

RayCore[®] API Specifications

Version 1.0

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Contents

Chapter 1 Introduction	5
1.1 3D Graphics.....	5
1.2 RayCore®.....	5
1.3 RayCore® API	6
Chapter 2 Function List.....	7
2.1 rcBindBuffer.....	8
2.2 rcBindMaterial.....	9
2.3 rcBindTexture.....	10
2.4 rcBufferData.....	11
2.5 rcBufferSubData.....	12
2.6 rcClearColor	13
2.7 rcColor.....	14
2.8 rcDeleteBuffers	15
2.9 rcDeleteMaterials	16
2.10 rcDeleteTextures	17
2.11 rcDrawArrays	18
2.12 rcDrawElements	19
2.13 rcEnable.....	20
2.14 rcEnableClientState	22
2.15 rcFinish.....	23
2.16 rcFlush	24
2.17 rcFrustum	25
2.18 rcGenBuffers	26
2.19 rcGenMaterials	27
2.20 rcGenTextures	28
2.21 rcGet	29
2.22 rcGetBufferParameteriv	34
2.23 rcGetError.....	35
2.24 rcGetLight	36
2.25 rcGetMaterial.....	38
2.26 rcGetPointerv.....	40
2.27 rcGetString	41
2.28 rcGetTexParameter.....	42
2.29 rcHint.....	43
2.30 rcIsBuffer	45
2.31 rcIsEnabled.....	46

2.32	rcIsMaterial	47
2.33	rcIsTexture	48
2.34	rcLight	49
2.35	rcLoadIdentity	52
2.36	rcLoadMatrix	53
2.37	rcMaterial	54
2.38	rcMatrixMode	56
2.39	rcMultMatrix	57
2.40	rcNormalPointer	58
2.41	rcPushMatrix, rcPopMatrix	59
2.42	rcRotate	60
2.43	rcScale	61
2.44	rcTexCoordPointer	62
2.45	rcTexImage2D	63
2.46	rcTexParameter	65
2.47	rcTranslate	67
2.48	rcVertexPointer	68
2.49	rcViewport	69

Chapter 3 Extended Function List.....70

3.1	rcuLookAt	71
3.2	rcuPerspective	72
3.3	rcCurrentPaletteMatrixOES	73
3.4	rcLoadPaletteFromModelViewMatrixOES	74
3.5	rcMatrixIndexPointerOES	75
3.6	rcWeightPointerOES	76
3.7	rcSceneAllInit	77
3.8	rcStaticSceneBegin, rcStaticSceneEnd	78
3.9	rcTextureAlpha	79
3.10	rcDepthBounce	80

Chapter 1 Introduction

1.1 3D Graphics

OpenGL ES is a software interface for graphics hardware in embedded system. The interface consists of a set of procedures and functions that allow a programmer to specify the objects and operations involved in producing high quality graphics images, especially color images of three-dimensional objects.

Many versions of OpenGL ES require that the graphics hardware contain a frame buffer. They are especially suitable for drawing objects such as points, lines and polygons; however, some functions in OpenGL ES are especially concerned with frame buffer manipulation. For example, some drawings including the operations such as antialiasing or texturing rely on a frame buffer.

OpenGL ES mainly supports raster based acceleration hardware. Raster based hardware in 3D graphics uses forward rendering which processes every polygon to generate images. Forward rendering is widely used, but its image quality is very low. To overcome the weakness, an additional hardware such as shader is implemented. As a result, the development period for application programs is long, and the development cost is high.

1.2 RayCore®

RayCore® is trademark of ray tracing rendering engine that is developed by Siliconarts, Inc. Unlike raster based hardware, RayCore® does not additional image processing but is capable of generating high quality 3D graphics images on real-time basis. Therefore, it is very easy to develop new 3D applications with RayCore®.

It supports the following major features:

- Backward rendering method
- Lighting
- Phong shading
- Shadow
- Reflection and refraction
- Texture mapping
- Antialiasing

In forward rendering to be used by raster based hardware generally, every polygon should be transformed to screen coordinates. This is because polygons will not be able to identify their position before rendering process is complete; hence depth test is required to secure the visibility of the polygons. On the other hand, backward rendering to be used by RayCore® can secure the visibility without depth test and also reduce data processing, since it does not process all of the polygons.

Lighting is set to display objects similar to those in real world, and hence produces various effects such as shadow, reflection and refraction. Texture mapping is a basic feature for photorealistic 3D graphics. Antialiasing also supports to provide higher image quality.

RayCore® renders 3D graphics images with a ray tracing algorithm containing an acceleration structure such as tree. A tree acceleration structure enables fast polygon searching during the process. A software tree builder is integrated into RayCore® API.

1.3 RayCore® API

RayCore® API is newly developed in OpenGL ES Version 1.1 - familiar format. New functions or parameters may be needed for ray tracing specific features. RayCore® API uses modified versions of the functions and parameters in OpenGL ES Version 1.1. Prefixes of the functions are changed, and the parameters are changed minimum. In addition, only a few functions are added for the ray tracing specific capabilities.

