Chapter One

Basics of Computer Graphics

Introduction of Computer Graphics.

Definition of Computer Graphics.

Advantages and Disadvantages of ComputerGraphics.

Why Computer Graphics Used?

Applications of Computer Graphics.

Elements of Pictures Created in Computer Graphics.

Raster Graphics.

Display Screens.

Screen Clarity.

Chapter One

Basics of Computer Graphics

1.1 Introduction of Computer Graphics

Computer graphics necessitates the use of technology. The Process transforms and presents information in a visual form. The role of computer graphics insensible. In today life, computer graphics has now become a common element in user interfaces, T.V commercial motion pictures.

Computer Graphics is the creation of pictures with the help of a computer. The product of the computer graphics is a picture it may be a business graph, drawing, and engineering.

In computer graphics, two or three-dimensional pictures can be created that are used for research. Many hardware devices algorithm has been developing for improving the speed of picture generation with the passes of time. It includes the creation storage of models and image of objects. These models for various fields like engineering, mathematical and so on.

Today computer graphics is entirely different from the earlier one. It is an interactive user can control the structure of an object of various input devices such as (keyboard, mouse, joystick,..etc).

1.2 Definition of Computer Graphics

Computer Graphics is an art of drawing pictures, lines, charts, etc….. using computers with the help of programming computer graphics image is made up of number of pixels. **Pixel** is an abbreviation of (picture element) is the smallest addressable graphical unit represented on the computer screen. Computer graphics also are essential to scientific visualization, a discipline that uses images and colors to model complex phenomena such as air currents and electric fields, and to computer-aided engineering and design, in which objects are drawn and analyzed in computer programs.

"Computer graphics" also refers to the tools used to make such pictures. There are both **hardware** and **software** tools. ***Hardware*** tools include video monitors and printers that display graphics, as well as input devices like a mouse or trackball that let a user point to items and draw figures. The computer itself, of course, is a hardware tool, along with its special circuitry to facilitate graphical display or image capture.

As for ***software*** tools, familiar with the usual ones: the operating system, editor, compiler, and debugger that are found in any programming environment. For graphics, there must also be a

collection of "graphics routines" that produce the pictures themselves.

1.3 Advantages and Disadvantages of Computer Graphics

The main advantages of computer graphics are as follows: -

1. Usability:- Graphical techniques offer more flexible and options compared to other traditional methods in design. One can make changes and undo them without tampering with the whole design. It is also possible to view a model from different angles by rotating it along various axes. One can also perfect on minute details of a design by magnifying it to see them clearly.

2. Research and Product Development:-Graphical representation software contributes much in research. Models can be presented in three dimensions giving researchers a broader picture of how natural phenomena operate. In engineering, presentation of models in three-dimensional manner enables engineers to identify weaknesses in structures and areas of possible improvement.

3. Time:- Computer aided design on the other hand involves designing of a graphical presentation of a virtual model. Tests are then done on the model using special software. This saves not only

time, but also other resources that would have been used in testing the real structure, hence the cost of production.

4. Design: - Advertising is an important aspect in the business world. Customers respond to product or service depending on how it presented to them.

The main **disadvantages** of computer graphics are as follows:-

1. Complexity: - A majority of complex graphical system applications requires prior training before use. Some of the graphics applications are so complex that they need an expert to install and customize the settings.

2. Limitations:- Like all other computerized systems, graphical system lack the intelligence of understanding real world conditions and principles like the purpose of the structure it is designing. The designer has to figure out a way of obtaining the relevant results while maintaining the objective of the design process.

1.4 Why Computer Graphics Used?

Computer graphics is responsible for displaying art and image data effectively and meaningfully to the consumer. It also used for processing image data received from the physical world, such as photo and video content.

Suppose a shoe manufacturing company want to show the sale of shoes for five years. For this vast amount of information is to store. So a lot of time and memory will needed. This method will be tough to understand by a common person. In this situation graphics is a better alternative. Graphics tools are charts and graphs. Using graphs, data can represented in pictorial form. A picture can be understood easily just with a single look.

