Video Display Devices

1. Pixel
2. Image Resolution / PPI / Pixel Density
3. Aspect Ratio
4. Cathode Ray Tube-Crt
5. Vector Scan Display / Random Scan Display
6. Raster Scan Display
7. Difference btw Vector & Raster
8. Color Generation Techniques In Color CRT ->
   -> Beam Penetration Technique
   -> Shadow Mask Technique

1. **Pixel : What is a Pixel ?**

In digital imaging, a pixel (picture element) is the smallest item of information in an image. Arranged in 2-d grid (row & column) and are often represented as dots, squares, rectangles.

Pixel is the smallest unit of display on video monitors.
Intensity of each pixel is variable

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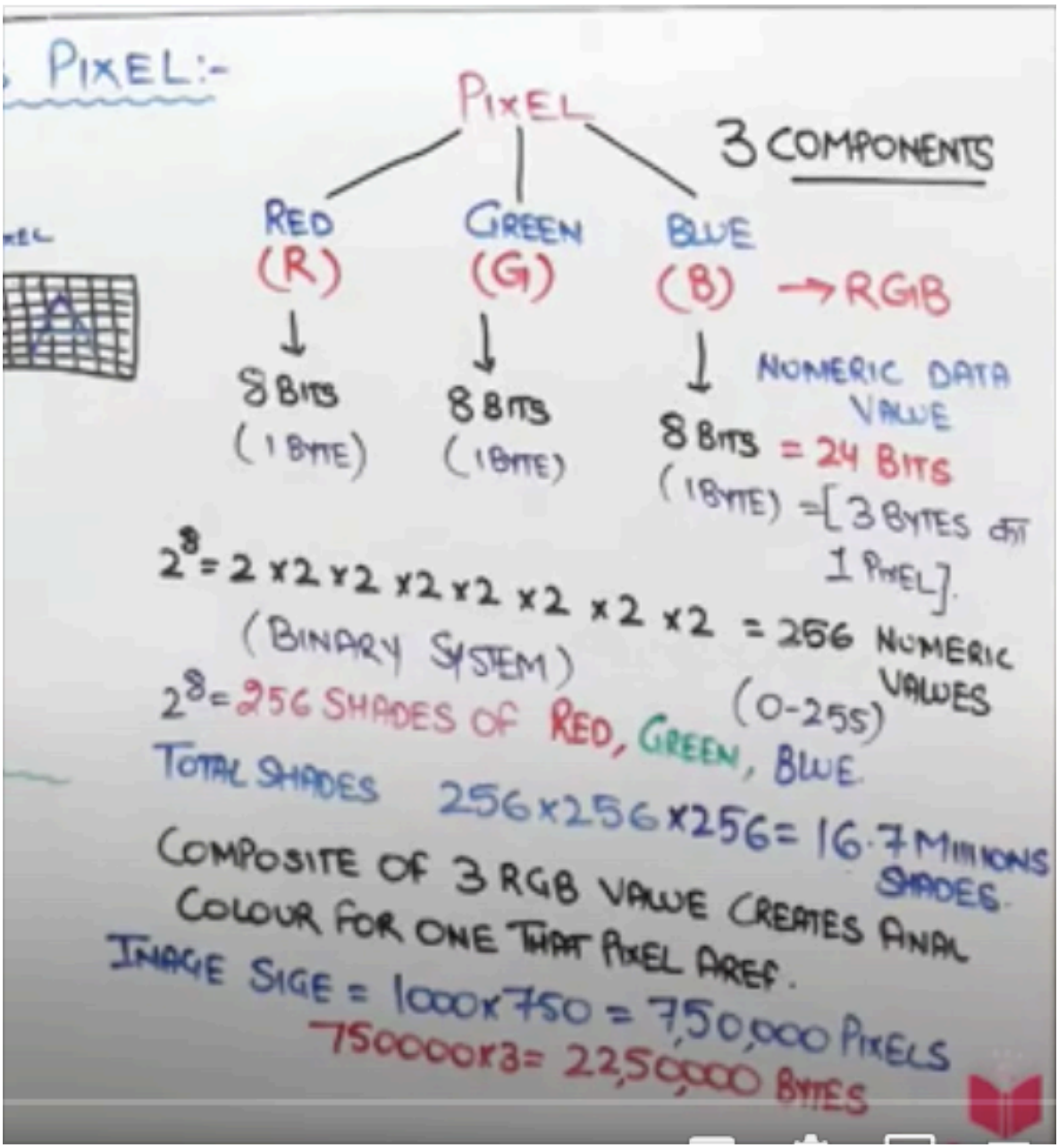
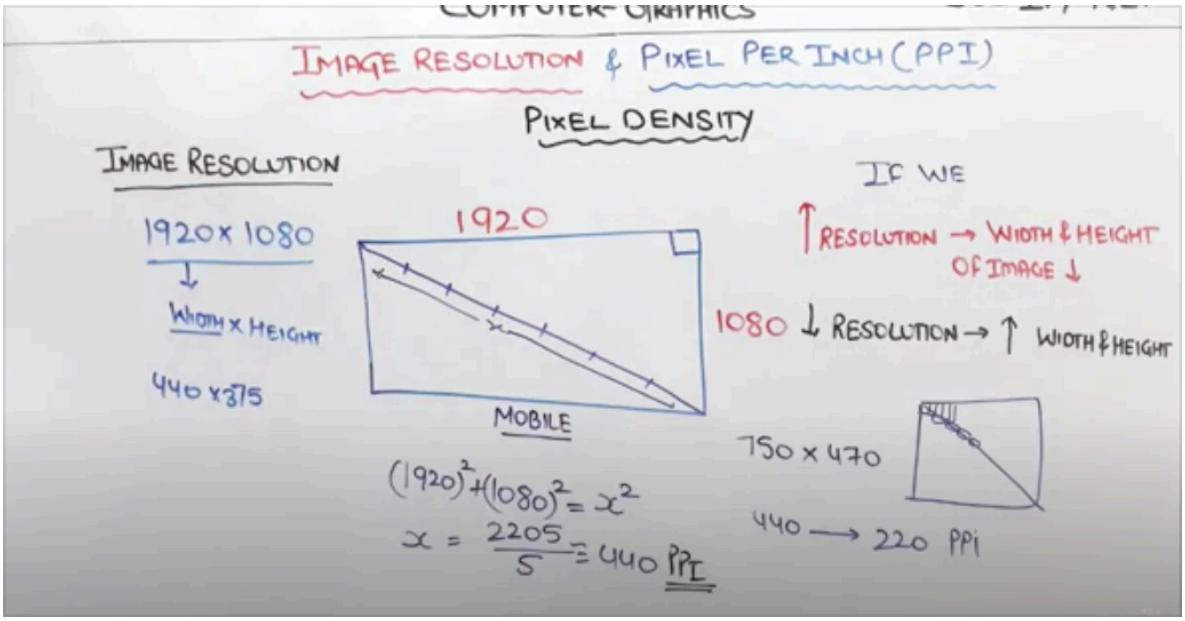
In RGB -> Yellow color -> Red + Green + Blue => Yellow
255. 255 0

Black	0 0 0
White	255 255 255
Light Grey	220 220 220
Bark Grey	40 40 40

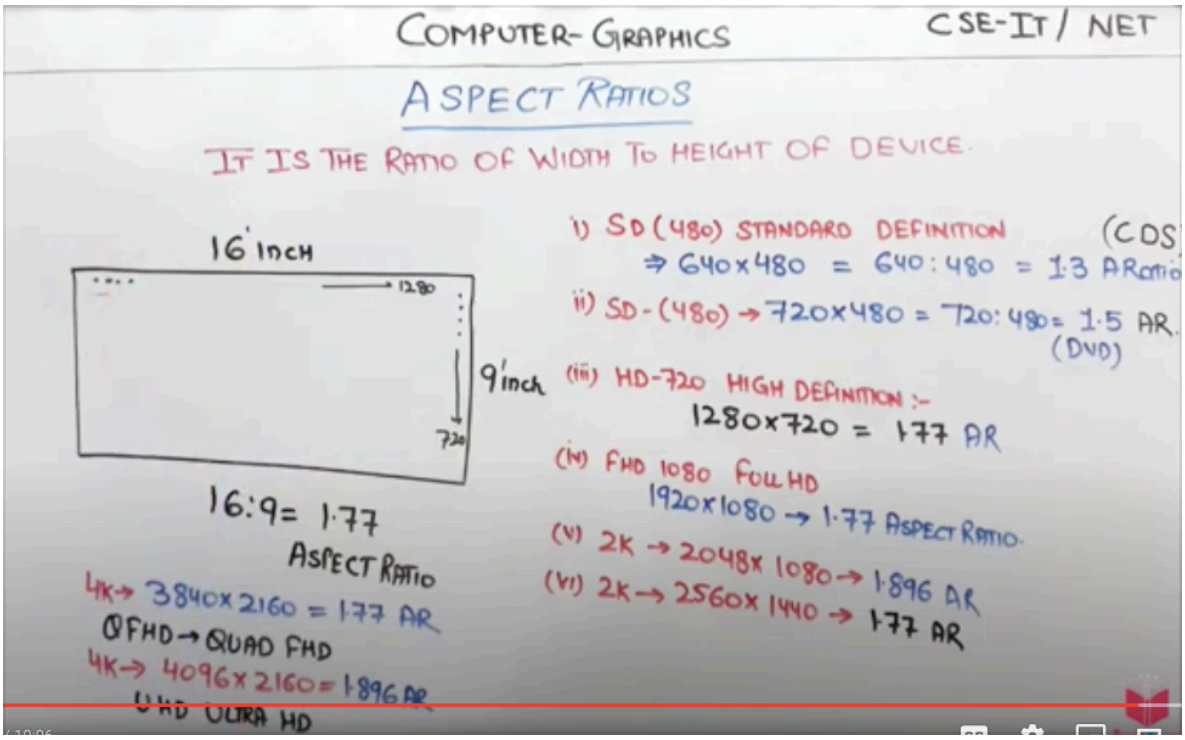


2. **Image Resolution / Pixel per Inch**

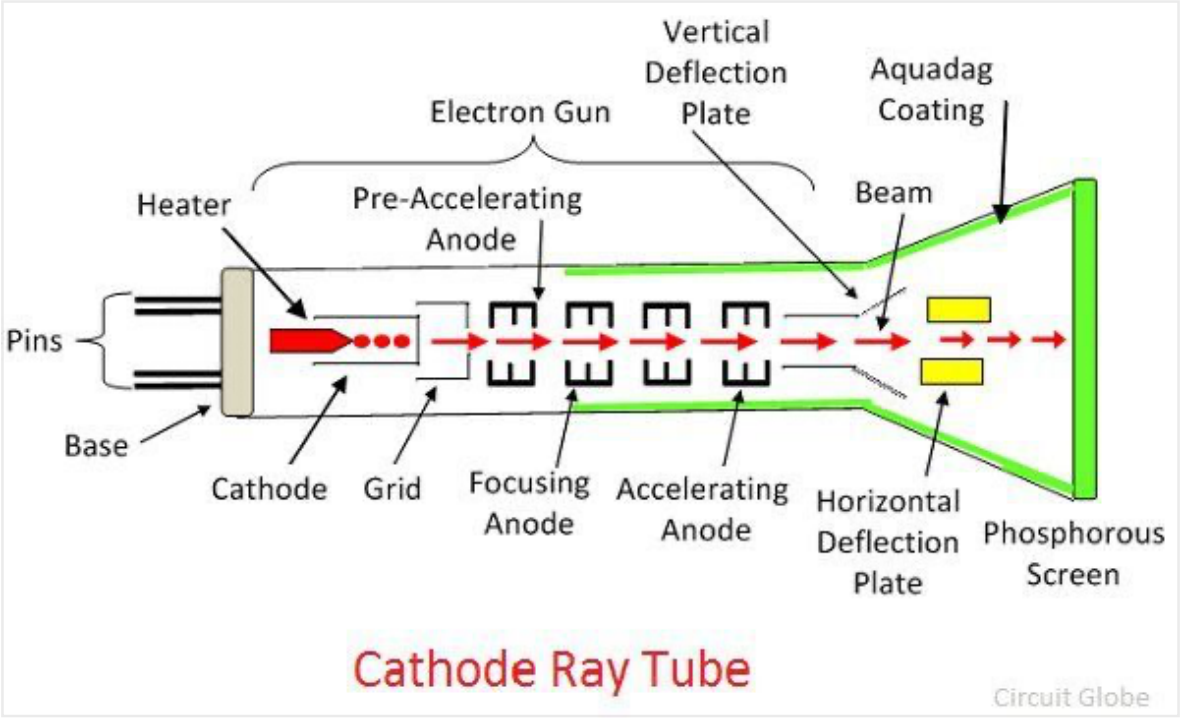
   Let take a example of a smartphone 5 inch smartphone



3. **Aspect Ratios :**



Cathode Ray Tube (CRT) :



CRT is a device which convert electrical signal, into visual signals.

Cathode emits electrons when its get heated by the heater
Pins : Used to provide voltage to the whole system
Heater : Heats the cathode so that it could produce electrons in a large amount
Grid : Focusses & Pass electrons beam at a high speed.
Pre-Accelerating Anode : Focusing anode -> Provide path to the electron
Vertical Deflection Plate : It deflects electron beam in up down direction on screen.
Horizontal Deflection Plane : Deflects electron beam in right -> left direction.
Aquadag Coating : It recenter the deflected electron to their right path.
Phosphorous Screen : Coated with phosphorus
Electron Gun : Heater & cathode assembly called electric gun as a whole.
Horizontal & Vertical Plate : These are used to move the focus of the electron beam over the screen by changing the positive voltage over them.

Zinc sulphate and tungsten, zinc oxide is used on screen as a coating before phosphorus

After exiting from the electron gun, the beam passes through the pairs of electrostatic deflection plate. These plates deflected the beams when the voltage applied across it. The one pair of plate moves the beam upward and the second pair of plate moves the beam from one side to another. The horizontal and vertical movement of the electron are independent of each other, and hence the electron beam positioned anywhere on the screen.
The working parts of a CRT are enclosed in a vacuum glass envelope so that the emitted electron can easily move freely from one end of the tube to the other.

Construction of CRT
The Electrons Gun Assembly, Deflection Plate Assembly, Fluorescent Screen, Glass Envelope, Base are the important parts of the CRT. The electron gun emits the electron beam, and through deflecting plates, it is strikes on the phosphorous screen. The detail explanation of their parts is explained below.

Electrons Gun Assembly
The electron gun is the source of the electron beams. The electron gun has a heater, cathode, grid, pre-accelerating anode, focusing anode and accelerating anode. The electrons are emitted from the highly emitted cathode. The cathode is cylindrical in shape, and at the end of it, the layer of strontium and barium oxide is deposited which emit the high emission of electrons at the end of the tube.
The electron passes through the electron in the small grid. This control grid is made up of nickel material with a centrally located hole which is coaxial with the CRT axis. The electron which is emitted from the electron gun and passes through the control grid have high positive potential which is applied across the pre-accelerating and accelerating anodes.

The beam is focused by focusing anode. The accelerating and focusing electrodes are cylindrical in shape which has a small opening in the centre of each electrode. After exiting the focusing anode, the beams passes through the vertical and horizontal deflecting plates.
The pre-accelerating and accelerating anode are connected to the positive high voltage of about 1500V and the focusing anode are connected to the lower voltage of about 500V.There are two methods

of focusing the electron beam. They are the Electrostatic Focussing Beam and the Electromagnetic Focusing.

Electrostatic Deflection Plates
The deflection plate produces the uniform electrostatic field only in the one direction. The electron beam entering into the deflection plates will accelerate only in the one direction, and hence electrons will not move in the other directions.

Screen For CRT
The front of the CRT is called the face plate. The face plate of the CRT is made up of entirely fibre optics which has special characteristics. The internal surface of the faceplate is coated with the phosphor. The phosphorous converts the electrical energy into light energy. The energy level of the phosphorous crystal raises when the electron beams strike on it. This phenomenon is called cathodoluminescence.
The light which is emitted through phosphorous excitation is called fluorescence. When the electron beam stop, the phosphorous crystal regain their original position and release a quantum of light energy which is called phosphorescence or persistence.

Aquadag:
The Aquadag is the aqueous solution of graphite which is connected to the secondary of the anode. The Aquadag collects the secondary emitted electrons which are necessary for keeping the CRT screen in the state of electrical equilibrium.

Cathode Ray Tube has two of its different types :

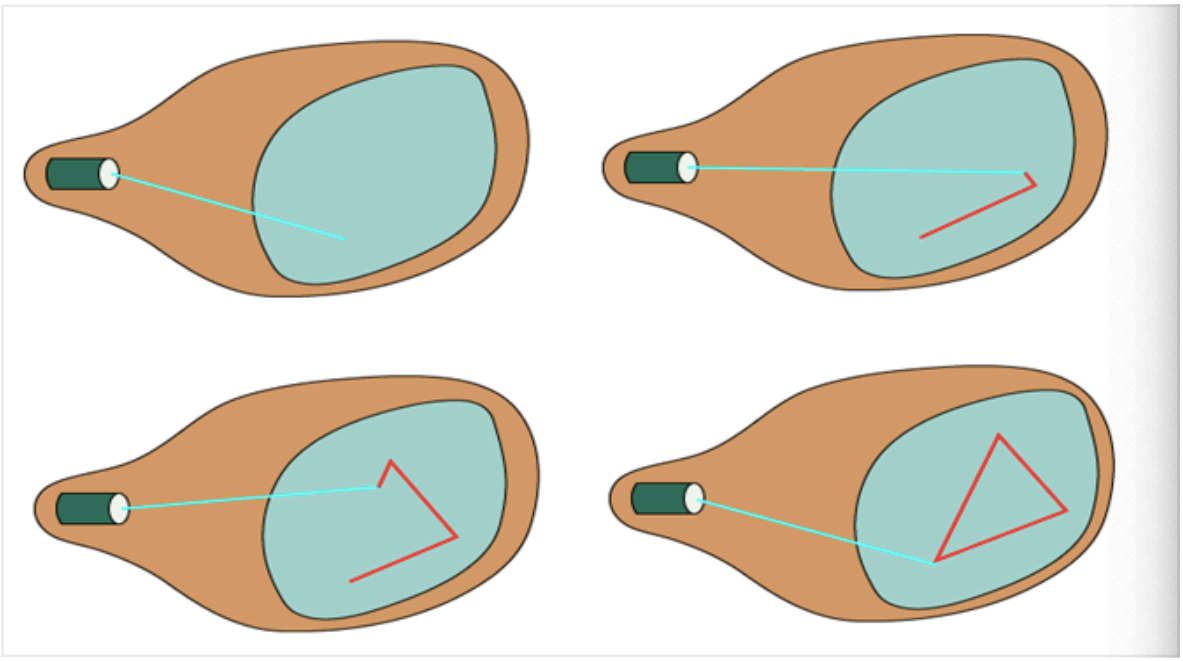
1. **Vector Scan Display / Random Scan Display**
2. Raster Scan Display

Vector / Random Scan Display :

Also known as
Calligraphic display / Stroke Writing Display,

Random Scan System uses an electron beam which operates like a pencil to create a line image on the CRT screen. The picture is

constructed out of a sequence of straight-line segments. Each line segment is drawn on the screen by directing the beam to move from one point on the screen to the next, where its x & y coordinates define each point. After drawing the picture. The system cycles back to the first line and design all the lines of the image 30 to 60 time each second. The process is shown in fig:



-> Vector Scan is a technique used for producing images on the screen. Beam is directed to the area on the screen where picture is to be rendered.
-> The display buffer memory stores the 'Display list' which contains point & lines plotting commands with (x, y) or (x, y, z) coordinates as character plotting commands.
-> Display controller interests these commands & help beam-deflection circuit to displace e' beam writing on cat's phosphor coating.
-> The Phosphor light decays after a few milli seconds so we have to refresh phosphor at least 30-60 times per second I.e. 30-60fps

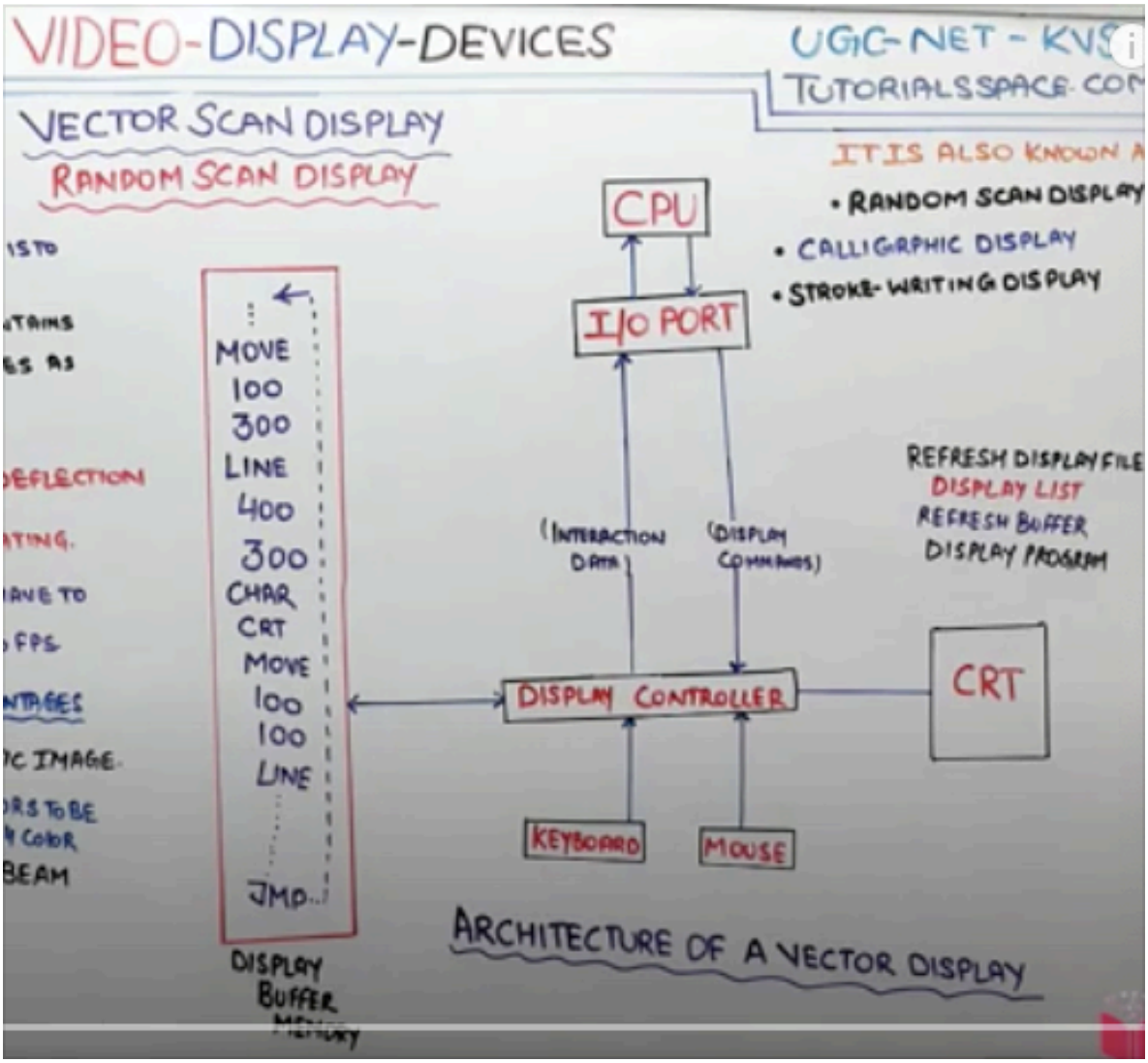
Advantages :

1. Higher Resolution than raster scan display
2. Produce smooth line paths
3. Need less memory to store picture definition
4. Stores images in .svg, .pdf formates

Disadvantages :

1. Can't draw realistic image.
2. Limitation on colors to be displayed max -4 color depends on

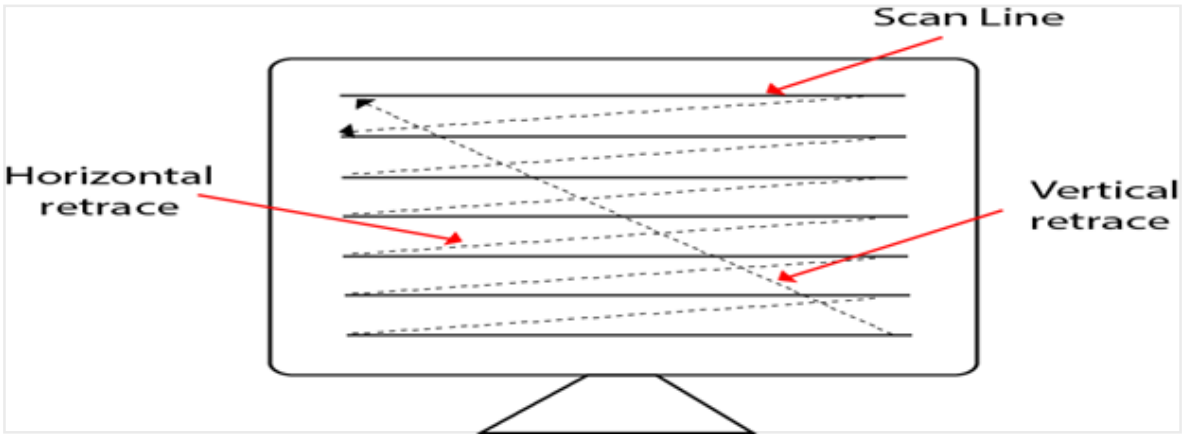
how deep the electron gonna penetrate on that screen.



Raster Scan Display

A Raster Scan Display is based on intensity control of pixels in the form of a rectangular box called Raster on the screen. Information of on and off pixels is stored in refresh buffer or Frame buffer. Televisions in our house are based on Raster Scan Method. The raster scan system can store information of each pixel position, so it is suitable for realistic display of objects. Raster Scan provides a refresh rate of 60 to 80 frames per second.

Frame Buffer is also known as Raster or bit map. In Frame Buffer the positions are called picture elements or pixels. Beam refreshing is of two types. First is horizontal retracing and second is vertical retracing. When the beam starts from the top left corner and reaches the bottom right scale, it will again return to the top left side called at vertical retrace. Then it will again more horizontally from top to bottom call as horizontal retracing shown in fig:



Types of Scanning or traveling of beam in Raster Scan

1. Interlaced Scanning
2. Non-Interlaced Scanning

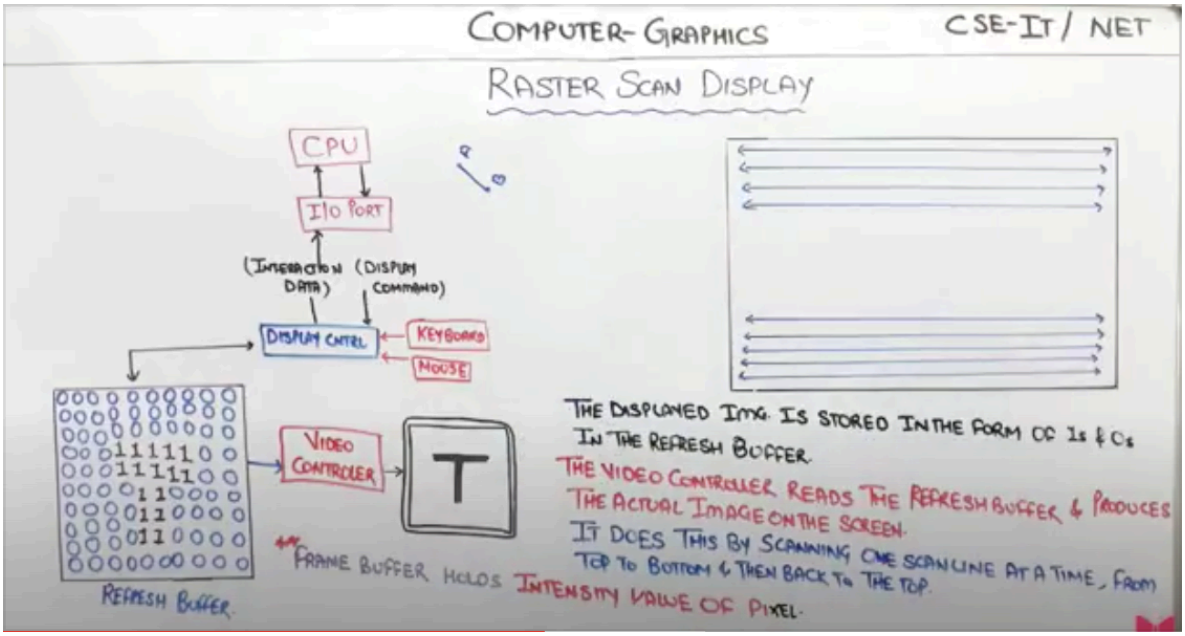
In Interlaced scanning, each horizontal line of the screen is traced from top to bottom. Due to which fading of display of object may occur. This problem can be solved by Non-Interlaced scanning. In this first of all odd numbered lines are traced or visited by an electron beam, then in the next circle, even number of lines are located.
For non-interlaced display refresh rate of 30 frames per second used. But it gives flickers. For interlaced display refresh rate of 60 frames per second is used.

Advantages:

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

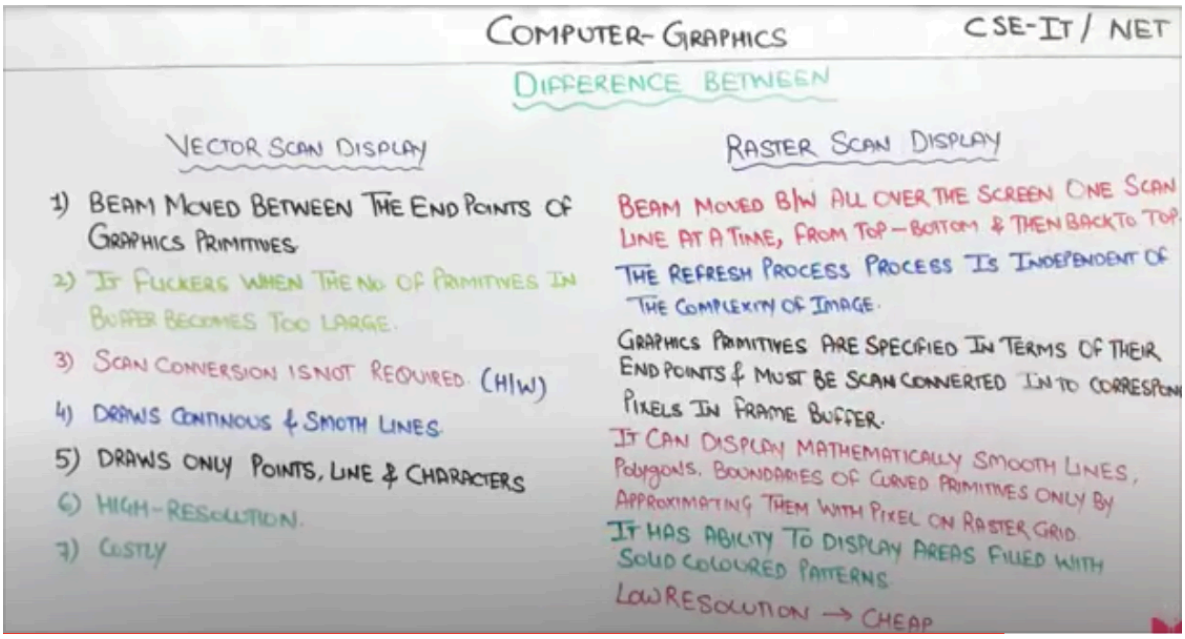
Disadvantages:

1. Low Resolution
2. Expensive



Differentiate between Random and Raster Scan Display:

Random Scan / Vector Scan	Raster Scan/ Bit Mapping
1. It has high Resolution	1. Its resolution is low.
2. It is more expensive	2. It is less expensive
3. Any modification if needed is easy	3.Modification is tough
4. Solid pattern is tough to fill	4.Solid pattern is easy to fill
5. Refresh rate depends on resolution	5. Refresh rate does not depend on the picture.
6. Only screen with view on an area is displayed.	6. Whole screen is scanned.
7. Beam Penetration technology comes under it.	7. Shadow mark technology came under this.
8. It does not use interlacing method.	8. It uses interlacing
9. It is restricted to line drawing applications	9. It is suitable for realistic display.
10. Use char etc coding for display buffer	10. Use 0's & 1's coding for display buffer.



Beam Penetration Method - In Vector / Random Scan :

Last Updated : 13 Nov, 2022

The cathode ray tube (CRT) monitor displays with the help of a combination of phosphorus, as phosphorus exists in multi-color. Beam penetration is a method for producing color displays with CRT. The beam penetration technique uses multilayer phosphorus and achieves color by modulating the beam's accelerating potential. It uses a random scan system to display color.

The arrangement of beam penetration CRT is similar to the normal CRT. The only unusual component is the use of multilayer phosphorus inside beam penetration. In multilayer phosphorus, a layer of red phosphorus is deposited behind the initial layer of green phosphorus. This method produces four colors only, red, green, orange, and yellow. The electron beam is produced by using an electron gun.

