

The OpenGL Utility Toolkit (GLUT) Programming Interface

API Version 3

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1 Introduction

The OpenGL Utility Toolkit (GLUT) is a programming interface with ANSI C and FORTRAN bindings for writing window system independent OpenGL programs. The toolkit supports the following functionality:

- Multiple windows for OpenGL rendering.
- Callback driven event processing.
- Sophisticated input devices.
- An “idle” routine and timers.
- A simple, cascading pop-up menu facility.
- Utility routines to generate various solid and wire frame objects.
- Support for bitmap and stroke fonts.
- Miscellaneous window management functions, including managing overlays.

An ANSI C implementation of GLUT for the X Window System [15] has been implemented by the author. Windows NT and OS/2 versions of GLUT are also available.

This documentation serves as both a specification and a programming guide. If you are interested in a brief introduction to programming with GLUT, look for the introductory OpenGL column [9] published in *The X Journal*. For a complete introduction to using GLUT, obtain the book *Programming OpenGL for the X Window System* [10]. GLUT is also used by the 2nd edition of the *OpenGL Programming Guide*. Teachers and students interested in using GLUT in conjunction with a college-level computer graphics class should investigate Angel’s textbook *Interactive Computer Graphics: A top-down approach with OpenGL* [2] that uses GLUT for its OpenGL-based examples programs.

The remainder of this section describes GLUT’s design philosophy and usage model. The following sections specify the GLUT routines, grouped by functionality. The final sections discuss usage advice, the FORTRAN binding, and implementation issues. Appendix A enumerates and annotates the logical programmer visible state maintained by GLUT. Appendix B presents the ANSI C GLUT API via its header file. Appendix C presents the FORTRAN GLUT API via its header file.

1.1 Background

One of the major accomplishments in the specification of OpenGL [16, 12] was the isolation of window system dependencies from OpenGL’s rendering model. The result is that OpenGL is window system independent.

Window system operations such as the creation of a rendering window and the handling of window system events are left to the native window system to define. Necessary interactions between OpenGL and the window system such as creating and binding an OpenGL context to a window are described separately from the OpenGL specification in a window system dependent specification. For example, the GLX specification [4] describes the standard by which OpenGL interacts with the X Window System.

The predecessor to OpenGL is IRIS GL [17, 18]. Unlike OpenGL, IRIS GL *does* specify how rendering windows are created and manipulated. IRIS GL’s windowing interface is reasonably popular largely because it is simple to use. IRIS GL programmers can worry about graphics programming without needing to be an expert in programming the native window system. Experience also demonstrated that IRIS GL’s windowing interface was high-level enough that it could be retargeted to different window systems. Silicon Graphics migrated from NeWS to the X Window System without any major changes to IRIS GL’s basic windowing interface.

Removing window system operations from OpenGL is a sound decision because it allows the OpenGL graphics system to be retargeted to various systems including powerful but expensive graphics workstations as well as mass-production graphics systems like video games, set-top boxes for interactive television, and PCs.

Unfortunately, the lack of a window system interface for OpenGL is a gap in OpenGL’s utility. Learning native window system APIs such as the X Window System’s Xlib [7] or Motif [8] can be daunting. Even those familiar with native window system APIs need to understand the interface that binds OpenGL to the native

window system. And when an OpenGL program is written using the native window system interface, despite the portability of the program's OpenGL rendering code, the program itself will be window system dependent.

Testing and documenting OpenGL's functionality lead to the development of the `tk` and `aux` toolkits. The `aux` toolkit is used in the examples found in the *OpenGL Programming Guide* [11]. Unfortunately, `aux` has numerous limitations and its utility is largely limited to toy programs. The `tk` library has more functionality than `aux` but was developed in an *ad hoc* fashion and still lacks much important functionality that IRIS GL programmers expect, like pop-up menus and overlays.

GLUT is designed to fill the need for a window system independent programming interface for OpenGL programs. The interface is designed to be simple yet still meet the needs of useful OpenGL programs. Features from the IRIS GL, `aux`, and `tk` interfaces are included to make it easy for programmers used to these interfaces to develop programs for GLUT.

1.2 Design Philosophy

GLUT simplifies the implementation of programs using OpenGL rendering. The GLUT application programming interface (API) requires very few routines to display a graphics scene rendered using OpenGL. The GLUT API (like the OpenGL API) is stateful. Most initial GLUT state is defined and the initial state is reasonable for simple programs.

The GLUT routines also take relatively few parameters. No pointers are returned. The only pointers passed into GLUT are pointers to character strings (all strings passed to GLUT are copied, not referenced) and opaque font handles.

The GLUT API is (as much as reasonable) window system independent. For this reason, GLUT does not return *any* native window system handles, pointers, or other data structures. More subtle window system dependencies such as reliance on window system dependent fonts are avoided by GLUT; instead, GLUT supplies its own (limited) set of fonts.

For programming ease, GLUT provides a simple menu sub-API. While the menuing support is designed to be implemented as pop-up menus, GLUT gives window system leeway to support the menu functionality in another manner (pull-down menus for example).

Two of the most important pieces of GLUT state are the *current window* and *current menu*. Most window and menu routines affect the *current window* or *menu* respectively. Most callbacks implicitly set the *current window* and *menu* to the appropriate window or menu responsible for the callback. GLUT is designed so that a program with only a single window and/or menu will not need to keep track of any window or menu identifiers. This greatly simplifies very simple GLUT programs.

GLUT is designed for simple to moderately complex programs focused on OpenGL rendering. GLUT implements its own event loop. For this reason, mixing GLUT with other APIs that demand their own event handling structure may be difficult. The advantage of a builtin event dispatch loop is simplicity.

GLUT contains routines for rendering fonts and geometric objects, however GLUT makes no claims on the OpenGL display list name space. For this reason, none of the GLUT rendering routines use OpenGL display lists. It is up to the GLUT programmer to compile the output from GLUT rendering routines into display lists if this is desired.

GLUT routines are logically organized into several sub-APIs according to their functionality. The sub-APIs are:

Initialization. Command line processing, window system initialization, and initial window creation state are controlled by these routines.

Beginning Event Processing. This routine enters GLUT's event processing loop. This routine never returns, and it continuously calls GLUT callbacks as necessary.

Window Management. These routines create and control windows.

Overlay Management. These routines establish and manage overlays for windows.

Menu Management. These routines create and control pop-up menus.

Callback Registration. These routines register callbacks to be called by the GLUT event processing loop.

Color Index Colormap Management. These routines allow the manipulation of color index colormaps for windows.

State Retrieval. These routines allows programs to retrieve state from GLUT.

Font Rendering. These routines allow rendering of stroke and bitmap fonts.

Geometric Shape Rendering. These routines allow the rendering of 3D geometric objects including spheres, cones, icosahedrons, and teapots.

1.3 API Version 2

In response to feedback from the original version of GLUT, GLUT API version 2 was developed. Additions to the original GLUT API version 1 are:

- Support for requesting stereo and multisample windows.
- New routines to query support for and provide callbacks for sophisticated input devices: the Spaceball, tablet, and dial & button box.
- New routine to register a callback for keyboard function and directional keys. In version 1, only ASCII characters could be generated.
- New queries for stereo, multisampling, and elapsed time.
- New routine to ease querying for OpenGL extension support.

GLUT API version 2 is completely compatible with version 1 of the API.

1.4 API Version 3

Further feedback lead to the development of GLUT API version 3. Additions to the GLUT API version 2 are:

- The `glutMenuStateFunc` has been deprecated in favor of the `glutMenuStatusFunc`.
- `glutFullScreen` requests full screen top-level windows.
- Three additional Helvetica bitmap fonts.
- Implementations should enforce not allowing any modifications to menus while menus are in use.
- `glutBitmapWidth` and `glutStrokeBitmap` return the widths of individual characters.
- `glutGetModifiers` called during a keyboard, mouse, or special callback returns the modifiers (Shift, Ctrl, Alt) held down when the mouse or keyboard event was generated.
- Access to per-window transparent overlays when overlay hardware is supported. The routines added are `glutEstablishOverlay`, `glutRemoveOverlay`, `glutShowOverlay`, `glutHideOverlay`, `glutUseOverlay`, `glutLayerGet`, and `glutPostOverlayRedisplay`.
- A new display mode called `GLUT_LUMINANCE` using OpenGL's RGBA color model, but that has no green or blue components. The red component is converted to an index and looked up in a writable colormap to determine displayed colors. See `glutInitDisplayMode`.

GLUT API version 3 should be largely compatible with version 2. Be aware that programs that used to (through some degree of fortuitous timing) modify menus while menus are in use will encounter fatal errors when doing so in version 3.

Another change in GLUT 3.0 that may require source code modification to pre-3.0 GLUT programs. GLUT 3.0 no longer lets a window be shown without a display callback registered. This change makes sure windows are not displayed on the screen without the GLUT application providing a way for them to be rendered. In

conjunction with this change, `glutDisplayFunc` no longer allows `NULL` to deregister a display callback. While there is no longer a way to deregister a display callback, you can still change the display callback routine with subsequent calls to `glutDisplayFunc`.

The display mode mask parameter for `glutInitDisplayMode` and the milliseconds parameter for `glutTimerFunc` are now of type `unsigned int` (previously `unsigned long`).

1.5 Conventions

GLUT window and screen coordinates are expressed in pixels. The upper left hand corner of the screen or a window is (0,0). X coordinates increase in a rightward direction; Y coordinates increase in a downward direction. Note: This is inconsistent with OpenGL's coordinate scheme that generally considers the lower left hand coordinate of a window to be at (0,0) but is consistent with most popular window systems.

Integer identifiers in GLUT begin with one, not zero. So window identifiers, menu identifiers, and menu item indices are based from one, not zero.

In GLUT's ANSI C binding, for most routines, basic types (`int`, `char *`) are used as parameters. In routines where the parameters are directly passed to OpenGL routines, OpenGL types (`GLfloat`) are used.

The header files for GLUT should be included in GLUT programs with the following include directive:

```
#include <GL/glut.h>
```

Because a very large window system software vendor (who will remain nameless) has an apparent inability to appreciate that OpenGL's API is independent of their window system API, portable ANSI C GLUT programs should not directly include `<GL/gl.h>` or `<GL/glu.h>`. Instead, ANSI C GLUT programs should rely on `<GL/glut.h>` to include the necessary OpenGL and GLU related header files.

The ANSI C GLUT library archive is typically named `libglut.a` on Unix systems. GLUT programs need to link with the system's OpenGL and GLUT libraries (and any libraries these libraries potentially depend on). A set of window system dependent libraries may also be necessary for linking GLUT programs. For example, programs using the X11 GLUT implementation typically need to link with Xlib, the X extension library, possibly the X Input extension library, the X miscellaneous utilities library, and the math library. An example X11/Unix compile line would look like:

```
cc -o foo foo.c -lglut -lGLU -lGL -lXmu -lXi -lXext -lX11 -lm
```

1.6 Terminology

A number of terms are used in a GLUT-specific manner throughout this document. The GLUT meaning of these terms is independent of the window system GLUT is used with. Here are GLUT-specific meanings for the following GLUT-specific terms:

Callback A programmer specified routine that can be registered with GLUT to be called in response to a specific type of event. Also used to refer to a specific callback routine being called.

Colormap A mapping of pixel values to RGB color values. Use by color index windows.

Dials and button box A sophisticated input device consisting of a pad of buttons and an array of rotating dials, often used by computer-aided design programs.

Display mode A set of OpenGL frame buffer capabilities that can be attributed to a window.

Idle A state when no window system events are received for processing as callbacks and the idle callback, if one is registered, is called.

Layer in use Either the normal plane or overlay. This per-window state determines what frame buffer layer OpenGL commands affect.

Menu entry A menu item that the user can select to trigger the menu callback for the menu entry's value.

Menu item Either a menu entry or a sub-menu trigger.

Modifiers The Shift, Ctrl, and Alt keys that can be held down simultaneously with a key or mouse button being pressed or released.

Multisampling A technique for hardware antialiasing generally available only on expensive 3D graphics hardware [1]. Each pixel is composed of a number of samples (each containing color and depth information). The samples are averaged to determine the displayed pixel color value. Multisampling is supported as an extension to OpenGL.

Normal plane The default frame buffer layer where GLUT window state resides; as opposed to the *overlay*.

Overlay A frame buffer layer that can be displayed preferentially to the *normal plane* and supports transparency to display through to the *normal plane*. Overlays are useful for rubber-banding effects, text annotation, and other operations, to avoid damaging the normal plane frame buffer state. Overlays require hardware support not present on all systems.

Pop The act of forcing a window to the top of the stacking order for sibling windows.

Pop-up menu A menu that can be set to appear when a specified mouse button is pressed in a window. A pop-menu consists of multiple menu items.

Push The act of forcing a window to the bottom of the stacking order for sibling windows.

Reshape The act of changing the size or shape of the window.

Spaceball A sophisticated 3D input device that provides six degrees of freedom, three axes of rotation and three axes of translation. It also supports a number of buttons. The device is a hand-sized ball attached to a base. By cupping the ball with one's hand and applying torsional or directional force on the ball, rotations and translations are generated.

Stereo A frame buffer capability providing left and right color buffers for creating stereoscopic renderings. Typically, the user wears LCD shuttered goggles synchronized with the alternating display on the screen of the left and right color buffers.

Sub-menu A menu cascaded from some sub-menu trigger.

Sub-menu trigger A menu item that the user can enter to cascade another pop-up menu.

Subwindow A type of window that is the child window of a top-level window or other subwindow. The drawing and visible region of a subwindow is limited by its parent window.

Tablet A precise 2D input device. Like a mouse, 2D coordinates are returned. The absolute position of the tablet "puck" on the tablet is returned. Tablets also support a number of buttons.

Timer A callback that can be scheduled to be called in a specified interval of time.

Top-level window A window that can be placed, moved, resized, etc. independently from other top-level windows by the user. Subwindows may reside within a top-level window.

Window A rectangular area for OpenGL rendering.

Window display state One of shown, hidden, or iconified. A shown window is potentially visible on the screen (it may be obscured by other windows and not actually visible). A hidden window will never be visible. An iconified window is not visible but could be made visible in response to some user action like clicking on the window's corresponding icon.

Window system A broad notion that refers to both the mechanism and policy of the window system. For example, in the X Window System both the window manager and the X server are integral to what GLUT considers the window system.

2 Initialization

Routines beginning with the `glutInit`- prefix are used to initialize GLUT state. The primary initialization routine is `glutInit` that should only be called exactly once in a GLUT program. No non-`glutInit`- prefixed GLUT or OpenGL routines should be called before `glutInit`.

The other `glutInit`- routines may be called before `glutInit`. The reason is these routines can be used to set default window initialization state that might be modified by the command processing done in `glutInit`. For example, `glutInitWindowSize(400, 400)` can be called before `glutInit` to indicate 400 by 400 is the program's default window size. Setting the *initial window size* or *position* before `glutInit` allows the GLUT program user to specify the initial size or position using command line arguments.

2.1 glutInit

`glutInit` is used to initialize the GLUT library.

Usage

```
void glutInit(int *argc, char **argv);
```

argc A pointer to the program's *unmodified* `argc` variable from `main`. Upon return, the value pointed to by `argc` will be updated, because `glutInit` extracts any command line options intended for the GLUT library.

argv The program's *unmodified* `argv` variable from `main`. Like `argc`, the data for `argv` will be updated because `glutInit` extracts any command line options understood by the GLUT library.

Description

`glutInit` will initialize the GLUT library and negotiate a session with the window system. During this process, `glutInit` may cause the termination of the GLUT program with an error message to the user if GLUT cannot be properly initialized. Examples of this situation include the failure to connect to the window system, the lack of window system support for OpenGL, and invalid command line options.

`glutInit` also processes command line options, but the specific options parse are window system dependent.

X Implementation Notes

The X Window System specific options parsed by `glutInit` are as follows:

- display **DISPLAY** Specify the X server to connect to. If not specified, the value of the `DISPLAY` environment variable is used.
- geometry **WxH+X+Y** Determines where window's should be created on the screen. The parameter following -geometry should be formatted as a standard X geometry specification. The effect of using this option is to change the GLUT *initial size* and *initial position* the same as if `glutInitWindowSize` or `glutInitWindowPosition` were called directly.
- iconic Requests all top-level windows be created in an iconic state.
- indirect Force the use of *indirect* OpenGL rendering contexts.
- direct Force the use of *direct* OpenGL rendering contexts (not all GLX implementations support direct rendering contexts). A fatal error is generated if direct rendering is not supported by the OpenGL implementation.

If neither `-indirect` or `-direct` are used to force a particular behavior, GLUT will attempt to use direct rendering if possible and otherwise fallback to indirect rendering.

- gldebug After processing callbacks and/or events, check if there are any OpenGL errors by calling `glGetError`. If an error is reported, print out a warning by looking up the error code with `gluErrorString`. Using this option is helpful in detecting OpenGL run-time errors.
- sync Enable synchronous X protocol transactions. This option makes it easier to track down potential X protocol errors.

2.2 `glutInitWindowPosition`, `glutInitWindowSize`

`glutInitWindowPosition` and `glutInitWindowSize` set the *initial window position* and *size* respectively.

Usage

```
void glutInitWindowSize(int width, int height);
void glutInitWindowPosition(int x, int y);
```

`width` Width in pixels.

`height` Height in pixels.

`x` Window X location in pixels.

`y` Window Y location in pixels.

Description

Windows created by `glutCreateWindow` will be requested to be created with the current *initial window position* and *size*.

The initial value of the *initial window position* GLUT state is -1 and -1. If either the X or Y component to the *initial window position* is negative, the actual window position is left to the window system to determine. The initial value of the *initial window size* GLUT state is 300 by 300. The *initial window size* components must be greater than zero.

The intent of the *initial window position* and *size* values is to provide a suggestion to the window system for a window's initial size and position. The window system is not obligated to use this information. Therefore, GLUT programs should not assume the window was created at the specified size or position. A GLUT program should use the window's reshape callback to determine the true size of the window.

2.3 `glutInitDisplayMode`

`glutInitDisplayMode` sets the *initial display mode*.

Usage

```
void glutInitDisplayMode(unsigned int mode);
```

`mode` Display mode, normally the bitwise OR-ing of GLUT display mode bit masks. See values below:

`GLUT_RGBA` Bit mask to select an RGBA mode window. This is the default if neither `GLUT_RGBA` nor `GLUT_INDEX` are specified.

`GLUT_RGB` An alias for `GLUT_RGBA`.

`GLUT_INDEX` Bit mask to select a color index mode window. This overrides `GLUT_RGBA` if it is also specified.

`GLUT_SINGLE` Bit mask to select a single buffered window. This is the default if neither `GLUT_DOUBLE` or `GLUT_SINGLE` are specified.

`GLUT_DOUBLE` Bit mask to select a double buffered window. This overrides `GLUT_SINGLE` if it is also specified.

GLUT_ACCUM Bit mask to select a window with an accumulation buffer.

GLUT_ALPHA Bit mask to select a window with an alpha component to the color buffer(s).

GLUT_DEPTH Bit mask to select a window with a depth buffer.

GLUT_STENCIL Bit mask to select a window with a stencil buffer.

GLUT_MULTISAMPLE Bit mask to select a window with multisampling support. If multisampling is not available, a non-multisampling window will automatically be chosen. Note: both the OpenGL client-side and server-side implementations must support the GLX_SAMPLE_SGIS extension for multisampling to be available.

GLUT_STEREO Bit mask to select a stereo window.

GLUT_LUMINANCE Bit mask to select a window with a “luminance” color model. This model provides the functionality of OpenGL’s RGBA color model, but the green and blue components are not maintained in the frame buffer. Instead each pixel’s red component is converted to an index between zero and `glutGet(GLUT_WINDOW_COLORMAP_SIZE) - 1` and looked up in a per-window color map to determine the color of pixels within the window. The initial colormap of GLUT_LUMINANCE windows is initialized to be a linear gray ramp, but can be modified with GLUT’s colormap routines.

Description

The *initial display mode* is used when creating top-level windows, subwindows, and overlays to determine the OpenGL display mode for the to-be-created window or overlay.

Note that GLUT_RGBA selects the RGBA color model, but it does not request any bits of alpha (sometimes called an *alpha buffer* or *destination alpha*) be allocated. To request alpha, specify GLUT_ALPHA. The same applies to GLUT_LUMINANCE.

GLUT_LUMINANCE Implementation Notes

GLUT_LUMINANCE is not supported on most OpenGL platforms.

3 Beginning Event Processing

After a GLUT program has done initial setup such as creating windows and menus, GLUT programs enter the GLUT event processing loop by calling `glutMainLoop`.

3.1 glutMainLoop

`glutMainLoop` enters the GLUT event processing loop.

Usage

```
void glutMainLoop(void);
```

Description

`glutMainLoop` enters the GLUT event processing loop. This routine should be called at most once in a GLUT program. Once called, this routine will never return. It will call as necessary any callbacks that have been registered.

4 Window Management

GLUT supports two types of windows: top-level windows and subwindows. Both types support OpenGL rendering and GLUT callbacks. There is a single identifier space for both types of windows.

4.1 `glutCreateWindow`

`glutCreateWindow` creates a top-level window.

Usage

```
int glutCreateWindow(const char *name);
```

`name` ASCII character string for use as window name.

Description

`glutCreateWindow` creates a top-level window. The name will be provided to the window system as the window's name. The intent is that the window system will label the window with the name.

Implicitly, the *current window* is set to the newly created window.

Each created window has a unique associated OpenGL context. State changes to a window's associated OpenGL context can be done immediately after the window is created.

The *display state* of a window is initially for the window to be shown. But the window's *display state* is not actually acted upon until `glutMainLoop` is entered. This means until `glutMainLoop` is called, rendering to a created window is ineffective because the window can not yet be displayed.

The value returned is a unique small integer identifier for the window. The range of allocated identifiers starts at one. This window identifier can be used when calling `glutSetWindow`.

X Implementation Notes

The proper X Inter-Client Communication Conventions Manual (ICCCM) top-level properties are established. The `WM_COMMAND` property that lists the command line used to invoke the GLUT program is only established for the first window created.

4.2 `glutCreateSubWindow`

`glutCreateSubWindow` creates a subwindow.

Usage

```
int glutCreateSubWindow(int win,  
                        int x, int y, int width, int height);
```

`win` Identifier of the subwindow's parent window.

`x` Window X location in pixels relative to parent window's origin.

`y` Window Y location in pixels relative to parent window's origin.

`width` Width in pixels.

`height` Height in pixels.

Description

`glutCreateSubWindow` creates a subwindow of the window identified by `win` of size `width` and `height` at location `x` and `y` within the *current window*. Implicitly, the *current window* is set to the newly created subwindow.

Each created window has a unique associated OpenGL context. State changes to a window's associated OpenGL context can be done immediately after the window is created.

The *display state* of a window is initially for the window to be shown. But the window's *display state* is not actually acted upon until `glutMainLoop` is entered. This means until `glutMainLoop` is called, rendering to a created window is ineffective. Subwindows can not be iconified.

Subwindows can be nested arbitrarily deep.

The value returned is a unique small integer identifier for the window. The range of allocated identifiers starts at one.

4.3 `glutSetWindow`, `glutGetWindow`

`glutSetWindow` sets the *current window*; `glutGetWindow` returns the identifier of the *current window*.

Usage

```
void glutSetWindow(int win);  
int glutGetWindow(void);
```

`win` Identifier of GLUT window to make the *current window*.

Description

`glutSetWindow` sets the *current window*; `glutGetWindow` returns the identifier of the *current window*. If no windows exist or the previously *current window* was destroyed, `glutGetWindow` returns zero. `glutSetWindow` does *not* change the *layer in use* for the window; this is done using `glutUseLayer`.

4.4 `glutDestroyWindow`

`glutDestroyWindow` destroys the specified window.

Usage

```
void glutDestroyWindow(int win);
```

`win` Identifier of GLUT window to destroy.

Description

`glutDestroyWindow` destroys the window specified by `win` and the window's associated OpenGL context, logical colormap (if the window is color index), and overlay and related state (if an overlay has been established). Any subwindows of destroyed windows are also destroyed by `glutDestroyWindow`. If `win` was the *current window*, the *current window* becomes invalid (`glutGetWindow` will return zero).

4.5 `glutPostRedisplay`

`glutPostRedisplay` marks the *current window* as needing to be redisplayed.

Usage

```
void glutPostRedisplay(void);
```

Description

Mark the normal plane of *current window* as needing to be redisplayed. The next iteration through `glutMainLoop`, the window's display callback will be called to redisplay the window's normal plane. Multiple calls to `glutPostRedisplay` before the next display callback opportunity generates only a single redisplay callback. `glutPostRedisplay` may be called within a window's display or overlay display callback to re-mark that window for redisplay.

Logically, normal plane damage notification for a window is treated as a `glutPostRedisplay` on the damaged window. Unlike damage reported by the window system, `glutPostRedisplay` will *not* set to true the normal plane's damaged status (returned by `glutLayerGet(GLUT_NORMAL_DAMAGED)`).

Also, see `glutPostOverlayRedisplay`.

4.6 **glutSwapBuffers**

`glutSwapBuffers` swaps the buffers of the *current window* if double buffered.

Usage

```
void glutSwapBuffers(void);
```

Description

Performs a buffer swap on the *layer in use* for the *current window*. Specifically, `glutSwapBuffers` promotes the contents of the back buffer of the *layer in use* of the *current window* to become the contents of the front buffer. The contents of the back buffer then become undefined. The update typically takes place during the vertical retrace of the monitor, rather than immediately after `glutSwapBuffers` is called.

An implicit `glFlush` is done by `glutSwapBuffers` before it returns. Subsequent OpenGL commands can be issued immediately after calling `glutSwapBuffers`, but are not executed until the buffer exchange is completed.

If the *layer in use* is not double buffered, `glutSwapBuffers` has no effect.

4.7 **glutPositionWindow**

`glutPositionWindow` requests a change to the position of the *current window*.

Usage

```
void glutPositionWindow(int x, int y);
```

x New X location of window in pixels.

y New Y location of window in pixels.

Description

`glutPositionWindow` requests a change in the position of the *current window*. For top-level windows, the x and y parameters are pixel offsets from the screen origin. For subwindows, the x and y parameters are pixel offsets from the window's parent window origin.

The requests by `glutPositionWindow` are not processed immediately. The request is executed after returning to the main event loop. This allows multiple `glutPositionWindow`, `glutReshapeWindow`, and `glutFullScreen` requests to the same window to be coalesced.

In the case of top-level windows, a `glutPositionWindow` call is considered only a request for positioning the window. The window system is free to apply its own policies to top-level window placement. The intent is that top-level windows should be repositioned according to `glutPositionWindow`'s parameters.

`glutPositionWindow` disables the full screen status of a window if previously enabled.

4.8 **glutReshapeWindow**

`glutReshapeWindow` requests a change to the size of the *current window*.

Usage

```
void glutReshapeWindow(int width, int height);
```

width New width of window in pixels.

height New height of window in pixels.

Description

`glutReshapeWindow` requests a change in the size of the *current window*. The `width` and `height` parameters are size extents in pixels. The `width` and `height` must be positive values.

The requests by `glutReshapeWindow` are not processed immediately. The request is executed after returning to the main event loop. This allows multiple `glutReshapeWindow`, `glutPositionWindow`, and `glutFullScreen` requests to the same window to be coalesced.

In the case of top-level windows, a `glutReshapeWindow` call is considered only a request for sizing the window. The window system is free to apply its own policies to top-level window sizing. The intent is that top-level windows should be reshaped according `glutReshapeWindow`'s parameters. Whether a reshape actually takes effect and, if so, the reshaped dimensions are reported to the program by a reshape callback.

`glutReshapeWindow` disables the full screen status of a window if previously enabled.

4.9 glutFullScreen

`glutFullScreen` requests that the *current window* be made full screen.

Usage

```
void glutFullScreen(void);
```

Description

`glutFullScreen` requests that the *current window* be made full screen. The exact semantics of what full screen means may vary by window system. The intent is to make the window as large as possible and disable any window decorations or borders added the window system. The window width and height are not guaranteed to be the same as the screen width and height, but that is the intent of making a window full screen.

`glutFullScreen` is defined to work only on top-level windows.

The `glutFullScreen` requests are not processed immediately. The request is executed after returning to the main event loop. This allows multiple `glutReshapeWindow`, `glutPositionWindow`, and `glutFullScreen` requests to the same window to be coalesced.

Subsequent `glutReshapeWindow` and `glutPositionWindow` requests on the window will disable the full screen status of the window.

X Implementation Notes

In the X implementation of GLUT, full screen is implemented by sizing and positioning the window to cover the entire screen and posting the `_MOTIF_WM_HINTS` property on the window requesting absolutely no decorations. Non-Motif window managers may not respond to `_MOTIF_WM_HINTS`.

4.10 glutPopWindow, glutPushWindow

`glutPopWindow` and `glutPushWindow` change the stacking order of the *current window* relative to its siblings.

Usage

```
void glutPopWindow(void);
void glutPushWindow(void);
```

Description

`glutPopWindow` and `glutPushWindow` work on both top-level windows and subwindows. The effect of pushing and popping windows does not take place immediately. Instead the push or pop is saved for execution upon return to the GLUT event loop. Subsequent push or pop requests on a window replace the previously

saved request for that window. The effect of pushing and popping top-level windows is subject to the window system's policy for restacking windows.

4.11 **glutShowWindow, glutHideWindow, glutIconifyWindow**

glutShowWindow, *glutHideWindow*, and *glutIconifyWindow* change the display status of the *current window*.

Usage

```
void glutShowWindow(void);  
void glutHideWindow(void);  
void glutIconifyWindow(void);
```

Description

glutShowWindow will show the *current window* (though it may still not be visible if obscured by other shown windows). *glutHideWindow* will hide the *current window*. *glutIconifyWindow* will iconify a top-level window, but GLUT prohibits iconification of a subwindow. The effect of showing, hiding, and iconifying windows does not take place immediately. Instead the requests are saved for execution upon return to the GLUT event loop. Subsequent show, hide, or iconification requests on a window replace the previously saved request for that window. The effect of hiding, showing, or iconifying top-level windows is subject to the window system's policy for displaying windows.

4.12 **glutSetWindowTitle, glutSetIconTitle**

glutSetWindowTitle and *glutSetIconTitle* change the window or icon title respectively of the *current top-level window*.

Usage

```
void glutSetWindowTitle(const char *name);  
void glutSetIconTitle(const char *name);
```

name ASCII character string for the window or icon name to be set for the window.

Description

These routines should be called only when the *current window* is a top-level window. Upon creation of a top-level window, the window and icon names are determined by the *name* parameter to *glutCreateWindow*. Once created, *glutSetWindowTitle* and *glutSetIconTitle* can change the window and icon names respectively of top-level windows. Each call requests the window system change the title appropriately. Requests are not buffered or coalesced. The policy by which the window and icon name are displayed is window system dependent.

4.13 **glutSetCursor**

glutSetCursor changes the cursor image of the *current window*.

Usage

```
void glutSetCursor(int cursor);
```

cursor Name of cursor image to change to.

GLUT_CURSOR_RIGHT_ARROW Arrow pointing up and to the right.

GLUT_CURSOR_LEFT_ARROW Arrow pointing up and to the left.
 GLUT_CURSOR_INFO Pointing hand.
 GLUT_CURSOR_DESTROY Skull & cross bones.
 GLUT_CURSOR_HELP Question mark.
 GLUT_CURSOR_CYCLE Arrows rotating in a circle.
 GLUT_CURSOR_SPRAY Spray can.
 GLUT_CURSOR_WAIT Wrist watch.
 GLUT_CURSOR_TEXT Insertion point cursor for text.
 GLUT_CURSOR_CROSSHAIR Simple cross-hair.
 GLUT_CURSOR_UP_DOWN Bi-directional pointing up & down.
 GLUT_CURSOR_LEFT_RIGHT Bi-directional pointing left & right.
 GLUT_CURSOR_TOP_SIDE Arrow pointing to top side.
 GLUT_CURSOR_BOTTOM_SIDE Arrow pointing to bottom side.
 GLUT_CURSOR_LEFT_SIDE Arrow pointing to left side.
 GLUT_CURSOR_RIGHT_SIDE Arrow pointing to right side.
 GLUT_CURSOR_TOP_LEFT_CORNER Arrow pointing to top-left corner.
 GLUT_CURSOR_TOP_RIGHT_CORNER Arrow pointing to top-right corner.
 GLUT_CURSOR_BOTTOM_RIGHT_CORNER Arrow pointing to bottom-right corner.
 GLUT_CURSOR_BOTTOM_LEFT_CORNER Arrow pointing to bottom-left corner.
 GLUT_CURSOR_FULL_CROSSHAIR Full-screen cross-hair cursor (if possible, otherwise GLUT_CURSOR_CROSSHAIR).
 GLUT_CURSOR_NONE Invisible cursor.
 GLUT_CURSOR_INHERIT Use parent's cursor.

Description

glutSetCursor changes the cursor image of the *current window*. Each call requests the window system change the cursor appropriately. The cursor image when a window is created is GLUT_CURSOR_INHERIT. The exact cursor images used are implementation dependent. The intent is for the image to convey the meaning of the cursor name. For a top-level window, GLUT_CURSOR_INHERIT uses the default window system cursor.

X Implementation Notes

GLUT for X uses SGI's _SGI_CROSSHAIR_CURSOR convention [5] to access a full screen cross-hair cursor if possible.

5 Overlay Management

When overlay hardware is available, GLUT provides a set of routine for establishing, using, and removing an overlay for GLUT windows. When an overlay is established, a separate OpenGL context is also established. A window's overlay OpenGL state is kept distinct from the normal planes OpenGL state.

5.1 glutEstablishOverlay

glutEstablishOverlay establishes an overlay (if possible) for the *current window*.

Usage

```
void glutEstablishOverlay(void);
```

Description

`glutEstablishOverlay` establishes an overlay (if possible) for the *current window*. The requested display mode for the overlay is determined by the *initial display mode*. `glutLayerGet(GLUT_OVERLAY_POSSIBLE)` can be called to determine if an overlay is possible for the *current window* with the current *initial display mode*. Do not attempt to establish an overlay when one is not possible; GLUT will terminate the program.

If `glutEstablishOverlay` is called when an overlay already exists, the existing overlay is first removed, and then a new overlay is established. The state of the old overlay's OpenGL context is discarded.

The initial display state of an overlay is shown, however the overlay is only actually shown if the overlay's window is shown.

Implicitly, the window's *layer in use* changes to the overlay immediately after the overlay is established.

X Implementation Notes

GLUT for X uses the `SERVER_OVERLAY_VISUALS` convention [6] is used to determine if overlay visuals are available. While the convention allows for opaque overlays (no transparency) and overlays with the transparency specified as a bitmask, GLUT overlay management only provides access to transparent pixel overlays.

Until RGBA overlays are better understood, GLUT only supports color index overlays.

5.2 *glutUseLayer*

`glutUseLayer` changes the *layer in use* for the *current window*.

Usage

```
void glutUseLayer(GLenum layer);
```

layer Either `GLUT_NORMAL` or `GLUT_OVERLAY`, selecting the normal plane or overlay respectively.

Description

`glutUseLayer` changes the per-window *layer in use* for the *current window*, selecting either the normal plane or overlay. The overlay should only be specified if an overlay exists, however windows without an overlay may still call `glutUseLayer(GLUT_NORMAL)`. OpenGL commands for the window are directed to the current *layer in use*.

To query the *layer in use* for a window, call `glutLayerGet(GLUT_LAYER_IN_USE)`.

5.3 *glutRemoveOverlay*

`glutRemoveOverlay` removes the overlay (if one exists) from the *current window*.

Usage

```
void glutRemoveOverlay(void);
```

Description

`glutRemoveOverlay` removes the overlay (if one exists). It is safe to call `glutRemoveOverlay` even if no overlay is currently established—it does nothing in this case. Implicitly, the window's *layer in use* changes to the normal plane immediately once the overlay is removed.

If the program intends to re-establish the overlay later, it is typically faster and less resource intensive to use `glutHideOverlay` and `glutShowOverlay` to simply change the display status of the overlay.

5.4 `glutPostOverlayRedisplay`

`glutPostOverlayRedisplay` marks the overlay of the *current window* as needing to be redisplayed.

Usage

```
void glutPostOverlayRedisplay(void);
```

Description

Mark the overlay of *current window* as needing to be redisplayed. The next iteration through `glutMainLoop`, the window's overlay display callback (or simply the display callback if no overlay display callback is registered) will be called to redisplay the window's overlay plane. Multiple calls to `glutPostOverlayRedisplay` before the next display callback opportunity (or overlay display callback opportunity if one is registered) generate only a single redisplay. `glutPostOverlayRedisplay` may be called within a window's display or overlay display callback to re-mark that window for redisplay.

Logically, overlay damage notification for a window is treated as a `glutPostOverlayRedisplay` on the damaged window. Unlike damage reported by the window system, `glutPostOverlayRedisplay` will not set to true the overlay's damaged status (returned by `glutLayerGet(GLUT_OVERLAY_DAMAGED)`).

Also, see `glutPostRedisplay`.

5.5 `glutShowOverlay`, `glutHideOverlay`

`glutShowOverlay` shows the overlay of the *current window*; `glutHideOverlay` hides the overlay.

Usage

```
void glutShowOverlay(void);
void glutHideOverlay(void);
```

Description

`glutShowOverlay` shows the overlay of the *current window*; `glutHideOverlay` hides the overlay. The effect of showing or hiding an overlay takes place immediately. Note that `glutShowOverlay` will not actually display the overlay unless the window is also shown (and even a shown window may be obscured by other windows, thereby obscuring the overlay). It is typically faster and less resource intensive to use these routines to control the display status of an overlay as opposed to removing and re-establishing the overlay.

6 Menu Management

GLUT supports simple cascading pop-up menus. They are designed to let a user select various modes within a program. The functionality is simple and minimalistic and is meant to be that way. Do not mistake GLUT's pop-up menu facility with an attempt to create a full-featured user interface.

It is illegal to create or destroy menus, or change, add, or remove menu items while a menu (and any cascaded sub-menus) are in use (that is, popped up).

6.1 `glutCreateMenu`

`glutCreateMenu` creates a new pop-up menu.

Usage

```
int glutCreateMenu(void (*func)(int value));
```

func The callback function for the menu that is called when a menu entry from the menu is selected. The value passed to the callback is determined by the value for the selected menu entry.

Description

`glutCreateMenu` creates a new pop-up menu and returns a unique small integer identifier. The range of allocated identifiers starts at one. The menu identifier range is separate from the window identifier range. Implicitly, the *current menu* is set to the newly created menu. This menu identifier can be used when calling `glutSetMenu`.

When the menu callback is called because a menu entry is selected for the menu, the *current menu* will be implicitly set to the menu with the selected entry before the callback is made.

X Implementation Notes

If available, GLUT for X will take advantage of overlay planes for implementing pop-up menus. The use of overlay planes can eliminate display callbacks when pop-up menus are deactivated. The `SERVER_OVERLAY_VISUALS` convention [6] is used to determine if overlay visuals are available.

6.2 *glutSetMenu, glutGetMenu*

`glutSetMenu` sets the *current menu*; `glutGetMenu` returns the identifier of the *current menu*.

Usage

```
void glutSetMenu(int menu);  
int glutGetMenu(void);
```

`menu` The identifier of the menu to make the *current menu*.

Description

`glutSetMenu` sets the *current menu*; `glutGetMenu` returns the identifier of the *current menu*. If no menus exist or the previous *current menu* was destroyed, `glutGetMenu` returns zero.

6.3 *glutDestroyMenu*

`glutDestroyMenu` destroys the specified menu.

Usage

```
void glutDestroyMenu(int menu);
```

`menu` The identifier of the menu to destroy.

