الجامعة المستنصرية
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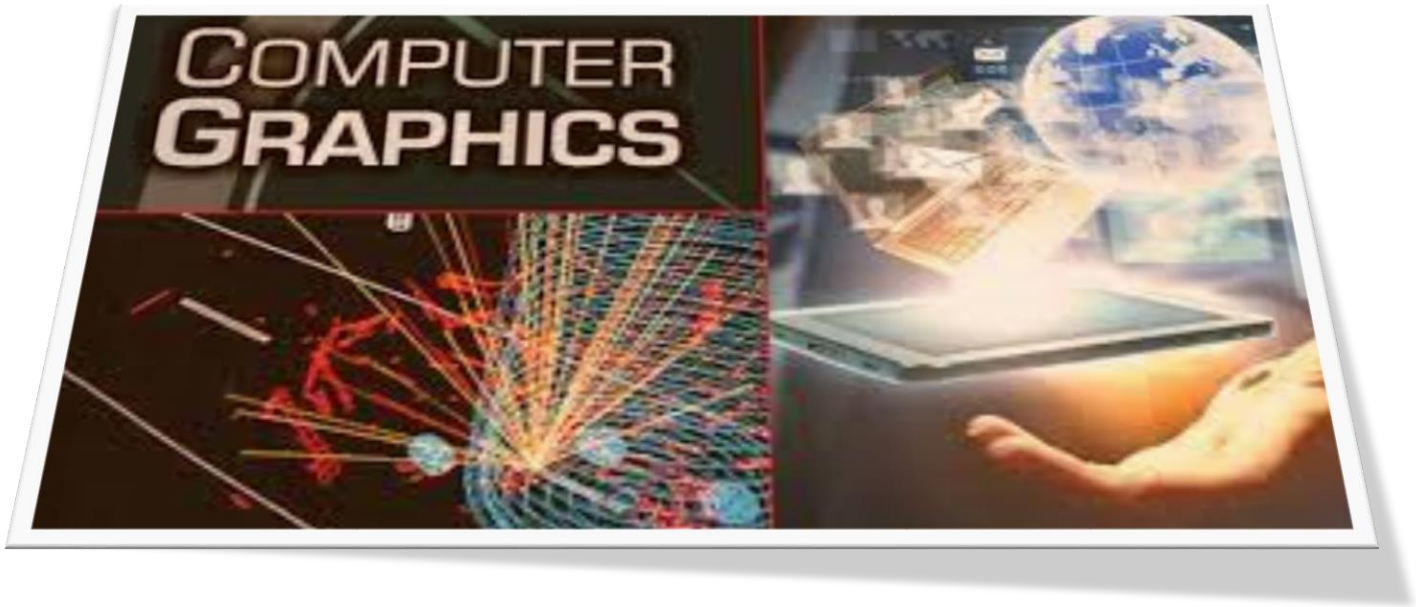
Computer Graphics



PART 1

Part One

1. What are Computer Graphics?
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Computer Graphics

The term "computer graphics" refers to anything involved in creating or manipulating images on a computer, including animated images.

- **Computer graphics involves using a computer to create and hold pictorial information and adapt and manipulate the display in different ways.**

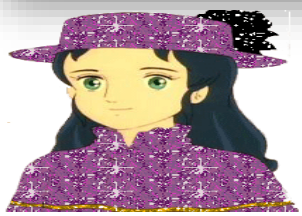
- **A computer is capable of sending its output to wide variety of devices, many of which are designed for special purposes.**

Advantages of Computer Graphics

- A high quality graphics displays of personal computer provide one of the most natural means of communicating with a computer.

- It has the ability to show moving pictures, and thus it is possible to produce animations with computer graphics.
- With computer graphics use can also control the animation by adjusting the speed, the portion of the total scene in view, the geometric relationship of the objects in the scene to one another, the amount of detail shown and so on.

- The computer graphics also provides facility called update dynamics. With update dynamics it is possible to change the shape, color or other properties of the objects being viewed.



- With the recent development of digital signal processing (DSP) and audio synthesis chip, interactive graphics can now provide audio feedback along with graphical feedbacks to make the simulated environment even more realistic.

