UNIT 2: GRAPHICS SYSTEM

UNIT STRUCTURE

2.1 Learning objectives

2.2 Introduction

2.3 Video display devices

2.4 Cathode ray tubes

2.5 Raster-scan displays

2.6 Random-scan displays

2.7 Colour - CRT Monitors

- 2.7.1 Beam penetration method
- 2.7.2 Shadow mask method

2.8 Flat panel displays

- 2.8.1 Plasma panel display device
- 2.8.2 Liquid Crystal Displays (LCD)
- 2.8.3 Electroluminescent displays

2.9 Graphics Software

- 2.9.1 GKS
- 2.9.2 PHIGS

2.10 Let Us Sum Up

2.11 Further Reading

2.12 Answer to Check Your Progress

2.13 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Cite the fundamentals of a graphics system
- Recognise video display devices
- Describe the working principle of CRT
- List the types of display devices
- Outline the working principle of Random and Raster scan display
- Describe how liquid crystals are used in the display device

- Recite the concept of plasma and its use in display devices.
- List different software used in computer graphics

2.2 INTRODUCTION

In the previous unit we have discussed about the definition and concept of computer graphics. Now in this unit we are going to introduce you to graphic systems. Graphics systems are used to create an image or a picture in the form of pixels drawn on the computer screen and manipulate the same. All around the world, computer graphics are used in almost all fields such as film, text documents, entertainment, photography, animation electronic gadgets, satellite imaging, scientific graphics, engineering drawings, business presentations, cartoons and artwork, simulation and modelling, GUI, etc. To enhance usability a broad range of hardware and software components are now available in the market. Two-dimensional and three-dimensional viewing is now common to almost all computers. In this chapter, we will discuss different graphics system, their features, working principle, architectures, and some of the popular and useful software packages. The next unit will be on Line drawing algorithm.

2.3 VIDEO DISPLAY DEVICES

The core hardware component of a computer graphics system is an output device. Primarily a video monitor is used by most computer graphics systems. Nowadays different types of video monitors are available such as - CRT and flat panel displays.

2.4 CATHODE-RAY TUBES

A cathode-ray tube (CRT) consists of a beam of electrons, an electron gun, control grids for controlling the deflection of the electron beam, and focused and directed the beam towards a specific location on the phosphor-coated screen of the device. When the emitted electron from the electron beam hit the phosphor-coated screen, the phosphor emits a tiny

spot of light for a moment. The light spots create a desirable picture on the screen. The light emitted by the phosphor atoms fades very rapidly. To maintain the durability of the light spot and the screen picture, some additional techniques are used. One of the popular techniques is redrawing the picture repeatedly by redirecting the electron beam on the phosphor-coated screen. The rate of regeneration or repainting of the screen picture is 75 times per second. This type of CRT is known as refresh CRT. Figure 1 depicts a typical design of a Cathode Ray Tube.

The electron gun consists of a heating filament with a heated metal cathode. When an electric current is supplied through the heating filament, it produces heat. Due to the heat generated by the filament, the negatively charged electrons of the cathode surface will be boiled off and emitted from it in a scattered manner. Applying a high positive voltage through the control grid, the scattered negatively charged electrons are directed and accelerated towards the phosphor-coated screen. The positively charged metal coating accelerator is placed within the CRT envelope near the phosphor-coated screen. In most CRTs, the control mechanism and the focusing grids are assembled within the same unit.

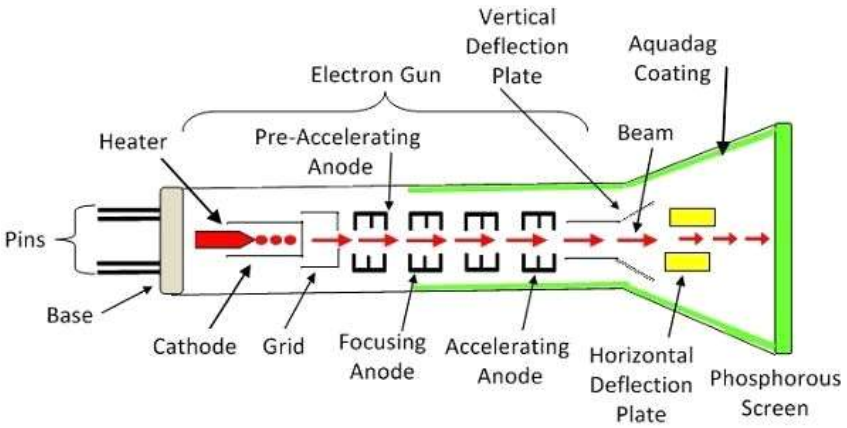


Figure 1: Cathode Ray Tube (Source: Internet)

The control grid fits over the cathode and are generally supplied with a negative voltage. By controlling the control grid voltages, the intensity of the electron beam can be controlled. The application of a high negative voltage in the control grid can repel the emitted electron from the cathode

surface and stop the electron beam from passing through the small hole at the end of the control grid towards the phosphor-coated screen. Thus by applying a low amount of negative charge on the control grid, a less number of electrons can allow passing through the hole and hit the phosphor-coated screen. The production of the light spot on the phosphor-coated screen is dependent on the number of hits made by the electrons, so by controlling the number of electrons in the beam by varying the supplied voltage into the control grid, the brightness of the display screen can be controlled. Specification of the intensity level for individual screen positions can be done through graphics software commands.