Description

`glutDestroyMenu` destroys the specified menu by `menu`. If `menu` was the *current menu*, the *current menu* becomes invalid and `glutGetMenu` will return zero.

When a menu is destroyed, this has no effect on any sub-menus for which the destroyed menu has triggers. Sub-menu triggers are by name, not reference.

6.4 *glutAddMenuEntry*

`glutAddMenuEntry` adds a menu entry to the bottom of the *current menu*.

Usage

```
void glutAddMenuEntry(const char *name, int value);
```

`name` ASCII character string to display in the menu entry.

`value` Value to return to the menu's callback function if the menu entry is selected.

Description

`glutAddMenuEntry` adds a menu entry to the bottom of the *current menu*. The string `name` will be displayed for the newly added menu entry. If the menu entry is selected by the user, the menu's callback will be called passing `value` as the callback's parameter.

6.5 glutAddSubMenu

`glutAddSubMenu` adds a sub-menu trigger to the bottom of the *current menu*.

Usage

```
void glutAddSubMenu(const char *name, int menu);
```

`name` ASCII character string to display in the menu item from which to cascade the sub-menu.

`menu` Identifier of the menu to cascade from this sub-menu menu item.

Description

`glutAddSubMenu` adds a sub-menu trigger to the bottom of the *current menu*. The string `name` will be displayed for the newly added sub-menu trigger. If the sub-menu trigger is entered, the sub-menu numbered `menu` will be cascaded, allowing sub-menu menu items to be selected.

6.6 glutChangeToMenuEntry

`glutChangeToMenuEntry` changes the specified menu item in the *current menu* into a menu entry.

Usage

```
void glutChangeToMenuEntry(int entry, const char *name, int value);
```

`entry` Index into the menu items of the *current menu* (1 is the topmost menu item).

`name` ASCII character string to display in the menu entry.

`value` Value to return to the menu's callback function if the menu entry is selected.

Description

`glutChangeToMenuEntry` changes the specified menu entry in the *current menu* into a menu entry. The `entry` parameter determines which menu item should be changed, with one being the topmost item. `entry` must be between 1 and `glutGet(GLUT_MENU_NUM_ITEMS)` inclusive. The menu item to change does not have to be a menu entry already. The string `name` will be displayed for the newly changed menu entry. The `value` will be returned to the menu's callback if this menu entry is selected.

6.7 glutChangeToSubMenu

`glutChangeToSubMenu` changes the specified menu item in the *current menu* into a sub-menu trigger.

Usage

```
void glutChangeToSubMenu(int entry, const char *name, int menu);
```

`entry` Index into the menu items of the *current menu* (1 is the topmost menu item).

`name` ASCII character string to display in the menu item to cascade the sub-menu from.

`menu` Identifier of the menu to cascade from this sub-menu menu item.

Description

`glutChangeToSubMenu` changes the specified menu item in the *current menu* into a sub-menu trigger. The `entry` parameter determines which menu item should be changed, with one being the topmost item. `entry` must be between 1 and `glutGet(GLUT_MENU_NUM_ITEMS)` inclusive. The menu item to change does not have to be a sub-menu trigger already. The string name will be displayed for the newly changed sub-menu trigger. The menu identifier names the sub-menu to cascade from the newly added sub-menu trigger.

6.8 *glutRemoveMenuItem*

`glutRemoveMenuItem` remove the specified menu item.

Usage

```
void glutRemoveMenuItem(int entry);
```

`entry` Index into the menu items of the *current menu* (1 is the topmost menu item).

Description

`glutRemoveMenuItem` remove the `entry` menu item regardless of whether it is a menu entry or sub-menu trigger. `entry` must be between 1 and `glutGet(GLUT_MENU_NUM_ITEMS)` inclusive. Menu items below the removed menu item are renumbered.

6.9 *glutAttachMenu, glutDetachMenu*

`glutAttachMenu` attaches a mouse button for the *current window* to the identifier of the *current menu*; `glutDetachMenu` detaches an attached mouse button from the *current window*.

Usage

```
void glutAttachMenu(int button);  
void glutDetachMenu(int button);
```

`button` The button to attach a menu or detach a menu.

Description

`glutAttachMenu` attaches a mouse button for the *current window* to the identifier of the *current menu*; `glutDetachMenu` detaches an attached mouse button from the *current window*. By attaching a menu identifier to a button, the named menu will be popped up when the user presses the specified button. `button` should be one of `GLUT_LEFT_BUTTON`, `GLUT_MIDDLE_BUTTON`, and `GLUT_RIGHT_BUTTON`. Note that the menu is attached to the button by identifier, not by reference.

7 Callback Registration

GLUT supports a number of callbacks to respond to events. There are three types of callbacks: window, menu, and global. Window callbacks indicate when to redisplay or reshape a window, when the visibility of the window changes, and when input is available for the window. The menu callback is set by the `glutCreateMenu` call described already. The global callbacks manage the passing of time and menu usage. The calling order of callbacks between different windows is undefined.

Callbacks for input events should be delivered to the window the event occurs in. Events should not propagate to parent windows.

X Implementation Notes

The X GLUT implementation uses the X Input extension [13, 14] to support sophisticated input devices: Spaceball, dial & button box, and digitizing tablet. Because the X Input extension does not mandate how particular types of devices are advertised through the extension, it is possible GLUT for X may not correctly support input devices that would otherwise be of the correct type. The X GLUT implementation will support the Silicon Graphics Spaceball, dial & button box, and digitizing tablet as advertised through the X Input extension.

7.1 glutDisplayFunc

glutDisplayFunc sets the display callback for the *current window*.

Usage

```
void glutDisplayFunc(void (*func)(void));
```

func The new display callback function.

Description

glutDisplayFunc sets the display callback for the *current window*. When GLUT determines that the normal plane for the window needs to be redisplayed, the display callback for the window is called. Before the callback, the *current window* is set to the window needing to be redisplayed and (if no overlay display callback is registered) the *layer in use* is set to the normal plane. The display callback is called with no parameters. The entire normal plane region should be redisplayed in response to the callback (this includes ancillary buffers if your program depends on their state).

GLUT determines when the display callback should be triggered based on the window's redisplay state. The redisplay state for a window can be either set explicitly by calling glutPostRedisplay or implicitly as the result of window damage reported by the window system. Multiple posted redisplays for a window are coalesced by GLUT to minimize the number of display callbacks called.

When an overlay is established for a window, but there is no overlay display callback registered, the display callback is used for redisplaying *both* the overlay and normal plane (that is, it will be called if either the redisplay state or overlay redisplay state is set). In this case, the *layer in use* is *not* implicitly changed on entry to the display callback.

See glutOverlayDisplayFunc to understand how distinct callbacks for the overlay and normal plane of a window may be established.

When a window is created, no display callback exists for the window. It is the responsibility of the programmer to install a display callback for the window before the window is shown. A display callback *must* be registered for any window that is shown. If a window becomes displayed without a display callback being registered, a fatal error occurs. Passing NULL to glutDisplayFunc is illegal as of GLUT 3.0; there is no way to “deregister” a display callback (though another callback routine can always be registered).

Upon return from the display callback, the *normal damaged* state of the window (returned by calling glutLayerGet (GLUT_NORMAL_DAMAGED) is cleared. If there is no overlay display callback registered the *overlay damaged* state of the window (returned by calling glutLayerGet (GLUT_OVERLAY_DAMAGED) is also cleared.

7.2 glutOverlayDisplayFunc

glutOverlayDisplayFunc sets the overlay display callback for the *current window*.

Usage

```
void glutOverlayDisplayFunc(void (*func)(void));
```

func The new overlay display callback function.

Description

`glutDisplayFunc` sets the overlay display callback for the *current window*. The overlay display callback is functionally the same as the window's display callback except that the overlay display callback is used to redisplay the window's overlay.

When GLUT determines that the overlay plane for the window needs to be redisplayed, the overlay display callback for the window is called. Before the callback, the *current window* is set to the window needing to be redisplayed and the *layer in use* is set to the overlay. The overlay display callback is called with no parameters. The entire overlay region should be redisplayed in response to the callback (this includes ancillary buffers if your program depends on their state).

GLUT determines when the overlay display callback should be triggered based on the window's overlay redisplay state. The overlay redisplay state for a window can be either set explicitly by calling `glutPostOverlayRedisplay` or implicitly as the result of window damage reported by the window system. Multiple posted overlay redisplays for a window are coalesced by GLUT to minimize the number of overlay display callbacks called.

Upon return from the overlay display callback, the *overlay damaged* state of the window (returned by calling `glutLayerGet ( GLUT_OVERLAY_DAMAGED )`) is cleared.

The overlay display callback can be deregistered by passing `NULL` to `glutOverlayDisplayFunc`. The overlay display callback is initially `NULL` when an overlay is established. See `glutDisplayFunc` to understand how the display callback alone is used if an overlay display callback is not registered.

7.3 *glutReshapeFunc*

`glutReshapeFunc` sets the reshape callback for the *current window*.

Usage

```
void glutReshapeFunc(void (*func)(int width, int height));
```

`func` The new reshape callback function.

Description

`glutReshapeFunc` sets the reshape callback for the *current window*. The reshape callback is triggered when a window is reshaped. A reshape callback is also triggered immediately before a window's first display callback after a window is created or whenever an overlay for the window is established. The `width` and `height` parameters of the callback specify the new window size in pixels. Before the callback, the *current window* is set to the window that has been reshaped.

If a reshape callback is not registered for a window or `NULL` is passed to `glutReshapeFunc` (to deregister a previously registered callback), the default reshape callback is used. This default callback will simply call `glViewport (0, 0, width, height)` on the normal plane (and on the overlay if one exists).

If an overlay is established for the window, a single reshape callback is generated. It is the callback's responsibility to update both the normal plane and overlay for the window (changing the *layer in use* as necessary).

When a top-level window is reshaped, subwindows are not reshaped. It is up to the GLUT program to manage the size and positions of subwindows within a top-level window. Still, reshape callbacks will be triggered for subwindows when their size is changed using `glutReshapeWindow`.

7.4 *glutKeyboardFunc*

`glutKeyboardFunc` sets the keyboard callback for the *current window*.

Usage

```
void glutKeyboardFunc(void (*func)(unsigned char key,
                                   int x, int y));
```

`func` The new keyboard callback function.

Description

`glutKeyboardFunc` sets the keyboard callback for the *current window*. When a user types into the window, each key press generating an ASCII character will generate a keyboard callback. The `key` callback parameter is the generated ASCII character. The state of modifier keys such as Shift cannot be determined directly; their only effect will be on the returned ASCII data. The `x` and `y` callback parameters indicate the mouse location in window relative coordinates when the key was pressed. When a new window is created, no keyboard callback is initially registered, and ASCII key strokes in the window are ignored. Passing `NULL` to `glutKeyboardFunc` disables the generation of keyboard callbacks.

During a keyboard callback, `glutGetModifiers` may be called to determine the state of modifier keys when the keystroke generating the callback occurred.

Also, see `glutSpecialFunc` for a means to detect non-ASCII key strokes.

7.5 `glutMouseFunc`

`glutMouseFunc` sets the mouse callback for the *current window*.

Usage

```
void glutMouseFunc(void (*func)(int button, int state,
                                int x, int y));
```

`func` The new mouse callback function.

Description

`glutMouseFunc` sets the mouse callback for the *current window*. When a user presses and releases mouse buttons in the window, each press and each release generates a mouse callback. The `button` parameter is one of `GLUT_LEFT_BUTTON`, `GLUT_MIDDLE_BUTTON`, or `GLUT_RIGHT_BUTTON`. For systems with only two mouse buttons, it may not be possible to generate `GLUT_MIDDLE_BUTTON` callback. For systems with a single mouse button, it may be possible to generate only a `GLUT_LEFT_BUTTON` callback. The `state` parameter is either `GLUT_UP` or `GLUT_DOWN` indicating whether the callback was due to a release or press respectively. The `x` and `y` callback parameters indicate the window relative coordinates when the mouse button state changed. If a `GLUT_DOWN` callback for a specific button is triggered, the program can assume a `GLUT_UP` callback for the same button will be generated (assuming the window still has a mouse callback registered) when the mouse button is released even if the mouse has moved outside the window.

If a menu is attached to a button for a window, mouse callbacks will not be generated for that button.

During a mouse callback, `glutGetModifiers` may be called to determine the state of modifier keys when the mouse event generating the callback occurred.

Passing `NULL` to `glutMouseFunc` disables the generation of mouse callbacks.

7.6 `glutMotionFunc`, `glutPassiveMotionFunc`

`glutMotionFunc` and `glutPassiveMotionFunc` set the motion and passive motion callbacks respectively for the *current window*.

Usage

```
void glutMotionFunc(void (*func)(int x, int y));
void glutPassiveMotionFunc(void (*func)(int x, int y));
```

`func` The new motion or passive motion callback function.

Description

`glutMotionFunc` and `glutPassiveMotionFunc` set the motion and passive motion callback respectively for the *current window*. The motion callback for a window is called when the mouse moves within the window while one or more mouse buttons are pressed. The passive motion callback for a window is called when the mouse moves within the window while *no* mouse buttons are pressed.

The `x` and `y` callback parameters indicate the mouse location in window relative coordinates.

Passing `NULL` to `glutMotionFunc` or `glutPassiveMotionFunc` disables the generation of the mouse or passive motion callback respectively.

7.7 *glutVisibilityFunc*

`glutVisibilityFunc` sets the visibility callback for the *current window*.

Usage

```
void glutVisibilityFunc(void (*func)(int state));
```

`func` The new visibility callback function.

Description

`glutVisibilityFunc` sets the visibility callback for the *current window*. The visibility callback for a window is called when the visibility of a window changes. The `state` callback parameter is either `GLUT_NOT_VISIBLE` or `GLUT_VISIBLE` depending on the current visibility of the window. `GLUT_VISIBLE` does not distinguish a window being totally versus partially visible. `GLUT_NOT_VISIBLE` means no part of the window is visible, i.e., until the window's visibility changes, all further rendering to the window is discarded.

GLUT considers a window visible if any pixel of the window is visible *or* any pixel of any descendant window is visible on the screen.

Passing `NULL` to `glutVisibilityFunc` disables the generation of the visibility callback.

If the visibility callback for a window is disabled and later re-enabled, the visibility status of the window is undefined; any change in window visibility will be reported, that is if you disable a visibility callback and re-enable the callback, you are guaranteed the next visibility change will be reported.

7.8 *glutEntryFunc*

`glutEntryFunc` sets the mouse enter/leave callback for the *current window*.

Usage

```
void glutEntryFunc(void (*func)(int state));
```

`func` The new entry callback function.

Description

`glutEntryFunc` sets the mouse enter/leave callback for the *current window*. The `state` callback parameter is either `GLUT_LEFT` or `GLUT_ENTERED` depending on if the mouse pointer has last left or entered the window.

Passing `NULL` to `glutEntryFunc` disables the generation of the mouse enter/leave callback.

Some window systems may not generate accurate enter/leave callbacks.

X Implementation Notes

An X implementation of GLUT should generate accurate enter/leave callbacks.

7.9 glutSpecialFunc

glutSpecialFunc sets the special keyboard callback for the *current window*.

Usage

```
void glutSpecialFunc(void (*func)(int key, int x, int y));
```

func The new special callback function.

Description

glutSpecialFunc sets the special keyboard callback for the *current window*. The special keyboard callback is triggered when keyboard function or directional keys are pressed. The key callback parameter is a GLUT_KEY_* constant for the special key pressed. The x and y callback parameters indicate the mouse in window relative coordinates when the key was pressed. When a new window is created, no special callback is initially registered and special key strokes in the window are ignored. Passing NULL to glutSpecialFunc disables the generation of special callbacks.

During a special callback, glutGetModifiers may be called to determine the state of modifier keys when the keystroke generating the callback occurred.

An implementation should do its best to provide ways to generate all the GLUT_KEY_* special keys. The available GLUT_KEY_* values are:

- GLUT_KEY_F1 F1 function key.
- GLUT_KEY_F2 F2 function key.
- GLUT_KEY_F3 F3 function key.
- GLUT_KEY_F4 F4 function key.
- GLUT_KEY_F5 F5 function key.
- GLUT_KEY_F6 F6 function key.
- GLUT_KEY_F7 F7 function key.
- GLUT_KEY_F8 F8 function key.
- GLUT_KEY_F9 F9 function key.
- GLUT_KEY_F10 F10 function key.
- GLUT_KEY_F11 F11 function key.
- GLUT_KEY_F12 F12 function key.
- GLUT_KEY_LEFT Left directional key.
- GLUT_KEY_UP Up directional key.
- GLUT_KEY_RIGHT Right directional key.
- GLUT_KEY_DOWN Down directional key.
- GLUT_KEY_PAGE_UP Page up directional key.
- GLUT_KEY_PAGE_DOWN Page down directional key.
- GLUT_KEY_HOME Home directional key.
- GLUT_KEY_END End directional key.
- GLUT_KEY_INSERT Inset directional key.

Note that the escape, backspace, and delete keys are generated as an ASCII character.

7.10 glutSpaceballMotionFunc

glutSpaceballMotionFunc sets the Spaceball motion callback for the *current window*.

Usage

```
void glutSpaceballMotionFunc(void (*func)(int x, int y, int z));
```

func The new spaceball motion callback function.

Description

glutSpaceballMotionFunc sets the Spaceball motion callback for the *current window*. The Spaceball motion callback for a window is called when the window has Spaceball input focus (normally, when the mouse is in the window) and the user generates Spaceball translations. The x, y, and z callback parameters indicate the translations along the X, Y, and Z axes. The callback parameters are normalized to be within the range of -1000 to 1000 inclusive.

Registering a Spaceball motion callback when a Spaceball device is not available has no effect and is not an error. In this case, no Spaceball motion callbacks will be generated.

Passing NULL to *glutSpaceballMotionFunc* disables the generation of Spaceball motion callbacks. When a new window is created, no Spaceball motion callback is initially registered.

7.11 *glutSpaceballRotateFunc*

glutSpaceballRotateFunc sets the Spaceball rotation callback for the *current window*.

Usage

```
void glutSpaceballRotateFunc(void (*func)(int x, int y, int z));
```

func The new spaceball rotate callback function.

Description

glutSpaceballRotateFunc sets the Spaceball rotate callback for the *current window*. The Spaceball rotate callback for a window is called when the window has Spaceball input focus (normally, when the mouse is in the window) and the user generates Spaceball rotations. The x, y, and z callback parameters indicate the rotation along the X, Y, and Z axes. The callback parameters are normalized to be within the range of -1800 to 1800 inclusive.

Registering a Spaceball rotate callback when a Spaceball device is not available is ineffectual and not an error. In this case, no Spaceball rotate callbacks will be generated.

Passing NULL to *glutSpaceballRotateFunc* disables the generation of Spaceball rotate callbacks. When a new window is created, no Spaceball rotate callback is initially registered.

7.12 *glutSpaceballButtonFunc*

glutSpaceballButtonFunc sets the Spaceball button callback for the *current window*.

Usage

```
void glutSpaceballButtonFunc(void (*func)(int button, int state));
```

func The new spaceball button callback function.

Description

glutSpaceballButtonFunc sets the Spaceball button callback for the *current window*. The Spaceball button callback for a window is called when the window has Spaceball input focus (normally, when the mouse is in the window) and the user generates Spaceball button presses. The *button* parameter will be the button number (starting at one). The number of available Spaceball buttons can be determined with

`glutDeviceGet ( GLUT_NUM_SPACEBALL_BUTTONS )`. The state is either `GLUT_UP` or `GLUT_DOWN` indicating whether the callback was due to a release or press respectively.

Registering a Spaceball button callback when a Spaceball device is not available is ineffectual and not an error. In this case, no Spaceball button callbacks will be generated.

Passing `NULL` to `glutSpaceballButtonFunc` disables the generation of Spaceball button callbacks. When a new window is created, no Spaceball button callback is initially registered.

7.13 `glutButtonBoxFunc`

`glutButtonBoxFunc` sets the dial & button box button callback for the *current window*.

Usage

```
void glutButtonBoxFunc(void (*func)(int button, int state));
```

`func` The new button box callback function.