Applications of computer graphics

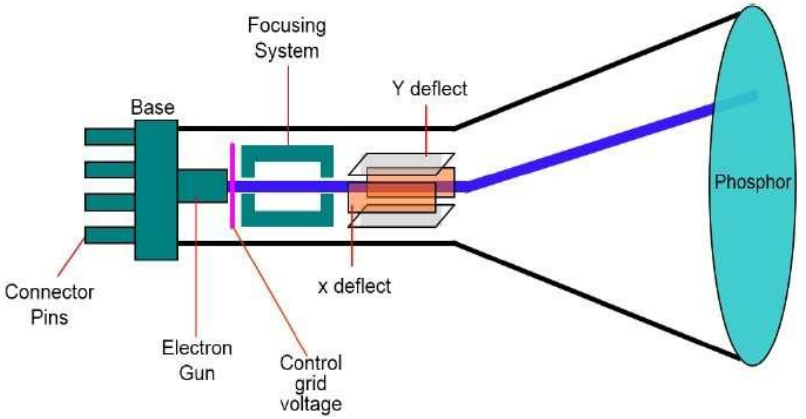
- Today almost every computer can do some graphics, and people have even come to expect to control their computer through icons and pictures rather than just by typing.
- Computer-generated imagery is used for movie making, video game and computer program development, scientific modeling, and design for catalogs and other commercial art. Some people even make computer graphics as art.

We can classify applications of computer graphics into four main areas.

Display of information	User interfaces	Design	Simulation
Computational Biology	Digital Art	Graphic Design	Computer Simulation
Computational Physics	Video Games	Computer-aided Design	Education
Information of Graphics	Virtual Reality	Web Design	Information Visualization
Scientific Visualization			

The Origins of Computer Graphics

- **In 1950 the first computer driven display, attached to MIT's computer, was used to generate simple pictures. This display used a Cathode-Ray tube (CRT).**



- **Interactive computer graphics made progress and the term computer graphics was first used in 1960.**
- **interactive computer graphics involves two-way communications between computer and user.**
- **The computer upon receiving signals from the input device can modify the displayed picture appropriately.**

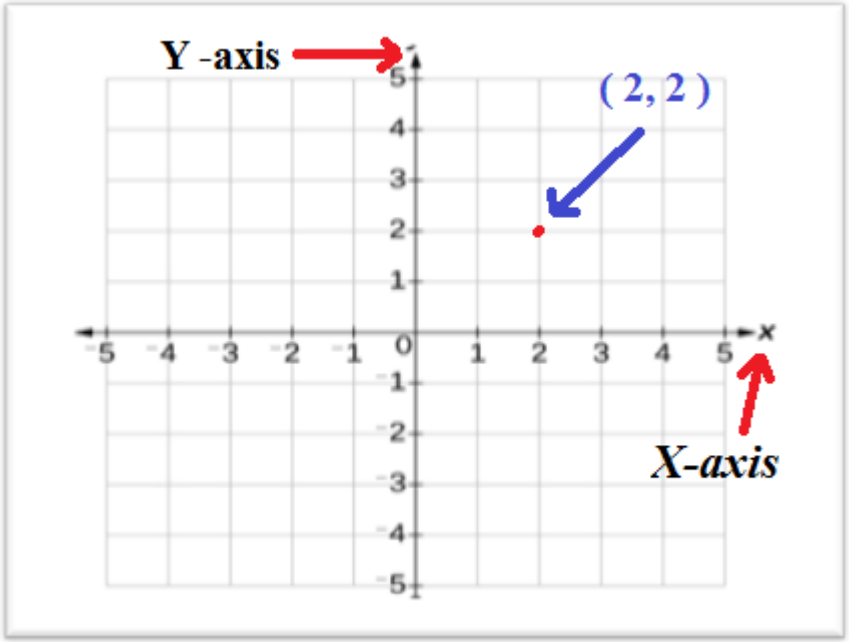
The main reason for the effectiveness of interactive computer graphics in many applications is the speed with which the user of the computer can assimilate the display information.

Cartesian Coordinate System

A coordinate system provides a framework for translating geometric ideas into numerical expressions.

- **In a two-dimensional plane, we pick any point and single it out as a reference point called the origin. Through the origin, we construct two perpendicular number lines called axes. These are labeled the *X-axis* and the *Y-axis*.**

- **Any point in two dimensions in this X-Y plane can be specified by a pair of numbers, the first number is for the *X-axis*, and the second number is for the *Y-axis*.**



Graphical User Interface

The aspects of the user interface of a program are the parts of the program that link the user to the computer and enable him to control it.

