CSE 3200– Graphics Hardware Units 5, 6 & 7

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Outline

- Hardware Categories
  - Input Hardware
  - Processing Hardware
  - Output/Display Hardware
- Input Hardware
  - Logical & Physical Devices
  - Mouse, Trackball, Joy Stick
  - Keyboard
- Processing Hardware
  - CPU/GPU Architecture
  - Video Cards
- Output Hardware
  - Monitors/Screens
    - CRT
    - LCD
    - Plasma
  - Printers
- Conclusion
- Questions
- Review Questions

Hardware Categories?

- Three main categories in respect to CG:
  - Input Hardware: Devices that allow human interaction with the graphics system
  - Processing Hardware: Components that do or assist in the modeling and rendering of CG objects/scenes
  - Output Hardware: Devices that allows for the output of processed graphics from a graphics system

Input Hardware/Devices

- Input Hardware: Devices that allow human interaction with the graphics system
- As seen as the way of use or physically – it is referred to as a ***physical device***, eg:
  - Mouse, trackball, joystick (pointing/location devices, touch screen etc)
  - Keyboard, motion detectors etc. (more advance than pointing)
- As seen by the application/program – it is referred to as a ***logical device***.
  - Your graphics program need not to know how the device work but only how to accept the input
  - Mouse input is seen as a x and y value together with the state of the buttons
  - Keyboard input is seen as a character input

mouse logical v.s physical

- Mouse

```
void mouse(int btn, int state, int x, int y)
{
   if (btn==GLUT_RIGHT_BUTTON &&
      state==GLUT_DOWN) exit(1);
}
```

keboard logical v.s physical

- Keyboard

```
void processSpecialKeys(int key, int x, int y) {
    switch(key) {
    case GLUT_KEY_F1 : red = 1.0; green = 0.0;
    blue = 0.0; break;
    case GLUT_KEY_F2 : red = 0.0; green = 1.0; blue = 0.0; break;
    case GLUT_KEY_F3 : red = 0.0; green = 0.0; blue = 1.0; break;
    }
}
```

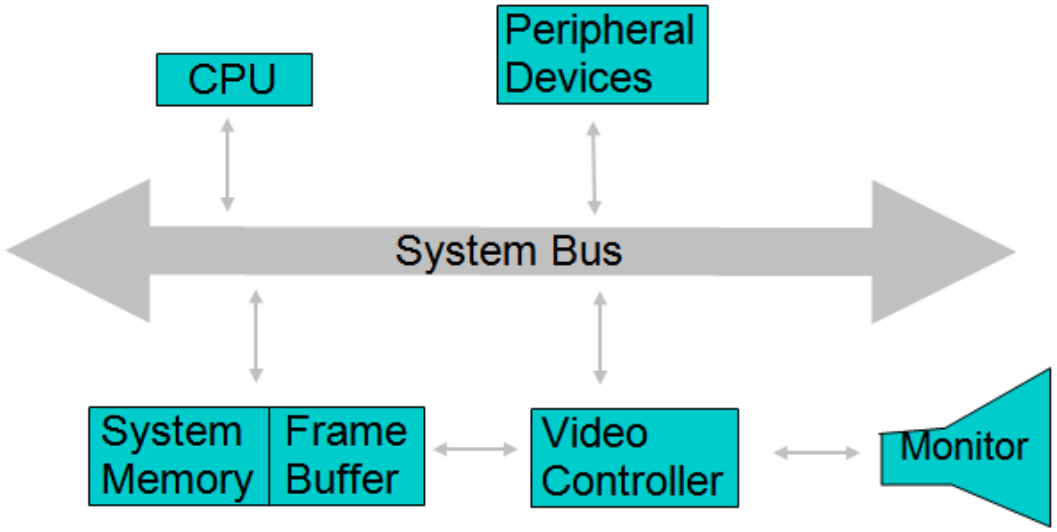
See More:
http://www.lighthouse3d.com/opengl/glut/index.php?5

Classes of Input (logical devices)

- *String*: a logical device that provides ASCII string to the user program
- *Locator*: A device that returns a position in world coordinates
- *Pick*: Returns the identifier of an object to the user program
- *Choice*: allows the selection of one option from a discrete number of options (menu item etc.)
- *Dial*: provide analog input to the user program (slide bars etc.)
- *Stroke*: A device that returns an array of location (drag on a mouse)

