation as the ball is pushed or pulled in various directions. Space balls are used for three-dimensional positioning and selection operations in virtual-reality systems, modelling, animation, CAD and other applications.

TRACKPADS OR TOUCHPADS

It is a stationary pointing device that many people find less tiring to use than a mouse or trackball. The motion of a finger across a small touch-sensitive surface is translated into pointer movement on the computer screen.

JOYSTICK

Similar to the trackball and mouse, the joystick consists, or a vertical lever (called the stick) which can be swing around moving the cursor on the screen. Most joystick select screen positions with actual stick movement. Others respond to pressure on the stick.

The distance that the stick is moved in any direction from its centre position corresponds to screen cursor movement in that direction. Potentiometers mounted at the base of the joystick measure the amount of movement, and springs return the stick to the centre position when it is released.

In any joystick, optical sensors are used instead of analog potentiometer to read stick movement digitally. One of the biggest additions to the world of joysticks is force feedback technology. On using a force feedback (also called haptic

feedback) joystick if we are shooting a machine gun in an action game, the stick would vibrate in our hands or if we crashed our plane in a flight in an action game, the stick would vibrate in our hands or if we crashed our plane in a flight simulator, the stick would push back suddenly which means the stick moves in conjunction with on screen actions.

Joystick are often used to control games.

TOUCH-SCREEN

It is a computer display screen that is sensitive to human touch, allowing a user to interact with the computer by touching pictures or words on the screen.

- It accept input directly though the monitor.
- They use sensors to detect the touch of a finger. They are useful where environment conditions prohibit the use of a keyboard or mouse.
- They are useful for selecting options from menus.

Most touch-screen computers use sensors on the screen's surface to detect th touch of a finger, but other touch-screen technologies are in use, as well.

LIGHT PEN

It is pointing device shaped like a pen and is connected to the computer. The tip of the light pen contains a light-sensitive element (photoelectric cell) which, when placed against the screen, detects the light from the screen enabling the computer to identify the location of the pen on the screen.

Unlike other devices which have associated hardware to track the device and determine x and y values, the light pen needs software support (same kind of tracking program). A light pen can work with any CRT based monitor, but not with LCD screen, projectors or other display devices.

The light pen actually works by sensing the sudden small change in brightness of a point on the screen when the electron gun refreshers that spot. By noting exactly where the scanning has reached at that moment, the x, y position of the pen can be resolved. The pen position is updated on very refresh of the screen.

DATA GLOVE

It is an interface device that uses position tracking sensors and fiber optic strands running down each finger and connected to a compatible computer, the movement of the hand and fingers are displayed live on the computer monitor which in turn allows the user to virtually touch an object displayed in the same monitor. With the object animated it would appear that the user (wearing the data glove) can pick up an object and do things with it just as he would do with a real object. In modern data glove devices, tactile sensors are used to provide the amount of pressure or force the gingers or hands are exerting even though the user is not actually touching anything. Thus data glove is an agent to transport the user to virtual reality.

The input from the glove can be used to position or manipulate objects in a virtual scene. Thus by wearing the data glove a user can grasp, move and rotate objects and then release them.

VOICE SYSTEM

It is a sophisticated input device that accepts voice or speech input from the user and transforms it to digital data that can be used to trigger graphic operations or enter data in specific fields. Later when a voice command is given by the same operator, the systems searches for a frequency-pattern match in the dictionary and if found the corresponding action is triggered.

SCANNER

In computing, It is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image.

HARDCOPY DEVICES

Monitor display is good for the creation, checking and modification of image but for further analysis, design documentation and presentation purposes, hardcopy in the form of printed and plotted output on paper is an absolute necessity.

