Stereoscopic and virtual-reality systems
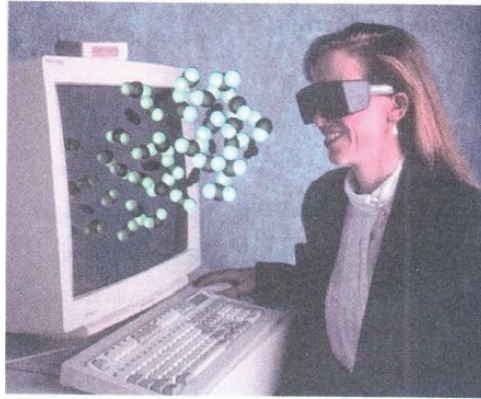
Stereoscopic system

Fig. 1.12: - stereoscopic views.

- Stereoscopic views does not produce three dimensional images, but it produce 3D effects by presenting different view to each eye of an observer so that it appears to have depth.
- To obtain this we first need to obtain two views of object generated from viewing direction corresponding to each eye.
- We can construct the two views as computer generated scenes with different viewing positions or we can use stereo camera pair to photograph some object or scene.
- When we see simultaneously both the view as left view with left eye and right view with right eye then two views is merge and produce image which appears to have depth.
- One way to produce stereoscopic effect is to display each of the two views with raster system on alternate refresh cycles.
- The screen is viewed through glasses with each lance design such a way that it act as a rapidly alternating shutter that is synchronized to block out one of the views.

Virtual-reality

Fig. 1.13: - virtual reality.

- Virtual reality is the system which produce images in such a way that we feel that our surrounding is what we are set in display devices but in actually it does not.
- In virtual reality user can step into a scene and interact with the environment.

- A head set containing an optical system to generate the stereoscopic views is commonly used in conjunction with interactive input devices to locate and manipulate objects in the scene.
- Sensor in the head set keeps track of the viewer's position so that the front and back of objects can be seen as the viewer "walks through" and interacts with the display.
- Virtual reality can also be produce with stereoscopic glass and video monitor instead of head set. This provides low cost virtual reality system.
- Sensor on display screen track head position and accordingly adjust image depth.

Raster graphics systems

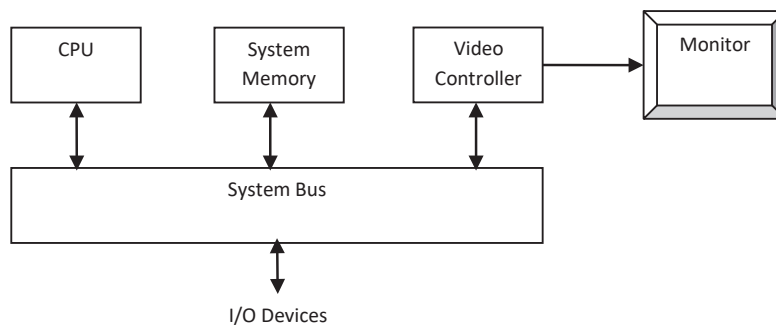## Simple raster graphics system

Fig. 1.14: - Architecture of a simple raster graphics system.

- Raster graphics systems having additional processing unit like video controller or display controller.
- Here frame buffer can be anywhere in the system memory and video controller access this for refresh the screen.
- In addition to video controller more processors are used as co-processors to accelerate the system in sophisticated raster system.

Raster graphics system with a fixed portion of the system memory reserved for the frame buffer
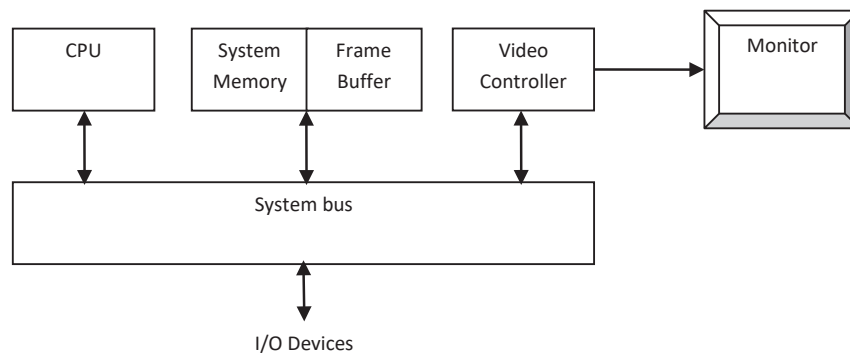

Fig. 1.15: - Architecture of a raster graphics system with a fixed portion of the system memory reserved for the frame buffer.