It supports the following major features:

- Vertex, normal, texture coordinate list
- Mipmap texture
- Triangle, strip, fan
- Material properties (ambient, diffuse, specular, reflection, refraction and etc.)
- Light properties (ambient, diffuse, specular and etc.)
- Matrix modes (Push, pop, load and etc.)

Chapter 2 Function List

This chapter describes RayCore® functions that are familiar to those in OpenGL ES 1.1. Most functions are similarly defined, while some of them are modified for RayCore®.

2.1 rcBindBuffer

```
void rcBindBuffer(RCenum target, RCuint buffer);
```

Sets a buffer object with the name *buffer* to the current buffer target

<i>target</i>	The current buffer target to which the buffer object is set (RC_ARRAY_BUFFER, RC_ELEMENT_ARRAY_BUFFER)
<i>buffer</i>	The name of the buffer object

Error Codes

RC_INVALID_ENUM : *target* is an invalid value

RC_OUT_OF_MEMORY : Failed to create the buffer object

Related Functions

rcBufferData, rcBufferSubData, rcDeleteBuffers, rcGenBuffers

rcGet

RC_ARRAY_BUFFER_BINDING

RC_ELEMENT_ARRAY_BUFFER_BINDING

Explanation

If the buffer object is set to the current buffer target, it is enabled to change and use its data. This buffer object remains active until the buffer object with a different name is set to the same buffer target, or until the buffer object is deleted. (See rcDeleteBuffers)

The buffer object name *buffer* is a non-negative integer, but the name that is actually used is a positive integer. If the reserved value 0 is set to *buffer*, the settings of the buffer object are initialized to the current buffer target. If the buffer object with the corresponding name does not exist, this buffer object is automatically created. The buffer object with a new name can be generated using rcGenBuffers. Once created, the named buffer object may be set again to the current buffer target when needed.

When rcBindBuffer is called with the RC_ARRAY_BUFFER, target, vertex, normal or texture coordinate array pointer parameter of rcDrawArrays, which is commonly represented as a memory pointer, is instead interpreted as a buffer object managed in RayCore® API.

Also, when rcBindBuffer is called with the RC_ELEMENT_ARRAY_BUFFER target, the index array parameter of rcDrawElements, which is commonly represented as a memory pointer, is instead represented as a buffer object managed in RayCore® API.

2.2 rcBindMaterial

```
void rcBindMaterial(RCuint material);
```

Sets a material object with the name *material* to the current material object

<i>material</i>	The name of the material object
------------------------	---------------------------------

Error Codes

RC_OUT_OF_MEMORY : Failed to create the material object

Related Functions

rcDeleteMaterials, rcGenMaterials

Attention

rcBindMaterial must be required before a call to rcEnable, rcDisable, or rcBindTexture of RC_TEXTURE_2D or RC_TEXTURE_2D_NORMAL, and rcMaterial.

Explanation

If the material object is set to the current material object, it is enabled to change and use its data. This material object remains active until the material object with a different name is set to the current material object, or until this object is deleted. (See rcDeleteMaterials)

The material object name *material* is not a negative integer. The reserved value 0 represents the default material object name that is used to initialize the binding state of the current material object. If the material object with the corresponding name does not exist, this material object is automatically created. The material object with a new name can be generated using rcGenMaterials. Once created, the named material object may be set again to the current material object when needed.

2.3 rcBindTexture

```
void rcBindTexture(RCenum target, RCuint texture);
```

Sets a texture object with the name *texture* to the current texture target

<i>target</i>	The current texture target to which the texture object is set (RC_TEXTURE_2D, RC_TEXTURE_2D_NORMAL)
<i>texture</i>	The name of the texture object

Error Codes

RC_INVALID_ENUM : *target* is an invalid value

RC_OUT_OF_MEMORY : Failed to create the texture object

Related Functions

rcDeleteTextures, rcGenTextures, rcTexImage2D, rcTexParameter

rcGet

RC_TEXTURE_BINDING_2D

Explanation

If the texture object is set to the current texture target, it is enabled to change and use its data. This texture object remains active until the texture object with a different name is set to the current texture target, or until the object is deleted. (See rcDeleteTextures) When the texture object is set, this object is applied to the current material object. (See rcBindMaterial)

The texture object name *texture* is not a negative integer. The reserved value 0 represents the default texture object name that is used to initialize the binding state of the current texture object. If the texture object with the corresponding name does not exist, this texture object is automatically created. The texture object with a new name can be generated using rcGenTextures. Once created, a named texture object may be set again to the current texture object when needed.

2.4 rcBufferData

```
void rcBufferData(RCenum target, RCsizeiptr size, const RCvoid * data, RCenum usage);
```

Sets the data information of a buffer object by initializing and creating the data store of the buffer object which is set to the current buffer target

<i>target</i>	The current buffer target to which the buffer data information is set (RC_ARRAY_BUFFER, RC_ELEMENT_ARRAY_BUFFER)
<i>size</i>	The size in bytes of the buffer object's new data store
<i>data</i>	The pointer of original data that will be copied into the data store of the buffer object (NULL if no data is to be copied)
<i>usage</i>	The usage pattern of the data store (RC_STATIC_DRAW, RC_DYNAMIC_DRAW)

Error Codes

RC_INVALID_ENUM

: *target* is an invalid value

: *usage* is an invalid value

RC_INVALID_VALUE : *size* is negative

RC_INVALID_OPERATION : The buffer object name 0 is set to *target*

RC_OUT_OF_MEMORY : Failed to create the data store

Related Functions

rcBufferSubData, rcBindBuffer

rcGetBufferParameteriv

RC_BUFFER_SIZE

RCL_BUFFER_USAGE

Attention

If *data* is NULL, a data store of the specified size is still created, but its contents remain uninitialized and thus undefined.