- If a low potential electron beam strikes the face, it excites only the red phosphor and produces red traces.
- If a high potential electron beam strikes the tube face, it excites the green phosphor and produces green traces.
- If an electron beam of intermediate potential and velocity, then it produces a combination of red and green i.e., orange and yellow.

However, the principle problem with this technique is the need to

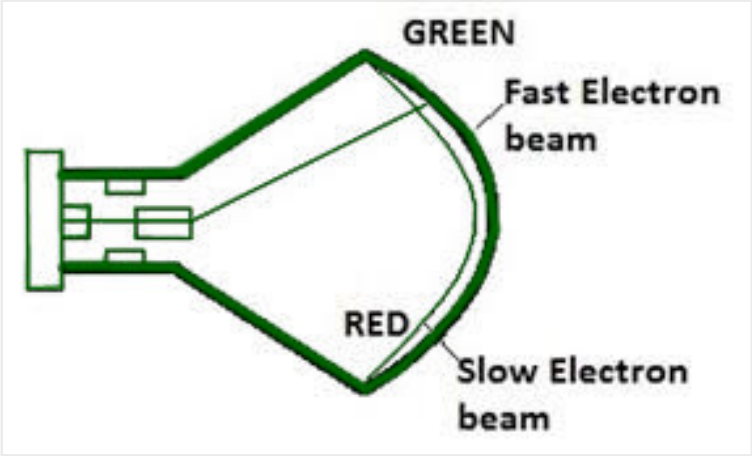
change the beam accelerating potential by an adequate amount in order to switch colors. When the accelerating potential changes, the deflection system must react to compensate. The hardware and software design must introduce delays between changes in color.

Advantages :

- It is a cheaper method.
- This method provides high resolution.
- It uses only one electron gun whereas the other method uses three or more electron guns.
- Easily identifies the type of electron i.e., high, low, or medium potential.
- A reliable method for producing colors.

Disadvantages :

- Produces only four colors.
- Not suitable for producing realistic views.
- Only suitable for the random scan.
- Color changing process takes time.
- The picture quality is quite poor.

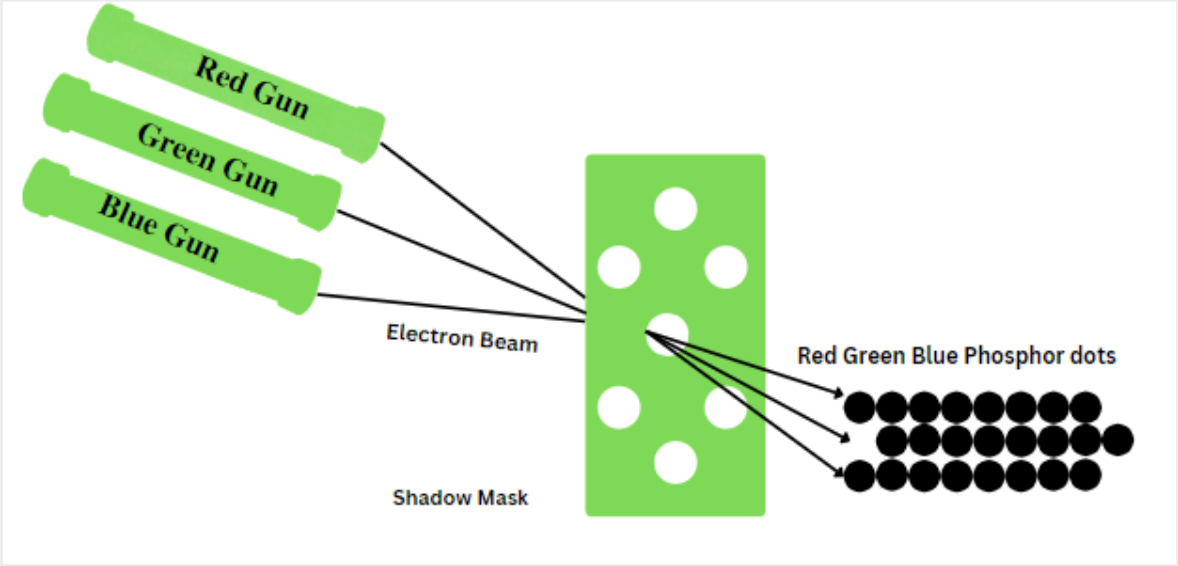


Shadow Mask Technique:

Shadow Mask Technique in Computer Graphics is commonly used in raster-scan systems (including color TV) because they produce a much wider range of colors than the Beam Penetration Method.

It has three phosphor color dots (RGB) at each pixel position. The first phosphor dot emits a red light, the second one emits a green light and the third emits a blue light. The phosphor transforms the Kinetic Energy of the electrons into Light Energy

The Shadow Mask Technique involves the usage of three electron guns, one for each color dot, and a shadow-mask grid just behind the phosphor-coated screen.



Types of Shadow-Mask Technique:

1. The below figure illustrates one of the shadow-mask techniques that is, the delta-delta shadow mask technique commonly used in color CRT systems. the electron beams are diverted and concentrated as a group on the shadow mask, which contains a sequence of holes lined up with phosphor-dot patterns. When these three beams cross through a hole in the shadow mask, they animate a dotted triangle, that appears as a small color spot over the screen. The phosphor dots on the triangle are arranged so that each electron beam can activate only its corresponding color dot when it passes through the shadow mask.
2. Another configuration for three electron guns is an in-line arrangement in which the three electron guns and the corresponding red-green-blue color dots on the screen, are aligned along a single scan line rather than in a triangular pattern. This type of arrangement of electron guns is convenient to keep in alignment and is generally used in high-resolution color CRTs.