- A fixed area of the system memory is reserved for the frame buffer and the video controller can directly access that frame buffer memory.
- Frame buffer location and the screen position are referred in Cartesian coordinates.
- For many graphics monitors the coordinate origin is defined at the lower left screen corner.
- Screen surface is then represented as the first quadrant of the two dimensional systems with positive X-value increases as left to right and positive Y-value increases bottom to top.

Basic refresh operation of video controller

```
        ┌──────────────────┐        Horizontal and Vertical
        │   Raster Scan    │───────▶ Deflection Voltages
        │    Generator     │
        └──────────────────┘
            │          │
            ▼          ▼
        ┌───────┐  ┌───────┐
        │   X   │  │   Y   │
        │register│ │register│
        └───────┘  └───────┘
            │          │
            ▼          ▼
        ┌──────────────────┐     ┌──────────┐
        │  Memory Address  │     │  Pixel   │───────▶ Intensity
        └──────────────────┘     │ register │
                 │               └──────────┘
                 ▼                    ▲
        ┌─────────────────────────────┐
        │         Frame Buffer        │
        └─────────────────────────────┘
```
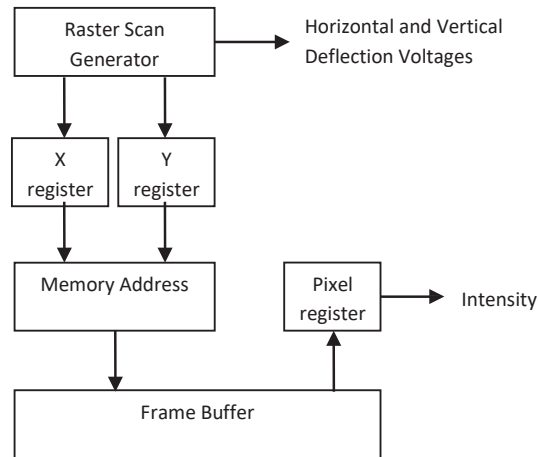
Fig. 1.16: - Basic video controller refresh operation.

- Two registers are used to store the coordinates of the screen pixels which are X and Y
- Initially the X is set to 0 and Y is set to Ymax.
- The value stored in frame buffer for this pixel is retrieved and used to set the intensity of the CRT beam.
- After this X register is incremented by one.
- This procedure is repeated till X becomes equals to Xmax.
- Then X is set to 0 and Y is decremented by one pixel and repeat above procedure.
- This whole procedure is repeated till Y is become equals to 0 and complete the one refresh cycle. Then controller reset the register as top –left corner i.e. X=0 and Y=Ymax and refresh process start for next refresh cycle.
- Since screen must be refreshed at the rate of 60 frames per second the simple procedure illustrated in figure cannot be accommodated by typical RAM chips.
- To speed up pixel processing video controller retrieves multiple values at a time using more numbers of registers and simultaneously refresh block of pixel.
- Such a way it can speed up and accommodate refresh rate more than 60 frames per second.

Raster-graphics system with a display processor

```
┌─────────────┬─────────┐        ┌────────────┐        ┌──────────────┐
│   Display   │ Frame   │        │   Video    │        │   Monitor    │
│  Processor  │ Buffer  │───────▶│ Controller │───────▶│              │
│   Memory    │         │        │            │        │              │
└─────────────┴─────────┘        └────────────┘        └──────────────┘
       ▲
       │
       ▼
┌──────────┐   ┌─────────────┐   ┌────────────┐
│   CPU    │   │   Display   │   │   System   │
│          │   │  Processor  │   │   Memory   │
└──────────┘   └─────────────┘   └────────────┘
     ▲                ▲                 ▲
     │                │                 │
     ▼                ▼                 ▼
┌──────────────────────────────────────────────┐
│                 System Bus                     │
└──────────────────────────────────────────────┘
                     ▲
                     │
                     ▼
                I/O Devices
```
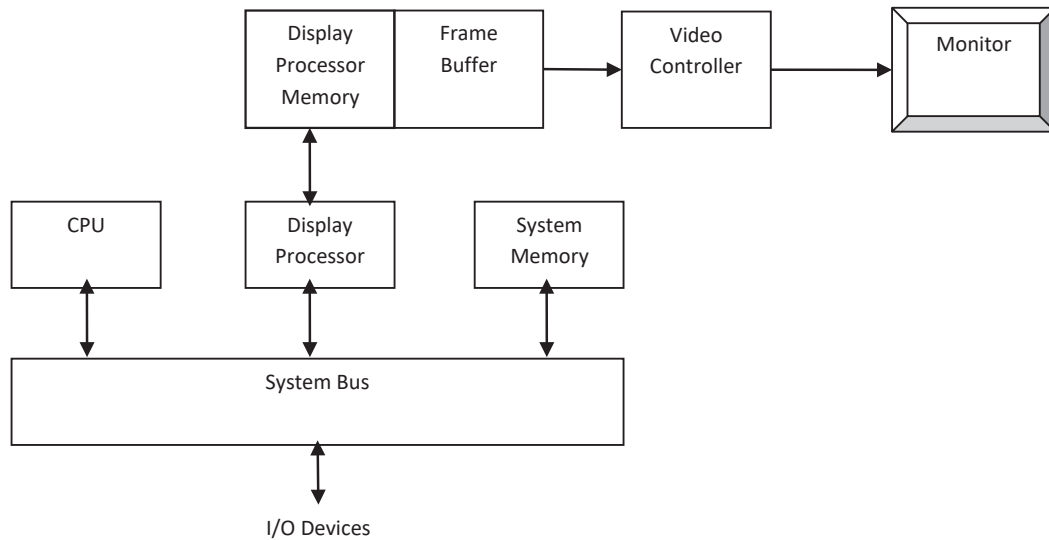
Fig. 1.17: - Architecture of a raster-graphics system with a display processor.

- One way to designing raster system is having separate display coprocessor.
- Purpose of display processor is to free CPU from graphics work.
- Display processors have their own separate memory for fast operation.
- Main work of display processor is digitalizing a picture definition given into a set of pixel intensity values for store in frame buffer.
- This digitalization process is scan conversion.
- Display processor also performs many other functions such as generating various line styles (dashed, dotted, or solid). Display color areas and performing some transformation for manipulating object.
- It also interfaces with interactive input devices such as mouse.
- For reduce memory requirements in raster scan system methods have been devised for organizing the frame buffer as a line list and encoding the intensity information.
- One way to do this is to store each scan line as a set of integer pair one number indicate number of adjacent pixels on the scan line that are having same intensity and second stores intensity value this technique is called run-length encoding.
- A similar approach is when pixel. Intensity is changes linearly, encoded the raster as a set of rectangular areas (cell encoding).
- Disadvantages of encoding is when run length is small it requires more memory then original frame buffer.
- It also difficult for display controller to process the raster when many sort runs are involved.
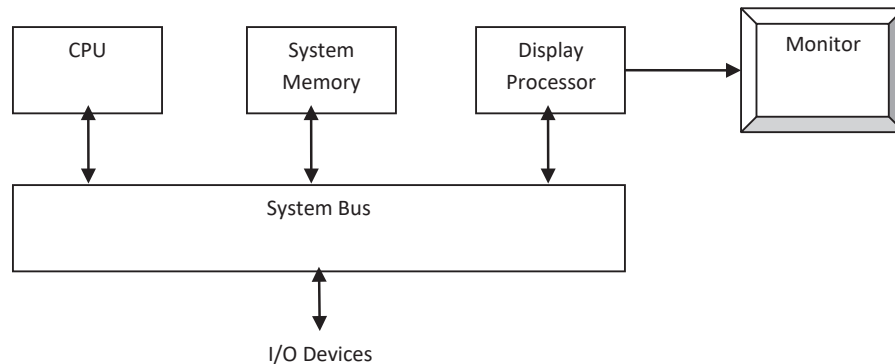
Random- scan system

Fig. 1.18: - Architecture of a simple random-scan system.