- **A good user interface makes the program not only easy to use and learn but also easier to operate and more efficient.**

How the Interactive Graphics display works

The modern graphics display is extremely simple. It consists of three components:

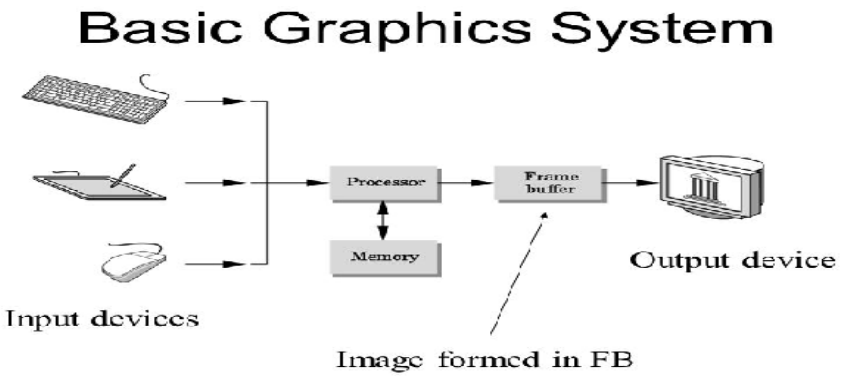
1. **A digital memory, or frame buffer, in which the displayed image is stored as a matrix of intensity values.**
2. **A monitor.**
3. **A display controller, which is a simple interface that passes the contents of the frame buffer to the monitor.**

Inside the frame buffer the image is stored as a pattern of binary digital numbers, which represent a rectangular array of picture elements, or pixel.

- **The pixel is the smallest addressable screen element.**
- **In the simplest case where we wish to store only black and white images, we can represent black pixels by 0's in the frame buffer and white pixels by 1's.**
- **The display controller simply reads each successive byte of data from the frame buffer and converts each 0 and 1 to the corresponding video signal. This signal is then fed to the monitor.**
- **If we wish to change the displayed picture all we need to do is to change of modify the frame buffer contents to represent the new pattern of pixels.**

Basic Graphics System

1- Graphics input Devices
2- Graphics output Devices
3- Processor
4- Memory
5- Frame buffer



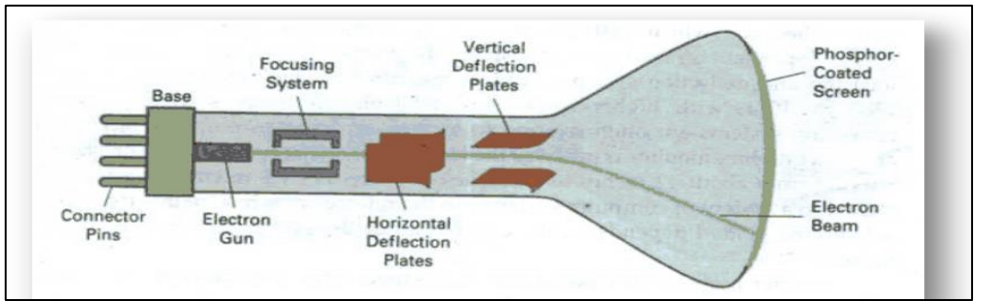
1. Mouse and Keyboard
2. Joysticks
3. Data Gloves
4. Touch panels
5. Light pens
6. Image scanners
7. Digitizers

1. Plotters.
2. laser printer plotters.
3. Films.
4. Storage tube.
5. Cathode ray tube (CRT).

Graphics Output Devices

Because the large majority of computer graphics systems utilize some type of CRT display and because most of the fundamental display concepts are embedded in CRT display technology, we will limit our concern to CRT display. screens consist of three components:

1. **The cathode ray tube (CRT).**
2. **The frame buffer**
3. **The display controller.**



Cathode Ray Tube (CRT) :