The deflection of the electron beam can be controlled by applying electric or magnetic fields. The outside of the CRT neck is mounted with magnetic deflection coils, each pair are opposite to the other. The magnetic field produced by the deflection coils results in a traverse deflection force that is perpendicular both to the direction of the magnetic field and to the direction of the travel of the electron beam. One pair of deflection coils is responsible for horizontal deflection and the other is for vertical deflection. By controlling the current supply to the deflection coil, proper deflection can be achieved.

The spot in the phosphor-coated screen is produced due to the transfer of kinetic energy of the electron beam to the phosphor. During the collision of an electron with the phosphor atom, the static phosphor atoms absorb the kinetic energy from the electron beam. A small part of the beam energy transfers to heat energy due to friction, and the remaining amount excited the outer shell electrons to move up towards the higher energy levels. But the excited or the unstable electron cannot stay at a higher energy level for a long time. After a moment it starts dropping back to its original energy band i.e. the stable ground state, by releasing the extra amount of energy in the form of a small quantum of light energy. A set of such bright spots can be visualized as a picture or an image from the front of the display screen.

For CRT, different phosphors with the colour variant are available. The persistency of the phosphor is quite good, due to which the bright spot

can be visualized after removing the electron beam also. Generally, the persistency of phosphors used in graphics systems ranges between 10 to 60 microseconds. The number of spots per centimeter that can be plotted horizontally and vertically is known as the resolution of the graphics system. For high-quality graphics, CRT has a resolution of 1280x1024. To produce equal length lines on the display screen a ratio is used known as aspect ratio, which gives the number of pixels in both the direction, vertical and horizontal. Aspect ratio 2/3 means that a vertical line plotted with two points is equal in length to a horizontal line plotted with three points.

2.5 RASTER SCAN DISPLAYS

Raster scan display is the most common type of graphics monitor used in CRTs. In a raster scan display, the electron beam is swept across the phosphor-coated screen from left to right horizontally, one line at a time, and vertically from the right end to the left end for switch into the next row as shown in figure 2. The return to the left end of the screen, after refreshing each row is known as a horizontal retraceof the electron beam. The rows are termed the scan lines. After completion of traversing each scan line, the electron beam returns to the left top corner of the screen to begin the next frame, which is known as the vertical retrace. The electron beam illuminates the dots in the desired pattern on the display screen by the switch on or off the beam intensity. The pattern or the information about the displayed image or the picture definition is stored in a memory area known as the frame buffer or refresh buffer. The frame buffer holds the intensity values for all points on the display screen. During the display of the image, the intensity of each screen point is retrieved from the refresh buffer and illuminated on the screen one scan line at a time. Each of the screen points is defined as a pixel or a picture element. The intensity or the information regarding each pixel of a screen is stored in the frame buffer. Home television systems are a good example of raster scan displays. Depending on the system capability the intensity range may differ. For a black and white screen, the intensity value will be either on or off. That is

the intensity for a pixel can be set by one bit of information, 1 for the beam intensityto be on and 0 for the beam intensity to be off. So for a bi-level system, using one bit of information the intensity of a pixel can be controlled. To achieve intensity variations or different colours on the display screen more bits can be used against each pixel definition. The frame buffer used to store bits of information regarding a black and white display device is known as a bitmap. Nowadays 24 bits per pixel are used in high-definition display devices to obtain multiple colours. The frame buffer used to store information regarding a multi-colour display device is known as a pixmap. The storage capacity for high-quality multicolour display devices can be up to several megabytes. The refreshing rate of a raster scan display ranges between 60 to 80 frames per second. The refresh rate is measured in Hz, i.e. Number of frames per clock cycle.