- An application program is input & stored in the system memory along with a graphics package.
- Graphics commands in the application program are translated by the graphics package into a display file stored in the system memory.
- This display file is used by display processor to refresh the screen.
- Display process goes through each command in display file. Once during every refresh cycle.
- Sometimes the display processor in random scan system is also known as display processing unit or a graphics controller.
- In this system graphics platform are drawn on random scan system by directing the electron beam along the component times of the picture.
- Lines are defined by coordinate end points.
- This input coordinate values are converts to X and Y deflection voltages.
- A scene is then drawn one line at a time.

Graphics input devices

Keyboards
- Keyboards are used as entering text strings. It is efficient devices for inputting such a non-graphics data as picture label.
- Cursor control key's & function keys are common features on general purpose keyboards.
- Many other application of key board which we are using daily used of computer graphics are commanding & controlling through keyboard etc.

Mouse
- Mouse is small size hand-held box used to position screen cursor.
- Wheel or roller or optical sensor is directing pointer on the according to movement of mouse.
- Three buttons are placed on the top of the mouse for signaling the execution of some operation.
- Now a day's more advance mouse is available which are very useful in graphics application for example Z mouse.

Trackball and Spaceball
- Trackball is ball that can be rotated with the finger or palm of the hand to produce cursor movement.

- Potentiometer attached to the ball, measure the amount and direction of rotation.
- They are often mounted on keyboard or Z mouse.
- Space ball provide six-degree of freedom i.e. three dimensional.
- In space ball strain gauges measure the amount of pressure applied to the space ball to provide input for spatial positioning and orientation as the ball is pushed or pulled in various directions.
- Space balls are used in 3D positioning and selection operations in virtual reality system, modeling, animation, CAD and other application.

Joysticks
- A joy stick consists of small vertical lever mounted on a base that is used to steer the screen cursor around.
- Most joy sticks selects screen positioning according to actual movement of stick (lever).
- Some joy sticks are works on pressure applied on sticks.
- Sometimes joy stick mounted on keyboard or sometimes used alone.
- Movement of the stick defines the movement of the cursor.
- In pressure sensitive stick pressure applied on stick decides movement of the cursor. This pressure is measured using strain gauge.
- This pressure sensitive joy sticks also called as isometric joy sticks and they are non movable sticks.

Data glove
- Data glove is used to grasp virtual objects.
- The glow is constructed with series of sensors that detect hand and figure motions.
- Electromagnetic coupling is used between transmitter and receiver antennas which used to provide position and orientation of the hand.
- Transmitter & receiver Antenna can be structured as a set of three mutually perpendicular coils forming 3D Cartesian coordinates system.
- Input from the glove can be used to position or manipulate object in a virtual scene.

Digitizer
- Digitizer is common device for drawing painting or interactively selecting coordinates position on an object.
- One type of digitizers is graphics tablet which input two dimensional coordinates by activating hand cursor or stylus at selected position on a flat surface.
- Stylus is flat pencil shaped device that is pointed at the position on the tablet.

Image Scanner
- Image Scanner scan drawing, graph, color, & black and white photos or text and can stored for computer processing by passing an optical scanning mechanism over the information to be stored.
- Once we have internal representation of a picture we can apply transformation.
- We can also apply various image processing methods to modify the picture.
- For scanned text we can apply modification operation.

Touch Panels
- As name suggest Touch Panels allow displaying objects or screen-position to be selected with the touch or finger.
- A typical application is selecting processing option shown in graphical icons.