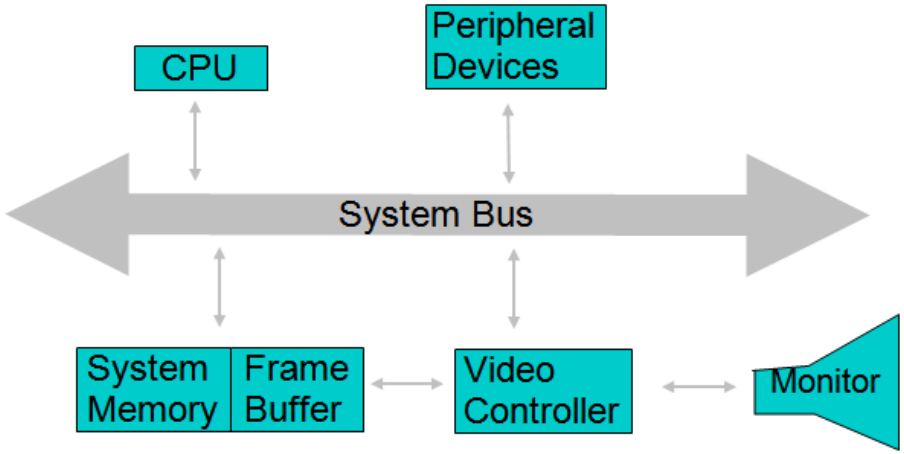
Processing Hardware

- Simple Raster Display System (old architecture in Micro-computers)
  - Frame buffer: stored pixel map of screen
  - Video controller just refreshes the frame buffer on the monitor periodically



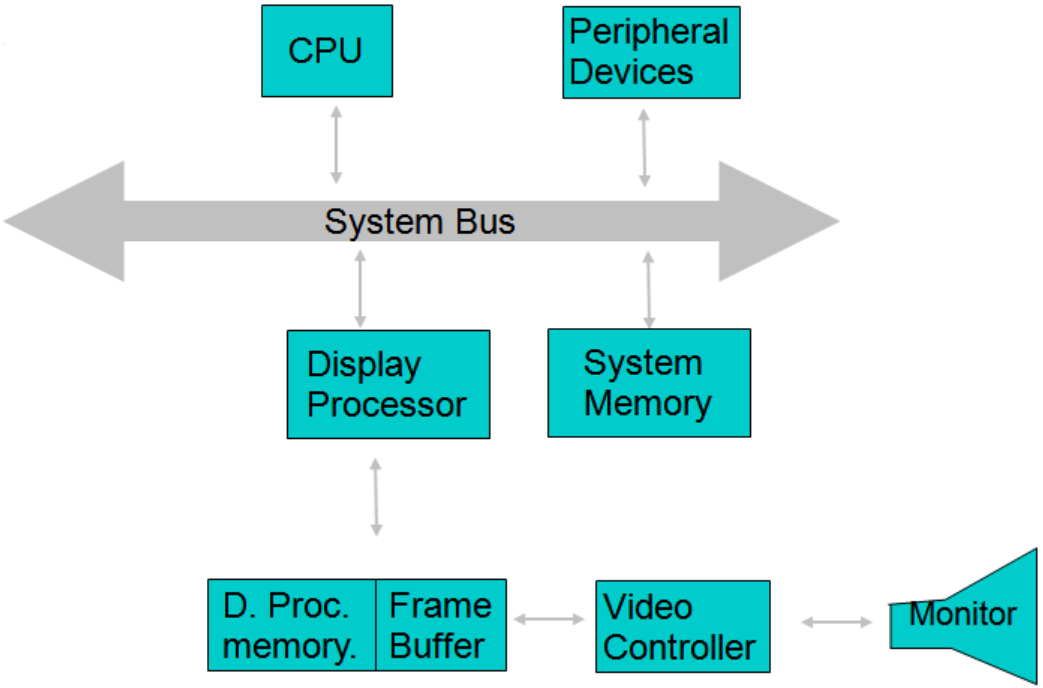
Processing Hardware

- Simple Raster Display System (old architecture in Micro-computers)
  - Inexpensive
  - Scan conversion of output primitives (lines, rectangles etc.) done by the CPU. Slow.
  - As refresh cycle increases, memory cycles used by the video controller increases. Memory is less available to CPU.
  - Solution: **Graphics Display Processor**



Graphics Display Processor

- Scan conversion, output primitives, raster operations (double buffering)
  - The GPU Architecture



Computer Video Cards

- **video card, video adapter, graphics-accelerator card, display adapter** or **graphics card .**
- Added functions,
  - accelerated rendering of 3D scenes and 2D graphics
  - video capture
  - TV-tuner adapter & TV output (s-video, HDMI),
  - MPEG-2/MPEG-4 decoding,
  - ability to connect multiple output.

