Video Display Devices

The display devices are known as output devices. The most commonly used output device in a graphics video monitor. The operations of most video monitors are based on the standard cathode-ray-tube (CRT) design.

How the Interactive Graphics display works

The modern graphics display is extremely simple in construction. 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.

Cathode-Ray-Tubes

A CRT is an evacuated glass tube. An electron gun at the rear of the tube produces a beam of electrons which is directed towards the front of the tube (screen). The inner side of the screen is coated with phosphor substance which gives off light when it is stroked by electrons. It is possible to control the point at which the electron beam strikes the screen, and therefore the position of the dot upon the screen, by deflecting the electron beam. The fig below shows the electrostatic deflection of the electron beam in a CRT.

The deflection system of the cathode-ray-tube consists of two pairs of parallel plates, referred to as the vertical and horizontal deflection plates. The voltage applied to vertical plates controls the vertical deflection of the electron beam and voltage applied to the horizontal deflection plates controls the horizontal deflection of the electron
beam. There are two techniques used for producing image on the CRT screen: Vector scan / random scan and Raster scan.

**Vector Scan / Random Scan Display**

As shown in fig, vector scan CRT display directly traces out only the desired lines on CRT i.e. If we want a line connecting point A with point B on the vector graphics display, we simply drive the beam deflection circuitry, which will cause beam to go directly from point A to B. If we want to move the beam from point A to point B without showing a line between points, we can blank the beam as we move it. To move the beam across
CRT, the information about, magnitude and direction is required. This information is generated with the help of vector graphics generator.

The figure below shows the typical vector display architecture. It consists of display controller, central processing unit (CPU), display buffer memory and a CRT. A display controller is connected as an I/O peripheral to the central processing unit. The display buffer memory stores the computer produced display list or display program. The program contains point and line plotting commands with \((x,y)\) or \((x,y,z)\) end point co-ordinates, as well as character plotting commands. The display controller interprets commands for plotting points, lines and characters and sends digital and point coordinates to a vector generator. The vector generator then converts the digital co-ordinate values to analog voltages for beam-deflection circuits that displace an electron beam writing on CRT’s phosphor coating.

Display buffer memory

In vector display beam is deflected from end point to end point, hence this technique is also called random scan. We know as beam, strikes phosphor it emits light. But phosphor light decays after few milliseconds and therefore it is necessary to repeat through the display list to refresh the phosphor at least 30 times per second to avoid
flicker. As display buffer is used to store display list and it is used for refreshing, the display buffer memory is also called refresh buffer.

**Raster Scan Display**

The Figure below shows the architecture of a raster display. It consists of display controller, central processing unit (CPU), video controller, refresh buffer, keyboard, mouse and the CRT.

As shown in the fig below the display image is stored in the form of 1s and 0s in the refresh buffer. The video controller reads this refresh buffer and produces the actual image on the screen. It does this by scanning one scan line at a time, from top to bottom and then back to the top.
Raster scan is the most common method of displaying images on the CRT screen. In this method, the horizontal and vertical deflection signals are generated to move the beam all over the screen in a pattern.

Here, the beam is swept back and forth from the left to the right across the screen. When the beam is moved from the left to the right, it is ON. The beam is OFF, when it is moved from the right to the left.

When the beam reaches the bottom of the screen, it is made OFF and rapidly retraced back to the top left to start again. A display produced in this way is called raster scan display.

In raster scan displays a special area of memory is dedicated to graphics only. This memory area is called frame buffer. It holds the set of intensity values for all the screen points. The stored intensity values are retrieved from frame buffer and displayed on the screen one row (scan line) at a time. Each screen point is referred to as a pixel. Each pixel on the screen can be specified by its row and column number. Thus by specifying row and column number we can specify the pixel position on the screen.

Intensity range for pixel positions depends on the capability of the raster system. It can be a simple black and white system or color system. In a simple black and white system, each pixel position is either on or off, so only one bit per pixel is needed to control the intensity of the pixel positions. Additional bits are required when color and intensity variations can be displayed. Up to 24 bits per pixel are included in high quality display systems, which can require several megabytes of storage space for the frame buffer. On a black and white system with one bit per pixel, the frame buffer is called a bitmap. For systems with multiple bits per pixel, the frame buffer is often referred to as a pixmap.

<table>
<thead>
<tr>
<th>Vector Scan Display</th>
<th>Raster Scan Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In vector scan display the beam is moved between the end points of the graphics primitives.</td>
<td>In raster scan display the beam is moved all over the screen one scan line at a time, from top to bottom and then back to top.</td>
</tr>
<tr>
<td>2. Vector display flickers when the number of primitives in the buffer becomes too large.</td>
<td>In raster display, the refresh process is independent of the complexity of the image.</td>
</tr>
<tr>
<td>3. Scan conversion is not required.</td>
<td>Graphics primitives are specified in terms of their endpoints and must be scan</td>
</tr>
</tbody>
</table>
converted into their corresponding pixels in the frame buffer.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Scan conversion hardware is not required.</td>
<td>Because each primitive must be scan-converted, real time dynamics is far more computational and requires separate scan conversion hardware.</td>
</tr>
<tr>
<td>5.</td>
<td>Vector display draws continuous and smooth lines.</td>
<td>Raster display can display mathematically smooth lines, polygons, and boundaries of curved primitives only by approximating them with pixels on the raster grid.</td>
</tr>
<tr>
<td>6.</td>
<td>Cost is more.</td>
<td>Cost is low.</td>
</tr>
<tr>
<td>7.</td>
<td>Vector display only draws line characters.</td>
<td>Raster display has ability to display areas filled with solid colors or patterns.</td>
</tr>
</tbody>
</table>

**Important Characteristics of Video Display Devices**

**Persistence**: The major difference between phosphors is their persistence. It decides how long they continue to emit light after the electron beam is removed. Persistence is defined as the time it takes the emitted light from the screen to decay to one-tenth of its original intensity. Lower persistence phosphors require higher refreshing rates to maintain a picture on the screen without flicker. However it is useful for displaying animations. On the other hand higher persistence phosphors are useful for displaying static and highly complex pictures.

**Resolution**: Resolution indicates the maximum number of points that can be displayed without overlap on the CRT. It is defined as the number of points per centimeter that can be plotted horizontally and vertically. Resolution depends on the type of phosphor, the intensity to be displayed and the focusing and deflection systems used in the CRT.

**Aspect Ratio**: It is the ratio of vertical points to horizontal points to produce equal length lines in both directions on the screen. An aspect ratio of 4/5 means that a vertical line plotted with four points has the same length as a horizontal line plotted with five points.