Interactive computer graphics work using the concept of two-way communication between computer users. The computer will receive signals from the input device, and the picture modified accordingly. Picture will changed quickly when we apply command figure 1.1 show computer graphics Used.

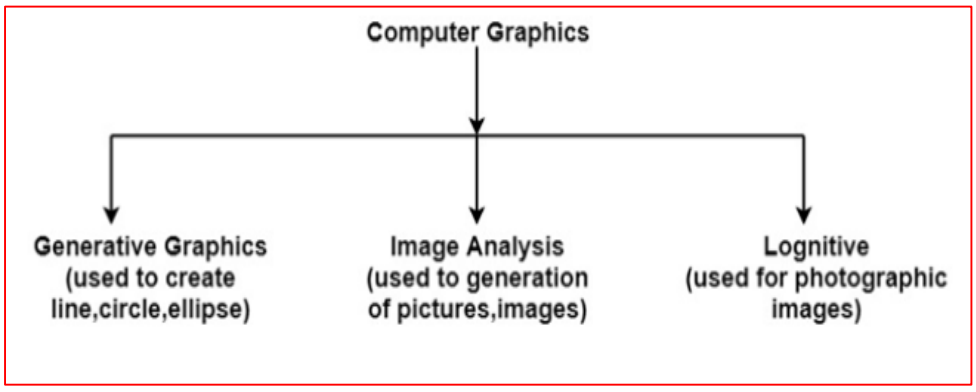

Figure 1.1 Computer Graphics Used

1.5 Applications of Computer Graphics

Computer graphics deals with creation, manipulation and storage of different type of images and objects, some of the applications of computer graphics are:

1. Computer Art: Using computer graphics we can create one and commercial art which include animation packages, paint packages. These packages provide facilities for designing object shapes and specifying object motion. Cartoon drawing, paintings, logo design can also be done.

2. Computer Aided Drawing: Designing of buildings, automobile, aircraft is done with the help of computer-aided drawing, this helps in providing minute details to the drawing and producing more accurate and sharp drawings with better specifications.

3. Presentation Graphics: For the preparation of reports or summarizing the financial, statistical, mathematical, scientific, economic data for research reports, managerial reports, moreover, creation of bar graphs, pie charts.

4. Education: Computer generated models are extremely useful for teaching huge number of concepts and fundamentals in an easy to understand and learn manner. Using computer graphics many educational models can created through which more interest can generated among the students regarding the subject.

5. Training: Specialized system for training as simulators can used for training the candidates in a way that can grasped in a short span of time with better understanding. Creation of training modules using computer graphics is simple and very useful.

6. Animation software: Enables you to chain and sequence a series of images to simulate movement. Each image is like a frame in a movie. It can defined as a simulation of movement created by displaying a series of pictures, or frames. A cartoon on television is one example of animation.

7. Image Processing: Various kinds of photographs or images require editing in order to use in different places. Processing of existing images into refined ones for better interpretation is one of the many applications.

8. Graphical User Interface: The use of pictures, images, icons, pop-up menus, graphical objects help in creating a user-friendly environment where working is easy and pleasant, using computer graphics we can create such an atmosphere where everything can be automated and anyone can get the desired action performed in an easy fashion.

9. Virtual –Reality Environments: a more recent application of computer graphics is in the creation of Virtual –Reality Environments in which a user can interact with the objects in a three-dimensional scene. Figure 1.2 show the Virtual -Reality

Figure 1.2 Virtual -Reality

10. Entertainment: Television production, motion picture, and music videos routinely use computer graphics method.

These are some of the applications of computer graphics due to which it's popularity has increased to a huge extend and will keep on increasing with the progress in technology.