Video Card Interface

- Main-board Interface:

Bus	Clock rate (MHz)	Bandwidth (MB/s)
PCI	33 - 100	132 - 800
AGP 4x	66	1000
AGP 8x	66	2000
PCIe x16	2500 / 5000	4000 / 8000
PCIe x16 2.0	5000 / 10000	8000 / 16000

Video Card – GPU

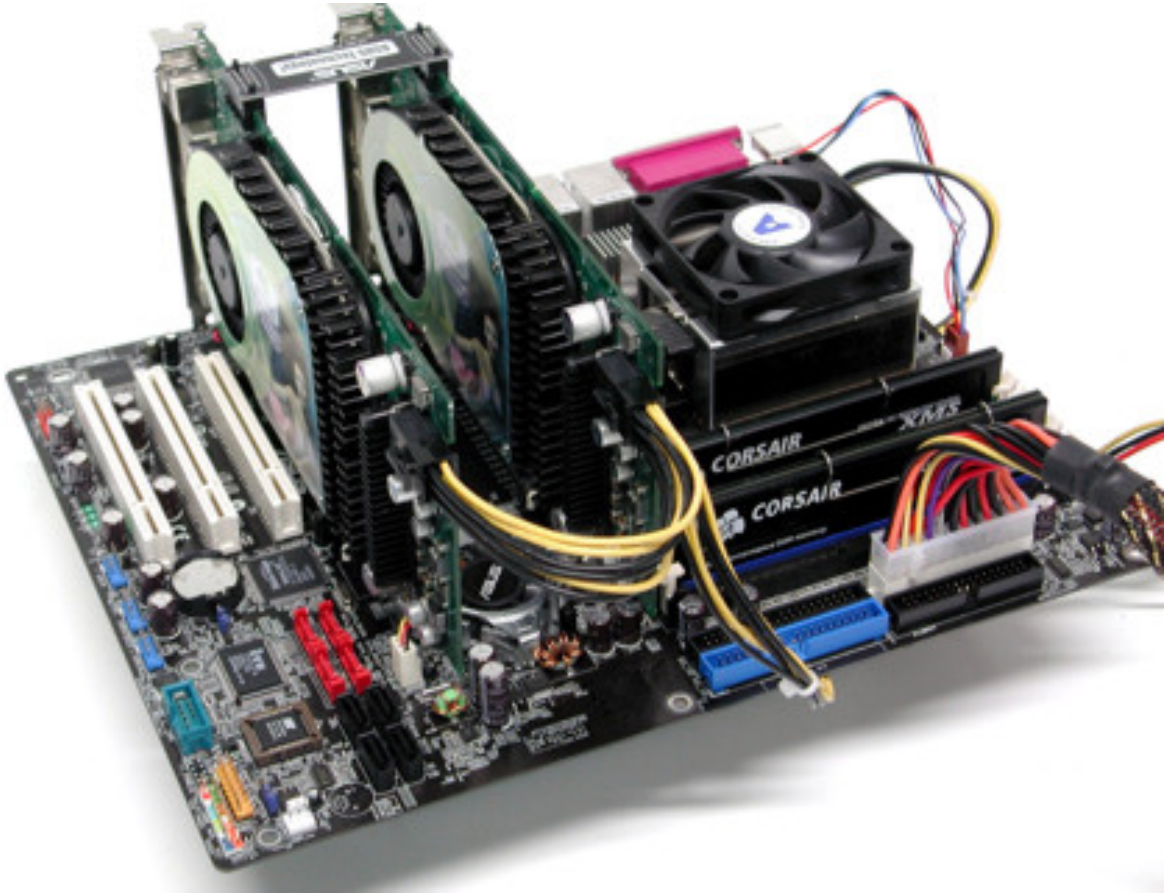
- GPU: a dedicated processor optimized for accelerating graphics. Designed specifically to
  - perform floating-point calculations
  - main attributes of the GPU are the
    - core clock frequency, which typically ranges from 250 MHz to 4 GHz
    - the number of pipelines (vertex and fragment shaders), which translate a 3D image characterized by vertices and lines into a 2D image formed by pixels
    - Video RAM