Description

`glutButtonBoxFunc` sets the dial & button box button callback for the *current window*. The dial & button box button callback for a window is called when the window has dial & button box input focus (normally, when the mouse is in the window) and the user generates dial & button box button presses. The `button` parameter will be the button number (starting at one). The number of available dial & button box buttons can be determined with `glutDeviceGet ( GLUT_NUM_BUTTON_BOX_BUTTONS )`. The state is either `GLUT_UP` or `GLUT_DOWN` indicating whether the callback was due to a release or press respectively.

Registering a dial & button box button callback when a dial & button box device is not available is ineffectual and not an error. In this case, no dial & button box button callbacks will be generated.

Passing `NULL` to `glutButtonBoxFunc` disables the generation of dial & button box button callbacks. When a new window is created, no dial & button box button callback is initially registered.

7.14 `glutDialsFunc`

`glutDialsFunc` sets the dial & button box dials callback for the *current window*.

Usage

```
void glutDialsFunc(void (*func)(int dial, int value));
```

`func` The new dials callback function.

Description

`glutDialsFunc` sets the dial & button box dials callback for the *current window*. The dial & button box dials callback for a window is called when the window has dial & button box input focus (normally, when the mouse is in the window) and the user generates dial & button box dial changes. The `dial` parameter will be the dial number (starting at one). The number of available dial & button box dials can be determined with `glutDeviceGet ( GLUT_NUM_DIALS )`. The `value` measures the absolute rotation in degrees. Dial values do not “roll over” with each complete rotation but continue to accumulate degrees (until the `int` dial value overflows).

Registering a dial & button box dials callback when a dial & button box device is not available is ineffectual and not an error. In this case, no dial & button box dials callbacks will be generated.

Passing `NULL` to `glutDialsFunc` disables the generation of dial & button box dials callbacks. When a new window is created, no dial & button box dials callback is initially registered.

7.15 **glutTabletMotionFunc**

`glutTabletMotionFunc` sets the special keyboard callback for the *current window*.

Usage

```
void glutTabletMotionFunc(void (*func)(int x, int y));
```

`func` The new tablet motion callback function.

Description

`glutTabletMotionFunc` sets the tablet motion callback for the *current window*. The tablet motion callback for a window is called when the window has tablet input focus (normally, when the mouse is in the window) and the user generates tablet motion. The `x` and `y` callback parameters indicate the absolute position of the tablet “puck” on the tablet. The callback parameters are normalized to be within the range of 0 to 2000 inclusive.

Registering a tablet motion callback when a tablet device is not available is ineffectual and not an error. In this case, no tablet motion callbacks will be generated.

Passing `NULL` to `glutTabletMotionFunc` disables the generation of tablet motion callbacks. When a new window is created, no tablet motion callback is initially registered.

7.16 **glutTabletButtonFunc**

`glutTabletButtonFunc` sets the special keyboard callback for the *current window*.

Usage

```
void glutTabletButtonFunc(void (*func)(int button, int state,  
                                     int x, int y));
```

`func` The new tablet button callback function.

Description

`glutTabletButtonFunc` sets the tablet button callback for the *current window*. The tablet button callback for a window is called when the window has tablet input focus (normally, when the mouse is in the window) and the user generates tablet button presses. The `button` parameter will be the button number (starting at one). The number of available tablet buttons can be determined with `glutDeviceGet(GLUT_NUM_TABLET_BUTTONS)`. The `state` is either `GLUT_UP` or `GLUT_DOWN` indicating whether the callback was due to a release or press respectively. The `x` and `y` callback parameters indicate the window relative coordinates when the tablet button state changed.

Registering a tablet button callback when a tablet device is not available is ineffectual and not an error. In this case, no tablet button callbacks will be generated.

Passing `NULL` to `glutTabletButtonFunc` disables the generation of tablet button callbacks. When a new window is created, no tablet button callback is initially registered.

7.17 **glutMenuStatusFunc**

`glutMenuStatusFunc` sets the global menu status callback.

Usage

```
void glutMenuStatusFunc(void (*func)(int status, int x, int y));  
void glutMenuStateFunc(void (*func)(int status));
```

`func` The new menu status (or state) callback function.

Description

`glutMenuStatusFunc` sets the global menu status callback so a GLUT program can determine when a menu is in use or not. When a menu status callback is registered, it will be called with the value `GLUT_MENU_IN_USE` for its `value` parameter when pop-up menus are in use by the user; and the callback will be called with the value `GLUT_MENU_NOT_IN_USE` for its `status` parameter when pop-up menus are no longer in use. The `x` and `y` parameters indicate the location in window coordinates of the button press that caused the menu to go into use, or the location where the menu was released (may be outside the window). The `func` parameter names the callback function. Other callbacks continue to operate (except mouse motion callbacks) when pop-up menus are in use so the menu status callback allows a program to suspend animation or other tasks when menus are in use. The cascading and unmapping of sub-menus from an initial pop-up menu does not generate menu status callbacks. There is a single menu status callback for GLUT.

When the menu status callback is called, the *current menu* will be set to the initial pop-up menu in both the `GLUT_MENU_IN_USE` and `GLUT_MENU_NOT_IN_USE` cases. The *current window* will be set to the window from which the initial menu was popped up from, also in both cases.

Passing `NULL` to `glutMenuStatusFunc` disables the generation of the menu status callback.

`glutMenuStateFunc` is a deprecated version of the `glutMenuStatusFunc` routine. The only difference is `glutMenuStateFunc` callback prototype does not deliver the two additional `x` and `y` coordinates.

7.18 glutIdleFunc

`glutIdleFunc` sets the global idle callback.

Usage

```
void glutIdleFunc(void (*func)(void));
```

`func` The new idle callback function.

Description

`glutIdleFunc` sets the global idle callback to be `func` so a GLUT program can perform background processing tasks or continuous animation when window system events are not being received. If enabled, the idle callback is continuously called when events are not being received. The callback routine has no parameters. The *current window* and *current menu* will not be changed before the idle callback. Programs with multiple windows and/or menus should explicitly set the *current window* and/or *current menu* and not rely on its current setting.

The amount of computation and rendering done in an idle callback should be minimized to avoid affecting the program's interactive response. In general, not more than a single frame of rendering should be done in an idle callback.

Passing `NULL` to `glutIdleFunc` disables the generation of the idle callback.

7.19 glutTimerFunc

`glutTimerFunc` registers a timer callback to be triggered in a specified number of milliseconds.

Usage

```
void glutTimerFunc(unsigned int msec,
                   void (*func)(int value), value);
```

`msec` Number of milliseconds to pass before calling the callback.

`func` The timer callback function.

`value` Integer value to pass to the timer callback.

Description

`glutTimerFunc` registers the timer callback `func` to be triggered in at least `msecs` milliseconds. The `value` parameter to the timer callback will be the value of the `value` parameter to `glutTimerFunc`. Multiple timer callbacks at same or differing times may be registered simultaneously.

The number of milliseconds is a lower bound on the time before the callback is generated. GLUT attempts to deliver the timer callback as soon as possible after the expiration of the callback's time interval.

There is no support for canceling a registered callback. Instead, ignore a callback based on its `value` parameter when it is triggered.

8 Color Index Colormap Management

OpenGL supports both RGBA and color index rendering. The RGBA mode is generally preferable to color index because more OpenGL rendering capabilities are available and color index mode requires the loading of colormap entries.

The GLUT color index routines are used to write and read entries in a window's color index colormap. Every GLUT color index window has its own logical color index colormap. The size of a window's colormap can be determined by calling `glutGet ( GLUT_WINDOW_COLORMAP_SIZE )`.

GLUT color index windows within a program can attempt to share colormap resources by copying a single color index colormap to multiple windows using `glutCopyColormap`. If possible GLUT will attempt to share the actual colormap. While copying colormaps using `glutCopyColormap` can potentially allow sharing of physical colormap resources, logically each window has its own colormap. So changing a copied colormap of a window will force the duplication of the colormap. For this reason, color index programs should generally load a single color index colormap, copy it to all color index windows within the program, and then not modify any colormap cells.

Use of multiple colormaps is likely to result in colormap installation problems where some windows are displayed with an incorrect colormap due to limitations on colormap resources.

8.1 `glutSetColor`

`glutSetColor` sets the color of a colormap entry in the *layer of use* for the *current window*.

Usage

```
void glutSetColor(int cell,
                  GLfloat red, GLfloat green, GLfloat blue);
```

`cell` Color cell index (starting at zero).

`red` Red intensity (clamped between 0.0 and 1.0 inclusive).

`green` Green intensity (clamped between 0.0 and 1.0 inclusive).

`blue` Blue intensity (clamped between 0.0 and 1.0 inclusive).

Description

Sets the `cell` color index colormap entry of the *current window*'s logical colormap for the *layer in use* with the color specified by `red`, `green`, and `blue`. The *layer in use* of the *current window* should be a color index window. `cell` should be zero or greater and less than the total number of colormap entries for the window. If the *layer in use*'s colormap was copied by reference, a `glutSetColor` call will force the duplication of the colormap. Do not attempt to set the color of an overlay's transparent index.

8.2 `glutGetColor`

`glutGetColor` retrieves a red, green, or blue component for a given color index colormap entry for the *layer in use*'s logical colormap for the *current window*.

Usage

```
GLfloat glutGetColor(int cell, int component);
```

cell Color cell index (starting at zero).

component One of GLUT_RED, GLUT_GREEN, or GLUT_BLUE.

Description

`glutGetColor` retrieves a red, green, or blue component for a given color index colormap entry for the *current window*'s logical colormap. The *current window* should be a color index window. *cell* should be zero or greater and less than the total number of colormap entries for the window. For valid color indices, the value returned is a floating point value between 0.0 and 1.0 inclusive. `glutGetColor` will return -1.0 if the color index specified is an overlay's transparent index, less than zero, or greater or equal to the value returned by `glutGet(GLUT_WINDOW_COLORMAP_SIZE)`, that is if the color index is transparent or outside the valid range of color indices.

8.3 glutCopyColormap

`glutCopyColormap` copies the logical colormap for the *layer in use* from a specified window to the *current window*.

Usage

```
void glutCopyColormap(int win);
```

win The identifier of the window to copy the logical colormap from.

Description

`glutCopyColormap` copies (lazily if possible to promote sharing) the logical colormap from a specified window to the *current window*'s *layer in use*. The copy will be from the normal plane to the normal plane; or from the overlay to the overlay (never across different layers). Once a colormap has been copied, avoid setting cells in the colormap with `glutSetColor` since that will force an actual copy of the colormap if it was previously copied by reference. `glutCopyColormap` should only be called when both the *current window* and the *win* window are color index windows.

9 State Retrieval

GLUT maintains a considerable amount of programmer visible state. Some (but not all) of this state may be directly retrieved.

9.1 glutGet

`glutGet` retrieves simple GLUT state represented by integers.

Usage

```
int glutGet(GLenum state);
```

state Name of state to retrieve.

GLUT_WINDOW_X X location in pixels (relative to the screen origin) of the *current window*.

GLUT_WINDOW_Y Y location in pixels (relative to the screen origin) of the *current window*.

GLUT_WINDOW_WIDTH Width in pixels of the *current window*.

GLUT_WINDOW_HEIGHT Height in pixels of the *current window*.

GLUT_WINDOW_BUFFER_SIZE Total number of bits for *current window*'s color buffer. For an RGBA window, this is the sum of GLUT_WINDOW_RED_SIZE, GLUT_WINDOW_GREEN_SIZE, GLUT_WINDOW_BLUE_SIZE, and GLUT_WINDOW_ALPHA_SIZE. For color index windows, this is the number of bits for color indices.

GLUT_WINDOW_STENCIL_SIZE Number of bits in the *current window*'s stencil buffer.

GLUT_WINDOW_DEPTH_SIZE Number of bits in the *current window*'s depth buffer.

GLUT_WINDOW_RED_SIZE Number of bits of red stored the *current window*'s color buffer. Zero if the window is color index.

GLUT_WINDOW_GREEN_SIZE Number of bits of green stored the *current window*'s color buffer. Zero if the window is color index.

GLUT_WINDOW_BLUE_SIZE Number of bits of blue stored the *current window*'s color buffer. Zero if the window is color index.

GLUT_WINDOW_ALPHA_SIZE Number of bits of alpha stored the *current window*'s color buffer. Zero if the window is color index.

GLUT_WINDOW_ACCUM_RED_SIZE Number of bits of red stored in the *current window*'s accumulation buffer. Zero if the window is color index.

GLUT_WINDOW_ACCUM_GREEN_SIZE Number of bits of green stored in the *current window*'s accumulation buffer. Zero if the window is color index.

GLUT_WINDOW_ACCUM_BLUE_SIZE Number of bits of blue stored in the *current window*'s accumulation buffer. Zero if the window is color index.

GLUT_WINDOW_ACCUM_ALPHA_SIZE Number of bits of alpha stored in the *current window*'s accumulation buffer. Zero if the window is color index.

GLUT_WINDOW_DOUBLEBUFFER One if the *current window* is double buffered, zero otherwise.

GLUT_WINDOW_RGBA One if the *current window* is RGBA mode, zero otherwise (i.e., color index).

GLUT_WINDOW_PARENT The window number of the *current window*'s parent; zero if the window is a top-level window.

GLUT_WINDOW_NUM_CHILDREN The number of subwindows the *current window* has (not counting children of children).

GLUT_WINDOW_COLORMAP_SIZE Size of *current window*'s color index colormap; zero for RGBA color model windows.

GLUT_WINDOW_NUM_SAMPLES Number of samples for multisampling for the *current window*.

GLUT_WINDOW_STEREO One if the *current window* is stereo, zero otherwise.

GLUT_WINDOW_CURSOR Current cursor for the *current window*.

GLUT_SCREEN_WIDTH Width of the screen in pixels. Zero indicates the width is unknown or not available.

GLUT_SCREEN_HEIGHT Height of the screen in pixels. Zero indicates the height is unknown or not available.

GLUT_SCREEN_WIDTH_MM Width of the screen in millimeters. Zero indicates the width is unknown or not available.

GLUT_SCREEN_HEIGHT_MM Height of the screen in millimeters. Zero indicates the height is unknown or not available.

GLUT_MENU_NUM_ITEMS Number of menu items in the *current menu*.

GLUT_DISPLAY_MODE_POSSIBLE Whether the *current display mode* is supported or not.

GLUT_INIT_DISPLAY_MODE The *initial display mode* bit mask.

GLUT_INIT_WINDOW_X The X value of the *initial window position*.

GLUT_INIT_WINDOW_Y The Y value of the *initial window position*.

GLUT_INIT_WINDOW_WIDTH The width value of the *initial window size*.

GLUT_INIT_WINDOW_HEIGHT The height value of the *initial window size*.

GLUT_ELAPSED_TIME Number of milliseconds since `glutInit` called (or first call to `glutGet(GLUT_ELAPSED_TIME)`).

Description

`glutGet` retrieves simple GLUT state represented by integers. The `state` parameter determines what type of state to return. Window capability state is returned for the *layer in use*. GLUT state names beginning with `GLUT_WINDOW_` return state for the *current window*. GLUT state names beginning with `GLUT_MENU_` return state for the *current menu*. Other GLUT state names return global state. Requesting state for an invalid GLUT state name returns negative one.

9.2 glutLayerGet

`glutLayerGet` retrieves GLUT state pertaining to the layers of the *current window*.

Usage

```
int glutLayerGet(GLenum info);
```

`info` Name of device information to retrieve.

GLUT_OVERLAY_POSSIBLE Whether an overlay could be established for the *current window* given the current *initial display mode*. If false, `glutEstablishOverlay` will fail with a fatal error if called.

GLUT_LAYER_IN_USE Either `GLUT_NORMAL` or `GLUT_OVERLAY` depending on whether the normal plane or overlay is the *layer in use*.

GLUT_HAS_OVERLAY If the *current window* has an overlay established.

GLUT_TRANSPARENT_INDEX The transparent color index of the overlay of the *current window*; negative one is returned if no overlay is in use.

GLUT_NORMAL_DAMAGED True if the normal plane of the *current window* has damaged (by window system activity) since the last display callback was triggered. Calling `glutPostRedisplay` will not set this true.

GLUT_OVERLAY_DAMAGED True if the overlay plane of the *current window* has damaged (by window system activity) since the last display callback was triggered. Calling `glutPostRedisplay` or `glutPostOverlayRedisplay` will not set this true. Negative one is returned if no overlay is in use.

Description

`glutLayerGet` retrieves GLUT layer information for the *current window* represented by integers. The `info` parameter determines what type of layer information to return.

9.3 glutDeviceGet

`glutDeviceGet` retrieves GLUT device information represented by integers.

Usage

```
int glutDeviceGet(GLenum info);
```

`info` Name of device information to retrieve.

GLUT_HAS_KEYBOARD Non-zero if a keyboard is available; zero if not available. For most GLUT implementations, a keyboard can be assumed.

GLUT_HAS_MOUSE Non-zero if a mouse is available; zero if not available. For most GLUT implementations, a keyboard can be assumed.

GLUT_HAS_SPACEBALL Non-zero if a Spaceball is available; zero if not available.

GLUT_HAS_DIAL_AND_BUTTON_BOX Non-zero if a dial & button box is available; zero if not available.

GLUT_HAS_TABLET Non-zero if a tablet is available; zero if not available.

GLUT_NUM_MOUSE_BUTTONS Number of buttons supported by the mouse. If no mouse is supported, zero is returned.

GLUT_NUM_SPACEBALL_BUTTONS Number of buttons supported by the Spaceball. If no Spaceball is supported, zero is returned.

GLUT_NUM_BUTTON_BOX_BUTTONS Number of buttons supported by the dial & button box device. If no dials & button box device is supported, zero is returned.

GLUT_NUM_DIALS Number of dials supported by the dial & button box device. If no dials & button box device is supported, zero is returned.

GLUT_NUM_TABLET_BUTTONS Number of buttons supported by the tablet. If no tablet is supported, zero is returned.

Description

`glutDeviceGet` retrieves GLUT device information represented by integers. The `info` parameter determines what type of device information to return. Requesting device information for an invalid GLUT device information name returns negative one.

9.4 **glutGetModifiers**

`glutGetModifiers` returns the modifier key state when certain callbacks were generated.

Usage

```
int glutGetModifiers(void);
```

GLUT_ACTIVE_SHIFT Set if the Shift modifier or Caps Lock is active.

GLUT_ACTIVE_CTRL Set if the Ctrl modifier is active.

GLUT_ACTIVE_ALT Set if the Alt modifier is active.

Description

`glutGetModifiers` returns the modifier key state at the time the input event for a keyboard, special, or mouse callback is generated. This routine may only be called while a keyboard, special, or mouse callback is being handled. The window system is permitted to intercept window system defined modifier key strokes or mouse buttons, in which case, no GLUT callback will be generated. This interception will be independent of use of `glutGetModifiers`.

9.5 **glutExtensionSupported**

`glutExtensionSupported` helps to easily determine whether a given OpenGL extension is supported.

Usage

```
int glutExtensionSupported(const char *extension);
```

`extension` Name of OpenGL extension.

Description

`glutExtensionSupported` helps to easily determine whether a given OpenGL extension is supported or not. The `extension` parameter names the extension to query. The supported extensions can also be determined with `glGetString(GL_EXTENSIONS)`, but `glutExtensionSupported` does the correct parsing of the returned string.

`glutExtensionSupported` returns non-zero if the extension is supported, zero if not supported.

There must be a valid *current window* to call `glutExtensionSupported`.

`glutExtensionSupported` only returns information about OpenGL extensions only. This means window system dependent extensions (for example, GLX extensions) are not reported by `glutExtensionSupported`.

10 Font Rendering

GLUT supports two type of font rendering: stroke fonts, meaning each character is rendered as a set of line segments; and bitmap fonts, where each character is a bitmap generated with `glBitmap`. Stroke fonts have the advantage that because they are geometry, they can be arbitrarily scale and rendered. Bitmap fonts are less flexible since they are rendered as bitmaps but are usually faster than stroke fonts.

