Input and Output Devices

Foley & Van Dam, Chapter 4
Topics

Output Devices:
• Display Devices - (CRTs, Monitors)
• Hard Copy Devices - (Printers, Plotters)

Input Devices:
• Alphanumeric input- (Keyboards)
• 2D Inputs - (Joystick, Mouse, Digitizer etc)
• 3D Inputs - (Glove, Space Ball)
• Image Inputs - (Camera, Scanner)
CRT - Cathode Ray Tube

- Cathode (electron gun)
- Deflection yoke
- Focusing anode
- Shadow mask and phosphor coated screen
- Electron guns
- Phosphors on glass screen
Vector vs. Raster Display

Vector Display:
- Only lines can be drawn
- Locations are converted to analog voltage applied to the deflection joke
- Lines drawn by gradual change of voltage
- Also known as random scan
- Refresh time is scene dependent
- Old fashioned - very uncommon today

Raster Display:
- Discrete grid of elements (frame buffer’s pixels)
- Complex to draw “nice” lines
- Arbitrary shapes can be drawn
- Frame buffer is scanned, one line at a time
- Used almost everywhere.
Terminology

Pixel: Picture element.
- Smallest accessible element in picture
- Assume rectangular or circular shape

Aspect Ratio: Ratio between physical dimensions of a pixel (not necessarily 1)

Dynamic Range: The ratio between the minimal (not zero!) and the maximal light intensity a display pixel can emit

Resolution: The number of distinguishable rows and columns in the device. Measured in:
- Absolute values (1K x 1K) or,
- Density values (300 dpi [=dots per inch])

Screen Space: A discrete Cartesian coordinate system of the screen pixels

Object Space: The Cartesian coordinate system of the universe, in which the objects (to be displayed) are embedded
Hardcopy Devices

Pen Plotter

Dot Matrix Printer

ElectroMagnet

pin motion

ink covered tape

paper
Hardcopy Devices

Ink Jet Printer

- Resistor is heated and bubble nucleates.
- Bubble grows to maximum ink drop is ejected.
- Bubble collapses. Drop breaks off.
- System returns to initial state.

Thermal-Bubble Ink Jet Printer

- Resistor is heated and bubble nucleates.
- Bubble grows to maximum ink drop is ejected.
- Bubble collapses. Drop breaks off.
- System returns to initial state.
Hardcopy Devices

Laser Printer

Color Laser Printer
Hardcopy Devices

Thermal Wax Printer
Hardcopy Devices

Dye Sublimation Printer

color plastic roll

thermal elements

paper

plastic ink

thermal elements
Input Devices

Keyboard:
– For alphanumerical input

Joystick:
– Usually two degrees of freedom
– Provides relative movement information

Mouse/Trackball
– A two degrees of freedom device controlled by a rolling ball
– Provides relative movement information

Digitizer/Tablet
– A two degrees of freedom device controlled by electro-magnetic or sound sensing
– Provides absolute position information

Touch Screen
– A CRT screen that can sense pressure on its surface

Light Pen
– A two degrees of freedom sensing device
– Synchronized with the CRT scan, it can locate a position on the screen
Input Devices

Data Glove/Polhemus
– A modern attempt to provide the user with more degrees of freedom
– Common in Virtual Reality applications
– Polyhemus can provide six degrees of freedom (rotation and translation)

Head Mounted Display
– Although primary a display device, it can also track position and orientation like Polhemus

Space Ball
– Six degrees of freedom sphere

Video Camera
– Captures an array of image pixels

Scanner
– Digitizes a hardcopy images
Data Gloves
Head Mounted Display
Space Ball
Three Pass Color Scanner

RGB Filters

CCD array
Single Pass Color Scanner

CCD strips
R  G  B
Single Pass Color Scanner

Dichroic filters

\[ \lambda > \text{cutoff} \]

\[ \lambda < \text{cutoff} \]
Low Cost Digital Camera

CCD Array
Virtual Ink Mimio
Logitech Digital Pen