Video Card – Video Memory

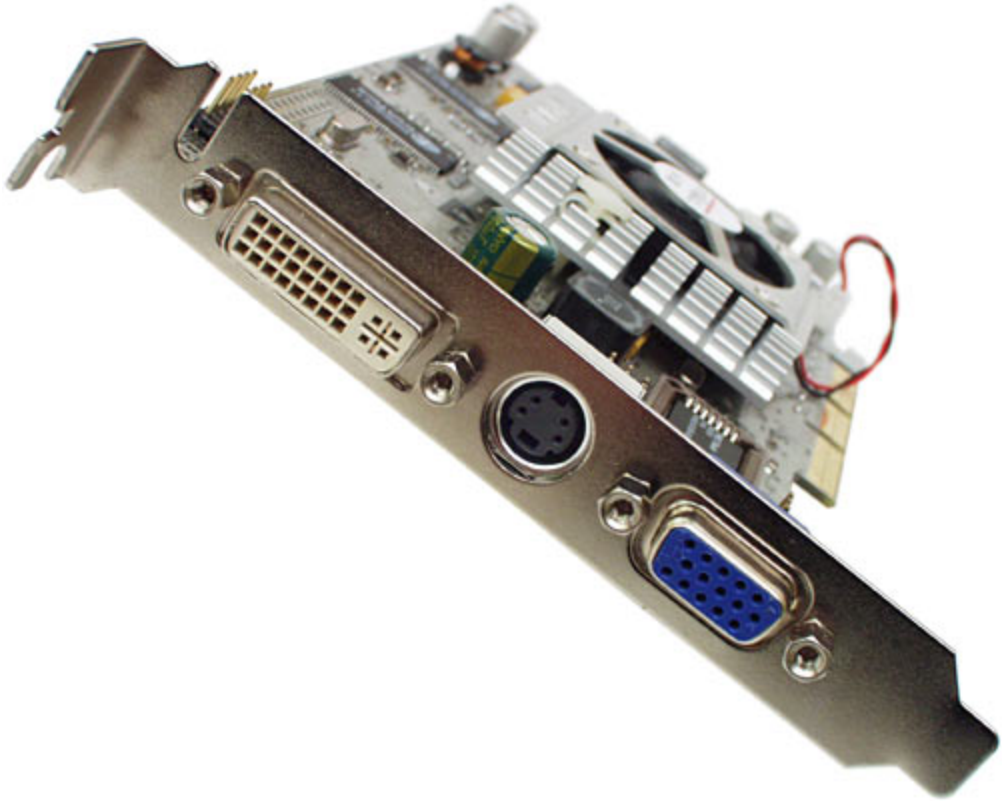
- Video Memory:
  - capacity ranges from 128 MB to 4 GB. (DDR – GDDR5)
  - usually high-speed or multi-port memory.
  - Memory clock rate is generally between 400 MHz and 3.8 GHz.
  - Video memory is used for storing data such as
    - the Z-buffer,
    - textures,
    - vertex buffers,
    - and compiled shader programs
    - Frame buffer(s)

- Cooling Issues: Active and Passive Cooling

Video Card Configuration



Video Cards Output Interface



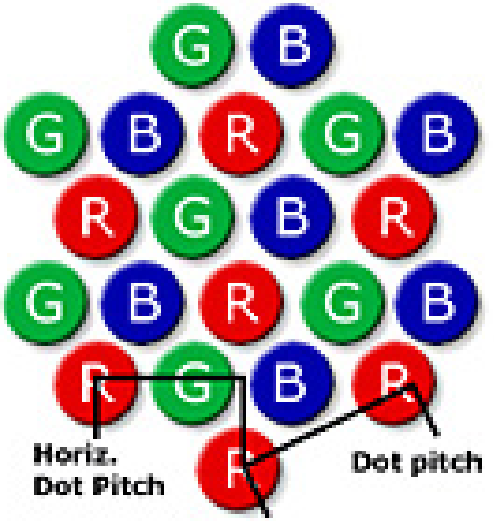
Output Hardware

- Output from a graphics system can take many forms,
  - Video Display Devices
  - Print Output Device
  - Recording Devices

- Video Display Devices
  - Liquid Crystal Display – LCD
  - *Raster* Cathode Ray Tube – CRT

Monitor Related Terms

- **Dot pitch** is measured in millimetres and it refers to the distance between like colored phosphors (in CRT) or cells (in LCD) on a screen. The lower the dot pitch the better the image quality. A dot pitch of .28mm or less is decent.