10.1 `glutBitmapCharacter`

`glutBitmapCharacter` renders a bitmap character using OpenGL.

Usage

```
void glutBitmapCharacter(void *font, int character);
```

`font` Bitmap font to use.

`character` Character to render (not confined to 8 bits).

Description

Without using any display lists, `glutBitmapCharacter` renders the `character` in the named bitmap `font`. The available fonts are:

GLUT_BITMAP_8_BY_13 A fixed width font with every character fitting in an 8 by 13 pixel rectangle. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

```
-misc-fixed-medium-r-normal--13-120-75-75-C-80-iso8859-1
```

GLUT_BITMAP_9_BY_15 A fixed width font with every character fitting in an 9 by 15 pixel rectangle. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

```
-misc-fixed-medium-r-normal--15-140-75-75-C-90-iso8859-1
```

GLUT_BITMAP_TIMES_ROMAN_10 A 10-point proportional spaced Times Roman font. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

```
-adobe-times-medium-r-normal--10-100-75-75-p-54-iso8859-1
```

GLUT_BITMAP_TIMES_ROMAN_24 A 24-point proportional spaced Times Roman font. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

```
-adobe-times-medium-r-normal--24-240-75-75-p-124-iso8859-1
```

GLUT_BITMAP_HELVETICA_10 A 10-point proportional spaced Helvetica font. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

```
-adobe-helvetica-medium-r-normal--10-100-75-75-p-56-iso8859-1
```

GLUT_BITMAP_HELVETICA_12 A 12-point proportional spaced Helvetica font. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

`-adobe-helvetica-medium-r-normal--12-120-75-75-p-67-iso8859-1`

GLUT_BITMAP_HELVETICA_18 A 18-point proportional spaced Helvetica font. The exact bitmaps to be used is defined by the standard X glyph bitmaps for the X font named:

`-adobe-helvetica-medium-r-normal--18-180-75-75-p-98-iso8859-1`

Rendering a nonexistent character has no effect. `glutBitmapCharacter` automatically sets the OpenGL unpack pixel storage modes it needs appropriately and saves and restores the previous modes before returning. The generated call to `glBitmap` will adjust the current raster position based on the width of the character.

10.2 **glutBitmapWidth**

`glutBitmapWidth` returns the width of a bitmap character.

Usage

```
int glutBitmapWidth(GLUTbitmapFont font, int character);
```

`font` Bitmap font to use.

`character` Character to return width of (not confined to 8 bits).

Description

`glutBitmapWidth` returns the width in pixels of a bitmap character in a supported bitmap font. While the width of characters in a font may vary (though fixed width fonts do not vary), the maximum height characteristics of a particular font are fixed.

10.3 **glutStrokeCharacter**

`glutStrokeCharacter` renders a stroke character using OpenGL.

Usage

```
void glutStrokeCharacter(void *font, int character);
```

`font` Stroke font to use.

`character` Character to render (not confined to 8 bits).

Description

Without using any display lists, `glutStrokeCharacter` renders the character in the named stroke font. The available fonts are:

GLUT_STROKE_ROMAN A proportionally spaced Roman Simplex font for ASCII characters 32 through 127. The maximum top character in the font is 119.05 units; the bottom descends 33.33 units.

GLUT_STROKE_MONO_ROMAN A mono-spaced spaced Roman Simplex font (same characters as **GLUT_STROKE_ROMAN**) for ASCII characters 32 through 127. The maximum top character in the font is 119.05 units; the bottom descends 33.33 units. Each character is 104.76 units wide.

Rendering a nonexistent character has no effect. A `glTranslatef` is used to translate the current model view matrix to advance the width of the character.

10.4 `glutStrokeWidth`

`glutStrokeWidth` returns the width of a stroke character.

Usage

```
int glutStrokeWidth(GLUTstrokeFont font, int character);
```

`font` Stroke font to use.

`character` Character to return width of (not confined to 8 bits).

Description

`glutStrokeWidth` returns the width in pixels of a stroke character in a supported stroke font. While the width of characters in a font may vary (though fixed width fonts do not vary), the maximum height characteristics of a particular font are fixed.

11 Geometric Object Rendering

GLUT includes a number of routines for generating easily recognizable 3D geometric objects. These routines reflect functionality available in the `aux` toolkit described in the *OpenGL Programmer's Guide*

and are included in GLUT to allow the construction of simple GLUT programs that render recognizable objects. These routines can be implemented as pure OpenGL rendering routines. The routines do *not* generate display lists for the objects they create.

The routines generate normals appropriate for lighting but do not generate texture coordinates (except for the teapot).

11.1 `glutSolidSphere`, `glutWireSphere`

`glutSolidSphere` and `glutWireSphere` render a solid or wireframe sphere respectively.

Usage

```
void glutSolidSphere(GLdouble radius,  
                    GLint slices, GLint stacks);  
void glutWireSphere(GLdouble radius,  
                   GLint slices, GLint stacks);
```

`radius` The radius of the sphere.

`slices` The number of subdivisions around the Z axis (similar to lines of longitude).

`stacks` The number of subdivisions along the Z axis (similar to lines of latitude).

Description

Renders a sphere centered at the modeling coordinates origin of the specified `radius`. The sphere is subdivided around the Z axis into slices and along the Z axis into stacks.

11.2 `glutSolidCube`, `glutWireCube`

`glutSolidCube` and `glutWireCube` render a solid or wireframe cube respectively.

Usage

```
void glutSolidCube(GLdouble size);
void glutWireCube(GLdouble size);
```

size Length of each edge.

Description

`glutSolidCube` and `glutWireCube` render a solid or wireframe cube respectively. The cube is centered at the modeling coordinates origin with sides of length *size*.

11.3 *glutSolidCone, glutWireCone*

`glutSolidCone` and `glutWireCone` render a solid or wireframe cone respectively.

Usage

```
void glutSolidCone(GLdouble base, GLdouble height,
                  GLint slices, GLint stacks);
void glutWireCone(GLdouble base, GLdouble height,
                  GLint slices, GLint stacks);
```

base The radius of the base of the cone.

height The height of the cone.

slices The number of subdivisions around the Z axis.

stacks The number of subdivisions along the Z axis.

Description

`glutSolidCone` and `glutWireCone` render a solid or wireframe cone respectively oriented along the Z axis. The base of the cone is placed at $Z = 0$, and the top at $Z = \text{height}$. The cone is subdivided around the Z axis into slices, and along the Z axis into stacks.

11.4 *glutSolidTorus, glutWireTorus*

`glutSolidTorus` and `glutWireTorus` render a solid or wireframe torus (doughnut) respectively.

Usage

```
void glutSolidTorus(GLdouble innerRadius,
                  GLdouble outerRadius,
                  GLint nsides, GLint rings);
void glutWireTorus(GLdouble innerRadius,
                  GLdouble outerRadius,
                  GLint nsides, GLint rings);
```

innerRadius Inner radius of the torus.

outerRadius Outer radius of the torus.

nsides Number of sides for each radial section.

rings Number of radial divisions for the torus.

Description

`glutSolidTorus` and `glutWireTorus` render a solid or wireframe torus (doughnut) respectively centered at the modeling coordinates origin whose axis is aligned with the Z axis.

11.5 `glutSolidDodecahedron`, `glutWireDodecahedron`

`glutSolidDodecahedron` and `glutWireDodecahedron` render a solid or wireframe dodecahedron (12-sided regular solid) respectively.

Usage

```
void glutSolidDodecahedron(void);  
void glutWireDodecahedron(void);
```

Description

`glutSolidDodecahedron` and `glutWireDodecahedron` render a solid or wireframe dodecahedron respectively centered at the modeling coordinates origin with a radius of $\sqrt{3}$.

11.6 `glutSolidOctahedron`, `glutWireOctahedron`

`glutSolidOctahedron` and `glutWireOctahedron` render a solid or wireframe octahedron (8-sided regular solid) respectively.

Usage

```
void glutSolidOctahedron(void);  
void glutWireOctahedron(void);
```

Description

`glutSolidOctahedron` and `glutWireOctahedron` render a solid or wireframe octahedron respectively centered at the modeling coordinates origin with a radius of 1.0.

11.7 `glutSolidTetrahedron`, `glutWireTetrahedron`

`glutSolidTetrahedron` and `glutWireTetrahedron` render a solid or wireframe tetrahedron (4-sided regular solid) respectively.

Usage

```
void glutSolidTetrahedron(void);  
void glutWireTetrahedron(void);
```

Description

`glutSolidTetrahedron` and `glutWireTetrahedron` render a solid or wireframe tetrahedron respectively centered at the modeling coordinates origin with a radius of $\sqrt{3}$.

11.8 `glutSolidIcosahedron`, `glutWireIcosahedron`

`glutSolidIcosahedron` and `glutWireIcosahedron` render a solid or wireframe icosahedron (20-sided regular solid) respectively.

Usage

```
void glutSolidIcosahedron(void);
void glutWireIcosahedron(void);
```

Description

`glutSolidIcosahedron` and `glutWireIcosahedron` render a solid or wireframe icosahedron respectively. The icosahedron is centered at the modeling coordinates origin and has a radius of 1.0.

11.9 `glutSolidTeapot, glutWireTeapot`

`glutSolidTeapot` and `glutWireTeapot` render a solid or wireframe teapot¹ respectively.

Usage

```
void glutSolidTeapot(GLdouble size);
void glutWireTeapot(GLdouble size);
```

`size` Relative size of the teapot.

Description

`glutSolidTeapot` and `glutWireTeapot` render a solid or wireframe teapot respectively. Both surface normals and texture coordinates for the teapot are generated. The teapot is generated with OpenGL evaluators.

12 Usage Advice

There are a number of points to keep in mind when writing GLUT programs. Some of these are strong recommendations, others simply hints and tips.

- Do not change state that will affect the way a window will be drawn in a window's display callback. Your display callbacks should be idempotent.
- If you need to redisplay a window, instead of rendering in whatever callback you happen to be in, call `glutPostRedisplay` (or `glutPostRedisplay` for overlays). As a general rule, the only code that renders directly to the screen should be in called from display callbacks; other types of callbacks should not be rendering to the screen.
- If you use an idle callback to control your animation, use the visibility callbacks to determine when the window is fully obscured or iconified to determine when not to waste processor time rendering.
- Do not call any GLUT routines between a `glBegin` and `glEnd`.
- Do not call any GLUT routines between a `glNewList` and `glEndList`.
- Neither GLUT nor the window system automatically reshape sub-windows. If subwindows should be reshaped to reflect a reshaping of the top-level window, the GLUT program is responsible for doing this.
- Avoid using color index mode if possible. The RGBA color model is more functional, and it is less likely to cause colormap swapping effects.
- Do not call any GLUT routine that affects the *current window* or *current menu* if there is no *current window* or *current menu* defined. This can be the case at initialization time (before any windows or menus have been created) or if you destroy the *current window* or *current menu*. GLUT implementations are not obliged to generate a warning because doing so would slow down the operation of every such routine to first make sure there was a *current window* or *current menu*.

¹ Yes, the *classic* computer graphics teapot modeled by Martin Newell in 1975 [3].

- For most callbacks, the *current window* and/or *current menu* is set appropriately at the time of the callback. Timer and idle callbacks are exceptions. If your application uses multiple windows or menus, make sure you explicitly set the *current window* or *menu* appropriately using `glutSetWindow` or `glutSetMenu` in the idle and timer callbacks.
- If you register a single function as a callback routine for multiple windows, you can call `glutGetWindow` within the callback to determine what window generated the callback. Likewise, `glutGetMenu` can be called to determine what menu.
- By default, timer and idle callbacks may be called while a pop-up menu is active. On slow machines, slow rendering in an idle callback may compromise menu performance. Also, it may be desirable for motion to stop immediately when a menu is triggered. In this case, use the menu entry/exit callback set with `glutMenuStateFunc` to track the usage of pop-up menus.
- Do not select for more input callbacks than you actually need. For example, if you do not need motion or passive motion callbacks, disable them by passing `NULL` to their callback register functions. Disabling input callbacks allows the GLUT implementation to limit the window system input events that must be processed.
- Not every OpenGL implementation supports the same range of frame buffer capabilities, though minimum requirements for frame buffer capabilities do exist. If `glutCreateWindow` or `glutCreateSubWindow` are called with an *initial display mode* not supported by the OpenGL implementation, a fatal error will be generated with an explanatory message. To avoid this, `glutGet(GLUT_DISPLAY_MODE_POSSIBLE)` should be called to determine if the *initial display mode* is supported by the OpenGL implementation.
- The Backspace, Delete, and Escape keys generate ASCII characters, so detect these key presses with the `glutKeyboardFunc` callback, not with the `glutSpecialFunc` callback.
- Keep in mind that when a window is damaged, you should assume *all* of the ancillary buffers are damaged and redraw them all.
- Keep in mind that after a `glutSwapBuffers`, you should assume the state of the back buffer becomes undefined.
- If not using `glutSwapBuffers` for double buffered animation, remember to use `glFlush` to make sure rendering requests are dispatched to the frame buffer. While many OpenGL implementations will automatically flush pending commands, this is specifically not mandated.
- Remember that it is illegal to create or destroy menus or change, add, or remove menu items while a menu (and any cascaded sub-menus) are in use (that is, “popped up”). Use the menu status callback to know when to avoid menu manipulation.
- It is more efficient to use `glutHideOverlay` and `glutShowOverlay` to control the display state of a window’s overlay instead of removing and re-establishing an overlay every time an overlay is needed.
- Few workstations have support for multiple simultaneously installed overlay colormaps. For this reason, if an overlay is cleared or otherwise not be used, it is best to hide it using `glutHideOverlay` to avoid other windows with active overlays from being displayed with the wrong colormap. If your application uses multiple overlays, use `glutCopyColormap` to promote colormap sharing.
- If you are encountering GLUT warnings or fatal errors in your programs, try setting a debugger breakpoint in `_glutWarning` or `_glutFatalError` (though these names are potentially implementation dependent) to determine where within your program the error occurred.
- GLUT has no special routine for exiting the program. GLUT programs should use ANSI C’s `exit` routine. If a program needs to perform special operations before quitting the program, use the ANSI C `onexit` routine to register exit callbacks. GLUT will exit the program unilaterally when fatal errors occur or when the window system requests the program to terminate. For this reason, avoid calling any GLUT routines within an exit callback.

- Definitely, definitely, use the `-gldebug` option to look for OpenGL errors when OpenGL rendering does not appear to be operating properly. OpenGL errors are only reported if you explicitly look for them!

13 FORTRAN Binding

All GLUT functionality is available through the GLUT FORTRAN API. The GLUT FORTRAN binding is intended to be used in conjunction with the OpenGL and GLU FORTRAN APIs.

A FORTRAN routine using GLUT routines should include the GLUT FORTRAN header file. While this is potentially system dependent, on Unix systems this is normally done by including after the `SUBROUTINE`, `FUNCTION`, or `PROGRAM` line:

```
#include "GL/fglut.h"
```

Though the FORTRAN 77 specification differentiates identifiers by their first six characters only, the GLUT FORTRAN binding (and the OpenGL and GLU FORTRAN bindings) assume identifiers are not limited to 6 characters.

The FORTRAN GLUT binding library archive is typically named `libfglut.a` on Unix systems. FORTRAN GLUT programs need to link with the system's OpenGL and GLUT libraries and the respective Fortran binding libraries (and any libraries these libraries potentially depend on). A set of window system dependent libraries may also be necessary for linking GLUT programs. For example, programs using the X11 GLUT implementation typically need to link with Xlib, the X extension library, possibly the X Input extension library, the X miscellaneous utilities library, and the math library. An example X11/Unix compile line for a GLUT FORTRAN program would look like:

```
f77 -o foo foo.f -lfglut -lglut -lfglu -lGLU -lfgl -lGL \
-lXmu -lXi -lXext -lX11 -lm
```

13.1 Names for the FORTRAN GLUT Binding

Allowing for FORTRAN's case-insensitivity, the GLUT FORTRAN binding constant and routine names are the same as the C binding's names.

The OpenGL Architectural Review Board (ARB) official OpenGL FORTRAN API prefixes every routine and constant with the letter F. The justification was to avoid name space collisions with the C names in anachronistic compilers. Nearly all modern FORTRAN compilers avoid these name space clashes via other means (underbar suffixing of FORTRAN routines is used by most Unix FORTRAN compilers).

The GLUT FORTRAN API does *not* use such prefixing conventions because of the documentation and coding confusion introduced by such prefixes. The confusion is heightened by FORTRAN's default implicit variable initialization so programmers may realize the lack of a constant prefix as a result of a run-time error. The confusion introduced to support the prefixes was not deemed worthwhile simply to support anachronistic compilers.

13.2 Font Naming Caveat

Because GLUT fonts are compiled directly into GLUT programs as data, and programs should only have the fonts compiled into them that they use, GLUT font names like `GLUT_BITMAP_TIMES_ROMAN_24` are really symbols so the linker should only pull in used fonts.

Unfortunately, because some supposedly modern FORTRAN compilers link declared but unused data `EXTERNAL`s, "GL/fglut.h" does not explicitly declare `EXTERNAL` the GLUT font symbols. Declaring the GLUT font symbols as `EXTERNAL` risks forcing every GLUT FORTRAN program to contain the data for every GLUT font. GLUT Fortran programmers should explicitly declare `EXTERNAL` the GLUT fonts they use. Example:

```
SUBROUTINE PRINTA
#include "GL/fglut.h"
EXTERNAL GLUT_BITMAP_TIMES_ROMAN_24
CALL glutBitmapCharacter(GLUT_BITMAP_TIMES_ROMAN_24, 65)
END
```

13.3 NULL Callback

FORTRAN does not support passing NULL as a callback parameter the way ANSI C does. For this reason, GLUTNULL is used in place of NULL in GLUT FORTRAN programs to indicate a NULL callback.

14 Implementation Issues

While this specification is primarily intended to describe the GLUT API and not its implementation, the section describes implementation issues that are likely to help both GLUT implementors properly implement GLUT and provide GLUT programmers with information to better utilize GLUT.

14.1 Name Space Conventions

The GLUT implementation should have a well-defined name space for both exported symbols and visible, but not purposefully exported symbols. All exported functions are prefixed by `glut`. All exported macro definitions are prefixed by `GLUT_`. No data symbols are exported. All internal symbols that might be user-visible but not intended to be exported should be prefixed by `_glut`. Users of the GLUT API should *not* use any `_glut` prefixed symbols.

14.2 Modular Implementation

It is often the case that windowing libraries tend to result in large, bulky programs because a large measure of “dynamically dead” code is linked into the programs because it can not be determined at link time that the program will never require (that is, execute) the code. A consideration (not a primary one though) in GLUT’s API design is make the API modular enough that programs using a limited subset of GLUT’s API can minimize the portion of the GLUT library implementation required. This does assume the implementation of GLUT is structured to take advantage of the API’s modularity.

A good implementation can be structured so significant chunks of code for color index colormap management, non-standard device support (Spaceball, dial & button box, and tablet), overlay management, pop-up menus, miscellaneous window management routines (pop, push, show, hide, full screen, iconify), geometric shape rendering, and font rendering only need to be pulled into GLUT programs when the interface to this functionality is explicitly used by the GLUT program.

14.3 Error Checking and Reporting

How errors and warnings about improper GLUT usage are reported to GLUT programs is implementation dependent. The recommended behavior in the case of an error is to output a message and exit. In the case of a warning, the recommended behavior is to output a message and continue. All improper uses of the GLUT interface do not need to be caught or reported. What conditions are caught or reported should be based on how expensive the condition is to check for. For example, an implementation may not check every `glutSetWindow` call to determine if the window identifier is valid.

The run-time overhead of error checking for a very common operation may outweigh the benefit of clean error reporting. This trade-off is left for the implementor to make. The implementor should also consider the difficulty of diagnosing the improper usage without a message being output. For example, if a GLUT program attempts to create a menu while a menu is in use (improper usage!), this warrants a message because this improper usage may often be benign, allowing the bug to easily go unnoticed.