Explanation

The previous data store for the current buffer object is deleted, and the new data store is created with the specified *size* in bytes. If the original data pointer *data* is NULL, the data store of the current buffer object is initialized.

2.5 rcBufferSubData

```
void rcBufferSubData(RCenum target, RCintptr offset, RCsizeiptr size, const RCvoid *data);
```

Replaces the sub or entire data information for the data store of a buffer object which is set to the current buffer target

<i>target</i>	The current buffer target to which the buffer data information is set (RC_ARRAY_BUFFER, RC_ELEMENT_ARRAY_BUFFER)
<i>offset</i>	The offset in bytes into the data store of the buffer object where data replacement will begin
<i>size</i>	The size in bytes of the data store region being replaced
<i>data</i>	The pointer to the new data that will be copied into the data store of the buffer object

Error Codes

RC_INVALID_ENUM : *target* is an invalid value

RC_INVALID_VALUE : *offset* or *size* is negative, or is beyond the region of the buffer object's allocated data store

RC_INVALID_OPERATION : The buffer object name 0 is set to *target*, or the buffer object *usage* is RC_STATIC_DRAW

Related Functions

rcBindBuffer, rcBufferData

Explanation

The data starting at byte *offset* and extending for *size* bytes is copied from the specified memory pointer *data* to the data store.

2.6 rcClearColor

```
void rcClearColor(RCclampf red, RCclampf green, RCclampf blue, RCclampf alpha);  
void rcClearColorx(RCclampx red, RCclampx green, RCclampx blue, RCclampx alpha);
```

Sets the background color

<i>red, green, blue, alpha</i>	The red, green, blue, and alpha values of the background color
------------------------------------	--

Related Functions

- rcClear
- rcGet
- RC_COLOR_CLEAR_VALUE

Explanation

rcClearColor specifies the red, green, blue, and alpha values used to set the background color. All initial values are 0. Values specified by rcClearColor are clamped to the range [0, 1].

2.7 rcColor

<pre>void rcColor4f(RCfloat red, RCfloat green, RCfloat blue, RCfloat alpha); void rcColor4x(RCfixed red, RCfixed green, RCfixed blue, RCfixed alpha); void rcColor4ub(RCubyte red, RCubyte green, RCubyte blue, RCubyte alpha);</pre>	
Sets the default color	
<i>red, green, blue, alpha</i>	The red, green, blue, and alpha values of the default color

Related Functions
rcBindMaterial, rcGenMaterial, rcMaterial rcGet RC_CURRENT_COLOR

Attention

The initial value for the default color is (1, 1, 1, 1).

Explanation

In the current material properties, ambient and diffuse values are set with these RGBA values that are specified, and specular values are initialized to (0, 0, 0, 0).

Unsigned byte color components specified with rcColor4ub are linearly mapped to floating-point values such that 255 maps to 1.0 (full intensity), and 0 maps to 0.0 (zero intensity).

2.8 rcDeleteBuffers

```
void rcDeleteBuffers(RCsizei n, const RCuint * buffers);
```

Deletes buffer objects with *n* buffer object names in the array of buffer object names *buffers*

<i>n</i>	The count of buffer objects to be deleted
<i>buffers</i>	The array of buffer object names to be deleted

Error Codes

RC_INVALID_VALUE : *n* is negative

Related Functions

rcBufferData, rcBindBuffer, rcGenBuffers, rcIsBuffer

Explanation

When the buffer object is deleted, the reserved name 0 and the buffer object names that are yet to be created are ignored. The deleted buffer object has no contents, and its name is free for reuse. (See rcGenBuffers)

If the buffer object that is set to the buffer target is deleted, all bindings to that object are reset to 0.

2.9 rcDeleteMaterials

```
void rcDeleteMaterials(RCsizei n, const RCuint * materials);
```

Deletes material objects with *n* material object names in the array of material object names *materials*

<i>n</i>	The count of material objects to be deleted
<i>materials</i>	The array of material object names to be deleted

Error Codes

RC_INVALID_VALUE : *n* is negative

Related Functions

rcBindMaterial, rcGenMaterials, rcIsMaterial

Explanation

When the material object is deleted, the reserved name 0 and the material object names that are yet to be created are ignored. The deleted material object has no contents, and its name is free for reuse. (See rcGenMaterials)

If the material object that is set to the current material object is deleted, the current material object reverts to 0 (the default material).

