Computer Graphics

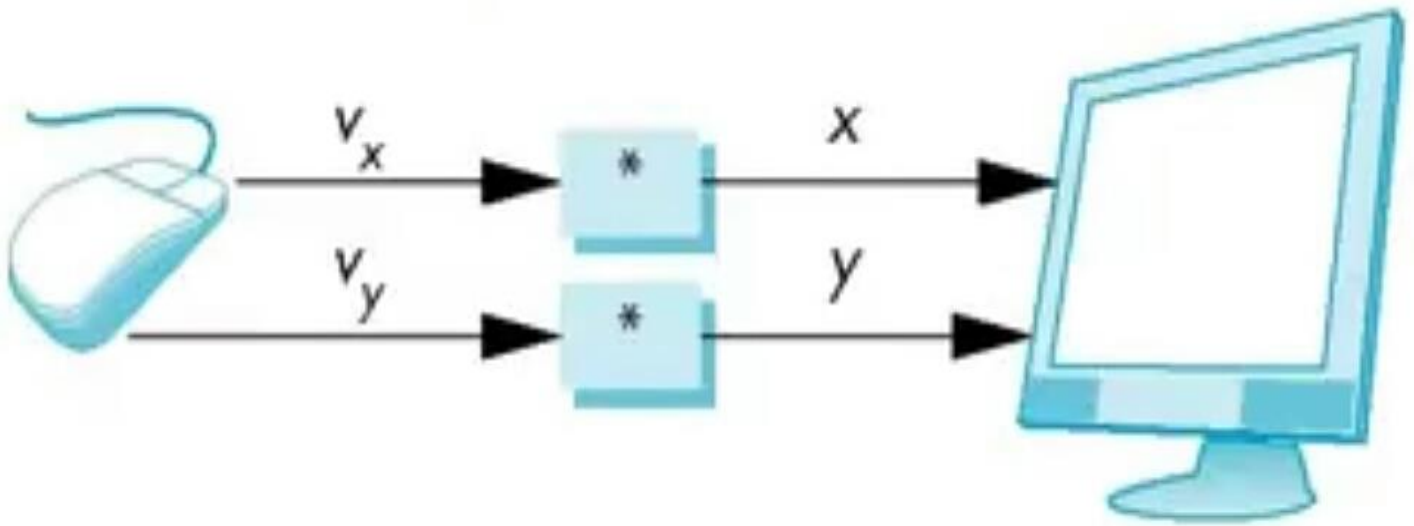
Unit 5 – Part 1

-By Manjula. S

Input Devices

- Physical input devices
  - Keyboard devices and pointing devices
- Logical input devices

Positioning



- Relative
  - Mouse, trackball, trackpoint
- Absolute
  - Data tablet

Logical Input Devices

- Characteristics
  - The measurements returned to the programs
  - The time these measurements returned
- Six classes of logical input devices

Pointing Devices

- Mouse
  - Mechanical versus optical

- Trackball

- Data tablet

1.KEYBOARD

- An alphanumeric keyboard on a graphics system is used primarily as a **device for entering text.**
- The keyboard is an efficient device for inputting such nongraphic data such as **picture labels** associated with a graphics display.
- Keyboards can also be provided with features to enter **screen coordinates, menu selection,** etc.
- **Keyboards** are also **used for computer gaming.**

Other types of cursor-positioning devices, such as a trackball or joystick, are included on some keyboards.

Additionally, a numeric keypad is, often included on the key- board for fast entry of numeric data.

2. MOUSE

- A mouse is small **hand-held DEVICE** used to position the screen cursor.
- Wheels or rollers on the bottom of the mouse can be used to record the amount and direction of movement OF THE CURSOR.
- The optical sensor detects movement Across the lines in the grid.

- Physically, a mouse consists of an object held in one's hand, with one or more buttons. Mice often also feature other elements, such as touch surfaces and "wheels", which enable additional control and dimensional input.

3. Trackball and Spaceball

- A **trackball** is a ball that can be rotated with the fingers or palm of the hand to produce cursor movement.
- Potentiometers, attached to the trackball, measure the amount and direction of rotation for movement.

spaceball

- While a trackball is a 2D positioning device, a spaceball provides 3D positioning.
- A spaceball does not actually move. Strain gauges measure the amount of pressure applied to the spaceball to provide positioning details.
- Spaceballs are used for three-dimensional positioning and selection operations in virtual-reality systems and animation systems etc.

4. joysticks

- A **joystick** is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling.
- Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer.