14.4 Avoid Unspecified GLUT Usage Restrictions

GLUT implementations should be careful to not limit the conditions under which GLUT routines may be called. GLUT implementations are expected to be resilient when GLUT programs call GLUT routines with defined behavior at “unexpected” times. For example, a program should be permitted to destroy the *current window* from within a display callback (assuming the user does not then call GLUT routines requiring a *current window*).

This means after dispatching callbacks, a GLUT implementation should be “defensive” about how the program might have used manipulated GLUT state during the callback.

A GLUT State

This appendix specifies precisely what programmer visible state GLUT maintains. There are three categories of programmer visible state that GLUT maintains: global, window, and menu. The window and menu state categories are maintained for each created window or menu. Additional overlay-related window state is maintained when an overlay is established for a window for the lifetime of the overlay.

The tables below name each element of state, define its type, specify what GLUT API entry points set or change the state (if possible), specify what GLUT API entry point or `glutGet`, `glutDeviceGet`, or `glutLayerGet` state constant is used to get the state (if possible), and how the state is initially set. For details of how any API entry point operates on the specified state, see the routine's official description. Footnotes for each category of state indicate additional caveats to the element of state.

A.1 Types of State

These types are used to specify GLUT's programmer visible state:

Bitmask A group of boolean bits.

Boolean True or false.

Callback A handle to a user-supplied routine invoked when the given callback is triggered (or `NULL` which is the default callback).

ColorCell Red, green, and blue color component triple, an array of which makes a colormap.

Cursor A GLUT cursor name.

Integer An integer value.

Layer Either normal plane or overlay.

MenuItem Either a menu entry or a submenu trigger. Both subtypes contain of a *String* name. A menu entry has an *Integer* value. A submenu cascade has an *Integer* menu name naming its associated submenu.

MenuState Either in use or not in use.

Stacking An ordering for top-level windows and sub-windows having the same parent. Higher windows obscure lower windows.

State One of shown, hidden, or iconified.

String A string of ASCII characters.

Timer A triple of a timer *Callback*, an *Integer* callback parameter, and a time in milliseconds (that expires in real time).

A.2 Global State

There are two types of global state: program controlled state which can be modified directly or indirectly by the program, and fixed system dependent state.

A.2.1 Program Controlled State

Name	Type	Set/Change	Get	Initial
currentWindow	Integer	glutSetWindow (1)	glutGetWindow	0
currentMenu	Integer	glutSetMenu (2)	glutGetMenu	0
initWindowX	Integer	glutInitWindowPosition	GLUT_INIT_WINDOW_X	-1
initWindowY	Integer	glutInitWindowPosition	GLUT_INIT_WINDOW_Y	-1
initWindowWidth	Integer	glutInitWindowSize	GLUT_INIT_WINDOW_WIDTH	300
initWindowHeight	Integer	glutInitWindowSize	GLUT_INIT_WINDOW_HEIGHT	300
initDisplayMode	Bitmask	glutInitDisplayMode	GLUT_INIT_DISPLAY_MODE	GLUT_RGB, GLUT_SINGLE, GLUT_DEPTH
idleCallback	Callback	glutIdleFunc	-	NULL
menuState	MenuState	-	(3)	NotInUse
menuStateCallback	Callback	glutMenuEntryFunc	-	NULL
timerList	list of Timer	glutTimerFunc	-	none

- (1) The *currentWindow* is also changed implicitly by every window or menu callback (to the window triggering the callback) and the creation of a window (to the window being created).
- (2) The *currentMenu* is also changed implicitly by every menu callback (to the menu triggering the callback) and the creation of a menu (to the menu being created).
- (3) The menu state callback is triggered when the *menuState* changes.

A.2.2 Fixed System Dependent State

Name	Type	Get
screenWidth	Integer	GLUT_SCREEN_WIDTH
screenHeight	Integer	GLUT_SCREEN_HEIGHT
screenWidthMM	Integer	GLUT_SCREEN_WIDTH_MM
screenHeightMM	Integer	GLUT_SCREEN_HEIGHT_MM
hasKeyboard	Boolean	GLUT_HAS_KEYBOARD
hasMouse	Boolean	GLUT_HAS_MOUSE
hasSpaceball	Boolean	GLUT_HAS_SPACEBALL
hasDialAndButtonBox	Boolean	GLUT_HAS_DIAL_AND_BUTTON_BOX
hasTablet	Boolean	GLUT_HAS_TABLET
numMouseButtons	Integer	GLUT_NUM_MOUSE_BUTTONS
numSpaceballButtons	Integer	GLUT_NUM_SPACEBALL_BUTTONS
numButtonBoxButtons	Integer	GLUT_NUM_BUTTON_BOX_BUTTONS
numDials	Integer	GLUT_NUM_DIALS
numTabletButtons	Integer	GLUT_NUM_TABLET_BUTTONS

A.3 Window State

For the purposes of listing the window state elements, window state is classified into three types: base state, frame buffer capability state, and layer state. The tags *top-level*, *sub-win*, and *cindex* indicate the table entry applies only to top-level windows, subwindows, or color index windows respectively.

A.3.1 Basic State

Name	Type	Set/Change	Get	Initial
number	Integer	-	glutGetWindow	<i>top-level</i> : glutCreateWindow (1) <i>sub-win</i> : glutCreateSubWindow (1)
x	Integer	glutPositionWindow	GLUT_WINDOW_X	<i>top-level</i> : initWindowX (2) <i>sub-win</i> : glutCreateSubWindow
y	Integer	glutPositionWindow	GLUT_WINDOW_Y	<i>top-level</i> : initWindowY (3) <i>sub-win</i> : glutCreateSubWindow
width	Integer	glutReshapeWindow	GLUT_WINDOW_WIDTH	<i>top-level</i> : initWindowWidth (4) <i>sub-win</i> : glutCreateSubWindow
height	Integer	glutReshapeWindow	GLUT_WINDOW_HEIGHT	<i>top-level</i> : initWindowHeight (5) <i>sub-win</i> : glutCreateSubWindow
top-level: fullScreen	Boolean	glutFullScreen glutPositionWindow glutReshapeWindow (6)	-	False
cursor	Cursor	glutSetCursor	GLUT_WINDOW_CURSOR	GLUT_CURSOR_INHERIT
stacking	Stacking	glutPopWindow glutPushWindow	-	top
displayState	State (7)	glutShowWindow (8) glutHideWindow glutIconifyWindow	-	shown
visibility	Visibility	(9)	(10)	undefined
redisplay	Boolean	glutPostRedisplay (11)	-	False
top-level: windowTitle	String	glutWindowTitle	-	glutCreateWindow
top-level: iconTitle	String	glutIconTitle	-	glutCreateWindow
displayCallback	Callback	glutDisplayFunc	-	NULL (12)
reshapeCallback	Callback	glutReshapeFunc	-	NULL (13)
keyboardCallback	Callback	glutKeyboardFunc	-	NULL
mouseCallback	Callback	glutMouseFunc	-	NULL
motionCallback	Callback	glutMotionFunc	-	NULL
passiveMotionCallback	Callback	glutPassiveMotionFunc	-	NULL
specialCallback	Callback	glutSpecialFunc	-	NULL
spaceballMotionCallback	Callback	glutSpaceballMotionFunc	-	NULL
spaceballRotateCallback	Callback	glutSpaceballRotateFunc	-	NULL
spaceballButtonCallback	Callback	glutSpaceballButtonFunc	-	NULL
buttonBoxCallback	Callback	glutButtonBoxFunc	-	NULL
dialsCallback	Callback	glutDialsFunc	-	NULL
tabletMotionCallback	Callback	glutTabletMotionFunc	-	NULL
tabletButtonCallback	Callback	glutTabletButtonFunc	-	NULL
visibilityCallback	Callback	glutVisibilityFunc	-	NULL
entryCallback	Callback	glutEntryFunc	-	NULL
<i>cindex</i> : colormap	array of ColorCell	glutSetColor glutCopyColormap	glutGetColor	undefined
windowParent	Integer	-	GLUT_WINDOW_PARENT	<i>top-level</i> : 0 <i>sub-win</i> : (14)
numChildren	Integer	glutCreateSubWindow glutDestroyWindow	GLUT_NUM_CHILDREN	0
leftMenu	Integer	glutAttachMenu glutDetachMenu	-	0
middleMenu	Integer	glutAttachMenu glutDetachMenu	-	0
rightMenu	Integer	glutAttachMenu glutDetachMenu	-	0

- (1) Assigned dynamically from unassigned window numbers greater than zero.
- (2) If *initWindowX* is greater or equal to zero and *initWindowY* is greater or equal to zero then *initWindowX*, else window location left to window system to decide.
- (3) If *initWindowY* is greater or equal to zero and *initWindowX* is greater or equal to zero then *initWindowY*, else window location left to window system to decide.
- (4) If *initWindowWidth* is greater than zero and *initWindowHeight* is greater than zero the *initWindowWidth*, else window size left to window system to decide.
- (5) If *initWindowHeight* is greater than zero and *initWindowWidth* is greater than zero then *initWindowHeight*, else window size left to window system to decide.
- (6) *glutFullScreen* sets to true; *glutPositionWindow* and *glutReshapeWindow* set to false.
- (7) Subwindows can not be iconified.
- (8) Window system events can also change the *displayState*.

- (9) Visibility of a window can change for window system dependent reason, for example, a new window may occlude the window. `glutPopWindow` and `glutPushWindow` can affect window visibility as a side effect.
- (10) The visibility callback set by `glutVisibilityFunc` allows the visibility state to be tracked.
- (11) The redisplay state can be explicitly enabled by `glutRedisplayFunc` or implicitly in response to normal plane redisplay events from the window system.
- (12) A window's *displayCallback* must be registered before the first display callback would be triggered (or the program is terminated).
- (13) Instead of being a no-op as most NULL callbacks are, a NULL *reshapeCallback* sets the OpenGL viewport to render into the complete window, i.e., `glViewport(0, 0, width, height)`.
- (14) Determined by *currentWindow* at `glutCreateSubWindow` time.

A.3.2 Frame Buffer Capability State

Name	Type	Get
Total number of bits in color buffer	Integer	GLUT_WINDOW_BUFFER_SIZE
Number of bits in stencil buffer	Integer	GLUT_WINDOW_STENCIL_SIZE
Number of bits in depth buffer	Integer	GLUT_WINDOW_DEPTH_SIZE
Number of bits of red stored in color buffer	Integer	GLUT_WINDOW_RED_SIZE
Number of bits of green stored in color buffer	Integer	GLUT_WINDOW_GREEN_SIZE
Number of bits of blue stored in color buffer	Integer	GLUT_WINDOW_BLUE_SIZE
Number of bits of alpha stored in color buffer	Integer	GLUT_WINDOW_ALPHA_SIZE
Number of bits of red stored in accumulation buffer	Integer	GLUT_WINDOW_ACCUM_RED_SIZE
Number of bits of green stored in accumulation buffer	Integer	GLUT_WINDOW_ACCUM_GREEN_SIZE
Number of bits of blue stored in accumulation buffer	Integer	GLUT_WINDOW_ACCUM_BLUE_SIZE
Number of bits of alpha stored in accumulation buffer	Integer	GLUT_WINDOW_ACCUM_ALPHA_SIZE
Color index colormap size	Integer	GLUT_WINDOW_COLORMAP_SIZE
If double buffered	Boolean	GLUT_WINDOW_DOUBLEBUFFER
If RGBA color model	Boolean	GLUT_WINDOW_RGBA
If stereo	Boolean	GLUT_WINDOW_STEREO
Number of samples for multisampling	Integer	GLUT_WINDOW_MULTISAMPLE

A window's (normal plane) frame buffer capability state is derived from the global `initDisplayMode` state at the window's creation. A window's frame buffer capabilities can not be changed.

A.3.3 Layer State

Name	Type	Set/Change	Get	Initial
hasOverlay	Boolean	<code>glutEstablishOverlay</code> <code>glutRemoveOverlay</code>	GLUT_HAS_OVERLAY	False
overlayPossible	Boolean	(1)	GLUT_OVERLAY_POSSIBLE	False
layerInUse	Layer	<code>glutUseLayer</code> (2)	GLUT_LAYER_IN_USE	normal plane
<i>cindex</i> : transparentIndex	Integer	-	GLUT_TRANSPARENT_INDEX	(3)
overlayRedisplay	Boolean	<code>glutPostOverlayRedisplay</code> (4)	-	False
overlayDisplayCallback	Callback	<code>glutOverlayDisplayFunc</code>	-	NULL
overlayDisplayState	State	<code>glutShowOverlay</code> <code>glutHideOverlay</code>	-	shown
normalDamaged	Boolean	(5)	GLUT_NORMAL_DAMAGED	False
overlayDamaged	Boolean	(6)	GLUT_OVERLAY_DAMAGED	False

- (1) Whether an overlay is possible is based on the *initDisplayMode* state and the frame buffer capability state of the window.
- (2) The *layerInUse* is implicitly set to overlay after `glutEstablishOverlay`; likewise, `glutRemoveOverlay` resets the state to normal plane.
- (3) The *transparentIndex* is set when a color index overlay is established. It cannot be set; it may change if the overlay is re-established. When no overlay is in use or if the overlay is not color index, the *transparentIndex* is -1.
- (4) The *overlayRedisplay* state can be explicitly enabled by `glutPostOverlayRedisplay` or implicitly in response to overlay redisplay events from the window system.
- (5) Set when the window system reports a region of the window's normal plane is undefined (for example, damaged by another window moving or being initially shown). The specifics of when damage occurs are left to the window system to determine. The window's *redisplay* state is always set true when damage occurs. *normalDamaged* is cleared whenever the window's display callback returns.
- (6) Set when the window system reports a region of the window's overlay plane is undefined (for example, damaged by another window moving or being initially shown). The specifics of when damage occurs are left to the window system to determine. The damage may occur independent from damage to the window's normal plane. The window's *redisplay* state is always set true when damage occurs. *normalDamaged* is cleared whenever the window's display callback returns.

When an overlay is established, *overlay* frame buffer capability state is maintained as described in Section A.3.2. The *layerInUse* determines whether `glutGet` returns normal plane or overlay state when an overlay is established.

A.4 Menu State

Name	Type	Set/Change	Get	Initial
number	Integer	-	glutSetMenu	<i>top-level:</i> glutCreateMenu (1)
select	Callback	-	-	glutCreateMenu
items	list of MenuItem	-	-	-
numItems	Integer	-	GLUT_MENU_NUM_ITEMS	0

(1) Assigned dynamically from unassigned window numbers greater than zero.

B glut.h ANSI C Header File

```

1  #ifndef __glut_h__
2  #define __glut_h__
3
4  /* Copyright (c) Mark J. Kilgard, 1994, 1995, 1996. */
5
6  /* This program is freely distributable without licensing fees and is
7     provided without guarantee or warranty expressed or implied. This
8     program is -not- in the public domain. */
9
10 #if defined(WIN32)
11 #include <windows.h>
12 #pragma warning (disable:4244)          /* disable bogus conversion warnings */
13 #endif
14 #include <GL/gl.h>
15 #include <GL/glu.h>
16
17 /* define APIENTRY and CALLBACK to null string if we aren't on Win32 */
18 #if !defined(WIN32)
19 #define APIENTRY
20 #define CALLBACK
21 #endif
22
23 #ifdef __cplusplus
24 extern "C" {
25 #endif
26
27 /**
28  GLUT API revision history:
29
30  GLUT_API_VERSION is updated to reflect incompatible GLUT
31  API changes (interface changes, semantic changes, deletions,
32  or additions).
33
34  GLUT_API_VERSION=1  First public release of GLUT.  11/29/94
35
36  GLUT_API_VERSION=2  Added support for OpenGL/GLX multisampling,
37  extension.  Supports new input devices like tablet, dial and button
38  box, and Spaceball.  Easy to query OpenGL extensions.
39
40  GLUT_API_VERSION=3  glutMenuStatus added.
41
42  GLUT_API_VERSION=4  glutInitDisplayString, glutWarpPointer,
43  glutBitmapLength, glutStrokeLength, glutWindowStatusFunc, dynamic
44  video resize subAPI, glutPostWindowRedisplay (NOT FINALIZED!).
45  */
46 #ifndef GLUT_API_VERSION /* allow this to be overridden */
47 #define GLUT_API_VERSION 3
48 #endif
49
50 /**
51  GLUT implementation revision history:
52
53  GLUT_XLIB_IMPLEMENTATION is updated to reflect both GLUT
54  API revisions and implementation revisions (ie, bug fixes).
55
56  GLUT_XLIB_IMPLEMENTATION=1  mjk's first public release of
57  GLUT Xlib-based implementation.  11/29/94
58
59  GLUT_XLIB_IMPLEMENTATION=2  mjk's second public release of
60  GLUT Xlib-based implementation providing GLUT version 2
61  interfaces.
62
63  GLUT_XLIB_IMPLEMENTATION=3  mjk's GLUT 2.2 images.  4/17/95
64
65  GLUT_XLIB_IMPLEMENTATION=4  mjk's GLUT 2.3 images.  6/?/95
66

```

```

67  GLUT_XLIB_IMPLEMENTATION=5  mjk's GLUT 3.0 images. 10/2/95
68
69  GLUT_XLIB_IMPLEMENTATION=7  mjk's GLUT 3.1+ with glutWarpPoiner. 7/24/96
70
71  GLUT_XLIB_IMPLEMENTATION=8  mjk's GLUT 3.1+ with glutWarpPoiner
72  and video resize. 1/3/97
73
74  GLUT_XLIB_IMPLEMENTATION=9  mjk's GLUT 3.4 release with early GLUT 4 routines.
75
76  GLUT_XLIB_IMPLEMENTATION=11 Mesa 2.5's GLUT 3.6 release.
77
78  GLUT_XLIB_IMPLEMENTATION=12 mjk's GLUT 3.6 release with early GLUT 4 routines + signal handling.
79  **/
80  #ifndef GLUT_XLIB_IMPLEMENTATION /* Allow this to be overridden. */
81  #define GLUT_XLIB_IMPLEMENTATION 12
82  #endif
83
84  /* Display mode bit masks. */
85  #define GLUT_RGB 0
86  #define GLUT_RGBA GLUT_RGB
87  #define GLUT_INDEX 1
88  #define GLUT_SINGLE 0
89  #define GLUT_DOUBLE 2
90  #define GLUT_ACCUM 4
91  #define GLUT_ALPHA 8
92  #define GLUT_DEPTH 16
93  #define GLUT_STENCIL 32
94  #if (GLUT_API_VERSION >= 2)
95  #define GLUT_MULTISAMPLE 128
96  #define GLUT_STEREO 256
97  #endif
98  #if (GLUT_API_VERSION >= 3)
99  #define GLUT_LUMINANCE 512
100 #endif
101
102 /* Mouse buttons. */
103 #define GLUT_LEFT_BUTTON 0
104 #define GLUT_MIDDLE_BUTTON 1
105 #define GLUT_RIGHT_BUTTON 2
106
107 /* Mouse button state. */
108 #define GLUT_DOWN 0
109 #define GLUT_UP 1
110
111 #if (GLUT_API_VERSION >= 2)
112 /* function keys */
113 #define GLUT_KEY_F1 1
114 #define GLUT_KEY_F2 2
115 #define GLUT_KEY_F3 3
116 #define GLUT_KEY_F4 4
117 #define GLUT_KEY_F5 5
118 #define GLUT_KEY_F6 6
119 #define GLUT_KEY_F7 7
120 #define GLUT_KEY_F8 8
121 #define GLUT_KEY_F9 9
122 #define GLUT_KEY_F10 10
123 #define GLUT_KEY_F11 11
124 #define GLUT_KEY_F12 12
125 /* directional keys */
126 #define GLUT_KEY_LEFT 100
127 #define GLUT_KEY_UP 101
128 #define GLUT_KEY_RIGHT 102
129 #define GLUT_KEY_DOWN 103
130 #define GLUT_KEY_PAGE_UP 104
131 #define GLUT_KEY_PAGE_DOWN 105
132 #define GLUT_KEY_HOME 106
133 #define GLUT_KEY_END 107
134 #define GLUT_KEY_INSERT 108