1.6 Elements of Pictures Created in Computer Graphics

What makes up a computer drawn picture? The basic objects out of which such pictures are composed are called output primitives. One useful categorization of these is:

- Polylines
- Text
- Filled Regions
- Raster images

1. Polylines

A polyline is a connected sequence of straight lines. When there are several lines in a polyline, each one called an edge, and two adjacent lines meet at a vertex. In Figure 1.3, we see an Example of Edge and Vertex.

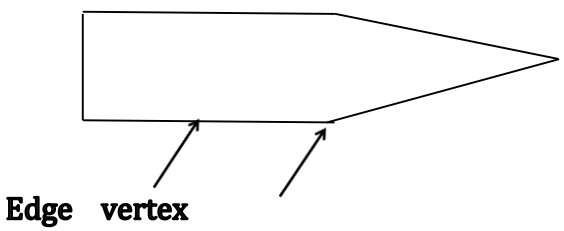

Figure 1.3 Example of Edge and Vertex.

A polyline need not form a closed figure, but if the first and last points are connected by an edge, the polyline is a polygon. The Figure 1.4 show Examples of polygons.

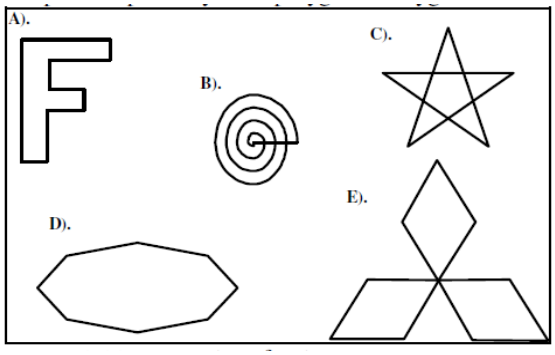

Figure 1.4 Examples of polygons.

For instance, the polyline shown in Figure 1.5 is given by the sequence (2, 4), (2, 11), (6, 14), (12, 11),(12, 4), ... (what are the remaining vertices in this polyline?).

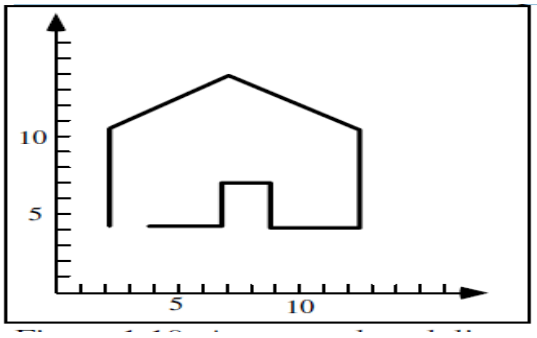

Figure 1.5 An example polyline.

Attributes of Lines and Polylines

The attributes of a graphic primitive are the characteristics that affect how it appears, and some important attributes of a polyline are the color and thickness of its edges, the manner in which the edges are dashed, and the manner in which thick edges blend together at their endpoints. Typically, all of the edges of a polyline are given the same attributes. Figure 1.6 show the line type.

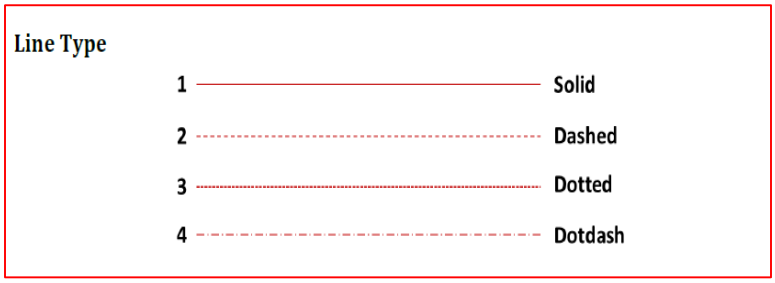

Figure 1.6 The Line Type.

2. Text

Some graphics devices have two distinct display modes, a text mode and a graphics mode. The text mode is used for simple input/output of characters to control the operating system or edit the code in a program.

Text displayed in this mode uses a built-in character generator. The character generator is capable of drawing alphabetic, numeric, and

punctuation characters, and some selection of special symbols such as ð and ⊕.

