

## The GL Utility Toolkit (GLUT)



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GLUT.pptx

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## What is GLUT?

The **GL Utility Toolkit** (GLUT) serves two major purposes:

1. It interfaces with your operating system and window system
2. It provides various application utilities, such as drawing 3D shapes for you

You can find GLUT (actually freeGLUT) at:

<http://freeglut.sourceforge.net/>

You don't actually have to go out here. We will give you some libraries that are ready-to-use.



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## Using GLUT to Setup the Window

All the GLUT\_XXX constants are #defined in **glut.h**

GLUT\_RGBA I want to display colors  
GLUT\_DOUBLE I want to do double-buffering  
GLUT\_DEPTH I want to use a depth-buffer while rendering

```
glutInitDisplayMode( GLUT_RGBA | GLUT_DOUBLE | GLUT_DEPTH );  
  
// set the initial window configuration:  
glutInitWindowPosition( 0, 0 );  
glutInitWindowSize( INIT_WINDOW_SIZE, INIT_WINDOW_SIZE );  
  
// open the window and set its title:  
MainWindow = glutCreateWindow( WINDOWTITLE );  
glutSetWindowTitle( WINDOWTITLE );
```

Constants not beginning with **GL\_** or **GLUT\_** are user-defined



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## Using GLUT to Specify Event-driven Callback Functions

```
glutSetWindow( MainWindow );  
glutDisplayFunc( Display );  
glutReshapeFunc( Resize );  
glutKeyboardFunc( Keyboard );  
glutMouseFunc( MouseButton );  
glutMotionFunc( MouseMotion );
```

For example, the **Keyboard()** function gets called whenever a keyboard key is hit

```
glutPassiveMotionFunc( NULL );  
glutVisibilityFunc( Visibility );  
glutEntryFunc( NULL );  
glutSpecialFunc( NULL );  
glutSpaceballMotionFunc( NULL );  
glutSpaceballRotateFunc( NULL );  
glutSpaceballButtonFunc( NULL );  
glutButtonBoxFunc( NULL );  
glutDialsFunc( NULL );  
glutTabletMotionFunc( NULL );  
glutTabletButtonFunc( NULL );  
glutMenuStateFunc( NULL );  
glutTimerFunc( -1, NULL, 0 );  
glutIdleFunc( NULL );
```

A NULL callback function means that this event will be ignored



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## The Keyboard Callback Function

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```
void
Keyboard( unsigned char c, int x, int y )
{
    if( DebugOn != 0 )
        fprintf( stderr, "Keyboard: '%c' (0x%0x)\n", c, c );

    switch( c )
    {
        case 'o': case 'O':
            WhichProjection = ORTHO;
            break;
        case 'p': case 'P':
            WhichProjection = PERSP;
            break;
        case 'q': case 'Q':
            DoMainMenu( QUIT ); // will not ever return
            break; // keep the compiler happy
        case ESCAPE:
            // will not ever return
            break; // keep the compiler happy
        default:
            fprintf( stderr, "Don't know what to do with keyboard hit: '%c' (0x%0x)\n", c, c );
    }

    // force a call to Display()
    glutPostRedisplay( );
}

// glutPostRedisplay( ) forces your Display( )
// function to be called to redraw the scene with
// the new display parameter values
```

Where the mouse was when the key was hit

The key that was hit

Assign new display parameter values depending on what key was hit

Good programming practice

## The MouseButton Callback Function

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```
void
MouseButton( int button, int state, int x, int y )
{
    int b = 0; // LEFT, MIDDLE, or RIGHT
    if( DebugOn != 0 )
        fprintf( stderr, "MouseButton: %d, %d, %d, %d\n", button, state, x, y );

    // get the proper button bit mask:
    switch( button )
    {
        case GLUT_LEFT_BUTTON:
            b = LEFT;
            break;
        case GLUT_MIDDLE_BUTTON:
            b = MIDDLE;
            break;
        case GLUT_RIGHT_BUTTON:
            b = RIGHT;
            break;
        default:
            b = 0;
            fprintf( stderr, "Unknown mouse button: %d\n", button );
    }

    // button down sets the bit, up clears the bit:
    if( state == GLUT_DOWN )
    {
        Xmouse = x;
        Ymouse = y;
        ActiveButton |= b; // set the proper bit
    }
    else
    {
        ActiveButton &= ~b; // clear the proper bit
    }
}

// glutPostRedisplay( ) forces your Display( )
// function to be called to redraw the scene with
// the new display parameter values
```