We get color variations in a shadow mask CRT by varying the intensity levels of the three electron beams. By turning off red and green guns, we get only the color coming from the blue phosphor. Other combinations of beam intensities generate a small light spot for each pixel position since our eyes tend to merge the three colors into one composite. The color we see depends on the excitation of the red, green and blue phosphorus. A white (grey) is the result of activating all three dots of equal intensity. Yellow is generated with the green and red dots only, magenta is generated with the blue and red dots and cyan shows up when blue and green are activated uniformly.

Advantages of the Shadow Mask Technique:

- The image is more real as compared to other RGB filtering methods.
- Tailored, that is this technique is customizable.
- And is relatively less expensive compared to other techniques but double expensive then the beam penetration method

Disadvantages of the Shadow Mask Technique:

- Use of very limited colors, only three to four colors usage.
- Other methods available provide much better results in terms of the quality of the picture.

Direct View Storage Tube

Last Updated : 18 Aug, 2022

Direct View Storage Tube (DVST) resembles CRT as it uses electron gun to draw picture and phosphor coated screen to display it. The phosphor used in this is of high persistence. DVST does not use refresh buffer or frame buffer to store picture definition. Picture definition is stored in inside CRT in form positive charged distribution. Because of this reason DVST is knows as Storage Type CRT. In DVST no refreshing is required as result picture drawn on DVST will be seen for several minutes before fading.

Various components of DVST :

1. Electron guns –
   Two electron guns are used in DVST : Primary Gun and Flood Gun. Primary gun is used to store picture pattern. Flood gun is used to maintain picture display on phosphor coated screen.
2. Phosphor Coated Screen –
   In DVST the inner surface of CRT is coated with phosphor crystals is of high persistence that emit light when beam of electrons strike them.
3. Storage Mesh –
   It is thin and high quality wire that is coated with dielectric and is located just behind phosphor coated screen. Primary gun deposits pattern of positive charge on this grid and it is

transferred to phosphor coated screen by continuous flood of electrons produced by flood gun. Thus Storage Mesh stores picture to be displayed in form of positive charge distribution.

4. Collector –
   This grid is located just behind storage mesh and purpose of this negatively charged grid is to smooth out flow of flood electrons.

Working principle of DVST:

In DVST similar with CRT electron gun and phosphor coated method is used. But in this no electron beam is used to directly writing pictures on screen, but instead of this we can used Storage mesh wire grid is used it is just located behind phosphor coated screen. There is also another grid located just behind storage mesh is called Collector and this purpose is to smooth out flow of flood electrons. The flood gun produce large number of electrons, this negatively charged grid reduces speed of these electrons. Then electrons pass through collector at low velocity and attracted by positive charged portions of storage mesh and strike at portions of phosphor coated screen to display picture. Some electrons get repelled by other portions of mesh that are negatively charged.

Since the collector has slowly down electrons, in this way they not able to produce sharpened images. So to reduce this problem, screen itself is maintained at a high positive potential by means of voltage applied to thin aluminium coating between tube face and phosphor.

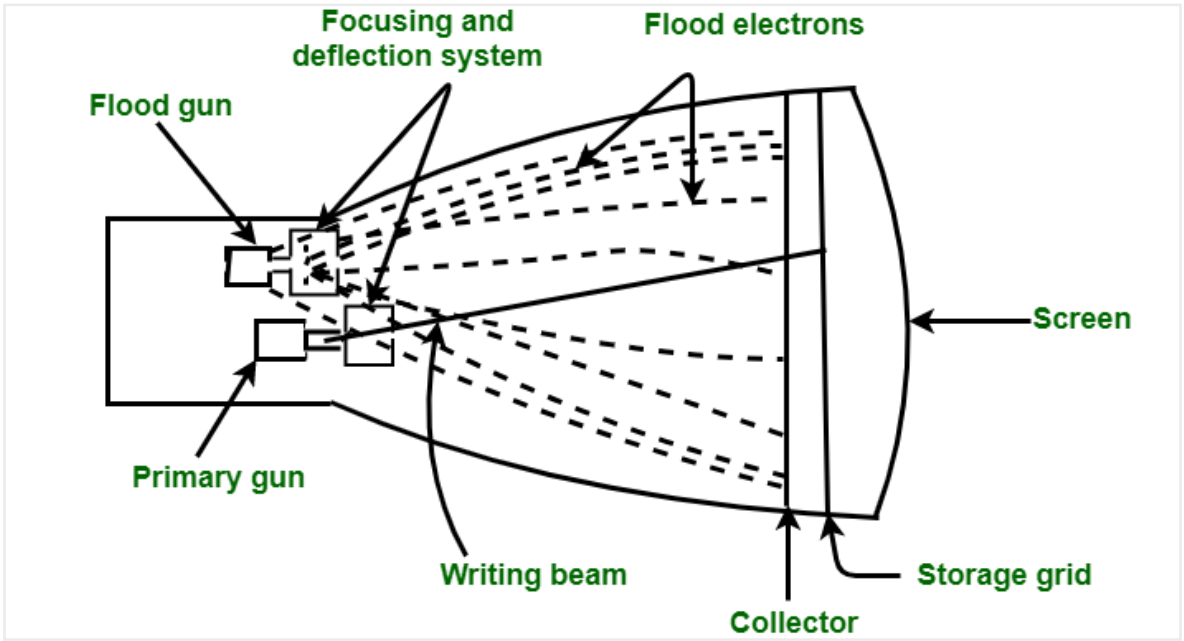


Figure – Direct View Storage Tube

Advantages of DVST :

- For picture display it does not require refreshing.
- Display complex pictures at high resolution without any flicker.
- No use of frame buffer or refresh buffer.

Disadvantages of DVST :

- Not used for dynamic graphic such as animation.
- These systems do not display colors.
- To erase selected part of an image, entire screen needs to be erased and modified pictures needs to be redrawn.