Compare with the graphic mode, the PC's text mode is easy to use. Displaying information on the screen is a simple as placing ASCII char in specific memory location. The text screen divided into 80 column and 25 rows. The graphic mode requires a completely different orientation instead of character; you have pixels, the smallest picture element on your computer display. Today most screens can display text and graphics.

Attributes of Text

There are many text attributes, the most important of which are typeface, color, size, spacing, and Orientation.

A font is a specific set of character shapes (a typeface) in a particular style and size.

3. Filled Regions

The filled region (sometimes called “fill area”) primitive is a shape filled with some color or pattern. The boundary of a filled region is often a polygon. In Figure 1.7, see Examples of filled Polygons and Figure 1.8 show Different Style of Area Filling

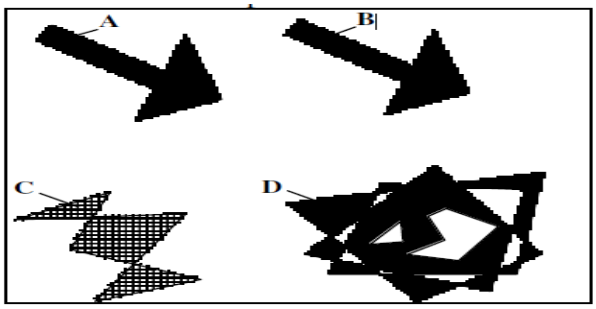

Figure 1.7 Examples of filled Polygons.

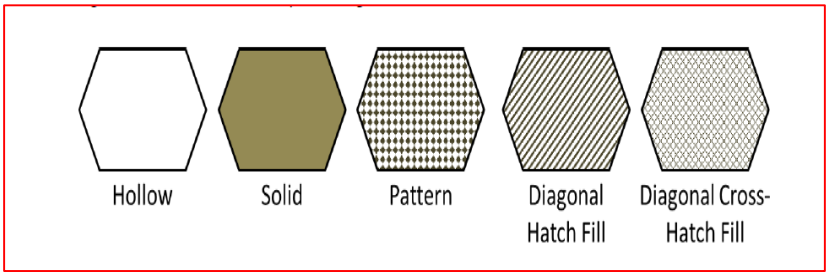

Figure 1.8 Different Style of Area Filling

4. Raster Image.

A raster image, It is made up of many small “cells”, in different shades of gray, The individual cells are often called “pixels” (short for “picture elements”). Normally your eye can’t see the individual cells, it blends them together and synthesizes an overall picture.

A raster image is stored in a computer as an array of numerical values. This array is thought of as being rectangular, with a certain number of rows and a certain number of columns. Each numerical value represents the value of the pixel stored there. The array as a whole is often called a “pixel map”. The term “bitmap” is also used.
A simple figure represented as a bitmap.

Figure 1.9a shows a simple example where a figure is represented by a 17 by 19 array (17 rows by 19columns) of cells in three shades of gray. Suppose the three gray levels are encoded as the values 1, 2, and 7. Figure 1.9b shows the numerical values of the pixel map for the upper-left 6 by 8 portion of the image.