```

```

135 #endif
136
137 /* Entry/exit state. */
138 #define GLUT_LEFT 0
139 #define GLUT_ENTERED 1
140
141 /* Menu usage state. */
142 #define GLUT_MENU_NOT_IN_USE 0
143 #define GLUT_MENU_IN_USE 1
144
145 /* Visibility state. */
146 #define GLUT_NOT_VISIBLE 0
147 #define GLUT_VISIBLE 1
148
149 /* Window status state. */
150 #define GLUT_HIDDEN 0
151 #define GLUT_FULLY_RETAINED 1
152 #define GLUT_PARTIALLY_RETAINED 2
153 #define GLUT_FULLY_COVERED 3
154
155 /* Color index component selection values. */
156 #define GLUT_RED 0
157 #define GLUT_GREEN 1
158 #define GLUT_BLUE 2
159
160 /* Layers for use. */
161 #define GLUT_NORMAL 0
162 #define GLUT_OVERLAY 1
163
164 #if defined(WIN32)
165 /* Stroke font constants (use these in GLUT program). */
166 #define GLUT_STROKE_ROMAN ((void*)0)
167 #define GLUT_STROKE_MONO_ROMAN ((void*)1)
168
169 /* Bitmap font constants (use these in GLUT program). */
170 #define GLUT_BITMAP_9_BY_15 ((void*)2)
171 #define GLUT_BITMAP_8_BY_13 ((void*)3)
172 #define GLUT_BITMAP_TIMES_ROMAN_10 ((void*)4)
173 #define GLUT_BITMAP_TIMES_ROMAN_24 ((void*)5)
174 #if (GLUT_API_VERSION >= 3)
175 #define GLUT_BITMAP_HELVETICA_10 ((void*)6)
176 #define GLUT_BITMAP_HELVETICA_12 ((void*)7)
177 #define GLUT_BITMAP_HELVETICA_18 ((void*)8)
178 #endif
179 #else
180 /* Stroke font opaque addresses (use constants instead in source code). */
181 extern void *glutStrokeRoman;
182 extern void *glutStrokeMonoRoman;
183
184 /* Stroke font constants (use these in GLUT program). */
185 #define GLUT_STROKE_ROMAN (&glutStrokeRoman)
186 #define GLUT_STROKE_MONO_ROMAN (&glutStrokeMonoRoman)
187
188 /* Bitmap font opaque addresses (use constants instead in source code). */
189 extern void *glutBitmap9By15;
190 extern void *glutBitmap8By13;
191 extern void *glutBitmapTimesRoman10;
192 extern void *glutBitmapTimesRoman24;
193 extern void *glutBitmapHelvetica10;
194 extern void *glutBitmapHelvetica12;
195 extern void *glutBitmapHelvetica18;
196
197 /* Bitmap font constants (use these in GLUT program). */
198 #define GLUT_BITMAP_9_BY_15 (&glutBitmap9By15)
199 #define GLUT_BITMAP_8_BY_13 (&glutBitmap8By13)
200 #define GLUT_BITMAP_TIMES_ROMAN_10 (&glutBitmapTimesRoman10)
201 #define GLUT_BITMAP_TIMES_ROMAN_24 (&glutBitmapTimesRoman24)
202 #if (GLUT_API_VERSION >= 3)

```

```

203 #define GLUT_BITMAP_HELVETICA_10      (&glutBitmapHelvetica10)
204 #define GLUT_BITMAP_HELVETICA_12      (&glutBitmapHelvetica12)
205 #define GLUT_BITMAP_HELVETICA_18      (&glutBitmapHelvetica18)
206 #endif
207 #endif
208
209 /* glutGet parameters. */
210 #define GLUT_WINDOW_X                  100
211 #define GLUT_WINDOW_Y                  101
212 #define GLUT_WINDOW_WIDTH              102
213 #define GLUT_WINDOW_HEIGHT             103
214 #define GLUT_WINDOW_BUFFER_SIZE        104
215 #define GLUT_WINDOW_STENCIL_SIZE       105
216 #define GLUT_WINDOW_DEPTH_SIZE         106
217 #define GLUT_WINDOW_RED_SIZE           107
218 #define GLUT_WINDOW_GREEN_SIZE         108
219 #define GLUT_WINDOW_BLUE_SIZE          109
220 #define GLUT_WINDOW_ALPHA_SIZE         110
221 #define GLUT_WINDOW_ACCUM_RED_SIZE     111
222 #define GLUT_WINDOW_ACCUM_GREEN_SIZE   112
223 #define GLUT_WINDOW_ACCUM_BLUE_SIZE    113
224 #define GLUT_WINDOW_ACCUM_ALPHA_SIZE   114
225 #define GLUT_WINDOW_DOUBLEBUFFER       115
226 #define GLUT_WINDOW_RGBA               116
227 #define GLUT_WINDOW_PARENT             117
228 #define GLUT_WINDOW_NUM_CHILDREN       118
229 #define GLUT_WINDOW_COLORMAP_SIZE      119
230 #if (GLUT_API_VERSION >= 2)
231 #define GLUT_WINDOW_NUM_SAMPLES         120
232 #define GLUT_WINDOW_STEREO             121
233 #endif
234 #if (GLUT_API_VERSION >= 3)
235 #define GLUT_WINDOW_CURSOR              122
236 #endif
237 #define GLUT_SCREEN_WIDTH               200
238 #define GLUT_SCREEN_HEIGHT              201
239 #define GLUT_SCREEN_WIDTH_MM            202
240 #define GLUT_SCREEN_HEIGHT_MM           203
241 #define GLUT_MENU_NUM_ITEMS             300
242 #define GLUT_DISPLAY_MODE_POSSIBLE      400
243 #define GLUT_INIT_WINDOW_X              500
244 #define GLUT_INIT_WINDOW_Y              501
245 #define GLUT_INIT_WINDOW_WIDTH          502
246 #define GLUT_INIT_WINDOW_HEIGHT         503
247 #define GLUT_INIT_DISPLAY_MODE          504
248 #if (GLUT_API_VERSION >= 2)
249 #define GLUT_ELAPSED_TIME               700
250 #endif
251
252 #if (GLUT_API_VERSION >= 2)
253 /* glutDeviceGet parameters. */
254 #define GLUT_HAS_KEYBOARD                600
255 #define GLUT_HAS_MOUSE                   601
256 #define GLUT_HAS_SPACEBALL               602
257 #define GLUT_HAS_DIAL_AND_BUTTON_BOX    603
258 #define GLUT_HAS_TABLET                  604
259 #define GLUT_NUM_MOUSE_BUTTONS           605
260 #define GLUT_NUM_SPACEBALL_BUTTONS       606
261 #define GLUT_NUM_BUTTON_BOX_BUTTONS      607
262 #define GLUT_NUM_DIALS                    608
263 #define GLUT_NUM_TABLET_BUTTONS          609
264 #endif
265
266 #if (GLUT_API_VERSION >= 3)
267 /* glutLayerGet parameters. */
268 #define GLUT_OVERLAY_POSSIBLE            800
269 #define GLUT_LAYER_IN_USE                 801
270 #define GLUT_HAS_OVERLAY                  802

```

```

271 #define GLUT_TRANSPARENT_INDEX      803
272 #define GLUT_NORMAL_DAMAGED         804
273 #define GLUT_OVERLAY_DAMAGED        805
274
275 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
276 /* glutVideoResizeGet parameters. */
277 #define GLUT_VIDEO_RESIZE_POSSIBLE    900
278 #define GLUT_VIDEO_RESIZE_IN_USE      901
279 #define GLUT_VIDEO_RESIZE_X_DELTA     902
280 #define GLUT_VIDEO_RESIZE_Y_DELTA     903
281 #define GLUT_VIDEO_RESIZE_WIDTH_DELTA 904
282 #define GLUT_VIDEO_RESIZE_HEIGHT_DELTA 905
283 #define GLUT_VIDEO_RESIZE_X           906
284 #define GLUT_VIDEO_RESIZE_Y           907
285 #define GLUT_VIDEO_RESIZE_WIDTH       908
286 #define GLUT_VIDEO_RESIZE_HEIGHT      909
287 #endif
288
289 /* glutUseLayer parameters. */
290 #define GLUT_NORMAL                    0
291 #define GLUT_OVERLAY                   1
292
293 /* glutGetModifiers return mask. */
294 #define GLUT_ACTIVE_SHIFT              1
295 #define GLUT_ACTIVE_CTRL               2
296 #define GLUT_ACTIVE_ALT                4
297
298 /* glutSetCursor parameters. */
299 /* Basic arrows. */
300 #define GLUT_CURSOR_RIGHT_ARROW        0
301 #define GLUT_CURSOR_LEFT_ARROW         1
302 /* Symbolic cursor shapes. */
303 #define GLUT_CURSOR_INFO                2
304 #define GLUT_CURSOR_DESTROY            3
305 #define GLUT_CURSOR_HELP                4
306 #define GLUT_CURSOR_CYCLE               5
307 #define GLUT_CURSOR_SPRAY               6
308 #define GLUT_CURSOR_WAIT                7
309 #define GLUT_CURSOR_TEXT                8
310 #define GLUT_CURSOR_CROSSHAIR           9
311 /* Directional cursors. */
312 #define GLUT_CURSOR_UP_DOWN            10
313 #define GLUT_CURSOR_LEFT_RIGHT          11
314 /* Sizing cursors. */
315 #define GLUT_CURSOR_TOP_SIDE            12
316 #define GLUT_CURSOR_BOTTOM_SIDE         13
317 #define GLUT_CURSOR_LEFT_SIDE           14
318 #define GLUT_CURSOR_RIGHT_SIDE           15
319 #define GLUT_CURSOR_TOP_LEFT_CORNER     16
320 #define GLUT_CURSOR_TOP_RIGHT_CORNER    17
321 #define GLUT_CURSOR_BOTTOM_RIGHT_CORNER 18
322 #define GLUT_CURSOR_BOTTOM_LEFT_CORNER  19
323 /* Inherit from parent window. */
324 #define GLUT_CURSOR_INHERIT             100
325 /* Blank cursor. */
326 #define GLUT_CURSOR_NONE                 101
327 /* Fullscreen crosshair (if available). */
328 #define GLUT_CURSOR_FULL_CROSSHAIR      102
329 #endif
330
331 /* GLUT initialization sub-API. */
332 extern void APIENTRY glutInit(int *argc, char **argv);
333 extern void APIENTRY glutInitDisplayMode(unsigned int mode);
334 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
335 extern void APIENTRY glutInitDisplayString(const char *string);
336 #endif
337 extern void APIENTRY glutInitWindowPosition(int x, int y);
338 extern void APIENTRY glutInitWindowSize(int width, int height);

```

```

339 extern void APIENTRY glutMainLoop(void);
340
341 /* GLUT window sub-API. */
342 extern int APIENTRY glutCreateWindow(const char *title);
343 extern int APIENTRY glutCreateSubWindow(int win, int x, int y, int width, int height);
344 extern void APIENTRY glutDestroyWindow(int win);
345 extern void APIENTRY glutPostRedisplay(void);
346 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 11)
347 extern void APIENTRY glutPostWindowRedisplay(int win);
348 #endif
349 extern void APIENTRY glutSwapBuffers(void);
350 extern int APIENTRY glutGetWindow(void);
351 extern void APIENTRY glutSetWindow(int win);
352 extern void APIENTRY glutSetWindowTitle(const char *title);
353 extern void APIENTRY glutSetIconTitle(const char *title);
354 extern void APIENTRY glutPositionWindow(int x, int y);
355 extern void APIENTRY glutReshapeWindow(int width, int height);
356 extern void APIENTRY glutPopWindow(void);
357 extern void APIENTRY glutPushWindow(void);
358 extern void APIENTRY glutIconifyWindow(void);
359 extern void APIENTRY glutShowWindow(void);
360 extern void APIENTRY glutHideWindow(void);
361 #if (GLUT_API_VERSION >= 3)
362 extern void APIENTRY glutFullScreen(void);
363 extern void APIENTRY glutSetCursor(int cursor);
364 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
365 extern void APIENTRY glutWarpPointer(int x, int y);
366 #endif
367
368 /* GLUT overlay sub-API. */
369 extern void APIENTRY glutEstablishOverlay(void);
370 extern void APIENTRY glutRemoveOverlay(void);
371 extern void APIENTRY glutUseLayer(GLenum layer);
372 extern void APIENTRY glutPostOverlayRedisplay(void);
373 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 11)
374 extern void APIENTRY glutPostWindowOverlayRedisplay(int win);
375 #endif
376 extern void APIENTRY glutShowOverlay(void);
377 extern void APIENTRY glutHideOverlay(void);
378 #endif
379
380 /* GLUT menu sub-API. */
381 extern int APIENTRY glutCreateMenu(void (*)(int));
382 extern void APIENTRY glutDestroyMenu(int menu);
383 extern int APIENTRY glutGetMenu(void);
384 extern void APIENTRY glutSetMenu(int menu);
385 extern void APIENTRY glutAddMenuEntry(const char *label, int value);
386 extern void APIENTRY glutAddSubMenu(const char *label, int submenu);
387 extern void APIENTRY glutChangeToMenuEntry(int item, const char *label, int value);
388 extern void APIENTRY glutChangeToSubMenu(int item, const char *label, int submenu);
389 extern void APIENTRY glutRemoveMenuItem(int item);
390 extern void APIENTRY glutAttachMenu(int button);
391 extern void APIENTRY glutDetachMenu(int button);
392
393 /* GLUT sub-API. */
394 extern void APIENTRY glutDisplayFunc(void (*)(void));
395 extern void APIENTRY glutReshapeFunc(void (*)(int width, int height));
396 extern void APIENTRY glutKeyboardFunc(void (*)(unsigned char key, int x, int y));
397 extern void APIENTRY glutMouseFunc(void (*)(int button, int state, int x, int y));
398 extern void APIENTRY glutMotionFunc(void (*)(int x, int y));
399 extern void APIENTRY glutPassiveMotionFunc(void (*)(int x, int y));
400 extern void APIENTRY glutEntryFunc(void (*)(int state));
401 extern void APIENTRY glutVisibilityFunc(void (*)(int state));
402 extern void APIENTRY glutIdleFunc(void (*)(void));
403 extern void APIENTRY glutTimerFunc(unsigned int millis, void (*)(int value), int value);
404 extern void APIENTRY glutMenuStateFunc(void (*)(int state));
405 #if (GLUT_API_VERSION >= 2)
406 extern void APIENTRY glutSpecialFunc(void (*)(int key, int x, int y));

```

```

407 extern void APIENTRY glutSpaceballMotionFunc(void (*)(int x, int y, int z));
408 extern void APIENTRY glutSpaceballRotateFunc(void (*)(int x, int y, int z));
409 extern void APIENTRY glutSpaceballButtonFunc(void (*)(int button, int state));
410 extern void APIENTRY glutButtonBoxFunc(void (*)(int button, int state));
411 extern void APIENTRY glutDialsFunc(void (*)(int dial, int value));
412 extern void APIENTRY glutTabletMotionFunc(void (*)(int x, int y));
413 extern void APIENTRY glutTabletButtonFunc(void (*)(int button, int state, int x, int y));
414 #if (GLUT_API_VERSION >= 3)
415 extern void APIENTRY glutMenuStatusFunc(void (*)(int status, int x, int y));
416 extern void APIENTRY glutOverlayDisplayFunc(void (*)(void));
417 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
418 extern void APIENTRY glutWindowStatusFunc(void (*)(int state));
419 #endif
420 #endif
421 #endif
422
423 /* GLUT color index sub-API. */
424 extern void APIENTRY glutSetColor(int, GLfloat red, GLfloat green, GLfloat blue);
425 extern GLfloat APIENTRY glutGetColor(int ndx, int component);
426 extern void APIENTRY glutCopyColormap(int win);
427
428 /* GLUT state retrieval sub-API. */
429 extern int APIENTRY glutGet(GLenum type);
430 extern int APIENTRY glutDeviceGet(GLenum type);
431 #if (GLUT_API_VERSION >= 2)
432 /* GLUT extension support sub-API */
433 extern int APIENTRY glutExtensionSupported(const char *name);
434 #endif
435 #if (GLUT_API_VERSION >= 3)
436 extern int APIENTRY glutGetModifiers(void);
437 extern int APIENTRY glutLayerGet(GLenum type);
438 #endif
439
440 /* GLUT font sub-API */
441 extern void APIENTRY glutBitmapCharacter(void *font, int character);
442 extern int APIENTRY glutBitmapWidth(void *font, int character);
443 extern void APIENTRY glutStrokeCharacter(void *font, int character);
444 extern int APIENTRY glutStrokeWidth(void *font, int character);
445 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
446 extern int APIENTRY glutBitmapLength(void *font, const unsigned char *string);
447 extern int APIENTRY glutStrokeLength(void *font, const unsigned char *string);
448 #endif
449
450 /* GLUT pre-built models sub-API */
451 extern void APIENTRY glutWireSphere(GLdouble radius, GLint slices, GLint stacks);
452 extern void APIENTRY glutSolidSphere(GLdouble radius, GLint slices, GLint stacks);
453 extern void APIENTRY glutWireCone(GLdouble base, GLdouble height, GLint slices, GLint stacks);
454 extern void APIENTRY glutSolidCone(GLdouble base, GLdouble height, GLint slices, GLint stacks);
455 extern void APIENTRY glutWireCube(GLdouble size);
456 extern void APIENTRY glutSolidCube(GLdouble size);
457 extern void APIENTRY glutWireTorus(GLdouble innerRadius, GLdouble outerRadius, GLint sides, GLint rings);
458 extern void APIENTRY glutSolidTorus(GLdouble innerRadius, GLdouble outerRadius, GLint sides, GLint rings);
459 extern void APIENTRY glutWireDodecahedron(void);
460 extern void APIENTRY glutSolidDodecahedron(void);
461 extern void APIENTRY glutWireTeapot(GLdouble size);
462 extern void APIENTRY glutSolidTeapot(GLdouble size);
463 extern void APIENTRY glutWireOctahedron(void);
464 extern void APIENTRY glutSolidOctahedron(void);
465 extern void APIENTRY glutWireTetrahedron(void);
466 extern void APIENTRY glutSolidTetrahedron(void);
467 extern void APIENTRY glutWireIcosahedron(void);
468 extern void APIENTRY glutSolidIcosahedron(void);
469
470 #if (GLUT_API_VERSION >= 4 || GLUT_XLIB_IMPLEMENTATION >= 9)
471 /* GLUT video resize sub-API. */
472 extern int APIENTRY glutVideoResizeGet(GLenum param);
473 extern void APIENTRY glutSetupVideoResizing(void);
474 extern void APIENTRY glutStopVideoResizing(void);

```

```
475 extern void APIENTRY glutVideoResize(int x, int y, int width, int height);
476 extern void APIENTRY glutVideoPan(int x, int y, int width, int height);
477
478 /* GLUT debugging sub-API. */
479 extern void APIENTRY glutReportErrors(void);
480 #endif
481
482 #ifdef __cplusplus
483 }
484
485 #endif
486 #endif                /* __glut_h__ */
```