2.10 rcDeleteTextures

void rcDeleteTextures(RCsizei <i>n</i> , const RCuint * <i>textures</i>);	
Deletes texture objects with <i>n</i> texture object names in the array of texture object names <i>textures</i>	
<i>n</i>	The count of texture objects to be deleted
<i>textures</i>	The array of texture object names to be deleted

Error Codes

RC_INVALID_VALUE : *n* is negative

Related Functions

rcBindTexture, rcGenTextures, rcIsTexture

Explanation

When the texture objects are deleted, the reserved name 0 and the texture object names that are yet to be created are ignored. The deleted texture objects have no contents, and its name is free for reuse. (See rcGenTextures)

If the texture object that is set to the current texture object is deleted, the current texture object reverts to 0 (the default texture).

2.11 rcDrawArrays

```
void rcDrawArrays(RCenum mode, RCint first, RCsizei count);
```

Creates primitives to render from the array of preset vertices, normals, colors, and texture coordinates

<i>mode</i>	The kind of primitives to render (RC_TRIANGLE_STRIP, RC_TRIANGLE_FAN, RC_TRIANGLES, RC_QUADS)
<i>first</i>	The starting index in the enabled arrays
<i>count</i>	The count of indices to be used in creating primitives

Error Codes

RC_INVALID_ENUM : *mode* is an invalid value

RC_INVALID_VALUE : *count* is negative

Related Functions

rcDrawElements, rcNormalPointer, rcTexCoordPointer, rcVertexPointer

Explanation

After prespecifying the separate arrays of vertices, normals, colors, and texture coordinates, primitives to render can be constructed by calling rcDrawArrays.

Geometric primitives are constructed by using *count* sequential elements from the starting index, *first*, of each array. *mode* means what kind of primitives is constructed, and how those primitives are constructed by the array elements. If the vertex array is not enabled, no geometric primitives are created.

2.12 rcDrawElements

```
void rcDrawElements(RCenum mode, RCsizei count, RCenum type, const RCvoid *  
indices);
```

Creates primitives to render from arrays of preset vertices, normals, colors, texture coordinates and indices

<i>mode</i>	The kind of primitives to render (RC_TRIANGLE_STRIP, RC_TRIANGLE_FAN, RC_TRIANGLES, RC_QUADS)
<i>count</i>	The count of indices to be used in creating primitives
<i>type</i>	The data type of an indices array (RC_BYTE, RC_UNSIGNED_BYTE, RC_SHORT, RC_UNSIGNED_SHORT, RC_INT, RC_UNSIGNED_INT)
<i>indices</i>	The pointer to data store where the indices are loaded

Error Codes

RC_INVALID_ENUM

: *mode* is an invalid value

: *type* is an invalid value

RC_INVALID_VALUE : *count* is negative

Related Functions

rcDrawArrays, rcNormalPointer, rcTexCoordPointer, rcVertexPointer

Explanation

After prespecifying the separate arrays of vertices, normals, colors, texture coordinates, and related indices, primitives to render can be constructed by calling rcDrawElements.

Geometric primitives are constructed by using *count* sequential indices from the pointer, *indices*, of an indices array to lookup elements in each array. *mode* means what kind of primitives is constructed, and how those primitives are constructed with with the array elements. If the vertex array is not enabled, no geometric primitives are created.

2.13 rcEnable

```
void rcEnable(RCenum cap);
void rcDisable(RCenum cap);
```

Enables or disables various capabilities of RayCore® API

<i>cap</i>	The capability of RayCore® API
------------	--------------------------------

Error Codes

RC_INVALID_ENUM : *cap* is an invalid value

Related Functions

rcEnableClientState, rcGet, rcIsEnabled, rcLight, rcMaterial, rcTexImage2D, rcTexSubImage2D

Explanation

The following is the description of RayCore® API capability *cap*.

- RC_LIGHTi
Enables or disables the *i*th light source. (See rcLight)
- RC_LIGHTING
Enables or disables lighting. (See rcLight)
- RC_MATRIX_PALETTE_OES
Enables or disables palette matrix. (See rcCurrentPaletteMatrixOES and rcLoadPaletteFromModelViewMatrixOES)
- RC_TEXTURE_2D
Enables or disables two-dimensional texturing which is performed for the active texture unit and the current material. (See rcBindMaterial and rcTexImage2D)
- RC_TEXTURE_2D_NORMAL
Enables or disables two-dimensional normal map texturing which is performed for the active texture unit and the current material. (See rcBindMaterial and rcTexImage2D)
- RC_USE_COLOR_SHADOW
Sets whether color values of each material object are applied to shadow. If it is disabled, grayscale colors are simply applied. (See rcMaterial and rcLight)
- RC_USE_SHADOW
Sets whether shadow is rendered. If it is disabled, no shadow is rendered.
- RC_USE_TEXTURE_ALPHA_SHADOW
Sets whether alpha values of a material texture is applied to shadow. If it is disabled, the texture without alpha values is simply applied. (See rcMaterial and rcTexImage2D)

- **RC_USE_TEXTURE_ONLY:**
Sets whether shadow and reflection effects are applied to the texture of the current material object. If it is disabled, shadow and reflection effects are applied. (See rcMaterial and rcTexImage2D)
- **RC_USE_TRANSMITTANCE_SHADOW**
Sets whether the transmittance value of a material object is applied to shadow. If it is disabled, the dark shadow is generated without the transmittance effect. (See rcMaterial and rcTexImage2D)