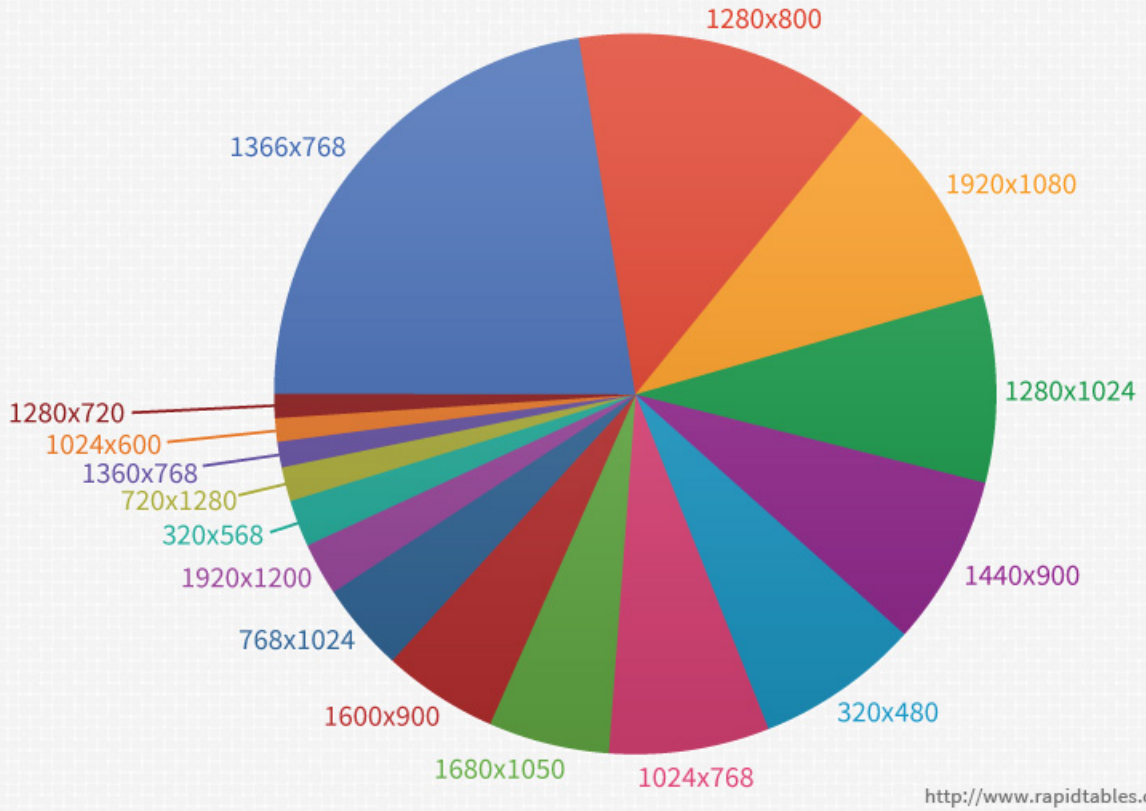


Monitor Related Terms Con't

- **Aspect ratio** refers to ratio between the width and the height of the screen. E.g. 4:3, 16:9

Monitor Related Terms Con't

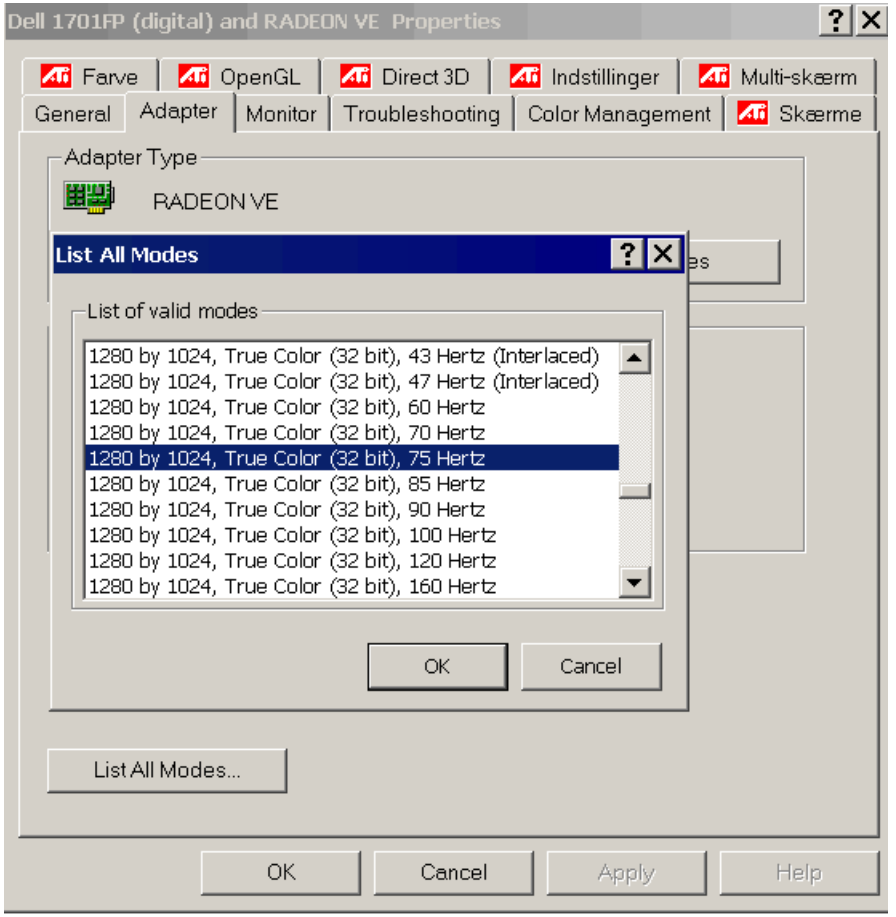
SCREEN RESOLUTION STATISTICS



http://www.rapidtables.com/web/dev/screen-resolution-statistics.htm

Monitor Related Terms Con't

- **Refresh rate** refers to the speed at which the entire screen is refreshed (how many times per second).
- 75Hz means 75 times in one second.
- Increasing the refresh rate decreases flickering, reducing eye strain.
- If you specify a refresh rate beyond what is recommended for your monitor, you might damage it!



Raster Cathode Ray Tube

- How it works?
  - A CRT monitor contains millions of tiny red, green, and blue phosphor dots that glow when struck by an electron beam that travels across the screen to create a visible image.
  - The phosphors are into fine RGB vertical strips; at maximum resolution on a monitor each pixel is made up of one RGB phosphor.

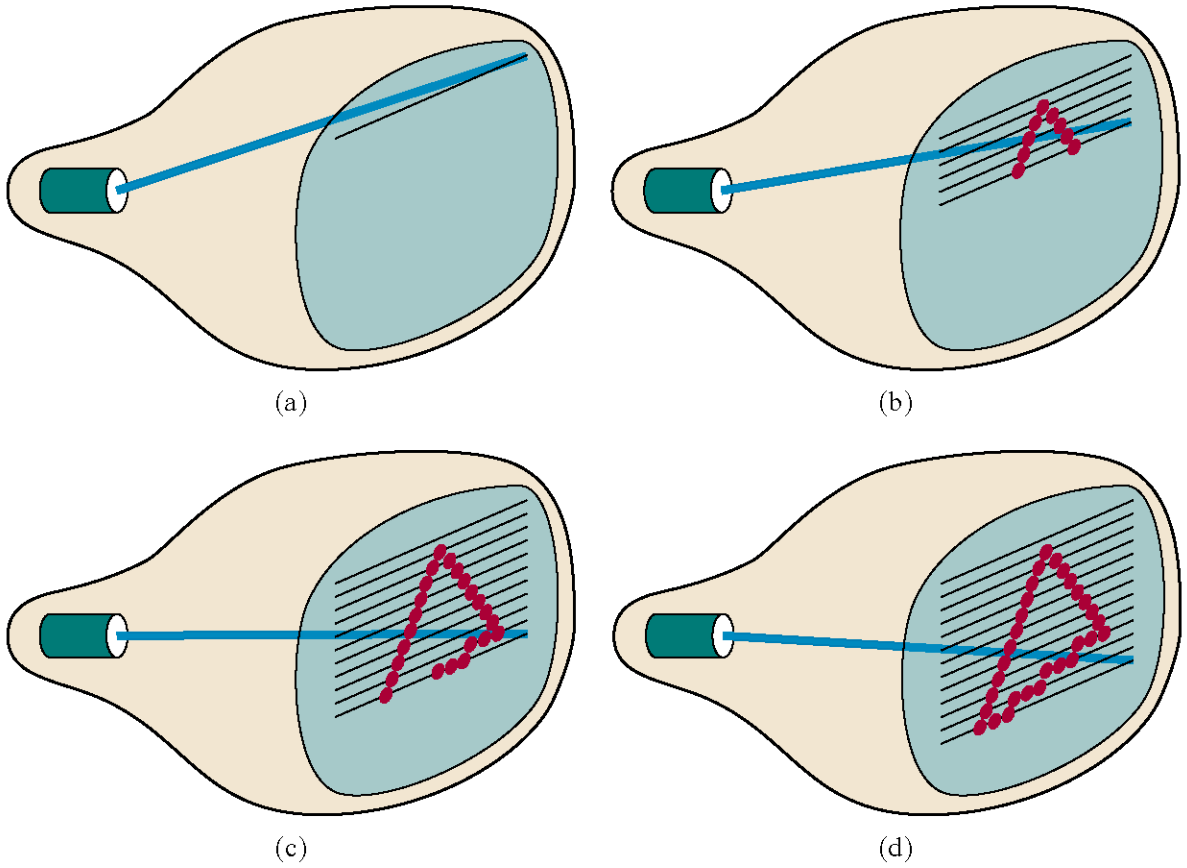


Figure 2-7
A raster-scan system displays an object as a set of discrete points across each scan line.

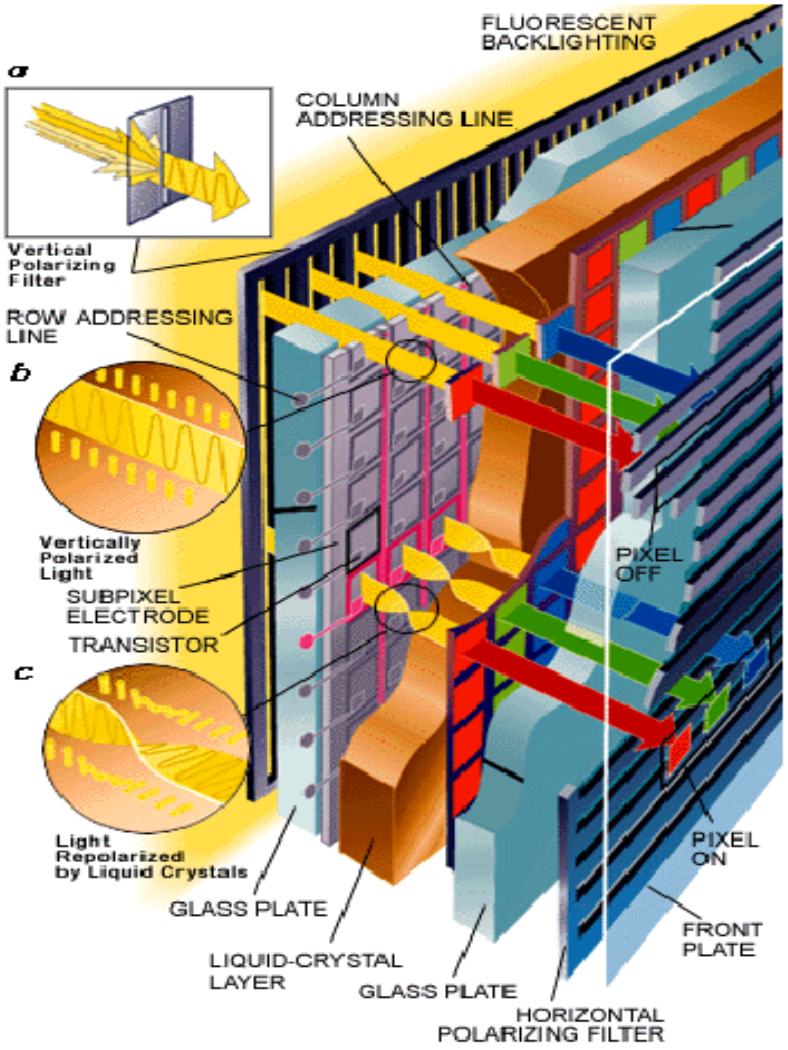
Raster Cathode Ray Tube

- Pros & Cons
- Pros:
  - Capable of high resolution (multiple options)
  - Good color fidelity
  - High contrast ratio (100:1)
- Cons:
  - More space
  - More power

Liquid Crystal Display

- Liquid crystal display technology works by blocking light.
  - LCD is made of two pieces of polarized glass (also called substrate) that contain a liquid crystal material between them. A backlight creates light that passes through the first substrate. At the same time, electrical currents cause the liquid crystal molecules to align to allow varying levels of light to pass through to the second substrate and create the colors and images that you see.
- No refresh unless the screen changes.