C fglut.h FORTRAN Header File

```

1 C Copyright (c) Mark J. Kilgard, 1994.
2
3 C This program is freely distributable without licensing fees
4 C and is provided without guarantee or warrantee expressed or
5 C implied. This program is -not- in the public domain.
6
7 C GLUT Fortran header file
8
9 C display mode bit masks
10     integer*4 GLUT_RGB
11     parameter ( GLUT_RGB = 0 )
12     integer*4 GLUT_RGBA
13     parameter ( GLUT_RGBA = 0 )
14     integer*4 GLUT_INDEX
15     parameter ( GLUT_INDEX = 1 )
16     integer*4 GLUT_SINGLE
17     parameter ( GLUT_SINGLE = 0 )
18     integer*4 GLUT_DOUBLE
19     parameter ( GLUT_DOUBLE = 2 )
20     integer*4 GLUT_ACCUM
21     parameter ( GLUT_ACCUM = 4 )
22     integer*4 GLUT_ALPHA
23     parameter ( GLUT_ALPHA = 8 )
24     integer*4 GLUT_DEPTH
25     parameter ( GLUT_DEPTH = 16 )
26     integer*4 GLUT_STENCIL
27     parameter ( GLUT_STENCIL = 32 )
28     integer*4 GLUT_MULTISAMPLE
29     parameter ( GLUT_MULTISAMPLE = 128 )
30     integer*4 GLUT_STEREO
31     parameter ( GLUT_STEREO = 256 )
32
33 C mouse buttons
34     integer*4 GLUT_LEFT_BUTTON
35     parameter ( GLUT_LEFT_BUTTON = 0 )
36     integer*4 GLUT_MIDDLE_BUTTON
37     parameter ( GLUT_MIDDLE_BUTTON = 1 )
38     integer*4 GLUT_RIGHT_BUTTON
39     parameter ( GLUT_RIGHT_BUTTON = 2 )
40
41 C mouse button callback state
42     integer*4 GLUT_DOWN
43     parameter ( GLUT_DOWN = 0 )
44     integer*4 GLUT_UP
45     parameter ( GLUT_UP = 1 )
46
47 C special key callback values
48     integer*4 GLUT_KEY_F1
49     parameter ( GLUT_KEY_F1 = 1 )
50     integer*4 GLUT_KEY_F2
51     parameter ( GLUT_KEY_F2 = 2 )
52     integer*4 GLUT_KEY_F3
53     parameter ( GLUT_KEY_F3 = 3 )
54     integer*4 GLUT_KEY_F4
55     parameter ( GLUT_KEY_F4 = 4 )
56     integer*4 GLUT_KEY_F5
57     parameter ( GLUT_KEY_F5 = 5 )
58     integer*4 GLUT_KEY_F6
59     parameter ( GLUT_KEY_F6 = 6 )
60     integer*4 GLUT_KEY_F7
61     parameter ( GLUT_KEY_F7 = 7 )
62     integer*4 GLUT_KEY_F8
63     parameter ( GLUT_KEY_F8 = 8 )
64     integer*4 GLUT_KEY_F9
65     parameter ( GLUT_KEY_F9 = 9 )
66     integer*4 GLUT_KEY_F10

```

```

67         parameter ( GLUT_KEY_F10 = 10 )
68         integer*4 GLUT_KEY_F11
69         parameter ( GLUT_KEY_F11 = 11 )
70         integer*4 GLUT_KEY_F12
71         parameter ( GLUT_KEY_F12 = 12 )
72         integer*4 GLUT_KEY_LEFT
73         parameter ( GLUT_KEY_LEFT = 100 )
74         integer*4 GLUT_KEY_UP
75         parameter ( GLUT_KEY_UP = 101 )
76         integer*4 GLUT_KEY_RIGHT
77         parameter ( GLUT_KEY_RIGHT = 102 )
78         integer*4 GLUT_KEY_DOWN
79         parameter ( GLUT_KEY_DOWN = 103 )
80         integer*4 GLUT_KEY_PAGE_UP
81         parameter ( GLUT_KEY_PAGE_UP = 104 )
82         integer*4 GLUT_KEY_PAGE_DOWN
83         parameter ( GLUT_KEY_PAGE_DOWN = 105 )
84         integer*4 GLUT_KEY_HOME
85         parameter ( GLUT_KEY_HOME = 106 )
86         integer*4 GLUT_KEY_END
87         parameter ( GLUT_KEY_END = 107 )
88         integer*4 GLUT_KEY_INSERT
89         parameter ( GLUT_KEY_INSERT = 108 )
90
91 C  entry/exit callback state
92         integer*4 GLUT_LEFT
93         parameter ( GLUT_LEFT = 0 )
94         integer*4 GLUT_ENTERED
95         parameter ( GLUT_ENTERED = 1 )
96
97 C  menu usage callback state
98         integer*4 GLUT_MENU_NOT_IN_USE
99         parameter ( GLUT_MENU_NOT_IN_USE = 0 )
100        integer*4 GLUT_MENU_IN_USE
101        parameter ( GLUT_MENU_IN_USE = 1 )
102
103 C  visibility callback state
104        integer*4 GLUT_NOT_VISIBLE
105        parameter ( GLUT_NOT_VISIBLE = 0 )
106        integer*4 GLUT_VISIBLE
107        parameter ( GLUT_VISIBLE = 1 )
108
109 C  color index component selection values
110        integer*4 GLUT_RED
111        parameter ( GLUT_RED = 0 )
112        integer*4 GLUT_GREEN
113        parameter ( GLUT_GREEN = 1 )
114        integer*4 GLUT_BLUE
115        parameter ( GLUT_BLUE = 2 )
116
117 C XXX Unfortunately, SGI's Fortran compiler links with
118 C EXTERNAL data even if it is not used. This defeats
119 C the purpose of GLUT naming fonts via opaque symbols.
120 C This means GLUT Fortran programmers should explicitly
121 C declared EXTERNAL GLUT fonts in subroutines where
122 C the fonts are used.
123
124 C  stroke font opaque names
125 C      external GLUT_STROKE_ROMAN
126 C      external GLUT_STROKE_MONO_ROMAN
127
128 C  bitmap font opaque names
129 C      external GLUT_BITMAP_9_BY_15
130 C      external GLUT_BITMAP_8_BY_13
131 C      external GLUT_BITMAP_TIMES_ROMAN_10
132 C      external GLUT_BITMAP_TIMES_ROMAN_24
133 C      external GLUT_BITMAP_HELVETICA_10
134 C      external GLUT_BITMAP_HELVETICA_12

```

```

135 C      external GLUT_BITMAP_HELVETICA_18
136
137 C  glutGet parameters
138      integer*4 GLUT_WINDOW_X
139      parameter ( GLUT_WINDOW_X = 100 )
140      integer*4 GLUT_WINDOW_Y
141      parameter ( GLUT_WINDOW_Y = 101 )
142      integer*4 GLUT_WINDOW_WIDTH
143      parameter ( GLUT_WINDOW_WIDTH = 102 )
144      integer*4 GLUT_WINDOW_HEIGHT
145      parameter ( GLUT_WINDOW_HEIGHT = 103 )
146      integer*4 GLUT_WINDOW_BUFFER_SIZE
147      parameter ( GLUT_WINDOW_BUFFER_SIZE = 104 )
148      integer*4 GLUT_WINDOW_STENCIL_SIZE
149      parameter ( GLUT_WINDOW_STENCIL_SIZE = 105 )
150      integer*4 GLUT_WINDOW_DEPTH_SIZE
151      parameter ( GLUT_WINDOW_DEPTH_SIZE = 106 )
152      integer*4 GLUT_WINDOW_RED_SIZE
153      parameter ( GLUT_WINDOW_RED_SIZE = 107 )
154      integer*4 GLUT_WINDOW_GREEN_SIZE
155      parameter ( GLUT_WINDOW_GREEN_SIZE = 108 )
156      integer*4 GLUT_WINDOW_BLUE_SIZE
157      parameter ( GLUT_WINDOW_BLUE_SIZE = 109 )
158      integer*4 GLUT_WINDOW_ALPHA_SIZE
159      parameter ( GLUT_WINDOW_ALPHA_SIZE = 110 )
160      integer*4 GLUT_WINDOW_ACCUM_RED_SIZE
161      parameter ( GLUT_WINDOW_ACCUM_RED_SIZE = 111 )
162      integer*4 GLUT_WINDOW_ACCUM_GREEN_SIZE
163      parameter ( GLUT_WINDOW_ACCUM_GREEN_SIZE = 112 )
164      integer*4 GLUT_WINDOW_ACCUM_BLUE_SIZE
165      parameter ( GLUT_WINDOW_ACCUM_BLUE_SIZE = 113 )
166      integer*4 GLUT_WINDOW_ACCUM_ALPHA_SIZE
167      parameter ( GLUT_WINDOW_ACCUM_ALPHA_SIZE = 114 )
168      integer*4 GLUT_WINDOW_DOUBLEBUFFER
169      parameter ( GLUT_WINDOW_DOUBLEBUFFER = 115 )
170      integer*4 GLUT_WINDOW_RGBA
171      parameter ( GLUT_WINDOW_RGBA = 116 )
172      integer*4 GLUT_WINDOW_PARENT
173      parameter ( GLUT_WINDOW_PARENT = 117 )
174      integer*4 GLUT_WINDOW_NUM_CHILDREN
175      parameter ( GLUT_WINDOW_NUM_CHILDREN = 118 )
176      integer*4 GLUT_WINDOW_COLORMAP_SIZE
177      parameter ( GLUT_WINDOW_COLORMAP_SIZE = 119 )
178      integer*4 GLUT_WINDOW_NUM_SAMPLES
179      parameter ( GLUT_WINDOW_NUM_SAMPLES = 120 )
180      integer*4 GLUT_WINDOW_STEREO
181      parameter ( GLUT_WINDOW_STEREO = 121 )
182      integer*4 GLUT_WINDOW_CURSOR
183      parameter ( GLUT_WINDOW_CURSOR = 122 )
184      integer*4 GLUT_SCREEN_WIDTH
185      parameter ( GLUT_SCREEN_WIDTH = 200 )
186      integer*4 GLUT_SCREEN_HEIGHT
187      parameter ( GLUT_SCREEN_HEIGHT = 201 )
188      integer*4 GLUT_SCREEN_WIDTH_MM
189      parameter ( GLUT_SCREEN_WIDTH_MM = 202 )
190      integer*4 GLUT_SCREEN_HEIGHT_MM
191      parameter ( GLUT_SCREEN_HEIGHT_MM = 203 )
192      integer*4 GLUT_MENU_NUM_ITEMS
193      parameter ( GLUT_MENU_NUM_ITEMS = 300 )
194      integer*4 GLUT_DISPLAY_MODE_POSSIBLE
195      parameter ( GLUT_DISPLAY_MODE_POSSIBLE = 400 )
196      integer*4 GLUT_INIT_WINDOW_X
197      parameter ( GLUT_INIT_WINDOW_X = 500 )
198      integer*4 GLUT_INIT_WINDOW_Y
199      parameter ( GLUT_INIT_WINDOW_Y = 501 )
200      integer*4 GLUT_INIT_WINDOW_WIDTH
201      parameter ( GLUT_INIT_WINDOW_WIDTH = 502 )
202      integer*4 GLUT_INIT_WINDOW_HEIGHT

```

```

203     parameter ( GLUT_INIT_WINDOW_HEIGHT = 503 )
204     integer*4 GLUT_INIT_DISPLAY_MODE
205     parameter ( GLUT_INIT_DISPLAY_MODE = 504 )
206     integer*4 GLUT_ELAPSED_TIME
207     parameter ( GLUT_ELAPSED_TIME = 700 )
208
209 C   glutDeviceGet parameters
210     integer*4 GLUT_HAS_KEYBOARD
211     parameter ( GLUT_HAS_KEYBOARD = 600 )
212     integer*4 GLUT_HAS_MOUSE
213     parameter ( GLUT_HAS_MOUSE = 601 )
214     integer*4 GLUT_HAS_SPACEBALL
215     parameter ( GLUT_HAS_SPACEBALL = 602 )
216     integer*4 GLUT_HAS_DIAL_AND_BUTTON_BOX
217     parameter ( GLUT_HAS_DIAL_AND_BUTTON_BOX = 603 )
218     integer*4 GLUT_HAS_TABLET
219     parameter ( GLUT_HAS_TABLET = 604 )
220     integer*4 GLUT_NUM_MOUSE_BUTTONS
221     parameter ( GLUT_NUM_MOUSE_BUTTONS = 605 )
222     integer*4 GLUT_NUM_SPACEBALL_BUTTONS
223     parameter ( GLUT_NUM_SPACEBALL_BUTTONS = 606 )
224     integer*4 GLUT_NUM_BUTTON_BOX_BUTTONS
225     parameter ( GLUT_NUM_BUTTON_BOX_BUTTONS = 607 )
226     integer*4 GLUT_NUM_DIALS
227     parameter ( GLUT_NUM_DIALS = 608 )
228     integer*4 GLUT_NUM_TABLET_BUTTONS
229     parameter ( GLUT_NUM_TABLET_BUTTONS = 609 )
230
231 C   glutLayerGet parameters
232     integer*4 GLUT_OVERLAY_POSSIBLE
233     parameter ( GLUT_OVERLAY_POSSIBLE = 800 )
234     integer*4 GLUT_LAYER_IN_USE
235     parameter ( GLUT_LAYER_IN_USE = 801 )
236     integer*4 GLUT_HAS_OVERLAY
237     parameter ( GLUT_HAS_OVERLAY = 802 )
238     integer*4 GLUT_TRANSPARENT_INDEX
239     parameter ( GLUT_TRANSPARENT_INDEX = 803 )
240     integer*4 GLUT_NORMAL_DAMAGED
241     parameter ( GLUT_NORMAL_DAMAGED = 804 )
242     integer*4 GLUT_OVERLAY_DAMAGED
243     parameter ( GLUT_OVERLAY_DAMAGED = 805 )
244
245 C   glutUseLayer parameters
246     integer*4 GLUT_NORMAL
247     parameter ( GLUT_NORMAL = 0 )
248     integer*4 GLUT_OVERLAY
249     parameter ( GLUT_OVERLAY = 1 )
250
251 C   glutGetModifiers return mask
252     integer*4 GLUT_ACTIVE_SHIFT
253     parameter ( GLUT_ACTIVE_SHIFT = 1 )
254     integer*4 GLUT_ACTIVE_CTRL
255     parameter ( GLUT_ACTIVE_CTRL = 2 )
256     integer*4 GLUT_ACTIVE_ALT
257     parameter ( GLUT_ACTIVE_ALT = 4 )
258
259 C   glutSetCursor parameters
260     integer*4 GLUT_CURSOR_RIGHT_ARROW
261     parameter ( GLUT_CURSOR_RIGHT_ARROW = 0 )
262     integer*4 GLUT_CURSOR_LEFT_ARROW
263     parameter ( GLUT_CURSOR_LEFT_ARROW = 1 )
264     integer*4 GLUT_CURSOR_INFO
265     parameter ( GLUT_CURSOR_INFO = 2 )
266     integer*4 GLUT_CURSOR_DESTROY
267     parameter ( GLUT_CURSOR_DESTROY = 3 )
268     integer*4 GLUT_CURSOR_HELP
269     parameter ( GLUT_CURSOR_HELP = 4 )
270     integer*4 GLUT_CURSOR_CYCLE

```

```

271     parameter ( GLUT_CURSOR_CYCLE = 5 )
272     integer*4 GLUT_CURSOR_SPRAY
273     parameter ( GLUT_CURSOR_SPRAY = 6 )
274     integer*4 GLUT_CURSOR_WAIT
275     parameter ( GLUT_CURSOR_WAIT = 7 )
276     integer*4 GLUT_CURSOR_TEXT
277     parameter ( GLUT_CURSOR_TEXT = 8 )
278     integer*4 GLUT_CURSOR_CROSSHAIR
279     parameter ( GLUT_CURSOR_CROSSHAIR = 9 )
280     integer*4 GLUT_CURSOR_UP_DOWN
281     parameter ( GLUT_CURSOR_UP_DOWN = 10 )
282     integer*4 GLUT_CURSOR_LEFT_RIGHT
283     parameter ( GLUT_CURSOR_LEFT_RIGHT = 11 )
284     integer*4 GLUT_CURSOR_TOP_SIDE
285     parameter ( GLUT_CURSOR_TOP_SIDE = 12 )
286     integer*4 GLUT_CURSOR_BOTTOM_SIDE
287     parameter ( GLUT_CURSOR_BOTTOM_SIDE = 13 )
288     integer*4 GLUT_CURSOR_LEFT_SIDE
289     parameter ( GLUT_CURSOR_LEFT_SIDE = 14 )
290     integer*4 GLUT_CURSOR_RIGHT_SIDE
291     parameter ( GLUT_CURSOR_RIGHT_SIDE = 15 )
292     integer*4 GLUT_CURSOR_TOP_LEFT_CORNER
293     parameter ( GLUT_CURSOR_TOP_LEFT_CORNER = 16 )
294     integer*4 GLUT_CURSOR_TOP_RIGHT_CORNER
295     parameter ( GLUT_CURSOR_TOP_RIGHT_CORNER = 17 )
296     integer*4 GLUT_CURSOR_BOTTOM_RIGHT_CORNER
297     parameter ( GLUT_CURSOR_BOTTOM_RIGHT_CORNER = 18 )
298     integer*4 GLUT_CURSOR_BOTTOM_LEFT_CORNER
299     parameter ( GLUT_CURSOR_BOTTOM_LEFT_CORNER = 19 )
300     integer*4 GLUT_CURSOR_INHERIT
301     parameter ( GLUT_CURSOR_INHERIT = 100 )
302     integer*4 GLUT_CURSOR_NONE
303     parameter ( GLUT_CURSOR_NONE = 101 )
304     integer*4 GLUT_CURSOR_FULL_CROSSHAIR
305     parameter ( GLUT_CURSOR_FULL_CROSSHAIR = 102 )
306
307 C   GLUT functions
308     integer*4 glutcreatewindow
309     integer*4 glutcreatesubwindow
310     integer*4 glutgetwindow
311     integer*4 glutcreatemenu
312     integer*4 glutgetmenu
313     real glutgetcolor
314     integer*4 glutget
315     integer*4 glutdeviceget
316     integer*4 glutextensionsupported
317
318 C   GLUT NULL name
319     external glutnull
320

```

References

- [1] Kurt Akeley, "RealityEngine Graphics," *Proceedings of SIGGRAPH '93*, July 1993.
- [2] Edward Angel, *Interactive Computer Graphics: A top-down approach with OpenGL*, Addison-Wesley, ISBN 0-201-85571-2, 1996.
- [3] F.C. Crow, "The Origins of the Teapot," *IEEE Computer Graphics and Applications*, January 1987.
- [4] Phil Karlton, *OpenGL Graphics with the X Window System*, Ver. 1.0, Silicon Graphics, April 30, 1993.
- [5] Mark J. Kilgard, "Going Beyond the MIT Sample Server: The Silicon Graphics X11 Server," *The X Journal*, SIGS Publications, January 1993.
- [6] Mark Kilgard, "Programming X Overlay Windows," *The X Journal*, SIGS Publications, July 1993.
- [7] Mark Kilgard, "OpenGL and X, Part 2: Using OpenGL with Xlib," *The X Journal*, SIGS Publications, Jan/Feb 1994.
- [8] Mark Kilgard, "OpenGL and X, Part 3: Integrating OpenGL with Motif," *The X Journal*, SIGS Publications, Jul/Aug 1994.
- [9] Mark Kilgard, "An OpenGL Toolkit," *The X Journal*, SIGS Publications, Nov/Dec 1994.
- [10] Mark Kilgard, *Programming OpenGL for the X Window System*, Addison-Wesley, ISBN 0-201-48359-9, 1996.
- [11] Jackie Neider, Tom Davis, Mason Woo, *OpenGL Programming Guide: The official guide to learning OpenGL, Release 1*, Addison Wesley, 1993.
- [12] OpenGL Architecture Review Board, *OpenGL Reference Manual: The official reference document for OpenGL, Release 1*, Addison Wesley, 1992.
- [13] Mark Patrick, George Sachs, *X11 Input Extension Library Specification*, X Consortium Standard, X11R6, April 18, 1994.
- [14] Mark Patrick, George Sachs, *X11 Input Extension Protocol Specification*, X Consortium Standard, X11R6, April 17, 1994.
- [15] Robert Scheifler, James Gettys, *X Window System: The complete Reference to Xlib, X Protocol, ICCCM, XLFD*, third edition, Digital Press, 1992.
- [16] Mark Segal, Kurt Akeley, *The OpenGLTM Graphics System: A Specification*, Version 1.0, Silicon Graphics, June 30, 1992.
- [17] Silicon Graphics, *Graphics Library Programming Guide*, Document Number 007-1210-040, 1991.
- [18] Silicon Graphics, *Graphics Library Window and Font Library Guide*, Document Number 007-1329-010, 1991.

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