2.14 rcEnableClientState

```
void rcEnableClientState(RCenum array);
void rcDisableClientState(RCenum array);
```

Enables or disables the individual client state

<i>array</i>	The client state (RC_COLOR_ARRAY, RC_MATRIX_INDEX_ARRAY_OES, RC_NORMAL_ARRAY, RC_TEXTURE_COORD_ARRAY, RC_VERTEX_ARRAY, and RC_WEIGHT_ARRAY_OES)
--------------	---

Error Codes

RC_INVALID_ENUM : *array* is an invalide value

Related Functions

rcDrawArrays, rcDrawElements, rcEnable, rcIsEnabled, rcNormalPointer, rcTexCoordPointer, rcVertexPointer, rcMatrixIndexPointerOES, rcWeightPointerOES

Explanation

By default, all client states are disabled. The following is the description of the client state *array*.

- RC_MATRIX_INDEX_ARRAY_OES
Enables or disables the palette matrix index array to use during rendering when rcDrawArrays or rcDrawElements is called. (See rcMatrixIndexPointerOES)
- RC_NORMAL_ARRAY
Enables or disables the normal array to be used during rendering when rcDrawArrays or rcDrawElements is called. (See rcNormalPointer)
- RC_TEXTURE_COORD_ARRAY
Enables or disables the texture coordinate array to be used during rendering when rcDrawArrays or rcDrawElements is called. (See rcTexCoordPointer)
- RC_VERTEX_ARRAY
Enables or disables the vertex array to be used during rendering when rcDrawArrays or rcDrawElements is called. (See rcVertexPointer)
- RC_WEIGHT_ARRAY_OES
Enables or disables the weight array to use during rendering when rcDrawArrays or rcDrawElements is called. (See rcWeightPointerOES)

2.15 rcFinish

void rcFinish(void);

Executes ray tracing rendering

Related Functions

rcFlush, eglSwapBuffers

Explanation

It executes ray tracing rendering by RayCore®.

2.16 rcFlush

`void rcFlush(void);`

Executes the same operation with rcFinish

Related Functions

rcFinish

Explanation

rcFlush calls rcFinish.

2.17 rcFrustum

```
void rcFrustumf(RCfloat left, RCfloat right, RCfloat bottom, RCfloat top, RCfloat near,
RCfloat far);
void rcFrustumx(RCfixed left, RCfixed right, RCfixed bottom, RCfixed top, RCfixed near,
RCfixed far);
```

Sets a viewing frustum into the world coordinate system

<i>left, right</i>	The coordinates for the left and right vertical clipping planes
<i>bottom, top</i>	The coordinates for the bottom and top horizontal clipping planes
<i>near, far</i>	The distances to the near and far depth clipping planes (Both distances must be positive.)

Error Codes

RC_INVALID_VALUE

: *near* or *far* is not positive

: *near* is equal to *far*

: *left* is equal to *right*, or *bottom* is equal to *top*

Related Functions

rcViewport

Explanation

The starting position of ray generation, the pixel size of clipping planes, and the distance of camera and clipping planes are calculated with these specified values. *zNear* is the distance from the camera to the screen. *zFar* is not used.

2.18 rcGenBuffers

```
void rcGenBuffers(RCsizei n, RCuint * buffers);
```

Generates new buffer objects with *n* buffer object names in the array of buffer object names *buffers*

<i>n</i>	The count of buffer objects to be generated
-----------------	---

<i>buffers</i>	The array in which the generated buffer object names are stored
-----------------------	---

Error Codes

RC_INVALID_VALUE : *n* is negative

RC_OUT_OF_MEMORY : Failed to create the buffer object

Related Functions

rcBindBuffer, rcBufferData, rcBufferSubData, rcDeleteBuffers, rcIsBuffer

Explanation

Returned names of the buffer objects, which are yet to be either created or deleted, are not always continuous integers. This is because the buffer objects that have already been generated are not be returned by calling rcGenBuffers unless they are deleted by calling rcDeleteBuffers.

2.19 rcGenMaterials

```
void rcGenMaterials(RCsizei n, RCuint * materials);
```

Generates new material objects with *n* material object names in the array of material object names *materials*

<i>n</i>	The count of material objects to be generated
<i>materials</i>	The array in which the generated material object names are stored

Error Codes

RC_INVALID_VALUE : *n* is negative

RC_OUT_OF_MEMORY : Failed to create the material object

Related Functions

rcBindMaterial, rcDeleteMaterials, rcIsMaterial

Explanation

Returned names of the material objects, which are yet to be either created or deleted, are not always continuous integers. This is because the material objects that have already been generated are not returned by calling rcGenMaterials unless they are first deleted by calling rcDeleteMaterials.

2.20 rcGenTextures

```
void rcGenTextures(RCsizei n, RCuint * textures);
```

Generates new texture objects with *n* texture object names in the array of texture object names *textures*

<i>n</i>	The count of texture objects to be generated
<i>textures</i>	The array in which the generated texture object names are stored

Error Codes

RC_INVALID_VALUE : *n* is negative

RC_OUT_OF_MEMORY : Failed to create the texture object

Related Functions

rcBindTexture, rcDeleteTextures, rcIsTexture, rcTexImage2D, rcTexParameter

Explanation

Returned names of the texture objects, which are yet to be either created or deleted, are not always continuous integers. This is because the texture objects that have already been generated are not returned by calling rcGenTextures unless they are first deleted by calling rcDeleteTextures.

2.21 rcGet

```
void rcGetBooleanv(RCenum pname, RCboolean * params);
void rcGetFixedv(RCenum pname, RCfixed * params);
void rcGetFloatv(RCenum pname, RCfloat * params);
void rcGetInterv(RCenum pname, RCint * params);
```

Returns the values of static state variables of RayCore® API

<i>pname</i>	The parameter value of static state variables to be returned
<i>params</i>	The pointer to an array of data to be returned

Error Codes

RC_INVALID_ENUM : *pname* is an invalid value

Related Functions

rcGetError, rcGetString, rcCurrentPaletteMatrixOES,
rcLoadPaletteFromModelViewMatrixOES, rcMatrixIndexPointerOES, rcWeightPointerOES

Explanation

If the returned value type is different from the type of the value being obtained, a type conversion is performed.

- **GetBooleanv**
A floating-point or integer value is converted to RC_FALSE if and only if it is 0, otherwise it converts to RC_TRUE.
- **GetInterv**
If the value is not an RGBA color component, a boolean value is converted to either 1 or 0, and a floating-point value is rounded to the nearest integer. Otherwise it performs a linear mapping that maps a floating-point value 1.0 to the integer value 255, and a floating-point value 0.0 to the integer value 0.
- **GetFloatv**
A boolean value is converted to either 1.0 or 0.0

The following is the description of the static state variable *pname*.

- **RC_ARRAY_BUFFER_BINDING**
Returns the name of the buffer object currently specified to the target RC_ARRAY_BUFFER. If no buffer object is set to this target, 0 is returned. (See rcBindBuffer)
- **RC_COLOR_CLEAR_VALUE**
Returns the red, green, blue, and alpha values of the background color. (See rcClearColor)
- **RC_CURRENT_COLOR**

Returns the red, green, blue, and alpha values of the default color. Integer values, if requested, are linearly mapped from the internal floating-point representation such that 1.0 returns the integer value 255, and 0.0 returns the integer value 0. (See rcColor)

- **RC_ELEMENT_ARRAY_BUFFER_BINDING**
Returns the name of the buffer object currently specified to the target RC_ELEMENT_ARRAY_BUFFER. If no buffer object is set to this target, 0 is returned. (See rcBindBuffer)
- **RC_LIGHTi**
Returns the active state of the ith light source. (See rcLight)
- **RC_LIGHTING**
Returns the active state of the lighting. (See rcLight and rcMaterial)
- **RC_MAX_LIGHTS**
Returns the maximum number of the light sources. This value is 8. (See rcLight)
- **RC_MAX_MODELVIEW_STACK_DEPTH**
Returns the maximum supported depth of the modelview matrix stack. The value is 32. (See rcPushMatrix)
- **RC_MAX_PALETTE_MATRICES_OES**
Returns the maximum number of the palette matrix. This value is 128. (See rcCurrentPaletteMatrixOES)
- **RC_MAX_PROJECTION_STACK_DEPTH**
Returns the maximum supported depth of the projection matrix stack. The value is 32. (See rcPushMatrix)
- **RC_MAX_TEXTURE_SIZE**
Returns the maximum size of the texture supported in RayCore®. This value is 1024. (See rcTexImage2D)
- **RC_MAX_TEXTURE_STACK_DEPTH**
Returns the maximum supported depth of the texture matrix stack. The value is 32. (See rcPushMatrix)
- **RC_MAX_TEXTURE_UNITS**
Returns the count of texture units supported in RayCore®. This value is 1. RayCore® API does not support the multi texture.
- **RC_MAX_THRESHOLD_LEVELS**
Returns the maximum number of the ray bounce threshold level. The value is 10. (See rcHint)
- **RC_MAX_VERTEX_UNITS_OES**
Returns the maximum number of the vertex units for the palette matrix. The value is 128. (See rcMatrixIndexPointerOES and rcWeightPointerOES)

- **RC_MAX_VIEWPORT_DIMS**
Returns the maximum supported width and height of the viewport. The value is 2048. (See rcViewport)
- **RC_MATRIX_INDEX_ARRAY_OES**
Returns the active state of the palette matrix index array. (See rcMatrixIndexPointerOES)
- **RC_MATRIX_INDEX_ARRAY_BUFFER_BINDING_OES**
Returns the name of the buffer object specified to the palette matrix index array. (See rcMatrixIndexPointerOES)
- **RC_MATRIX_INDEX_ARRAY_SIZE_OES**
Returns the count of matrix indices per vertex in the palette matrix index array. (See rcMatrixIndexPointerOES)
- **RC_MATRIX_INDEX_ARRAY_STRIDE_OES**
Returns the byte length between two adjacent matrix indices in the palette matrix index array. (See rcMatrixIndexPointerOES)
- **RC_MATRIX_INDEX_ARRAY_TYPE_OES**
Returns the data type of the palette matrix index array. (See rcMatrixIndexPointerOES)
- **RC_MATRIX_MODE**
Returns the current matrix mode. (See rcMatrixMode)
- **RC_MATRIX_PALETTE_OES**
Returns the active state of the palette matrix. (See rcEnable and rcDisable)
- **RC_MODELVIEW_MATRIX**
Returns 16 values of the current modelview matrix. (See rcPushMatrix)
- **RC_MODELVIEW_STACK_DEPTH**
Returns the count of matrices on the modelview matrix stack. (See rcPushMatrix)
- **RC_NORMAL_ARRAY**
Returns the active state of the normal array. (See rcNormalPointer)
- **RC_NORMAL_ARRAY_BUFFER_BINDING**
Returns the name of the buffer object specified to the normal array. (See rcNormalPointer)
- **RC_NORMAL_ARRAY_STRIDE**
Returns the byte length between two adjacent normals in the normal array. (See rcNormalPointer)
- **RC_NORMAL_ARRAY_TYPE**
Returns the data type of the normal array. (See rcNormalPointer)
- **RC_PROJECTION_MATRIX**

Returns 16 values of the current projection matrix. (See rcPushMatrix)

- **RC_PROJECTION_STACK_DEPTH**
Returns the count of matrices on the projection matrix stack. (See rcPushMatrix)
- **RC_TEXTURE_2D**
Returns the active state of the 2D texturing. (See rcTexImage2D)
- **RC_TEXTURE_2D_NORMAL**
Returns the active state of the 2D normal map texturing. (See rcTexImage2D)
- **RC_TEXTURE_BINDING_2D**
Returns the name of the texture object currently specified to the current texture target (RC_TEXTURE_2D or RC_TEXTURE_2D_NORMAL). (See rcBindTexture)
- **RC_TEXTURE_COORD_ARRAY**
Returns the active state of the texture coordinate array. (See rcTexCoordPointer)
- **RC_TEXTURE_COORD_ARRAY_BUFFER_BINDING**
Returns the name of the buffer object specified to the texture coordinate array. (See rcTexCoordPointer)
- **RC_TEXTURE_COORD_ARRAY_SIZE**
Returns the count of coordinates per element in the texture coordinate array. (See rcTexCoordPointer)
- **RC_TEXTURE_COORD_ARRAY_STRIDE**
Returns the byte length between two adjacent elements in the texture coordinate array. (See rcTexCoordPointer)
- **RC_TEXTURE_COORD_ARRAY_TYPE**
Returns the data type of a texture coordinate array. (See rcTexCoordPointer)
- **RC_TEXTURE_MATRIX**
Returns 16 values of the current texture matrix. (See rcPushMatrix)
- **RC_TEXTURE_STACK_DEPTH**
Returns the count of matrices on the texture matrix stack. (See rcPushMatrix)
- **RC_USE_COLOR_SHADOW**
Returns the active state of the color shadow. (See rcEnable and rcDisable)
- **RC_USE_SHADOW**
Returns the active state of the shadow. (See rcEnable and rcDisable)
- **RC_USE_TEXTURE_ALPHA_SHADOW**
Returns the active state of the alpha texture shadow. (See rcEnable and rcDisable)
- **RC_USE_TEXTURE_ONLY**
Returns the active state of the background texture. (See rcEnable and rcDisable)

- **RC_USE_TRANSMITTANCE_SHADOW**
Returns the active state of the transmittance shadow. (See rcEnable and rcDisable)
- **RC_VIEWPORT**
Returns the x and y window coordinates of the viewport, followed by its width and height.
(See rcViewport)
- **RC_VERTEX_ARRAY**
Returns the active state of the vertex array. (See rcVertexPointer)
- **RC_VERTEX_ARRAY_BUFFER_BINDING**
Returns the name of the buffer object specified to the vertex array. (See rcVertexPointer)
- **RC_VERTEX_ARRAY_SIZE**
Returns the count of coordinates per vertex in the vertex array. (See rcVertexPointer)
- **RC_VERTEX_ARRAY_STRIDE**
Returns the byte length between two adjacent vertices in the vertex array. (See rcVertexPointer)
- **RC_VERTEX_ARRAY_TYPE**
Returns the data type of the vertex array. (See rcVertexPointer)
- **RC_WEIGHT_ARRAY_OES**
Returns the active state of the palette matrix weight array. (See rcWeightPointerOES)
- **RC_WEIGHT_ARRAY_BUFFER_BINDING_OES**
Returns the name of the buffer object specified to the palette matrix weight array. (See rcWeightPointerOES)
- **RC_WEIGHT_ARRAY_SIZE_OES**
Returns the count of weights per vertex in the palette matrix weight array. (See rcWeightPointerOES)
- **RC_WEIGHT_ARRAY_STRIDE_OES**
Returns the byte length between two adjacent weights in the palette matrix weight array.
(See rcWeightPointerOES)
- **RC_WEIGHT_ARRAY_TYPE_OES**
Returns the data type of the palette matrix weight array. (See rcWeightPointerOES)

2.22 rcGetBufferParameteriv

```
void rcGetBufferParameteriv(RCenum target, RCenum pname, RCint * params);
```

Returns the information of a buffer object that is set to the current buffer target

<i>target</i>	The current buffer target to request for information (RC_ARRAY_BUFFER, RC_ELEMENT_ARRAY_BUFFER)
<i>pname</i>	The information parameter of the buffer object (RC_BUFFER_SIZE, RC_BUFFER_USAGE)
<i>params</i>	The pointer to an array of data to be returned

Error Codes

RC_INVALID_ENUM : *pname* is an invalid value

RC_INVALID_OPERATION : The buffer object name 0 is set to *target*

Related Functions

rcBufferData, rcBindBuffer

Explanation

The following is the description of the returned value on the information parameter of a buffer object *pname*.