- Potentiometers mounted at the base of the joystick measure the amount of movement, and springs return the stick to the center position when it is released.
- Joysticks are also used for controlling machines such as cranes, trucks, etc.

5. Image Scanners

- Image scanner is a device that optically scans images, printed text, handwriting or an object and converts it to a digital image.
- Once we have the internal representation of a picture, we can apply transformations to rotate, scale, or crop the picture to a particular screen area.

6. Touch Panels

- Touch panels allow displayed objects or screen positions to be selected with the touch of a finger.
- A user can give input or control the information processing system through simple or multi-touch gestures by touching the screen with a special stylus and/or one or more fingers.

- The touchscreen enables the user to interact directly with what is displayed, rather than using a mouse, touchpad, or any other such device.
- The opposite vertical and horizontal edges contain light detectors.
- These detectors are used to record which beams are interrupted when the panel is touched.

7. Light Pens

- Light pens are pencil-shaped devices are used to select screen positions by detecting the light coming from points on the CRT screen.
- It allows the user to point to displayed objects or draw on the screen in a similar way to a touchscreen but with greater positional accuracy.
- A light pen detects a change of brightness of nearby screen pixels when scanned by cathode ray tube electron beam and communicates the timing of this event to the computer

- The first light pen was created around 1955 as part of the Whirlwind project at MIT.
- Because the user was required to hold their arm in front of the screen for long periods of time (potentially causing "gorilla arm") or to use a desk that tilts the monitor, the light pen fell out of use as a general purpose input device.

Logical Input Devices

- String: by keyboard
- Locator: by mouse or trackball
- Pick: id of the selected object is returned
- Choice: select one of a distinct number of options, e.g. menus
- Valuators: e.g. boxes to provide value.
- Stroke: returns an array of locations: multiple uses of a locator, could be implemented by a "mouse dragging"

GRAPHICAL INPUT TECHNIQUES

- It is a combination of hardware and software elements that provide a way for computer users to accomplish a single task.

- It is also called as Interaction Techniques or Users Interface Techniques.

GRAPHICAL INPUT TECHNIQUES INVOLVES:

- One or several input devices that capture user input.
- One or several output devices that display user feedback.
- A piece of software that:
  - Interprets user input into commands that computer can understand
  - It produces user feedback

EXAMPLE OF GIT

Consider the process of deleting a file as a example. In this process the existence of **mouse** as input device, a **screen** as output devices and **a piece of code** which update its selection and send a command to the file system when the user clicks on delete items.

FEEDBACK

- Feedback which helps in the control of such input devices as mouse and tablets.
- It reduce the user's uncertainty about the effect of his action.
- It display the preview before the command commits into action.
- It is an indispensable part of input process.

Types of Computer Graphics

Two Types of Computer Graphics:

1. Interactive Graphics
2. Non-Interactive/ Passive Graphics

Interactive Computer Graphics

- It involves two way communication between computer and user.
- User is given control over the image by providing an input device that takes the user request to the computer.
- Example: Flight simulator used to train pilots.

  Advantages: Fuel saving, safety.

  Another example is video game controller.

Computer Graphics

2. **Non Interactive Computer Graphics**: (passive computer graphics.)

- Here the user does not have any kind of control over the image.
- The image is totally under the control of program instructions not under the user.

Example : screen savers.

Different Types of Computer Graphics

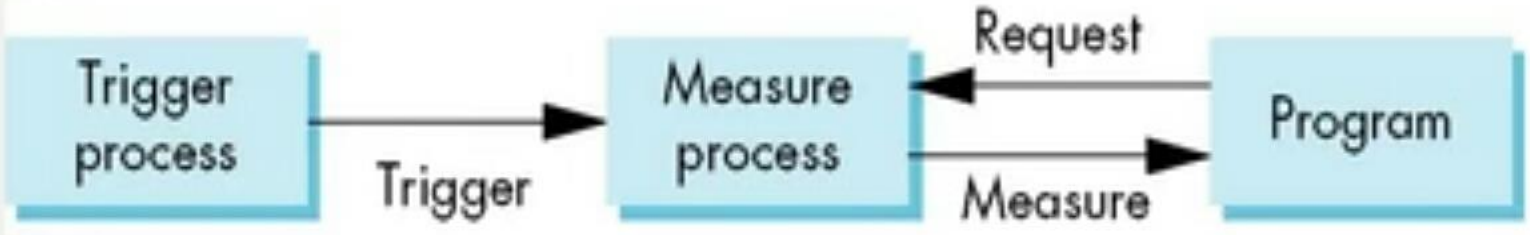
Non-Interactive Computer Graphics	Interactive Computer Graphics
- Is know a Passive Graphics. In Passive Graphics observer has no control over the Image.	- In Interactive Graphics user have some Control over the Image.
- One Way Communication. Television is a Example.	- Two way communication between Computer and User.
- **For Example:-** Familiar examples of this type of computer graphics include the titles shown on TV and other forms of computer art.	- **For Example:-** Almost all computer workstations and personal computer systems are now able to be used interactively.