Consist from several part as shown in the figure below

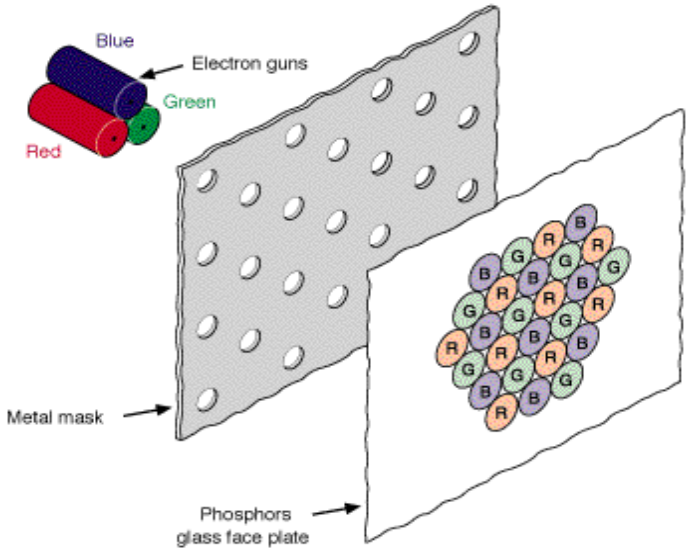
1- Electron gun: That contains a cathode that, when heated, emits a beam of negatively charged electrons toward a positively charged phosphor-coated screen.

2- Focusing System: Concentrates the electrons beam reach the screen.

3- Deflection system: The electron beam passes through the focusing and deflection system, which consists of an electrostatic field. It consists of two pairs of deflection plates (horizontal and vertical) that direct the electron beam to any point on the screen.

When the electron beam strikes the screen, the phosphor emits a spot of visible light whose intensity depends on the number of electrons on the beam. The light on the screen starts to fade as soon as the beam moves to another location.

- **The duration of this light depends on the type of phosphor that coats the screen in order to give the viewer the appearance of a continuous flicker-free image, each illuminated dot on the screen must be intensified many times per second this type is called refresh CRT.**



- **Two types of displaying on CRT are available: raster scan and random vector.**

A color CRT has three guns, one for each of three primary colors: red, green, blue. Each pixel is composed of triangular pattern of a red, green, blue phosphor dot.

Random Vector display

Raster scan system uses frame buffer to display an image in scan line: from top to bottom, left to right.

Advantages:

1. **Realistic image**
2. **Million Different colors to be generated**
3. **Shadow Scenes are possible.**

Disadvantages:

1. **Low Resolution**
2. **Expensive**

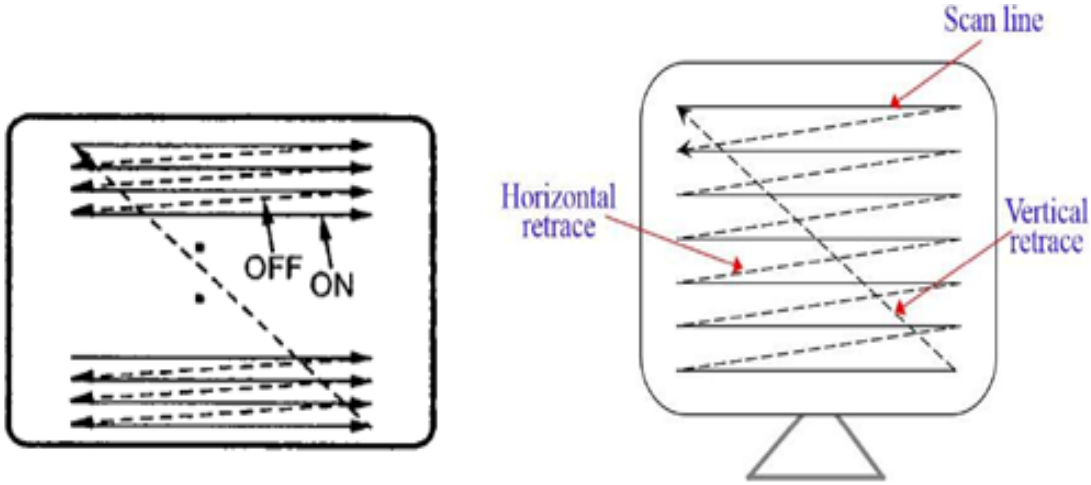


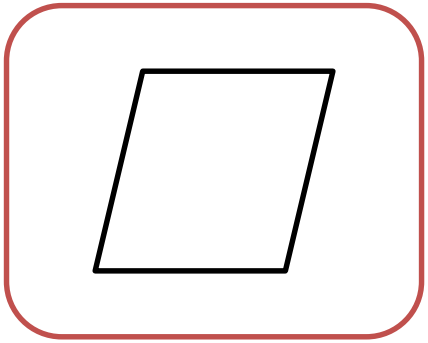
fig. Raster Scan CRT

Random Vector display

Random Scan (vector)

- If we wish to draw only lines

A line drawing graphic system is preferred which is call random vector. In this system there is memory region , called a display file, consisting of line drawing commands such as " draw line from A to B".