- Some system such as a plasma panel are designed with touch screen
- Other system can be adapted for touch input by fitting transparent touch sensing mechanism over a screen.
- Touch input can be recorded with following methods.
  1. Optical methods
  2. Electrical methods
  3. Acoustical methods

Optical method
- Optical touch panel employ a line of infrared LEDs along one vertical and one horizontal edge.
- The opposite edges of the edges containing LEDs are contain light detectors.
- When we touch at a particular position the line of light path breaks and according to that breaking line coordinate values are measured.
- In case two line cuts it will take average of both pixel positions.
- LEDs operate at infrared frequency so it cannot be visible to user.

Electrical method
- An electrical touch panel is constructed with two transparent plates separated by small distance.
- One is coated with conducting material and other is coated with resistive material.
- When outer plate is touch it will come into contact with internal plate.
- When both plates touch it creates voltage drop across the resistive plate that is converted into coordinate values of the selected position.

Acoustical method
- In acoustical touch panel high frequency sound waves are generated in horizontal and vertical direction across a glass plates.
- When we touch the screen the waves from that line are reflected from finger.
- These reflected waves reach again at transmitter position and time difference between sending and receiving is measure and converted into coordinate values.

Light pens
- Light pens are pencil-shaped device used to select positions by detecting light coming from points on the CRT screen.
- Activated light pens pointed at a spot on the screen as the electron beam lights up that spot and generate electronic pulse that causes the coordinate position of the electron beam to be recorded.

Voice systems
- It is used to accept voice command in some graphics workstations.
- It is used to initiate graphics operations.
- It will match input against predefined directory of words and phrases.
- Dictionary is setup for a particular operator by recording his voice.
- Each word is speak several times and then analyze the word and establishes a frequency pattern for that word along with corresponding function need to be performed.
- When operator speaks command it will match with predefine dictionary and perform desired action.

Graphics software and standard

- There are mainly two types of graphics software:
    1. General programming package
    2. Special-purpose application package

General programming package

- A general programming package provides an extensive set of graphics function that can be used in high level programming language such as C or FORTRAN.
- It includes basic drawing element shape like line, curves, polygon, color of element transformation etc.
- Example: - GL (Graphics Library).

Special-purpose application package

- Special-purpose application package are customize for particular application which implement required facility and provides interface so that user need not to vory about how it will work (programming). User can simply use it by interfacing with application.
- Example: - CAD, medical and business systems.

Coordinate representations

- Except few all other general packages are designed to be used with Cartesian coordinate specifications.
- If coordinate values for a picture are specified is some other reference frame they must be converted to Cartesian coordinate before giving input to graphics package.
- Special-purpose package may allow use of other coordinates which suits application.
- In general several different Cartesian reference frames are used to construct and display scene.
- We can construct shape of object with separate coordinate system called modeling coordinates or sometimes local coordinates or master coordinates.
- Once individual object shapes have been specified we can place the objects into appropriate positions called world coordinates.
- Finally the World-coordinates description of the scene is transferred to one or more output device reference frame for display. These display coordinates system are referred to as "**Device Coordinates"** or "**Screen Coordinates".**
- Generally a graphic system first converts the world-coordinates position to normalized device coordinates. In the range from 0 to 1 before final conversion to specific device coordinates.
- An initial modeling coordinates position (Xmc,Ymc) in this illustration is transferred to a device coordinates position(Xdc,Ydc) with the sequence (Xmc,Ymc)$\rightarrow$ (Xwc,Ywc)$\rightarrow$ (Xnc,Ync)$\rightarrow$ (Xdc,Ydc).

Graphic Function

- A general purpose graphics package provides user with Varity of function for creating and manipulating pictures.
- The basic building blocks for pictures are referred to as output primitives. They includes character, string, and geometry entities such as point, straight lines, curved lines, filled areas and shapes defined with arrays of color points.
- Input functions are used for control & process the various input device such as mouse, tablet, etc.
- Control operations are used to controlling and housekeeping tasks such as clearing display screen etc.
- All such inbuilt function which we can use for our purpose are known as graphics function