Where the mouse was when the button was hit

GLUT\_DOWN or GLUT\_UP

Which button was hit

## The MouseMotion Callback Function

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```
void
MouseMotion( int x, int y )
{
    if( DebugOn != 0 )
        fprintf( stderr, "MouseMotion: %d, %d\n", x, y );

    int dx = x - Xmouse; // change in mouse coords
    int dy = y - Ymouse; // change in mouse coords

    if( ( ActiveButton & LEFT ) != 0 )
    {
        Xrot += ( ANGFACT * dy );
        Yrot += ( ANGFACT * dx );
    }

    if( ( ActiveButton & MIDDLE ) != 0 )
    {
        Scale += SCLFACT * ( float ) ( dx - dy );
        // keep object from turning inside-out or disappearing:
        if( Scale < MINSCALE )
            Scale = MINSCALE;
    }

    Xmouse = x; // new current position
    Ymouse = y;

    glutPostRedisplay( );
}

// glutPostRedisplay( ) forces your Display( )
// function to be called to redraw the scene with
// the new display parameter values
```

Where the mouse moved to

If the mouse moved with the left button down, do a rotate

If the mouse moved with the middle button down, do a scale

## The Animate Idle Callback Function

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The Idle Function gets called when the GLUT event handler has nothing else to do

```
glutSetWindow( MainWindow );
glutIdleFunc( Animate );
```

Setting it up in InitGraphics( )

We'll talk about this later. This is a good way to control your animations!

```
void
Animate( )
{
    // put animation stuff in here -- change some global variables
    // for Display( ) to find:
    int ms = glutGet( GLUT_ELAPSED_TIME ); // milliseconds
    ms %= MS_PER_CYCLE;
    Time = ( float ) ms / ( float ) MS_PER_CYCLE; // [ 0., 1. )

    // force GLUT to do a call to Display( ) next time it is convenient:
    glutSetWindow( MainWindow );
    glutPostRedisplay( );
}

// glutPostRedisplay( ) forces your Display( )
// function to be called to redraw the scene with
// the new display parameter values
```

### Pop-up Menus are easy to Create with GLUT

```

void
InitMenu()
{
    glutSetWindow( MainWindow );

    int numColors = sizeof( Colors ) / ( 3*sizeof(int) );
    int colormenu = glutCreateMenu( DoColorMenu );
    for( int i = 0; i < numColors; i++ )
    {
        glutAddMenuEntry( ColorNames[i], i );
    }

    int axesmenu = glutCreateMenu( DoAxesMenu );
    glutAddMenuEntry( "Off", 0 );
    glutAddMenuEntry( "On", 1 );

    int depthmenu = glutCreateMenu( DoDepthMenu );
    glutAddMenuEntry( "Off", 0 );
    glutAddMenuEntry( "On", 1 );

    int debugmenu = glutCreateMenu( DoDebugMenu );
    glutAddMenuEntry( "Off", 0 );
    glutAddMenuEntry( "On", 1 );

    int projmenu = glutCreateMenu( DoProjectMenu );
    glutAddMenuEntry( "Orthographic", ORTHO );
    glutAddMenuEntry( "Perspective", PERSP );

    int mainmenu = glutCreateMenu( DoMainMenu );
    glutAddSubMenu( "Colors", colormenu );
    glutAddSubMenu( "Depth Cue", depthmenu );
    glutAddSubMenu( "Projection", projmenu );
    glutAddMenuEntry( "Reset", RESET );
    glutAddSubMenu( "Debug", debugmenu );
    glutAddMenuEntry( "Quit", QUIT );