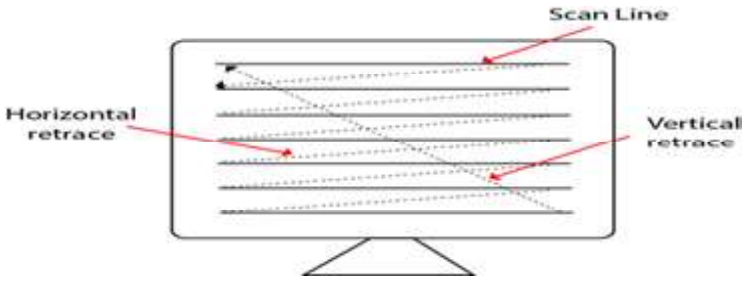


Figure 2: Scan lines in Raster scan display

2.6 RANDOM-SCAN DISPLAYS

In the case of a random-scan display, the electron beam is directed towards the part of the screen or dots on the display screen where the picture has to be drawn. Traversal of the electron beam during scan line conversion in a random scan display is shown in figure 3. The visual elements or the required picture elements are drawn one line at a time by random scan-display devices, due to which are also known as vector displays. The refresh rate depends on the number of lines to be drawn. A memory section known as the refresh display file stores the line drawing instructions or the picture definition.

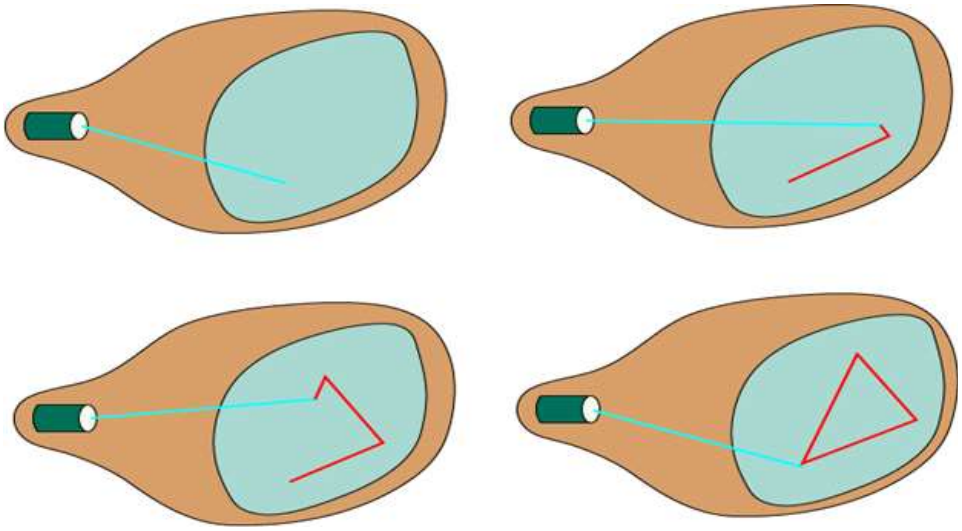


Figure 1: Random scan display (Source: Internet)

The memory area is also known as the refresh buffer. Through these specified line commands, the required picture element is drawn on the display screen. After completion of drawing all the picture elements, the electron beam returns to the first line command of the refresh buffer. This process of drawing the picture elements is repeated 30 to 60 times per second. Thus the refresh rate of the random-scan displays is 30 to 60 times per second or 30Hz to 60Hz. More than 60 times of refresh rate can lead to the burning of the phosphor atoms.

Random scan displays are better for line sketching than realistic visuals. This type of system stores the line drawing instructions rather than all points of the display screen. That is the refresh buffer does not store the intensity values for all the screen points. Thus the random-scan display or the vector display shows better resolution than a raster-scan display and produced smooth lines as the electron beam directly follows the line path. In comparison to a random scan, the raster-scan display generates jagged lines, which are plotted as discrete points.

2.7 COLOUR - CRT MONITORS

Different phosphor atoms are there, which can emit different colours. Combining more than one such phosphor atom, coloured pictures can be generated by CRT monitors. A variety of colours can be created by mixing

the emitted lights with coloured phosphor atoms.The beam penetration and the shadow mask method are the two most used ways to create coloured displays.

2.7.1 The Beam Penetration Method

To produce coloured pictures, the beam penetration method is used by the random-scan monitors. The phosphor-coated screen consists of two layers - red and green. The outer layer is red and the inner layer of phosphor coating is green. The colour of the display screen depends on the intensity of the electron beam, i.e. how far the beam can penetrate. A low-intensity electron beam can penetrate only the outer red layer, i.e. low-intensity beam can excite the phosphor atoms from the red layer. Thus a red spot can be visualized from the front of the display screen. If the electron beam accelerates toward the screen at high speed, the beam will penetrate through the red light layer and green light is emitted. For the intermediate speed of the electron beam, combinations of red and green lights are emitted to obtain multiple colours such as orange and yellow. The intensity of the electron beam can be controlled by applying different voltages at controlled grids. Thus the colour produced at different pixel positions can be controlled by the line instruction stored in the refresh buffer. The beam penetration is an inexpensive way to generate coloured pictures in random-scan monitors. Here only four colours for a pixel is possible to produce.

2.7.2 The Shadow Mask Method

Random-scan displays used the shadow-mask method to achieve multiple colours than the beam penetration method. In this method, each pixel point consists of three phosphor atoms - red, green, and blue. Each of these phosphor dots can emit light of their corresponding colour, i.e. red phosphor emits red light, the green phosphor emits green light, and the blue phosphor emits blue light.

To hit three different phosphor atoms within one pixel, three electron gun is used, one for each colour dot. Just behind the phosphor-coated screen, a shadow mask grid is used.A delta-delta shadow mask approach, which is often employed in shadow-mask systems, is depicted in figure 4.

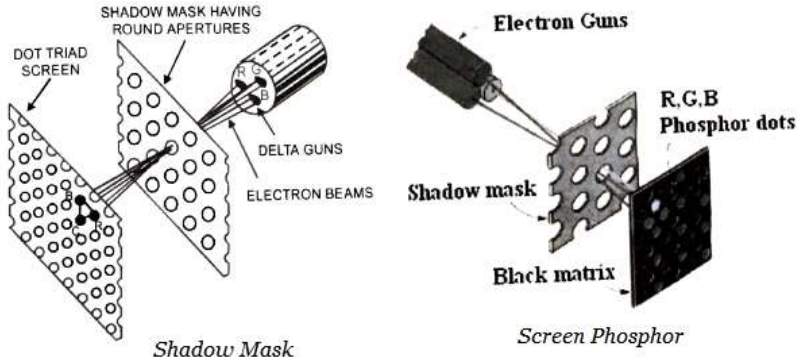


Figure 1: Depicts the structure of a shadow mask and its position (Source: Internet)

The shadow-mask grid consists of a set of holes aligned with the phosphor dots pattern in the display screen. The electron beams emitted by the three electron guns are allowed to focus on the shadow mask as a whole. The three beams trigger a dotted triangle on the display screen when they pass through a mask hole. The phosphor dots are arranged in such a way that a colour gun can activate the corresponding colour dot only. In another arrangement, the electron guns are arranged in an in-line pattern, and the three coloured phosphor atoms are also arranged in one scan line instead of in a triangular. The in-line arrangement is comparatively easy to implement and widely used in most high-resolution colour CRTs.



EXERCISE

Question1: Draw a diagram of Cathode Ray Tube and explain the functionalities of each component.

Question2: Explain the phenomenon, how light produced on a phosphor-coated screen.

Question3: Explain how colour images can display on a phosphor-coated screen.

Controlling the beam intensity level, a wide range of colour can be experienced in a shadow-mask CRT. If the switch of the blue and red gun is turned off, only the green electron gun will hit the green phosphor to produce green light on the screen. To make a small spot for each pixel position, different beam intensities can be used, because our eyes prefer to combine the three separate colours into one. By exciting the three phosphor atoms of red, green, and blue with different energy levels, different colour spots can be produced. If the three dots are excited equally, white or gray colour spots will be visible. Yellow spots can be produced by hitting the red and green phosphor dots of a pixel with equal intensities. Similarly, the equal intensity of blue and red phosphor produces a magenta colour; cyan can be produced by combining the blue and green colours. Using these three electron guns and three colours of phosphor atoms, at most eight colours can be produced. Some of the more sophisticated systems can produce millions of colours by controlling the beam intensity to some intermediate level. The control information regarding the beam intensity levels is stored in the refresh buffer. High-quality computer graphics systems use 24 bits per pixel to represent beam intensity levels by allowing 224 voltage settings for each electron gun. Using 24 bits approximately 17 million colours can be generated for a pixel. The system uses 24 bits per pixel and is known as **true-colour system** or **full-colour system.**



CHECK YOUR PROGRESS

Q 1: Define Computer graphics.

Q 2: Define Random and Raster scan displays?

Q 3: What is resolution?

Q 4: What is a frame buffer?

Q 5: What is Vertical Retrace of the Electron Beam?

2.8 FLAT PANEL DISPLAYS

CRT monitors are now replaced by some new technology such as flat-panel displays.In comparison to CRT monitors, flat-panel displays are flat and compact, require less power, and have a smaller volume and weight. Due to their thin and lightweight characteristics, flat-panel displays can hang on walls or wear them in our hands. Nowadays flat-panel displays are used in different electronic instruments such as calculators, television, smart-watch, mobile phone, laptop, different monitors, touch screen devices, etc. The flat panel displays can be categorized into two categories: emissive and non-emissive flat panel displays.

Emissive displays convert electrical energy into light energy, and in the case of non-emissive displays, optical effects were employed to turn sunshine or light from another source into graphical patterns. Some emissive displays are plasma panels, thin-film electroluminescent displays, and Light-emitting diodes (LED). Liquid crystal displays are an example of mostly used and popular non-emissive displays.

Flat CRT is also available, where the electron beams are accelerated parallelly to the display screen and deflected by 900 to the screen. Flat CRTs are not used for a long period because of heat generation and more power consumption characteristics.

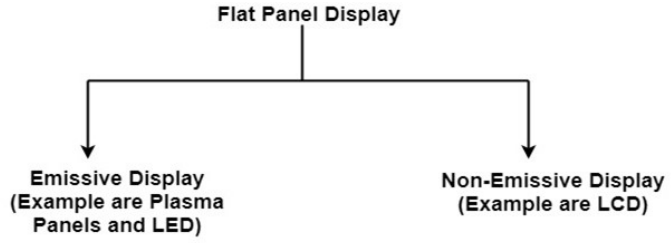


Figure 1: Categories of Flat Panel Display

2.8.1 Plasma Panel Display Device

In the plasma panel display, an amount of mixture of gas particles is sandwiched between two glass plates. Usually, neon gas is used for this purpose. Plasma panel display is also known as gas-

discharge displays because gas-particle are used to illuminate the spots on the display screen. In one glass panel, a series of conducting materials is attached vertically, and a series of conducting materials are attached horizontally in another glass panel as shown in figure 7. Applying firing voltages to these vertical and horizontal conducting ribbons, the gas-particle in the intersection region of the two conductor series can break down into glowing plasma of electrons and ions.

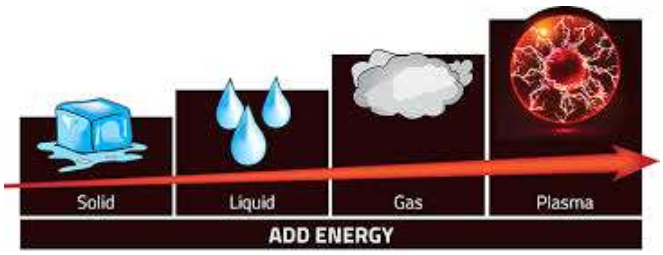


Figure 1: Different state of matter including Plasma
(Source: Internet)

Plasma can be defined as the fourth state of matter. When the gas particles are heated, it turns into plasma, which is a group of positively charged particles (ions) and negatively charged particles (electrons). Plasma is a superheated substance that has had its electrons ripped from its atoms, resulting in an ionized gas. It makes up more than 99% of the visible universe. Plasma glows in the night sky as stars, nebulas, and even auroras occasionally ripple over the north and south poles. Because plasma makes up so much of the universe, scientists from all fields are fascinated by its behaviour and qualities. Importantly, all matter is in the form of plasma at the temperatures required for viable fusion energy.

The refresh buffer stores the picture definition, and the firing voltage is used to refresh the pixel positions 60 times per second.AC voltage is employed to providea faster application of firing voltage and a brighter display.Plasma displays used to be monochromatic, however, newer systems can now display colours and grayscale as well.

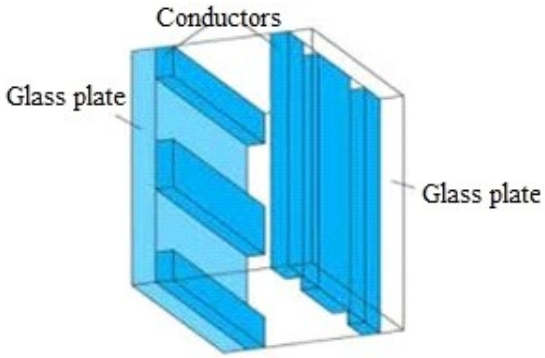


Figure 1: Design of a plasma panel display device

2.8.2 Thin-Film Electroluminescent Display

The thin-film luminescent display is also similar to the plasma panel display. The only difference is that in between the glass plates phosphor such as zinc-sulfide doped with manganese is used instead of gas to produce light spots as shown in figure 8. When sufficiently high voltages are applied to the vertical and horizontal conducting electrodes, the phosphor becomes a conductor in the area of the intersecting points of the two electrodes. When electrical energy passes through the phosphor, the manganese atoms absorbed electrical energy and jump to a higher energy state. Within a moment, the manganese atom releases the extra amount of energy in the form of light and creates the light spots which are similar to the glowing plasma. The thin-film electroluminescent displays consume more power in comparison to the plasma panel displays and good colour and greyscale are difficult to achieve.

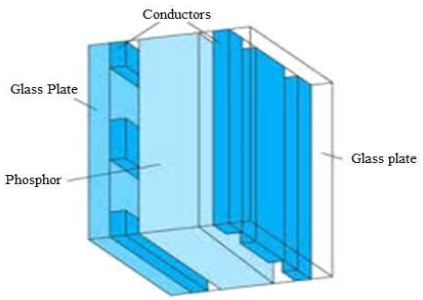


Figure 1: Basic design of thin-film electroluminescent display



EXERCISE

Question4: Draw a diagram of Plasma Panel Display and explain the functionalities of each component.

Question5: Explain the phenomenon, how light produced on a Plasma panel display.

Question6: Explain how colour images can display on a thin-film electroluminescent display.