Input Modes:
Measure and Trigger

- Measure: what returns to the user program
- Trigger: a physical input to signal the computer,
- for example:
  - Measure of keyboard is single / set of chars
  - Trigger is enter key.

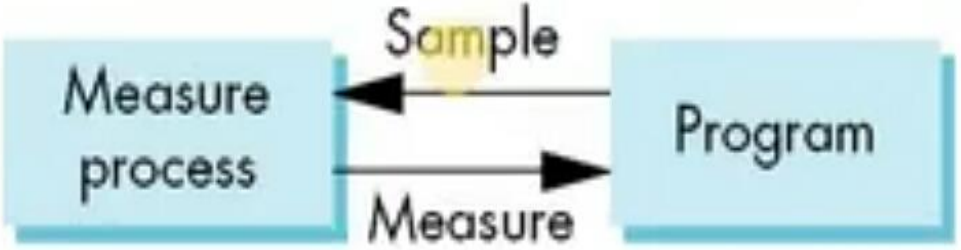
Input Modes

- **Request mode**: the measure of the device is not returned to the program until the device is triggered
- request_locator(device_id, &measure)



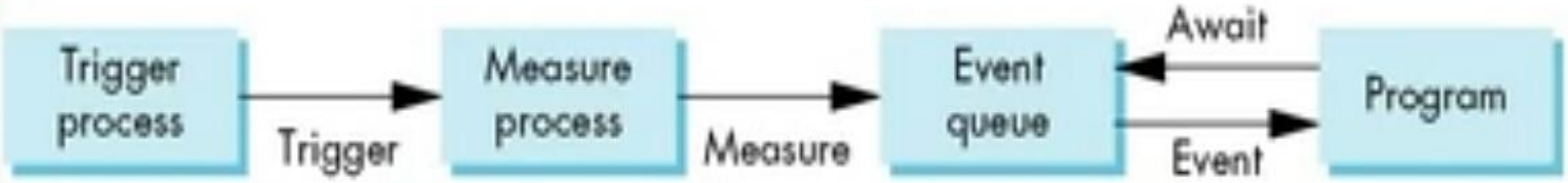
Input Modes

- **Sample mode**: input is immediate, no trigger is needed
- sample_locator(device_id, &measure)
- Both request and sample modes are useful for the program where only one input device is used.



