RASTER DISPLAYS

- Store the primitives in a framebuffer, or refresh buffer, which is a RAM with 1024*1280, or $V \times H$ addressable pixels.
- Bitmap -- array of 0/1 (pixels); pixmap -- array of gray-scale pixels.
- Monochrome -- bi-level (0/1); gray-scale -- multiple level (0-15); color -- (r, g, b).
- Scan-conversion (rasterization) -- objects are converted into discrete pixels in framebuffer.
- Aliasing -- jaggies or staircasing of lines/edges; anti-aliasing -- dealing with aliasing.
- Resolution -- # of distinguishable lines per inch.
LASER PRINTER (HARD COPY DISPLAY DEVICE)

The areas hit by the beam lose their charges color -- scan each line for 3 times.

CRT (CATHODE RAY TUBE)

Persistence: how long they continue to emit light.
Liquid Crystals (LC)

- intermediary substance between a liquid and solid state of matter.
- light passes through liquid crystal changes when it is stimulated by an electrical charge.
Operating Principle

• When coming into contact with grooved surface in a fixed direction, liquid crystal molecules line up parallel along the grooves.

• When voltage is applied (online), Liquid crystal molecules straighten out of their helix pattern vertically (Along with the electric field)
Operating Principle

Polarization of light

- When unpolarized light passes through a polarizing filter, only one plane of polarization is transmitted. Two polarizing filters used together transmit light differently depending on their relative orientation.
Sequences of offline and online mode

**Offline**
1. Light is polarized on the upper plate.
2. Light moves along liquid crystals (twist).
3. Molecules and lights are parallel to lower analyzer.
4. Light passes through the plate.
5. Screen appear transparent.

**Online**
1. ...
2. ...
3. Molecules and lights are perpendicular to lower analyzer.
4. Light cannot pass through the plate.
5. Screen appear dark.
Optical Response

- twisted nematic displays can switch between light and dark states, or somewhere in between (grayscale).
- Electro-distortional curve is shown as follows:

![Graphs showing electro-distortional response](image)

- the electro-distortional response determines the transmission of light through the cell.
- Different light intensity of an image projected on the screen is determined by different voltage supply. Thus the level of blocking of light may vary.
• **Graphics card**: handle scan-conversion and other advanced graphics functions
Video (Graphics) Card

**AGP**

AGP : Designed for use with 3D Graphics with a bandwidth of 266 Mbps to 1.07 Gbps.

**PCI**

PCI : It has a bandwidth of up to 133 Mbps to 512 Mbps.

**PCI-E**

PCI-E : PCI Express doubles the data transfer rates of a standard PCI card. It is the replacement for AGP.
Video Card Monitor Connection

- **Video Graphics Adapter**: VGA connects to analog monitors.
- **Digital Visual Interface**: DVI connects to digital display devices.
- **S-Video**: S-Video connects to a television, only capable of 480i or 576i resolution.
- **High Definition Multimedia Interface**: HDMI connects to your HDTV set.
What's a GPU?

- A Graphics processing Unit (GPU) is the graphics card’s CPU.
- ATI (AMD) and NVIDIA produce a large amount of the GPUs on the market.
Who Makes Video Cards?

- Asus, BFG, Chaintech, ECS, eVGA, Foxconn, Gigabyte, MSI, PNY, And XFX, etc.
• **Framebuffer (bit planes):** RAM with the generated pixmap and attributes ready for display

• **Video controller:** refresh the display; **interlaced**
  -- fine as long as adjacent scan lines display similar information; **non-interlaced** (NI)

• # of bits for color: **direct** (RGB mode) and **indirect** (Index mode)

• **Z-buffer (bit planes):** corresponding to the framebuffer; depth of each pixel in the framebuffer for hidden surface removal
• **Double-buffering**: don’t display until the entire scene is rendered

• **Transformation**: calculations of coordinates of object moving, rotating, and change

• **Clipping**: no imaging system can see the whole world (internal representation) at once.

• **Projection**: 3D objects are displayed on 2D screen

• **Output from video controller**: RGB, mono-chrome, or NTSC (National TV System Committee, effective resolution 350*350); **video mixing**

• **RGB, NTSC, SECAM, PAL** have different standards with their own # of scan lines, frequencies and synchronization.