2.8.3 Liquid-Crystal Display (LCD)

The molecules of a genuine liquid are in constant random motion; therefore their properties are uniform in all directions. The crystalline solids, in contrast, are anisotropic that is optical and other properties such as thermal and electrical conductivity vary with direction. A liquid crystal phase has many of the physical attributes of a liquid, but its molecular units are sufficiently ordered to give rise to some anisotropy, most notably in their optical properties. The properties of liquid crystals are:

- The appearance of liquid crystal phases is often hazy.
- Liquid crystals display birefringencedue to their anisotropy characteristics. That is, light entering the crystal is split into two oppositely polarised beams moving at different speeds.
- The molecules in a nematic phase (or "thread-like" crystal) are aligned in the same direction but free to move around freely, much like in a regular liquid.
- In smectic ("soap-like") phases the molecules are arranged in layers. with the long molecular axes approximately perpendicular to the laminar planes. The only long-range order extends along this axis, with the result that individual layers can slip over each other (hence the "soap-like" nature) like that observed in graphite. Within a layer, there is a certain amount of short-range order.

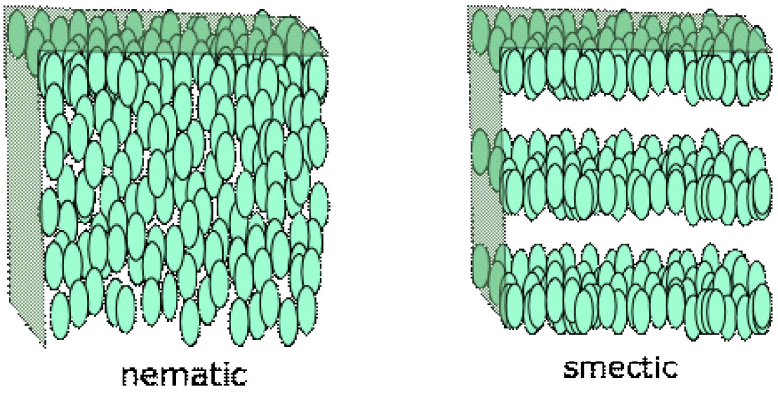


Figure 1: Illustrates the nematic and smectic structure of liquid crystal (Source: Internet)

Figure 9 illustrates the pattern of nematic and smectic liquid crystals. Unpolarized light can be defined as a light wave that is vibrating in more than one plane. The light emitted by the sun, by a lamp or a tube light are all unpolarised light sources. Polarized light can be defined as a light wave that vibrates in two dimensions only.In figure 10, it has shown that light beams coming from the source travel in a wave pattern.

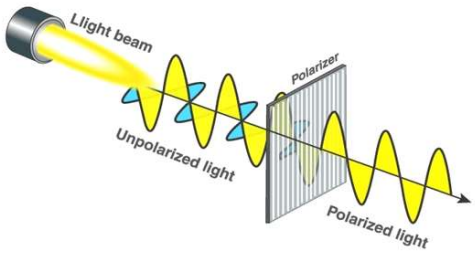


Figure 1: Illustrated the polarized and unpolarized light (Source: Internet)

The direction of the magnetic wave is directly perpendicular to the electric waves, and both the waves are perpendicular to the direction of the light beam. In the path of the light beam, a thin film or a light polarizer is placed. The polarizer reduced the dimensions of the light by stopping the wave signals travels in a particular direction. Thus the polarizer can be used as a light filter also. Liquid crystals show polarized characteristics. That is for some particular direction of the liquid crystals, it can be used as a good conductor of electricity, light, or heat. But changing the direction of the liquid crystals, the conductivity can be changed. In some particular

directions, the liquid crystals can show bad conductivity properties for light, electricity, and heat.

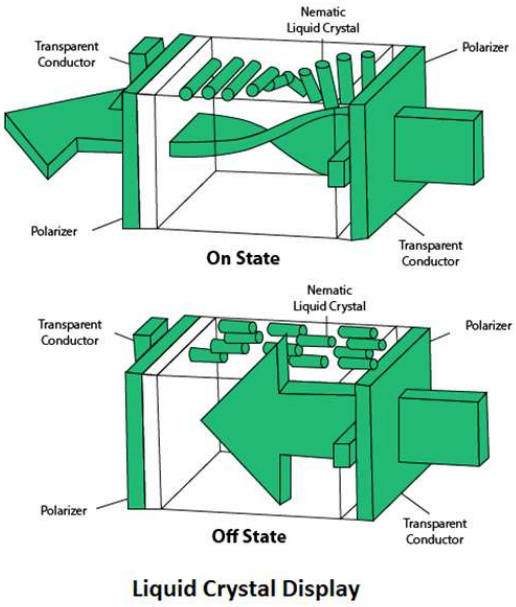


Figure 1 depicts the working principle of Liquid Crystal Display
(Source: Internet)