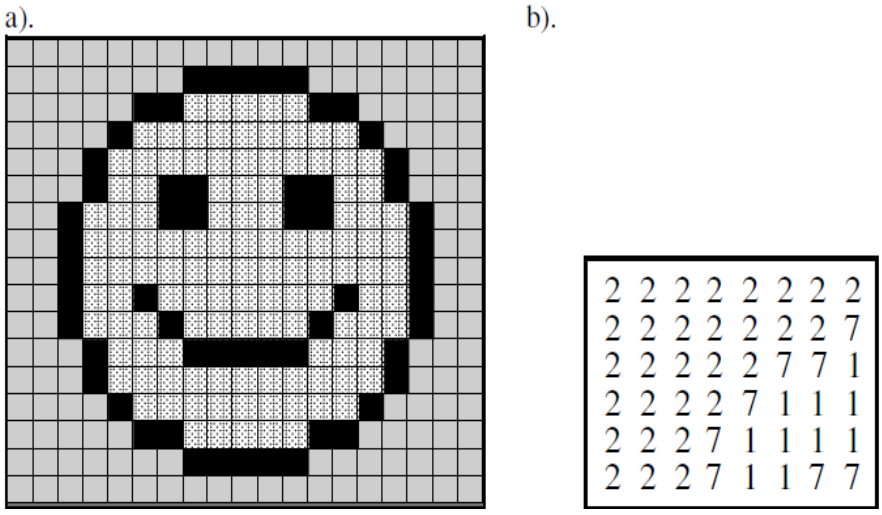

Figure 1.9 A simple figure represented as a bitmap.

How are raster images created?

The three principal sources are:

1. Hand designed images

A designer figures out what values are needed for each cell, and types them into memory. Sometimes a paint program can be used to help automate this: the designer can draw and manipulate various graphical shapes, viewing what has been made so far. When satisfied, the designer stores the result in a file.

2. Computed Images

An algorithm used to "render" a scene, which might be modeled abstractly in computer memory. As a simple example, a scene might consist of a single yellow smooth sphere illuminate by a light source that emanates orange light.

3. Scanned images.

A photograph or television image can digitized as described above. In effect, a grid is placed over the original image, and at each grid point, the digitizer reads into memory the "closest" color in its repertoire. The bitmap is then stored in a file for later use.

1.7 Raster Graphics

An image that is presented on the computer screen is made up of pixels. The screen consists of a rectangular grid of pixels, arranged in rows and columns. The pixels are small enough that they are not easy to see individually. In fact, for many very high-resolution displays, they become essentially invisible. At a given time, each pixel can show only one color. Most screens these days use 24-bit color, where a color can be specified by three 8-bit numbers, giving the levels of red, green, and blue in the color. Any color that can be shown on the screen is made up of some combination of these three "primary" colors. As we can see from Figure 1. 10 Graphical System.

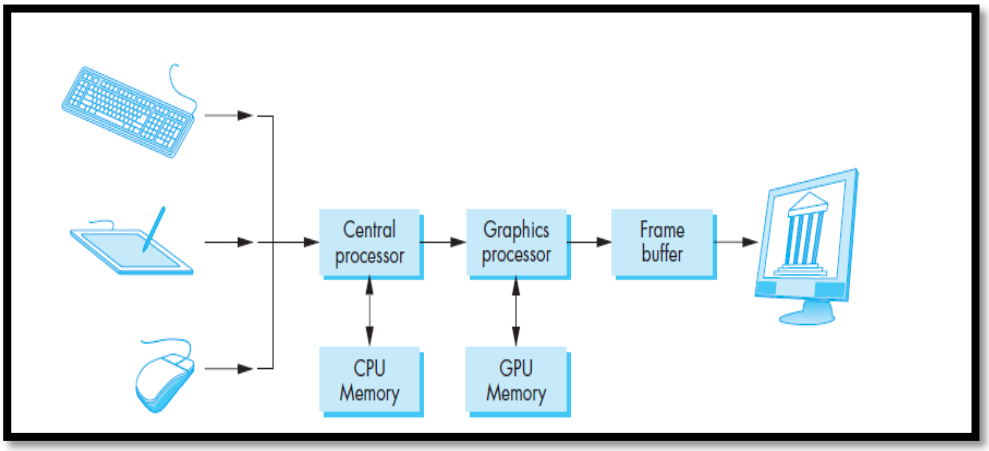

Figure 1. 10 Graphical System.

In any case, the color values for all the pixels on the screen are stored in a large block of memory known as a frame buffer. Changing the image on the screen requires changing color values that are stored in

the frame buffer. The screen is redrawn many times per second, so that almost immediately after the color values are changed in the frame buffer, the colors of the pixels on the screen will be changed to match, and the displayed image will change.