PRINT

It is an important accessory of any computer graphics system. Over the past decade, the variety of available printing devices has exploded, however three types of printers have become the most popular dot matrix, inkjet and loser. Within those three groups consumers have hundreds of options ranging widely in price and features.

a. Impact: There printers have a mechanism whereby formed character faces are pressed against an inked ribbon on the paper in order to create an image, e.g. dot matrix printer, line printer.

b. Non-impact: These printer do not touch the paper rather use laser techniques, ink sprays xerographic processes and electrostic methods to produce image on paper. For example laser printer, ink-jet printer, electrostatic printer, drum plotter, flatbed plotter etc.

c. Dot Matrix Printers: in the early year computing, dot matrix printers were the most commonly used printing devices. Dot matrix printers are popular in business and academic settings because they are relatively fast and inexpensive to operate and the do a good job of printing text and simply graphics.

A dot matrix printer creates an image by using a mechanism called a **print head,** which contains a cluster (or matrix) of shor t pins arranged in one or more columns. On receiving instructions from the PC, the printer can push any of the

pins out in any combination. By pushing out pins in various combinations the print head can create alphanumeric characters.

When pushed out from the cluster protruding pins ends strike a ribbon, which is held in place between the print head and the paper. When the pins strike the ribbon, they press ink from the ribbon onto the paper. The print head normally print along very raster row of the printer paper and the colour of print is the colour of the ink of the ribbon. Thus, a dot matrix printer forms a character by creating s series of dots.

The more pins that print head contains, the higher the printer's resolution. The lowest dot matrix printers have only 9 pins and the highest resolution printer have 24 pins.

The speed this is measured in characters per second (CPS). The slowest dot matrix printers create 50 to 70 characters per second and the fastest printer more than 500 cps.

Line printer: It is a special type of impact printer. It works like a dot matrix printer but uses a special wide print head that can print an entire line of text at one time.

The technology is usually both faster and less expensive than lesser printer. It has its use in medium volume accounting and other large business applications, where print volume and speed is a priority over quality. Line printers do not offer high resolution but are incredibly fast; the faster can print 3,000 lines of text per minute.

Band printers: It features a rotating band embossed with alphanumeric characters. To print a character, the machine rotates the band to the desired character, then a small hammer taps the band, pressing the character against a ribbon. Band printers are very fast and very robust. Depending on the character set used a good quality band printer can generate 2000 lines of text per minute.

Ink-Jet Printer: It is a non-impact printer that places extremely small droplets of ink into paper to create an image. The dots sprayed on paper are extremely small (usually between 50 and 60 microns in diameter) and are positioned very precisely with resolutions of up to 1440 × 720 dpi. The dots can have different colour combined together to create photo-quality image compared to laser printers, the operating cost of an ink-jet printer is relatively low. Many ink-jet printers use one cartridge for colour printing and a separate black only cartridge for black- and white printing. This feature saves money by reserving coloured ink only for colour printing.

The core of an inkjet printer is the print head that contain a series of nozzles that are used to spray drops of ink. The ink is contained in ink cartridges. A stepper motor moves the print head assembly (print head and ink cartridges) back and forth across the paper. The mechanical operation of the printer is controlled by a small circuit board containing a microprocessor and memory.

Colour inkjet printers have four ink nozzles: **Cyan (blue), magnetic (red), yellow and black.** For this reason, they are often known as CMYK printers. Notice that the colours are different from the primary additive colour (red, green and blue) used in monitors printed colour is the result of light source. Consequently, cyan, magneta, yellow and black are sometimes called subtractive colours and colour printing is sometimes called four-colour printing.

Laser Printer: As the name implies, a laser is at the heart of these printers. A CPU and memory are build into the printer to the printer to interpret the data that it receives from the computer and to control the laser. The result is a complicated piece of equipment that uses technology similar to that in photocopies.

As the electron gun in a monitor can target any pixel, the laser in a laser printer can aim at any point on a drum, creating an electrical charge. **Toner,** which is composed of small particles of ink, sticks to the drum in the places the laser has charged. With pressure and heat, the toner is moved off the drum onto the paper. The amount of memory that laser printers hold determines the speed at which documents are printed.

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