Suppose a horizontal polarizer can allow the horizontal light waves to pass through it, but it will stop the vertical light waves, i.e never allows the vertical light beam through a horizontal polarizer. Similarly, a vertical light polarizer allows only those light beams that vibrate in a vertical direction, and stop the horizontal waves as shown in figure 11.The term liquid-crystal refers to a crystalline arrangement of molecules that flows like liquids.Nematic or thread-like liquid crystal materials are extensively employed in LCDs. A flat panel display can be built using Nematic liquid crystal as shown in figure11. The architecture of a liquid crystal display consists of two glass plates containing light polarizers. The light polarizer of one plate is set at right angles to the other light polarizer associated with the other plate. The liquid crystal material is sandwiched between these two glass panels.One glass plate contains rows of horizontal transparent conductors, and Vertical conductor columns are inserted into the opposite plate. The pixel positions are defined by the intersection points of these two transparent conductors. The light passed through

the polarizer is twisted by the liquid crystals such that it can pass through the opposite polarizer. The state of the liquid crystals can be in two states: on or off state as shown in figure 3. The pixel spot can turn off by controlling the supplied voltage to align the liquid crystal direction, such that it cannot twist the light beam and such systems are known as passive-matrix LCD. If the light beam stops from its changing direction, it cannot pass through the polarizer. The viewer has received the light beam that has passed through the polarizer.The picture definitions are also kept in a refresh buffer, with a refresh rate of 60 frames per second.Because the light beam is generated by solid-state electricaldevices, the system is not entirely reliant on external light sources.Using thin-film transistor technology, LCDs may generate numerous colours by combining different materials or dyes and inserting a triad of colour pixels at each pixel position. In another method for constructing LCDs, transistors are employed to control the applied at each pixel position and to prevent voltage charge from leaking out of the liquid-crystal cells over time. These devices are known as active-matrix displays.



CHECK YOUR PROGRESS

Q 6. Differentiate Plasma Panel Display And Thin Film Electroluminescent Display?

Q 7. Write the merits and demerits of Plasma panel display.

Q 8. What do you mean by emissive and non-emissive displays?

Q 9. Explainthe characteristics of polarized light.

Q10. Define the term liquid crystal?

2.9 GRAPHICS SOFTWARE

2.9.1 GKS

The Graphical Kernel System (GKS) is an ISO specification that defines a standard interface for interactive computer graphics in

application programs.GKS was developed in 1977 by a group of specialists representing the national standards organizations of the world's most developed countries.The entire standard includes functional requirements for over 200 subroutines that conduct device-independent graphics input and output.Thus, application programs can easily port between different graphics devices and host computers. However, GKS is a kernel system, and is not portable. Individual GKS implementations will differ significantly since they must support various graphics devices on various systems. The layers of GKS are illustrated in figure 12. GKS never supports any graphics application software. These graphics software sit on top of the basic graphics packages. The GKS functions were created without reference to any particular programming language.In 1985, the Graphical Kernel System for two-dimensional graphics became an ISO standard. GKS functions are categorized into eight different classes such as control functions, output attributes, output primitives, segment functions, transformations, input functions, metafile functions, and inquiry functions.

Three basic parts of GKS are

- Casual presentation of the ingredients of the standards including how text is to be inserted, how polygonal zones are to be filled, and so on.
- An official description of the substances and conceptualize them in a separate functional explanation. Data like input/output parameters are contained in the functional explanations.
- The execution of abstract functions is accomplished using language bindings.

In GKS, some standard basic blocks are used to draw a picture which is known as primitives. To describe a picture, different primitives can be applied. The prime primitives used in the GKS system are:

- **Polyline:** is used to draw straight line segments providing the endpoint coordinates.

- **Poly-marker:** is used to put symbols like + * : *0*, andx against a particular coordinate.
- **Fill-area:** is used to draw polygons and fill the specified area
- **Text:** is used to add text or string at a specified coordinate.
- **Cell-array:** is used to show a colour or grayscale image at the specified location.

2.9.2 PHIGS

PHIGS (Programmer's Hierarchical Interactive Graphics Standard) is an interface between the graphics application software and the graphics subsystem. PHIGS is used to draw 2-dimensional or 3-dimensional images. It organizes visual elements in a hierarchical structure, allowing a whole assembly to be described along with all of its subassemblies. The PHIGS can be defined as a workstation that may be a single input device, a single output device or a combination of both the input and output devices, a file, a video monitor, etc.



CHECK YOUR PROGRESS

Q 11: Which of the following is a Computer Graphics type?

a) Raster and Vector
b) Raster and Scalar
c) Scalar only
d) All of the aboveQ12.List out the merits and demerits of Plasma panel display.