A computer screen used in this way is the basic model of raster graphics. The term “raster” technically refers to the mechanism used on older vacuum tube computer monitors: An electron beam would move along the rows of pixels, making them glow. The beam was moved across the screen by powerful magnets that would deflect the path of the electrons. The stronger the beam, the brighter the glow of the pixel, so the brightness of the pixels could be controlled by modulating the intensity of the electron beam. The color values stored in the frame buffer were used to determine the intensity of the electron beam. (For a color screen, each pixel had a red dot, a green dot, and a blue dot, which were separately illuminated by the beam.)

A modern flat-screen computer monitor is not a raster in the same sense. There is no moving electron beam. The mechanism that controls the colors of the pixels is different for different types of screen. But the screen is still made up of pixels, and the color values for all the pixels are still stored in a frame buffer. The idea of an image consisting of a grid of pixels, with numerical color values for each pixel, defines raster graphics.

1.8 Display Screens

Display screens are output devices that show programming instructions and data as they are being and information after it is processed, display screens are either CRT (Cathode-Ray-Tube) or Flat-panel display.

1. The Cathode Ray Tube (CRT) Display:

It contains tube of glass, with a big end represents the screen coated inside by phosphor layer, while the other end essentially contains the electronic gun and Deflection Coils. Figure 1. 11 show Cathode Ray Tube(CRT).

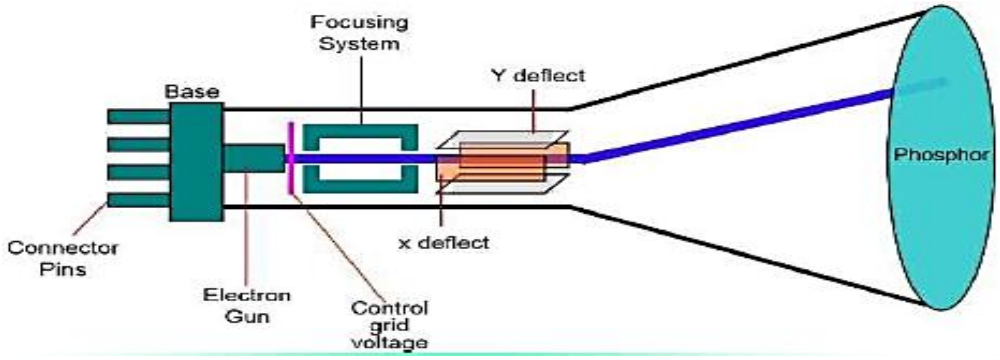

Figure 1. 11 Cathode Ray Tube (CRT).

The Electronic gun contains parts as follows:

1. Heating Element
2. Cathode
3. Control Grid
4. Acceleration Anode
5. Focusing Grid.

CRT based on the physical concept that the phosphor produce a light if its strike with Electrons have velocity and moment that affects the phosphor electron to speed and free to give the light.

CRT It is an evacuated glass tube with an inner side phosphor coated screen and the CRT works as follow:

1. The electron gun emits a beam of electrons (cathode rays).

2. The electron beam passes through focusing and deflection systems that direct it towards specified positions on the phosphor-coated screen.

3. When the beam hits the screen, the phosphor emits a small spot of light at each position contacted by the electron beam.

4. It redraws the picture by directing the electron beam back over the same screen points quickly.

There are two techniques used for producing images on the CRT screen:

1. Vector scan/Random Scan Display

It directly traces out only the desired lines on CRT based on equation stored at the computer memory. To draw a line between point p1 & p2 we directly drive the beam deflection circuitry, which focus beam directly from point p1 to p2. In Figure 1.12 we see the Architecture of a vector display