Display Screen

Draw line AB
Draw line BC
Draw line CD
Draw line DA

Display File

Advantages:

1. A CRT has the electron beam directed only to the parts of the screen where an image is to be drawn.
2. Produce smooth line drawings.
3. High Resolution

Disadvantages:

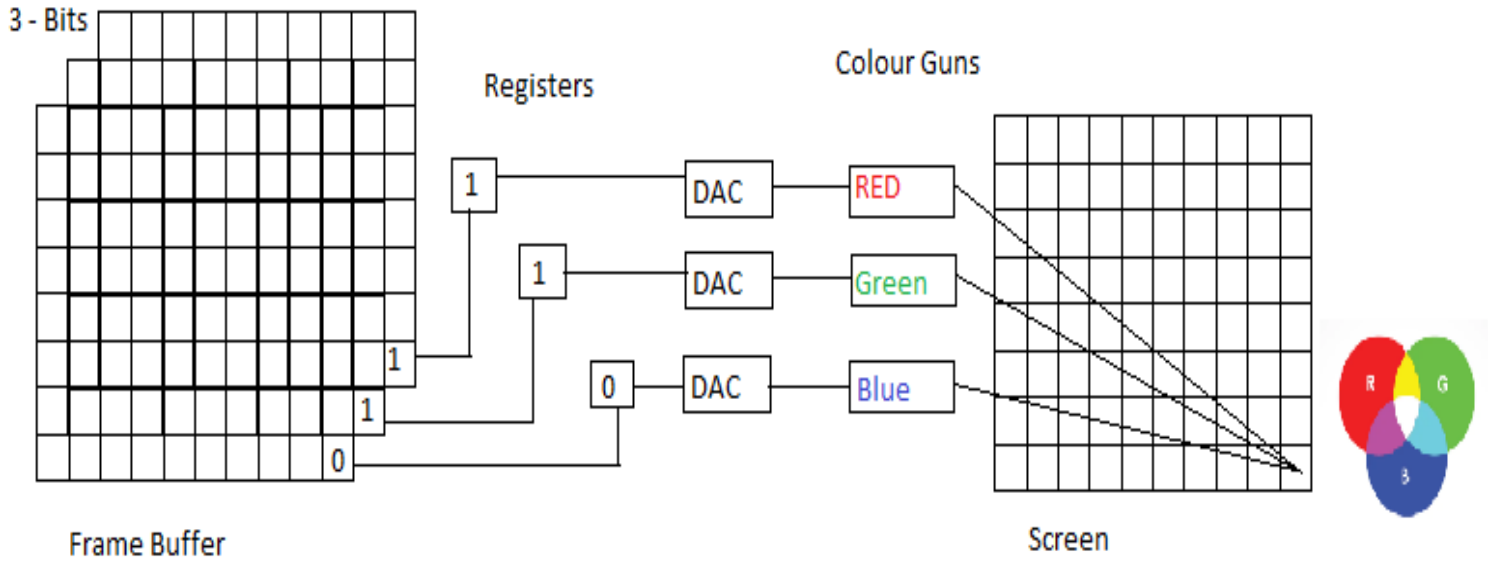
1. Random-scan monitors cannot display realistic shade scenes.

Unlike a raster scan system, it is not necessary to refresh the entire screen but only those parts of the screen where there is a straight line or vector.