LCD


FLUORESCENT BACKLIGHTING
a
COLUMN ADDRESSING LINE
Vertical Polarizing Filter
ROW ADDRESSING LINE
b
Vertically Polarized Light
SUBPIXEL ELECTRODE
TRANSISTOR
c
Light Repolarized by Liquid Crystals
PIXEL OFF
PIXEL ON
GLASS PLATE
LIQUID-CRYSTAL LAYER
GLASS PLATE
FRONT PLATE
HORIZONTAL POLARIZING FILTER

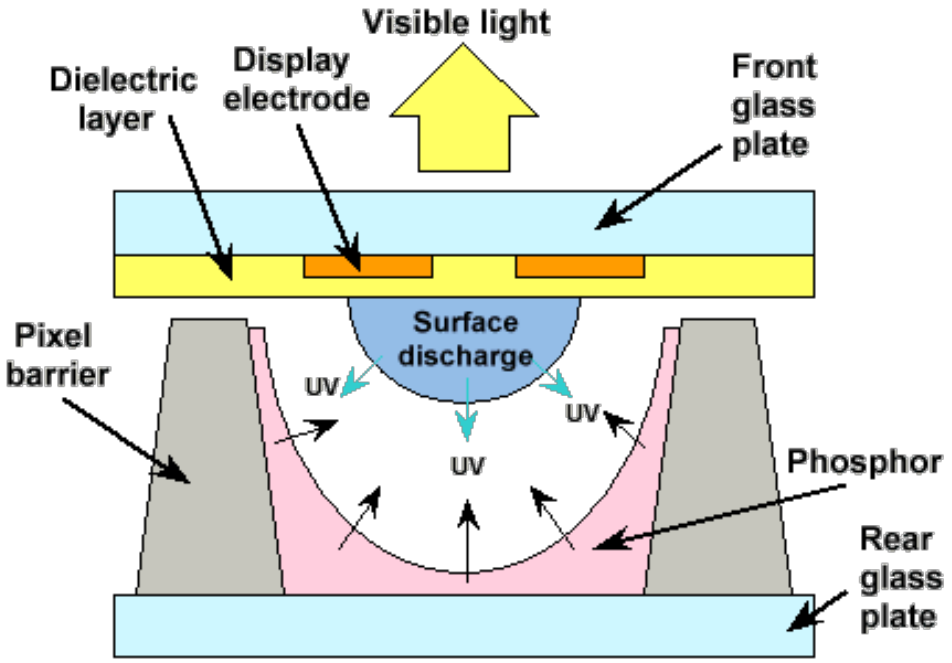
LCD – Pros & Cons

- Pros
  - Less space
  - Flicker free
  - Less power

- Cons
  - Decreased viewing angle
  - Manufactured for a prescribe resolution, if by chance your video card cannot support the required resolution then image quality is poor
  - Low contrast ratio
  - One or more pixels can die!

Plasma Displays

- Plasma display panels
  - Similar in principle to fluorescent light tubes
  - Small gas-filled capsules are excited by electric field, emits UV light
  - UV excites phosphor
  - Phosphor relaxes, emits some other color



Plasma Displays

- Plasma Display Panel Pros
  - Large viewing angle
  - Good for large-format displays
  - Fairly bright

- Cons
  - Expensive
  - Large pixels (~1 mm versus ~0.2 mm)
  - Phosphors gradually deplete
  - Less bright than CRTs, using more power

New Trend

- LED
- OLED
- Difference?
- Retina Display
  - Apple claims that the pixel density is high enough that the human eye is unable to notice pixelation at normal viewing distance. (PPI ~326)

Conclusion

- 3 categories of Hardware
- Input can be looked at as physical or logical devices
- Video Card/GPU architecture cause the advances we see today in CG

Questions?

References

- Logical & Physical Device: Angel, Edward. Interactive Computer Graphics: A Top-down Approach with OpenGL/Edward Angel. 2nd Ed.
- Video Card: http://en.wikipedia.org/wiki/Video_card
- CRT Displays: http://computer.howstuffworks.com/monitor7.htm
- LCD Displays:
- http://computer.howstuffworks.com/monitor5.htm