Working with Callbacks

Objectives

- Learn to build interactive programs using GLUT callbacks
  - Mouse
  - Keyboard
  - Reshape
- Introduce menus in GLUT

The mouse callback

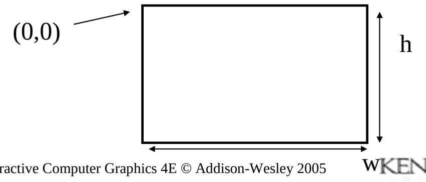
`glutMouseFunc(mymouse)`

`void mymouse(GLint button, GLint state, GLint x, GLint y)`

- Returns
  - which button (**`GLUT_LEFT_BUTTON`**, **`GLUT_MIDDLE_BUTTON`**, **`GLUT_RIGHT_BUTTON`**) caused event
  - state of that button (**`GLUT_UP`**, **`GLUT_DOWN`**)
  - Position in window

Positioning

- The position in the screen window is usually measured in pixels with the origin at the top-left corner
  - Consequence of refresh done from top to bottom
- OpenGL uses a world coordinate system with origin at the bottom left
  - Must invert *y* coordinate returned by callback by height of window
  - *$y = h - y$;*



Obtaining the window size

- To invert the *y* position we need the window height
  - Height can change during program execution
  - Track with a global variable
  - New height returned to reshape callback that we will look at in detail soon
  - Can also use query functions
    - **`glGetIntv`**
    - **`glGetFloatv`**

  to obtain any value that is part of the state

Terminating a program

- In our original programs, there was no way to terminate them through OpenGL
- We can use the simple mouse callback

```
void mouse(int btn, int state, int x, int y)
{
   if(btn==GLUT_RIGHT_BUTTON && state==GLUT_DOWN)
      exit(0);
}
```

Using the mouse position

- In the next example, we draw a small square at the location of the mouse each time the left mouse button is clicked
- This example does not use the display callback but one is required by GLUT; We can use the empty display callback function
  `mydisplay(){}`

Drawing squares at cursor location

```
void mymouse(int btn, int state, int x, int y)
{
   if(btn==GLUT_RIGHT_BUTTON && state==GLUT_DOWN)
      exit(0);
   if(btn==GLUT_LEFT_BUTTON && state==GLUT_DOWN)
      drawSquare(x, y);
}
void drawSquare(int x, int y)
{
    y=w-y; /* invert y position */
    glColor3ub( (char) rand()%256, (char) rand )%256,
       (char) rand()%256); /* a random color */
    glBegin(GL_POLYGON);
        glVertex2f(x+size, y+size);
        glVertex2f(x-size, y+size);
        glVertex2f(x-size, y-size);
        glVertex2f(x+size, y-size);
     glEnd();
}
```

Using the motion callback

- We can draw squares (or anything else) continuously as long as a mouse button is depressed by using the motion callback
  - **`glutMotionFunc(drawSquare)`**
- We can draw squares without depressing a button using the passive motion callback
  - **`glutPassiveMotionFunc(drawSquare)`**

Using the keyboard

```
glutKeyboardFunc(mykey)
void mykey(unsigned char key,
       int x, int y)
```

- Returns ASCII code of key depressed and mouse location

```
void mykey()
{
     if(key == ‘Q’ | key == ‘q’)
          exit(0);
}
```