Q 12: Bitmap is a collection of _____ that describes an image.

a) pixels
b) algorithms
c) bits
d) colors

Q 13: Which of the following is commonly known as frame buffer on a black and white system with one bit per pixel?

a) Bitmap
b) Pix map
c) Multi map
d) All of the mentionedQ15. Define the term liquid crystal?

Q 14: What does an aspect ratio mean?

a) Ratio of vertical points to horizontal points
b) Ratio of vertical points to horizontal points and horizontal points to vertical points
c) Number of pixels
d) Ratio of horizontal points to vertical points



2.10 LET US SUM UP

- The core hardware component of a computer graphics system is an output device.
- Different types of video monitors are - CRT and flat panel displays.
- A cathode-ray tube (CRT) consists of a beam of electrons, an electron gun, control grids for controlling the deflection of the electron beam, and focused and directed the beam towardsa specific location on the phosphor-coated screen of the device.
- The refresh rate of CRT is 75 times per second.
- The electron gun consists of a heating filament with a heated metal cathode.
- Applying a high positive voltage through the control grid, the scattered negatively charged electrons are directed and accelerated towards the phosphor-coated screen.
- The control grids fit over the cathode and are generally supplied with a negative voltage.
- The production of the light spot on the phosphor-coated screen is dependent on the number of hits made by the electrons.
- The deflection of the electron beam can be controlled by applying electric or magnetic fields.

- By controlling the current supply to the deflection coil, proper deflection can be achieved.
- The persistency of phosphors used in graphics systems ranges between 10 to 60 microseconds.
- For high-quality graphics, CRT has a resolution of 1280x1024.
- To produce equal length lines on the display screen a ratio is used known as aspect ratio, which gives the number of pixels in both the direction, vertical and horizontal.
- The return to the left end of the screen, after refreshing each row is known as a horizontal retraceof the electron beam.
- The electron beam returns to the left top corner of the screen to begin the next frame, which is known as the vertical retrace.
- Picture definition is stored in a memory area known as the frame buffer or refresh buffer.
- The frame buffer used to store bits of information regarding a black and white display device is known as a bitmap.
- The frame buffer used to store information regarding a multi-colour display device is known as a pixmap.
- The visual elements or the required picture elements are drawn one line at a time by random scan-display devices, due to which are also known as vector displays.
- The refresh rate of the random-scan displays is 30 to 60 times per second
- The intensity of the electron beam can be controlled by applying different voltages at controlled grids.
- The Colour produced at different pixel positions can be controlled by the line instruction stored in the refresh buffer.
- The shadow-mask grid consists of a set of holes aligned with the phosphor dots pattern in the display screen.
- In a shadow mask method, yellow spots can be produced by hitting the red and green phosphor dots of a pixel with equal intensities.
- The flat panel displays can be categorized into two categories: emissive and non-emissive flat panel displays.

- In a Flat CRT, the electron beams are accelerated parallelly to the display screen and deflected by 900 to the screen
- In plasma panel display, AC voltage is employed to providea faster application of firing voltage and a brighter display.
- The thin-film electroluminescent displays consume more power in comparison to the plasma panel displays
- Liquid crystals show polarized characteristics
- The Graphical Kernel System (GKS) is an ISO specification that defines a standard interface for interactive computer graphics in application programs.



2.11 FURTHER READINGS

1) Book Name: COMPUTER GRAPHICS C Version, Authors: Donald D. Hearn, M. Pauline Baker, Publisher: PEARSON.
2) Book Name: Computer Graphics (Special Indian Edition), Authors: Zhigang Xiang, Publisher: Amer Media Intl - McGraw Hill audio



2.12 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Answers to the "Check your progress"section containing multiple-choice questions

11. a
12. a
13. a
14. b
15. a



2.13 MODEL QUESTIONS

Short Questions (Answer each question in around 150 words).

Q 1: What are the raster and vector graphics?

Q 2: Write the difference between vector and raster graphics?

Q 3: What is meant by scan code?

Q 4: Explain the necessity of Scan-Line conversion in computer graphics systems.

Q 5: What is meant by refreshing the screen?

Q 6: Write the merits and demerits of Beam Penetration techniques.

Q 7: What is persistence?

Q 8: What is the Aspect ratio of a computer graphics system?

Q 9: What is a dot size?

Q 10: Define pixel.

Q 11: What is a bitmap and what is a pixmap?

Q 12: What do you mean by scan conversion?

Q 13: What is an output primitive?

Q 14: Write the two techniques for producing colour displays with A CRT?

Q 15: Explain the working principles of plasma panel display.

Q 16: Explain the working principles of Thin-Film Electroluminescent display.

Q 17: Explain the working principles of Liquid Crystal display.

Q 18: Explain how the total number of colour combinations of a pixel can be determined in a computer graphics system.

Q 19: Explain the use of GKS in a graphics system. What are the prime primitives included in GKS?

Q 20: Write a short note on computer graphics software and PHIGS.

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