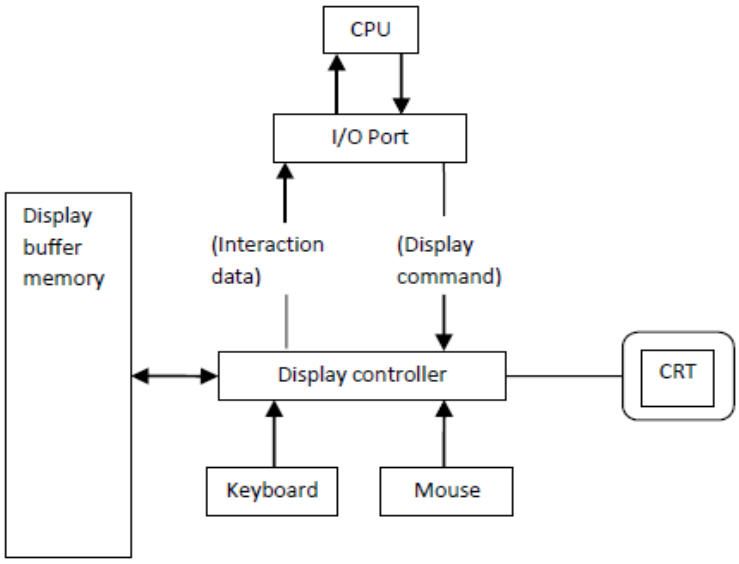

Figure 1.12 Architecture of a vector display

2. Raster Scan Display

The display image is stored in the form of 1's and 0's in the refresh buffer. The video controller reads this refresh buffer and produces the actual image on screen. It will scan one line at a time from top to bottom & then back to the top. Figure 1.13 show the Architecture of a raster display

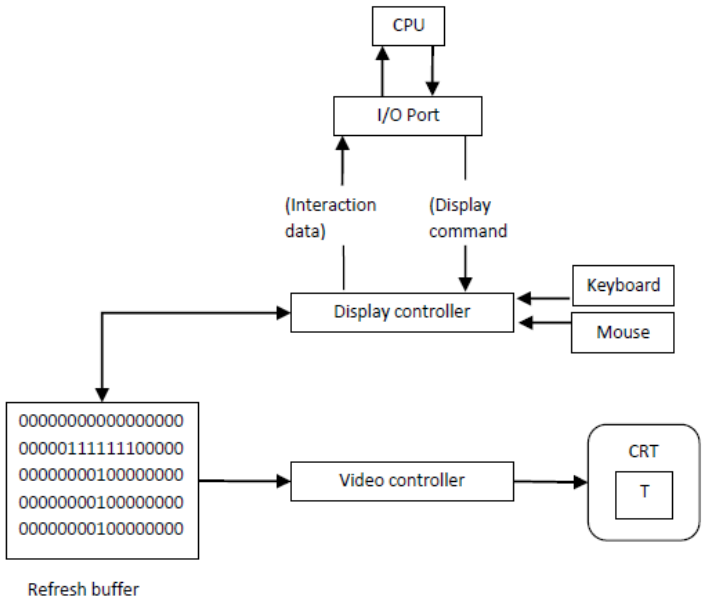

Figure 1.13 Architecture of a Raster Display

Frame Buffer is a special area of memory dedicated to graphics only used in raster image. The Frame buffer holds set of intensity values for all the screen points. These values are retrieved from frame buffer and display on screen one row at a time. Additional bits are required

when color and intensity variations can be displayed up to 24-bits per pixel are included in true color display systems. For monochrome system with one bit per pixel the frame buffer is commonly called a Bitmap. And for systems with multiple bits per pixel, the frame buffer is often referred as a Pix map.

Advantages of CRT display

1. Low cost.
2. Low weight.
3. High response and high resolution.
4. High flame and wide view angle.
5. Flat screen with clear image, clear colors and high resolution.
6. Authenticated technique and easy, expensive repairs.

Disadvantages of CRT display

1. The view angle is relatively narrow.
2. Big size, huge weight with the screen size.
3. Energy consumed.
4. Electromagnetic rays surrounds the screen.
5. Most of the CRT screen works with analogue signal and rarely with digital one.