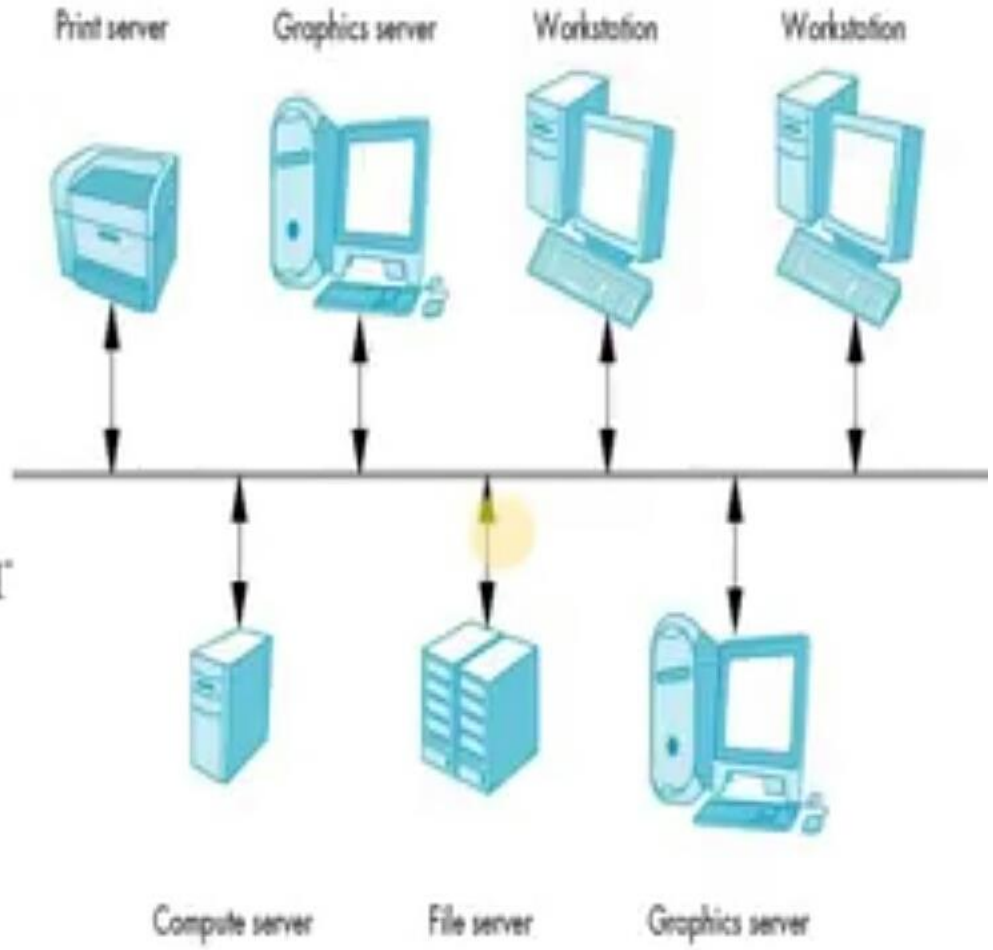
Input Modes

- **Event mode**: each time a device is triggered, an event is generated, with the id for the device and measurement is put in an **event queue**

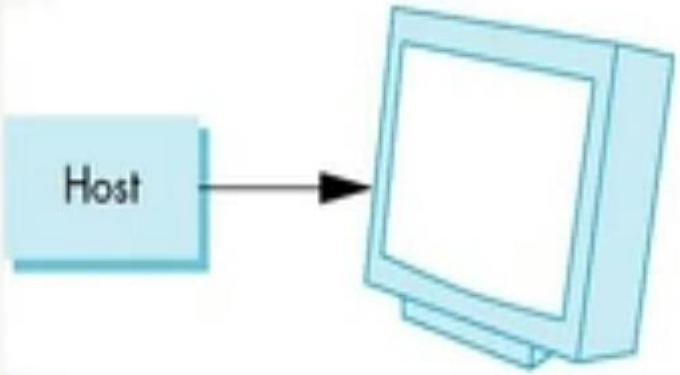


Clients and Servers

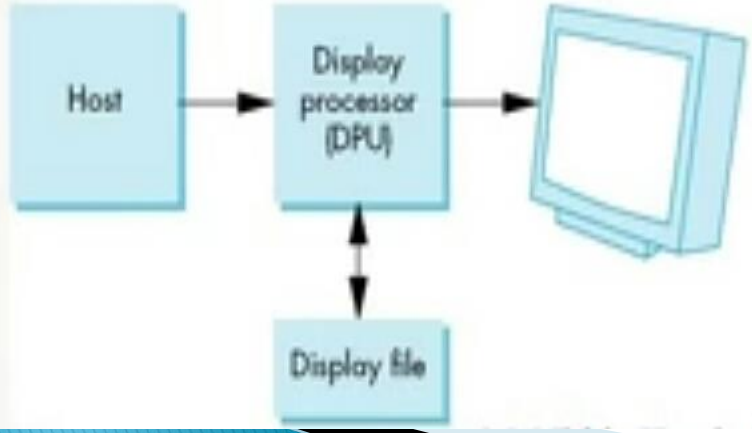
- Servers: provide services
  - Print servers, file servers, graphics servers…
- Clients: users and user programs that make use of these services
  - OpenGL application programs



Display Lists



Simple graphics architecture



Display-processor architecture

Immediate Mode v.s. Retained Mode

- Immediate mode: as soon as the program executes a statement for a object, the primitive sent to the display and no memory is retained for the object
- Retained mode: define an object once, and put its description in the display list in the server. Client issues a function call to the server

Raster Text v.s. Stroke Text

- Raster text:
  - Fixed size for each character
    e.g. a 8x13 raster character takes 13 bytes
  - Not good for scaling or rotation
- Stroke text:
  - No fixed size
  - Could store the patterns in ROM, selection is based on a single byte
  - Good for scaling or rotation

(a) Input Output

(b)

Programming Event-Driven Input

- Using the pointing device
  - Move event
    - Mouse is moved and one of the button pressed
  - Passive move event
    - Mouse is moved and no buttons are pressed
  - Mouse event: one of mouse buttons is pressed or released
    - glutMouseFunc(mouse): register the function
    - void mouse(int button, int state, int x, int y)

Other Events and CallBacks

- Reshape event: whenever the window is resized
  glutReshapeFunc(myReshape);
- Keyboard event:
  glutKeyboardFunc(keyboard);

```
void keyboard(unsigned char key, int x, int y)
{
    if(key=='q' || key == 'Q') exit();
}
```

Display and Idle CallBacks

- glutDisplay(display);
- glutPostRedisplay()
  ensures the display will drawn at most once in the main loop
- Idle callback: is invoked when there is no other events
- Callback could be changed at any time or disabled by setting to NULL

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Window Management

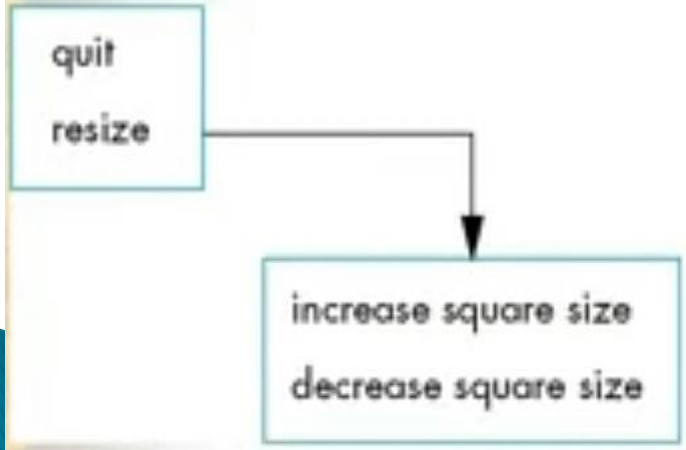
- GLUT support multiple windows
- id=glutCreateWindow("Second window");
  glutSetWindow(id);
- Call glutInitDisplayMode before glutCreateWindow() to set attributes

Menus – 1/2

- Pop-up menus
- glutCreateMenu(demo_menu); //register callback function
  glutAddMenuEntry("quit",1);
  glutAddMenuEntry("increase square size", 2);
  glutAddMenuEntry("decrease square size", 3);
  glutAttachMenu(GLUT_RIGHT_BUTTON);
- Void demo_menu(int id)
  {
  if(id == 1) exit();
  else if(id==2) size=2*size;
  else size=size/2;
  glutPostRedisplay();
  }

Hierarchical Menus – 2/2

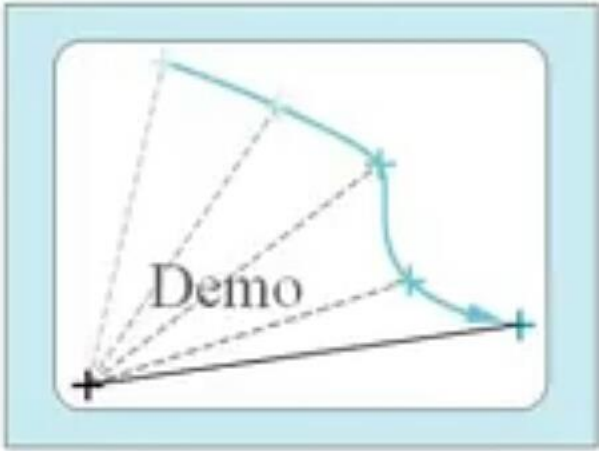
```
sub_menu=glutCreateMenu(size_menu);
glutAddMenuEntry("increase square size", 2);
glutAddMenuEntry("decrease square size", 3);
glutCreateMenu(top_menu);
glutAddMenuEntry("quit",1);
glutAddSubMenu("resize", sub_menu);
glutAttachMenu(GLUT_RIGHT_BUTTON);
```

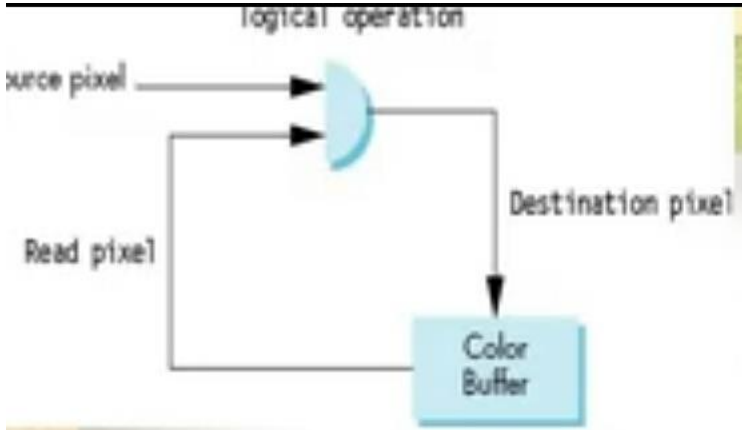


Rubberbanding

Rubberbanding: It is a technique used to define the elastic nature of pointing device to draw primitives.

Rubberbanding begin when mouse button is pressed and continue until button is released at that time final line segment is drawn.





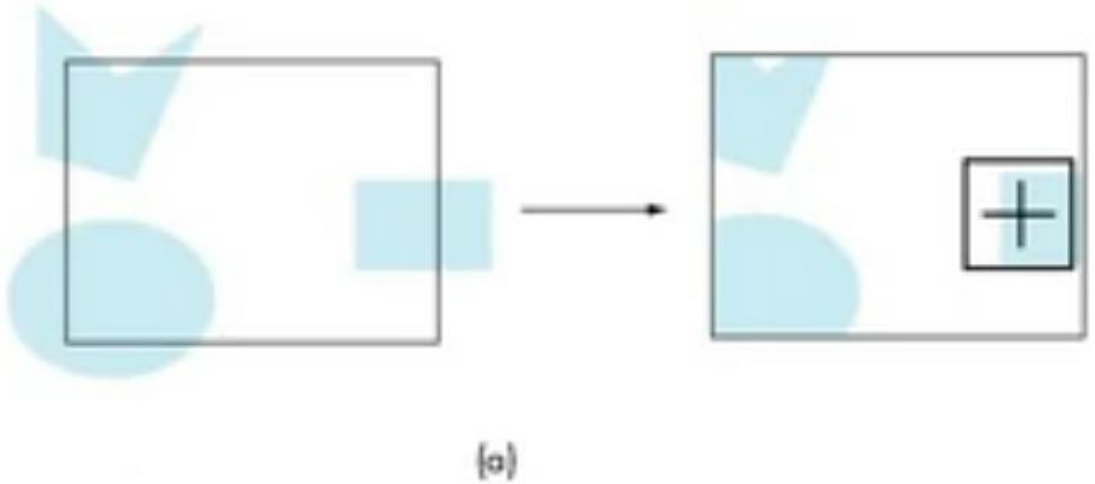
Logic Operation

- Copy or replacement mode
- There are 16 possible operations between 2 bits
- Source pixel and destination pixel
- $d' = d \oplus s$, where $\oplus$ means XOR (exclusive or)
  $d = (d \oplus s) \oplus s$, which means drawing something twice will erase it
- OpenGL support all 16 logic modes, GL_COPY is the default
- glEnable(GL_COLOR_LOGIC_OP);
  glLogicOP(GL_XOR); /* change it to XOR mode */

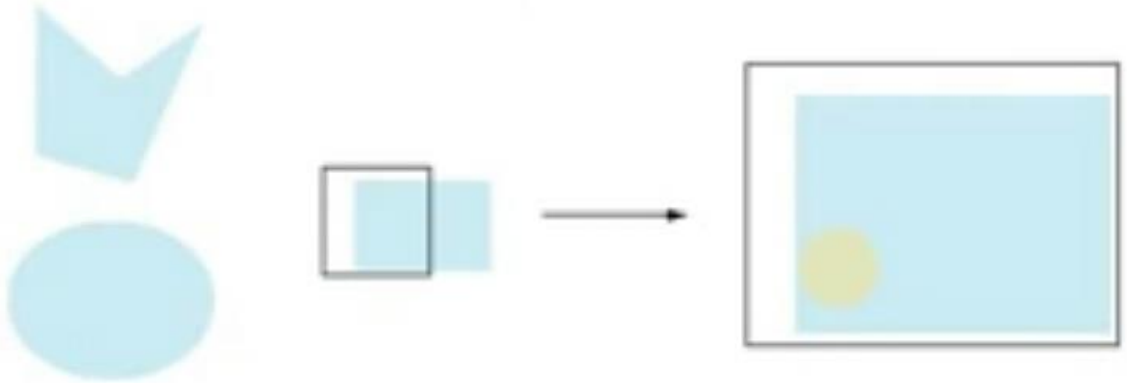
XOR and Color

- (00000000, 00000000, 11111111) ⊕
  (11111111, 11111111, 11111111) =
  (11111111, 11111111, 00000000)
  Blue ⊕ White = Yellow
- If a blue line crosses a red object, it will be colored as magenta inside the object

Picking



(a)



(b)

Picking

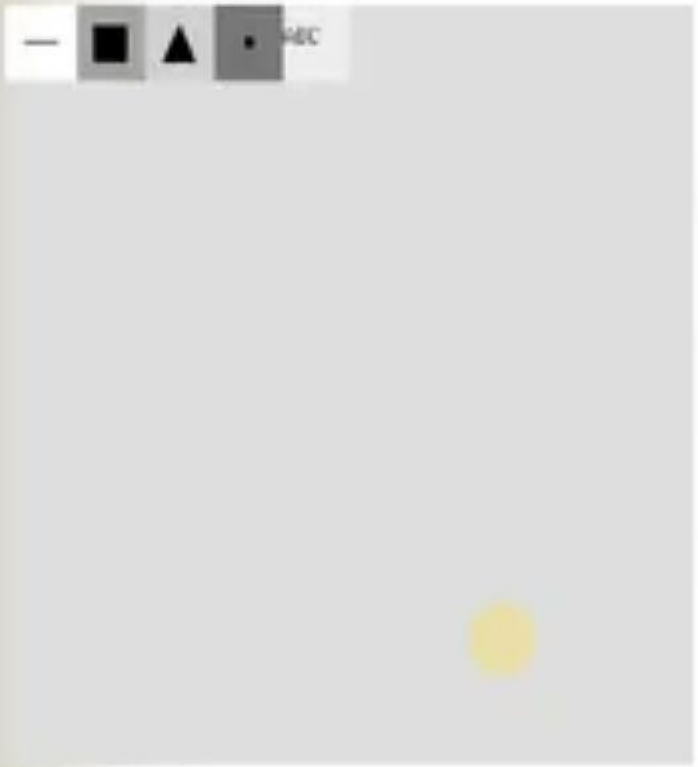
- Identify a user-defined object on the display
- In principle, it should be simple because the mouse gives the position and we should be able to determine to which object(s) a position corresponds
- Practical difficulties
  - Pipeline architecture is feed forward, hard to go from screen back to world
  - Complicated by screen being 2D, world is 3D
  - How close do we have to come to object to say we selected it?

A Simple Paint Program – 1

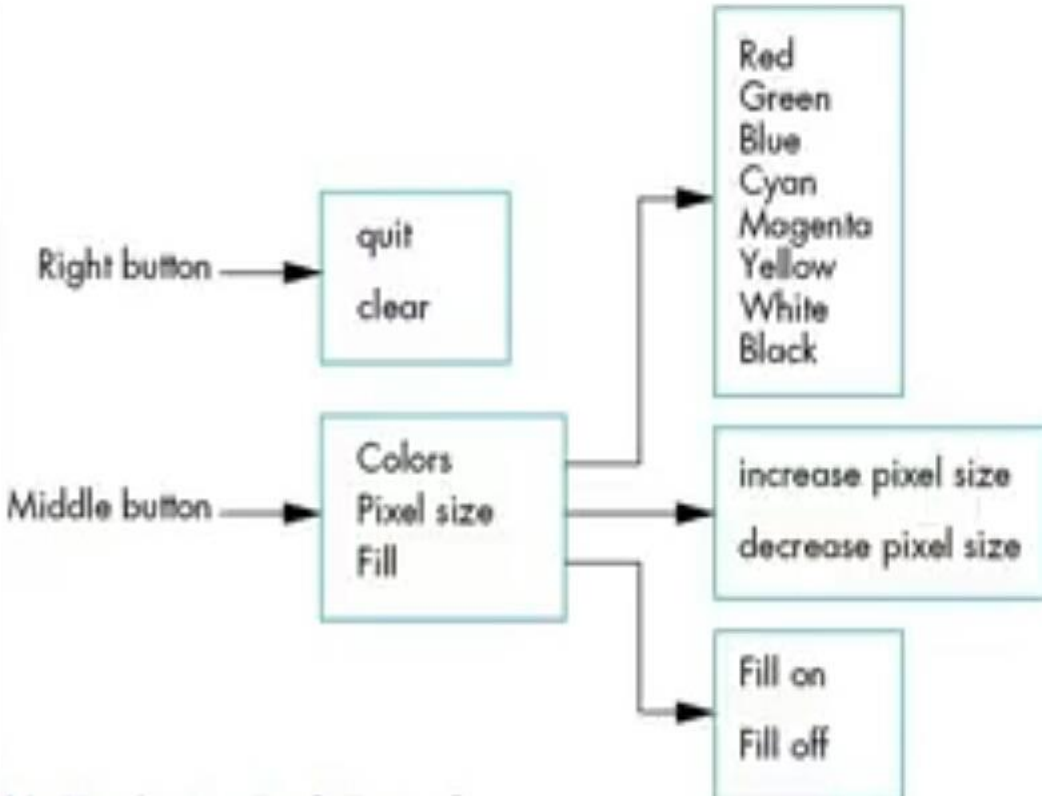
- Draw geometric primitives: line segments, polygons
- Manipulate pixels
- Control attributes of primitives
- Include menus
- Should behave correctly when moved or resized

A Simple Paint Program – 2

Initial display of paint program



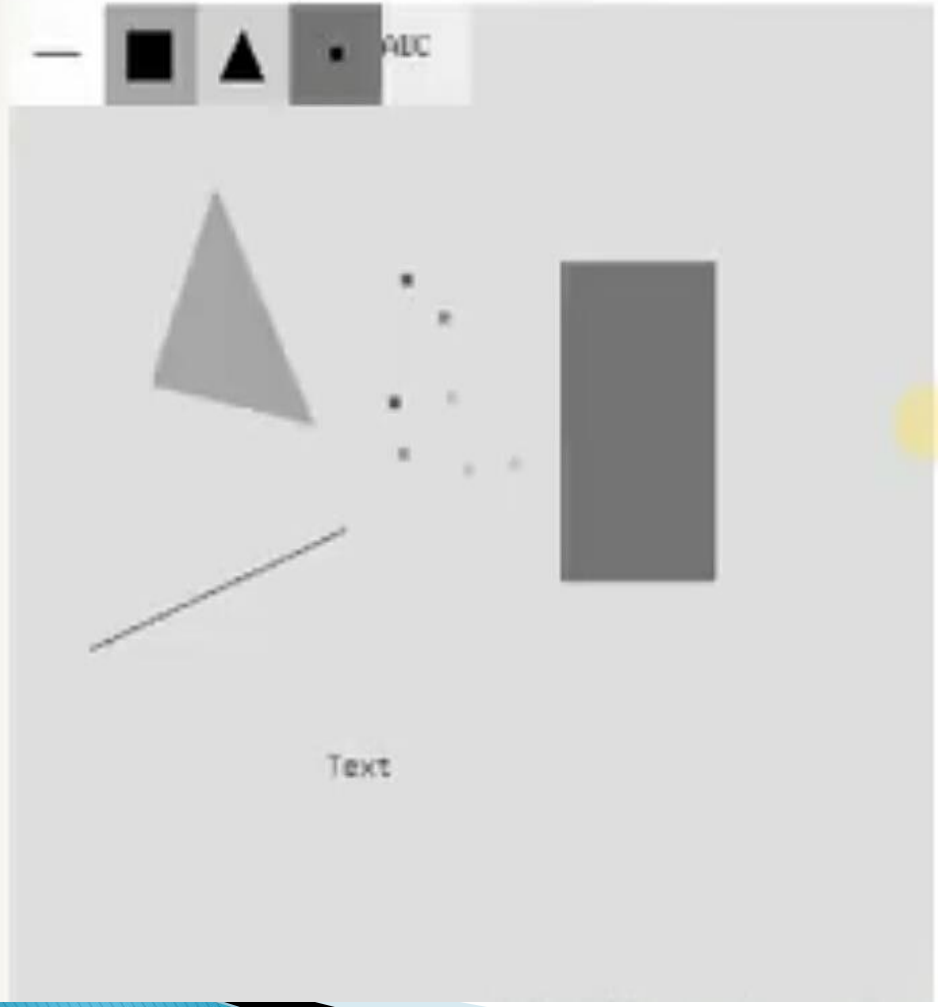
Menu structure of paint program



A Simple Paint Program – 3

- Five drawing modes: line segment, rectangle, triangle, pixel, and text
- Two (or three) clicks determine the locations of the end points of line segments, rectangles…
- Choose colors, pixel size, fill patterns…

A Simple Paint Program



Thank You