Frame buffer

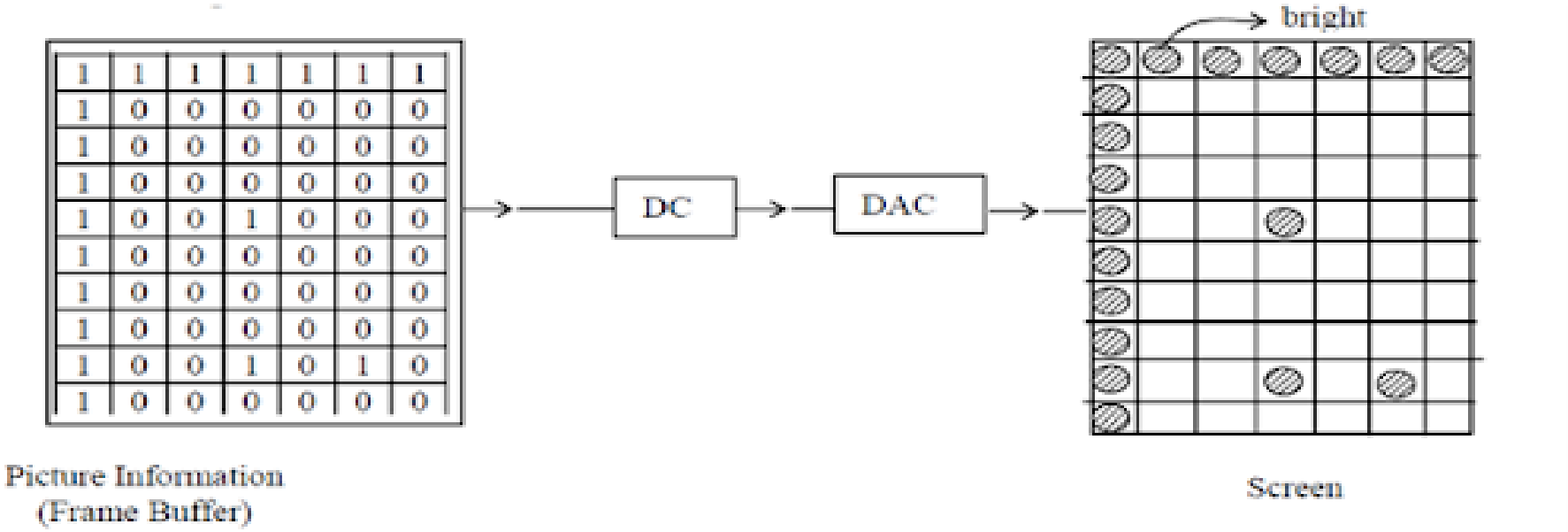
Each screen pixel corresponding to a particular entry in a two-dimensional array residing in memory. This memory is called a frame buffer or a bit map.

- **The number of rows in the frame buffer array equals the number of the raster lines on the display screen. The number of columns in this array equals the number of pixels on each raster line.**



Whenever we wish to display a pixel on the screen, a specific value is placed into the corresponding memory location in the frame buffer array.

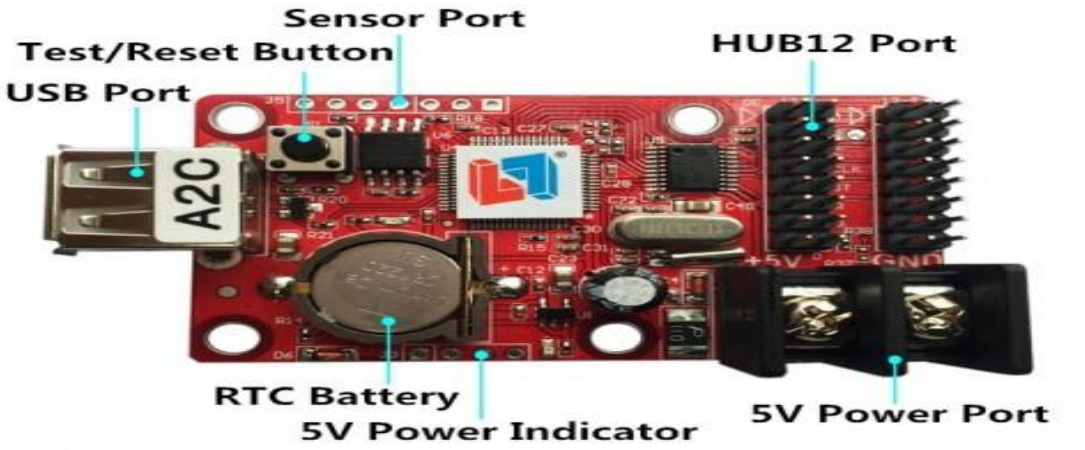
In figure below, a value of 1 placed in a location in the frame buffer results in the corresponding (bright) pixel being displayed on the screen.
Each screen location pixel and corresponding memory location in the frame buffer is accessed by an (x, y) integer coordinate pair. The x value refers to the column, the y value to the row position.