2. The Flat Panel Display:

Compared to CRT displays, flat panel displays are much thinner, weightless, and consuming less power. Thus, they are better for portable computers. Flat panel displays are made up of two plates of glass with a substance between them, which is activating in different ways. Flat panel displays are distinguished in two ways:

1. by the substance between the plates of glass.
2. by the arrangement of the transistors in the screens.

Two common types of technology used in flat panel display screens are:

a. Liquid Crystal display (LCD):

It consists of a substance called liquid crystal, the molecules of which line up in a way that alter their optical properties. As a result, light usually backlighting behind the screen is blocked or allowed through to create an image.

There are some advantages and disadvantages of LCD :-

Advantages:

1. Low power consumption.
2. Small size.
3. Low cost.

Disadvantages:

1. LCD are temperature dependent (0-70C).
2. LCD do not emit light; as a result, the image has very little contrast.
3. LCDs have no color capability.
4. The resolution is not as good as that of a CRT.

b. Gas Plasma Display:

It is like a neon bulb, in which the display uses a gas that emits light in the presence of an electric current. That is, the technology uses neon gas and electrodes above and below the gas. Figure 1.14- show Generic flat panel display.

When electric current passes between the electrodes, the gas glows. Although gas plasma technology has better resolution than LCD technology, it is more expensive and thus is not used as often as a LCD. On the other hand, LCDs are not practical for screens larger than 20 inches and so are not practical for TV size screen.

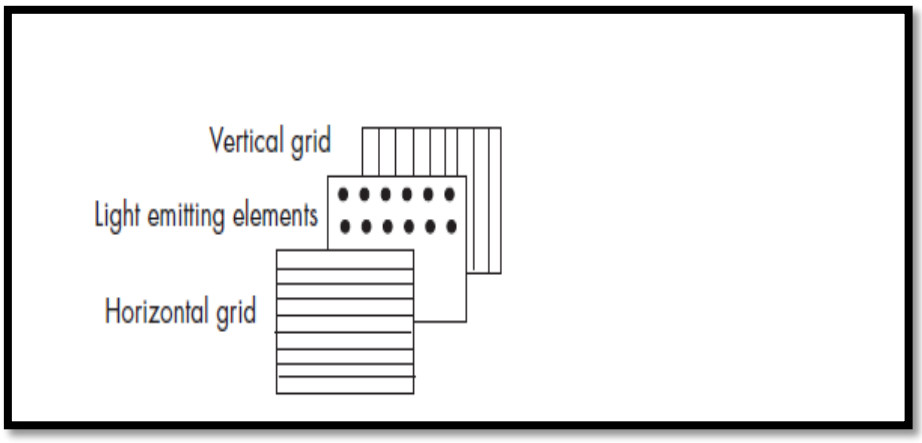

Figure 1.14 Generic flat panel display

There are some advantages and disadvantages of plasma panel display:

Advantages:

1. High resolution.
2. Large screen size is also possible.
3. Less volume.
4. Less weight.
5. Flicker free display.

Disadvantages:

1. Wiring requirement anode and the cathode is complex.
2. Its addressing is also complex.

1.9 Screen Clarity

The screen clarity depends on three qualities:

1 .Resolution:

Resolution is the numbers of pixels in digital image with N*M (N horizontal pixels× M vertical pixels), the number of pixels give the capacity to display the details in original image. Resolution is expressed in terms of the formula each pixel can be assigned a color or particular shade of gray. A screen with 640×480 pixels multiplied together equals 307200 pixels. This screen will be less clear and sharp than a screen with 800×600 (equals 480000) 0r 1024×768 (equals 786432) pixels.

Resolution depend on:

1. Special resolution (number of pixels).
2. Brightness resolution (values of pixels).

2 .Dot Pitch:

It is the amount of space between the center of adjacent pixels, the closer the dots, the crisper the image. For crisp images, dot pitch should be less than 0.31 millimeter.

3. Refresh Rate:

It is the number of times per second that the pixels are recharged so that their glow remains bright. In general, displays are refreshed 45 to 100 times per second.