    // attach the pop-up menu to the right mouse button.
    glutAttachMenu( GLUT_RIGHT_BUTTON );
}

```

This is the color menu's callback function. When the user selects from this pop-up menu, its callback function gets executed. Its argument is the integer ID of the menu item that was selected. You specify that integer ID in `glutAddMenuEntry( )`.

This is how you create hierarchical sub-menus

Finally, tell GLUT which mouse button activates the entire menu hierarchy

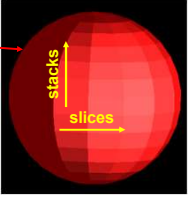
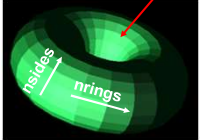


**glutAttachMenu( GLUT\_RIGHT\_BUTTON );**

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### The GLUT 3D Objects

- `glutSolidSphere( radius, slices, stacks );`
- `glutWireSphere( radius, slices, stacks );`
- `glutSolidCube( size );`
- `glutWireCube( size );`
- `glutSolidCone( base, height, slices, stacks );`
- `glutWireCone( base, height, slices, stacks );`
- `glutSolidTorus( innerRadius, outerRadius, nsides, nrings );`
- `glutWireTorus( innerRadius, outerRadius, nsides, nrings );`
- `glutSolidDodecahedron( );`
- `glutWireDodecahedron( );`
- `glutSolidOctahedron( );`
- `glutWireOctahedron( );`
- `glutSolidTetrahedron( );`
- `glutWireTetrahedron( );`
- `glutSolidIcosahedron( );`
- `glutWireIcosahedron( );`
- `glutSolidTeapot( size );`
- `glutWireTeapot( size );`

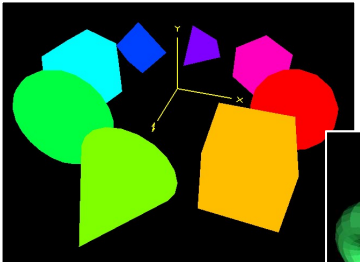





In case you have a hard time remembering which direction "slices" are, think of this:

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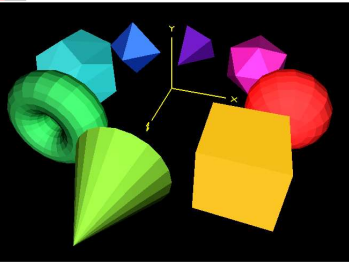
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### The GLUT 3D Objects



Without lighting

Without *lighting*, the GLUT solids don't look very cool. I'd recommend you stick with the wireframe versions of the GLUT 3D objects for now! We will get to lighting soon.



With lighting

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### The OSU 3D Objects

**Warning!** I recommend that you do not use the following GLUT functions:

- `glutSolidSphere( radius, slices, stacks );`
- `glutSolidCone( base, height, slices, stacks );`
- `glutSolidTorus( innerRadius, outerRadius, nsides, nrings );`

Use our own OSU versions of these instead:

- `OsuSphere( radius, slices, stacks );`
- `OsuCone( radBot, radTop, height, slices, stacks );`
- `OsuTorus( innerRadius, outerRadius, nsides, nrings );`

Our versions are better and more complete. Plus, you have the source code in case you want to make custom modifications.

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## Using the OSU 3D Objects

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### In InitLists( ):

```
SphereDL = glGenLists( 1 );  
glNewList( SphereDL, GL_COMPILE );  
OsuSphere(1., 32, 32);  
glEndList( );
```

```
ConeDL = glGenLists(1);  
glNewList(ConeDL, GL_COMPILE);  
OsuCone(1.0f, 0.5f, 3.f, 32, 32);  
glEndList();
```

```
TorusDL = glGenLists(1);  
glNewList(TorusDL, GL_COMPILE);  
OsuTorus(0.25f, 1., 32, 64);  
glEndList();
```

### In Display( ):

```
glColor3f( 0.8f, 0.2f, 0.2f);  
SetMaterial( 0.8f, 0.2f, 0.2f, 10.f );  
glCallList( SphereDL );
```

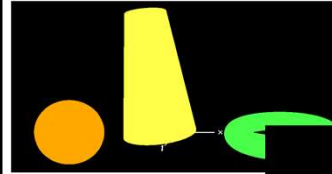
```
glColor3f( 0.8f, 0.8f, 0.2f);  
SetMaterial( 0.8f, 0.8f, 0.2f, 8.f );  
glCallList( ConeDL );
```

```
glColor3f( 0.2f, 0.8f, 0.2f);  
SetMaterial( 0.2f, 0.8f, 0.2f, 6.f );  
glCallList( TorusDL );
```

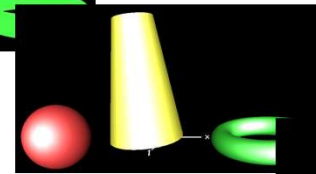
## The OSU 3D Objects Can All Be...

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### Colored:



### Lit:



### Textured:

