INTERACTIVE INPUT DEVICES
(Sections 8-1 to 8-8 in *Computer Graphics)*

- **Physical Input Devices**
- **Logical Classification of Input Devices**

a fundamental objective of computer graphics
is to widen the bandwidth between men and machines

- by making it easy for machines to communicate with people (pictures) and
- by making it easy for people to communicate with machines (input methods)

Physical Input Devices

- keyboards
- touch panels
- light pens
- graphics tablets
- joysticks
- track balls
- mice
- voice systems

keyboards

- alphanumeric keyboards
  - convenient for inputting nongraphic data
    - text
    - numeric values
    - menu selections
    - graphic functions
  - convenient for cursor control
- special-purpose keyboards
    - a set of buttons for graphic function selection
    - a set of dials for entering scalar values
    - a set of switches for entering selections

touch panels

- transparent surfaces placed in front of the display surface
  - see figure 8-5 on page 157
- optical touch panels
  - infrared LEDs along one vertical edge and one horizontal edge
  - light detectors along the opposite edges
  - interrupted beams indicate position with 0.25" accuracy

touch panels, continued

- electrical touch panels
  - two transparent plates a small distance apart
    - one conductive
    - one resistive
  - touching brings the plates into contact
  - contact creates a voltage drop across the resistive plate
  - the voltage drop is converted to coordinate values

touch panels, continued

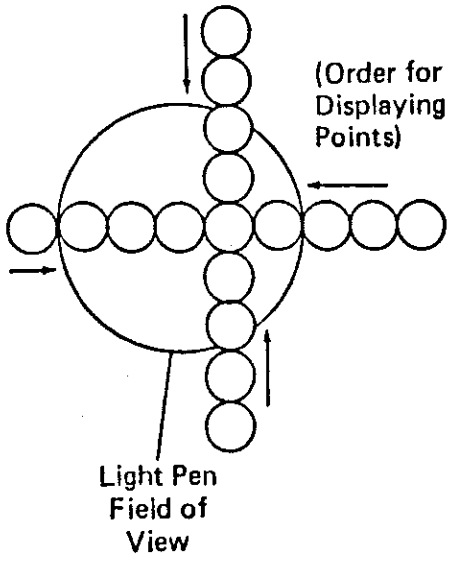
- acoustical touch panels
  - high frequency sound waves are generated vertically and horizontally across a glass plate
  - touching the screen causes part of each wave to be reflected
  - time between transmission of each wave and its reflection to the emitter determines position
- gas plasma touch panels
  - a grid of wires within a gas-filled panel
  - intersection points are energized by the user's touch

light pens

- pen shaped devices which detect light on the CRT
  - see figure 8-6 on page 158
- sensitive to fluorescence
- activated with mechanical or capacitive switches

light pen tracking

- the field of view is large relative to the screen pixel size
- provide a tracking cross
- slowly move the tracking cross
- calculate the new position of the tracking cross by activating pixels one at a time



- if the cross is lost
  - go back and retrieve it or
  - raster-scan, looking for the light pen

graphics tablets, hand cursors and styli

- hand cursors contain cross hairs for sighting positions on the tablet
- the stylus is a pen-like device which is positioned on the tablet
  - see figure 8-7 on page 159
- advantages of tablets
  - high accuracy
  - the display surface is not obscured

architecture of graphics tablets

- rectangular grid of embedded wires
  - each with a slightly different voltage or
  - each wire is gray-coded
  - stylus measures the voltage or senses the gray code to determine coordinates
- voltage gradients in a resistive plate
  - potential indicates the stylus position
- sound waves and strip microphones
  - perpendicular strip microphones
  - electrical spark in stylus tip emits sound
  - times of arrival of the sound at the two strip microphones indicate position
  - see figure 8-8a on page 160
- sound waves and point microphones
  - times of arrival of the sound at each point microphone indicates position
    - see figure 8-8b on page 160

three-dimensional digitizers

- acoustic devices
  - three perpendicular strip microphones or
  - four strip microphones around the edges of a two-dimensional tablet or
  - a hand-held transmitter and microphones at the four corners of a screen (the Lincoln Wand)
  - see figure 8-9 on page 161
- mechanical devices
  - wires dispensed by spring-loaded reels (the Utah Wand) used with a linkage system to measure head position - the head-mounted display
- optical device (Twinklebox)
  - multiple light-emitting diodes
  - slit-scanners with phototubes to determine planes
  - intersection of planes determines position
- magnetic device (*3SPACE*™)
  - digitizer stylus using magnetic transducing technology
  - x, y and z coordinates
  - orientation angles of digitizer stylus

joysticks

- a movable stick mounted in a base
  - see figure 8-10 on page 161
  - potentiometers measure movement of the stick or
  - the stick activates pulse generators at any of four or eight positions
  - springs return the stick to the center position
- a rigid stick mounted in a base
  - see figure 8-11 on page 162
  - strain gauges measure slight deflections

trackball

- a sphere mounted in a base
  - see figure 8-12 on page 162
- potentiometers measure the amount and direction of rotation

mechanical mouse

- wheels or rollers mounted in the base
- buttons mounted on the top
  - see figure 8-13 on page 163

optical mouse

- counts grid lines on a scribed surface
  - one color for horizontal
  - another color for vertical

voice systems

- predefined dictionary of words
  - a dictionary for each operator
- voice instructions are pattern-matched and echoed
- user's hands and eyes are available for other tasks

Logical Classification of Input Devices

- locator devices
- stroke devices
- string devices
- valuator devices
- choice devices
- pick devices

any logical input device can be modeled by any physical input device

LOCATOR	a device for providing a coordinate position (x, y) or (x, y, z)
STROKE	a device for providing a series of coordinate positions
STRING	a device for providing text
VALUATOR	a device for providing scalar values
CHOICE	a device for selecting menu options
PICK	a device for selecting picture components

locator devices

- used to provide a coordinate position
  - position the cursor at the desired location
  - activate a button
- common locator devices
  - thumbwheels
  - dials
  - trackball
  - joystick
  - mouse
  - tablet and stylus or hand cursor

light pens as locators

- require light intensity at the position to be detected
  - when used with a raster-scan system, the light pen behaves as a locator
  - when used with random-scan systems, light must be provided for the light pen to detect
- keyboards as locators
  - type in coordinate values or
  - use cursor control keys to position the cursor

stroke devices

- used to provide a series of coordinate positions
- essentially multiple calls to a locator device
- common stroke devices
  - tablet
  - light pen

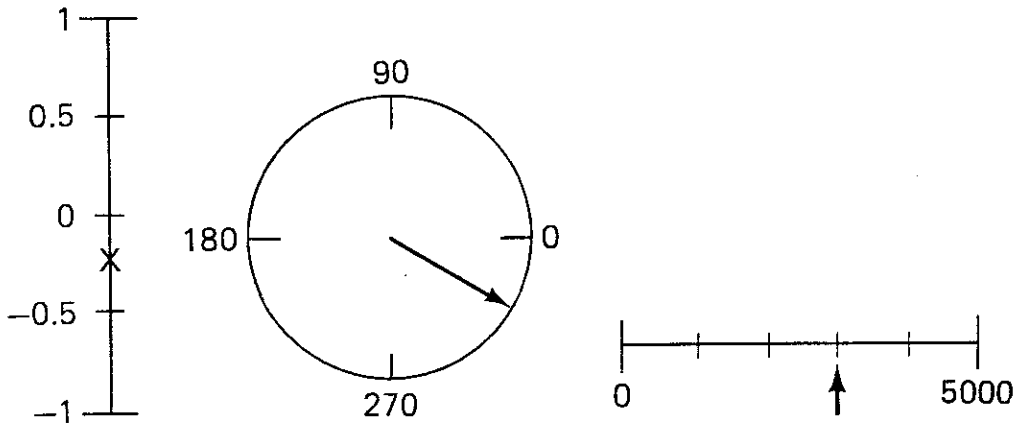
string devices

- used to provide text
- the common string device is the keyboard
- other string devices
  - stroke devices with character recognizers

valuator devices

- used to provide scalar values
  - rotation angles
  - scale factors
  - application parameters
    - voltage levels
    - temperatures
- common valuator devices
  - dials
  - slide potentiometers
  - keyboards (numeric input)
- adaptable physical devices
  - joysticks
  - trackballs
  - mice
  - tablets

locators as valuators



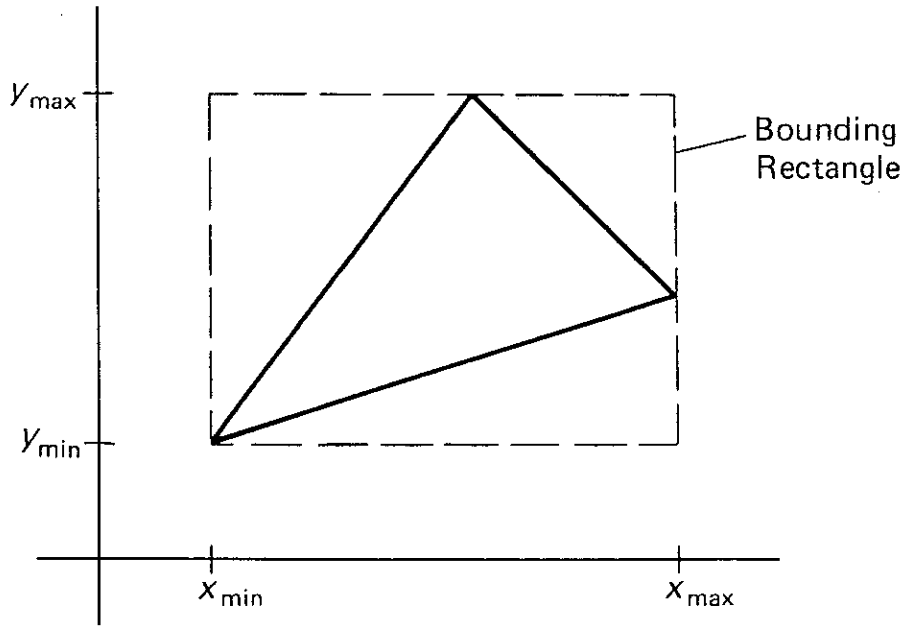
- selected numeric values can be displayed

choice devices

- used to select menu options
- common choice devices
  - buttons
  - touch panels
  - light pens
- locators with raster systems as choice devices
  - compare the selected screen position with the boundaries of each menu item
- alternatives
  - keyboards
  - voice systems

pick devices

- used to select picture components
- a common pick device is the light pen
  - straightforward in a random-scan system
  - in a raster-scan system, a light pen firing produces an (x, y) location
    - this must be mapped to a segment
    - if the location maps to multiple segments, a bounding box may help



locators as pick devices

- map the coordinate position to a segment
- if the coordinate position maps to multiple segments, a bounding box may help
- for vector devices
  - store the x and y locations of the cursor in comparator registers
  - continuously compare the comparator registers to the x and y deflection registers
- alternative pick devices
  - keyboards
  - buttons
  - voice systems

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- Physical Input Devices
- Logical Classification of Input Devices