- **Each pixel in the frame buffer array is composing of a number of bits. A black and white image that has only two intensity levels, on / off, has single bit plane frame buffer.**
- **In order to display a color image, additional bit planes are needed.**

Display controller

The hardware device that read the contents of the frame buffer into video buffer , which then converts the digital representation of a string of pixel values into analog voltage signals that are sent serially to the video display screen(CRT).



Flat Panel Display

Compared to CRT's ,

1- Flat panel display are much thinner .

2- Weight less .

3- Consuming less power .

4- Do not emit radiation .

Thus they are better for portable computers. There are several types of flat panel monitors, but the most common is the Liquid Crystal Display (LCD).

- **The disadvantage of LCD is that their image can be difficult to see in bright light.**

For this reason, laptop computers users often look for shady places to sit when working outdoors or near windows.

- **A bigger disadvantage of LCD monitors is their limited viewing angle.**

Screen Clarity

The screen clarity depends on three qualities:

1- Resolution

2- Dot pitch

3- Refresh rate

1- Resolution:

The clarity or sharpness of the display screen is called Resolution.

- **The more pixels per square inch, and the better of resolution.**
- **A high resolution graphic has more dots (pixels) per a specific area, while a low resolution graphic has a lower dots or pixels.**
- **Resolution applies to both graphics designed for print and graphics created for the display system.**

Resolution depends on:

1- The type of phosphor.

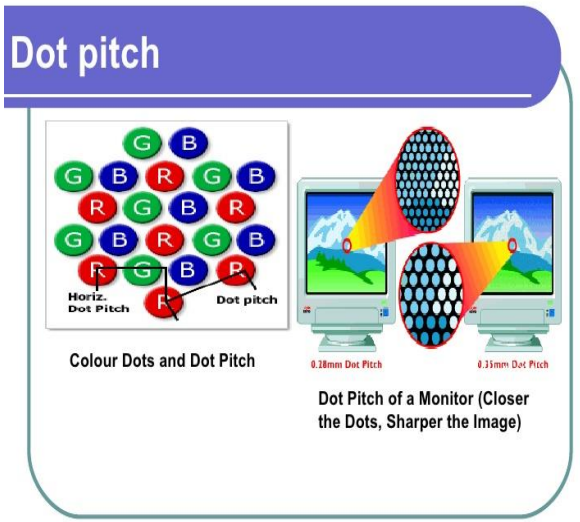
2- The intensity to be displayed

3- The focusing and deflection systems used in the CRT.

2- Dot Pitch:

The amount of space between the centers of adjacent pixels, the closer the dots, the crisper the image.

- **For crisp images , the dot pitch should be less than 0.31 millimeter.**
- **CRTs, the dot pitch is typically from 0.28 to 0.51mm, while large presentation monitors may go up to 1 mm.**
- **LCD monitors, the dot pitch is typically from 0.16 to 0.29mm.**



3- Refresh rates:-

Refresh rate is the number of times per second that the pixels are recharged so their glow remains bright.

- **In dual-scan screens, the top and the bottoms of the screens are refreshed independently at twice the rate of a single-scan screen, producing more clarity and richer colors.**
- **in general, displays are refreshed 45 to 100 times per second.**

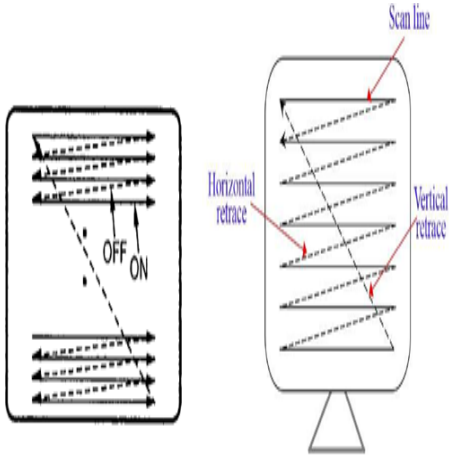


fig. Raster Scan CRT

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