Special and Modifier Keys

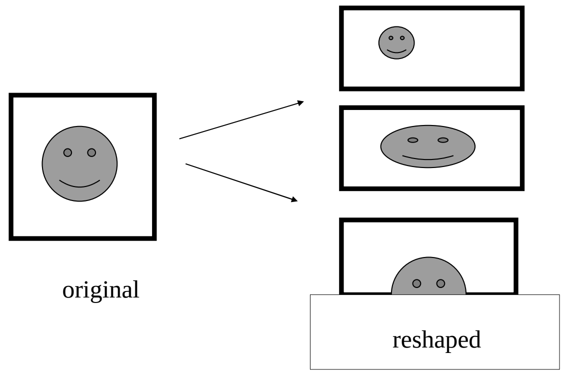
- GLUT defines the special keys in `glut.h`
  - Function key 1: `GLUT_KEY_F1`
  - Up arrow key: `GLUT_KEY_UP`
    - `if(key == ‘GLUT_KEY_F1’` ……
- Can also check if one of the modifiers
  - `GLUT_ACTIVE_SHIFT`
  - `GLUT_ACTIVE_CTRL`
  - `GLUT_ACTIVE_ALT`

  is depressed by
  `glutGetModifiers()`
  - Allows emulation of three-button mouse with one- or two-button mice

Reshaping the window

- We can reshape and resize the OpenGL display window by pulling the corner of the window
- What happens to the display?
  - Must redraw from application
  - Two possibilities
    - Display part of world
    - Display whole world but force to fit in new window
      – Can alter aspect ratio

Reshape possiblities



The Reshape callback

`glutReshapeFunc(myreshape)`

`void myreshape( int w, int h)`

- Returns width and height of new window (in pixels)
- A redisplay is posted automatically at end of execution of the callback
- GLUT has a default reshape callback but you probably want to define your own

• The reshape callback is a good place to put viewing functions because it is invoked when the window is first opened

Example Reshape

• This reshape preserves shapes by making the viewport and world window have the same aspect ratio

```
void myReshape(int w, int h)
{
    glViewport(0, 0, w, h);
    glMatrixMode(GL_PROJECTION); /* switch matrix mode */
    glLoadIdentity();
    if (w <= h)
        gluOrtho2D(-2.0, 2.0, -2.0 * (GLfloat) h / (GLfloat) w,
            2.0 * (GLfloat) h / (GLfloat) w);
    else  gluOrtho2D(-2.0 * (GLfloat) w / (GLfloat) h, 2.0 *
            (GLfloat) w / (GLfloat) h, -2.0, 2.0);
    glMatrixMode(GL_MODELVIEW); /* return to modelview mode */
}
```

Toolkits and Widgets

• Most window systems provide a toolkit or library of functions for building user interfaces that use special types of windows called *widgets*

• Widget sets include tools such as
  - Menus
  - Slidebars
  - Dials
  - Input boxes

• But toolkits tend to be platform dependent

• GLUT provides a few widgets including menus

Menus

• GLUT supports pop-up menus
  - A menu can have submenus

• Three steps
  - Define entries for the menu
  - Define action for each menu item
    • Action carried out if entry selected
  - Attach menu to a mouse button

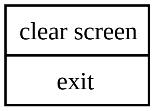
Defining a simple menu

- In **`main.c`**

```
menu_id = glutCreateMenu(mymenu);
glutAddmenuEntry(“clear Screen”, 1);

gluAddMenuEntry(“exit”, 2);

glutAttachMenu(GLUT_RIGHT_BUTTON);
```



entries that appear when right button depressed

identifiers

Menu actions

- Menu callback

```
void mymenu(int id)
{
      if(id == 1) glClear();
      if(id == 2) exit(0);
}
```

- Note each menu has an id that is returned when it is created
- Add submenus by

`glutAddSubMenu(char *submenu_name, submenu id)`

entry in parent menu

Other functions in GLUT

- Dynamic Windows
  - Create and destroy during execution
- Subwindows
- Multiple Windows
- Changing callbacks during execution
- Timers
- Portable fonts
  - **`glutBitmapCharacter`**
  - **`glutStrokeCharacter`**

Timers

- On modern graphics processors may need to slow down rendering or get a blur
- Options
  - Use OS timers
  - Lock buffer swap on graphics card to refresh rate
  - Use GLUT timer

    glutTimerFunc(int delay, void(*timer_func)(int), int value);
    - delay the event loop for delay seconds
    - See book for more details on use