- RC_BUFFER_SIZE
Returns the size in bytes of the buffer object.
- RC_BUFFER_USAGE
Returns the usage pattern of the buffer object.

2.23 rcGetError

RCenum rcGetError(void);

Returns the error code that is currently set

Explanation

Initially, the error flag is set to RC_NO_ERROR. When an error occurs during RayCore® operation, the error flag is set to the appropriate error code value.

No other errors are recorded until rcGetError is called. After the error code is returned, the error flag is reset to RC_NO_ERROR. If rcGetError returns RC_NO_ERROR, there has been no detectable error since the last call to rcGetError, or since RayCore® API was initialized. The following is the definition of errors.

- RC_NO_ERROR
No error occurs. This value is 0.
- RC_INVALID_ENUM
An unacceptable value is specified for an enumerated argument.
- RC_INVALID_VALUE
A numeric argument is out of range.
- RC_INVALID_OPERATION
The specified operation is not allowed in the current state.
- RC_STACK_OVERFLOW
This command would cause a stack overflow.
- RC_STACK_UNDERFLOW
This command would cause a stack underflow.
- RC_OUT_OF_MEMORY
There is not enough memory left to execute the command.

2.24 rcGetLight

```
void rcGetLightfv(RCenum light, RCenum pname, RCfloat * params);
void rcGetLightxv(RCenum light, RCenum pname, RCfixed * params);
```

Returns the information of a light source

<i>light</i>	The light source to request for information, RC_LIGHT <i>i</i> ($0 \leq i < \text{RC_MAX_LIGHTS}$) (The maximum number of supported light source is 8.)
<i>pname</i>	The information parameter of the light source (RC_AMBIENT, RC_DIFFUSE, RC_SPECULAR, RC_POSITION, RC_SPOT_DIRECTION, RC_SPOT_EXPONENT, RC_SPOT_INNER_CONE, RC_SPOT_OUTER_CONE, RC_SPOT_CUTOFF, RC_ATTENUATION_RANGE, RC_START_ATTENUATION, RC_END_ATTENUATION, RC_CONSTANT_ATTENUATION, RC_LINEAR_ATTENUATION, RC_QUADRATIC_ATTENUATION)
<i>params</i>	The pointer to an array of data to be returned

Error Codes

RC_INVALID_ENUM : *light* or *pname* is an invalide value

Related Functions

rcLight

Attention

RC_LIGHT*i* and RC_LIGHT0+*i* are the same.

Explanation

The following is the description of the returned value on the information parameter of a light source *pname*.

- RC_AMBIENT
Returns the ambient RGBA intensity of the light source.
- RC_DIFFUSE
Returns the diffuse RGBA intensity of the light source.
- RC_SPECULAR
Returns the specular RGBA intensity of the light source.
- RC_POSITION
Returns 4 values representing the position and type of the light source. First 3 values are coordinates of the position in the eye coordinate system. Last value is the type (0 : directional light, 1 : point light) of the light source.
- RC_SPOT_DIRECTION
Returns 3 values representing the direction of the light source.

- **RC_SPOT_EXPONENT**
Returns the spot exponent of the light source that is related to the intensity distribution.
- **RC_SPOT_INNER_CONE**
Returns the attenuated start angle of the light source that is related to the intensity distribution.
- **RC_SPOT_OUTER_CONE, RC_SPOT_CUTOFF**
Returns the maximum spread angle of the light source that is related to the intensity distribution.
- **RC_ATTENUATION_RANGE**
Returns the distance range from the light position that is attenuated. First value is the start distance, second value is the end distance.
- **RC_START_ATTENUATION**
Returns the distance from the light source to begin the intensity attenuation.
- **RC_END_ATTENUATION**
Returns the distance from the light source to end the intensity attenuation.
- **RC_CONSTANT_ATTENUATION, RC_LINEAR_ATTENUATION, RC_QUADRATIC_ATTENUATION**
Returns one of the three attenuation coefficient on the intensity of the light source.

2.25 rcGetMaterial

```
void rcGetMaterialfv(RCenum face, RCenum pname, RCfloat * params);
void rcGetMaterialxv(RCenum face, RCenum pname, RCfixed * params);
```

Returns the information of a material object

<i>face</i>	The face of a current material object to request for information (RC_FRONT, RC_BACK, RC_FRONT_AND_BACK)
<i>pname</i>	The information parameter of the material object (RC_AMBIENT, RC_DIFFUSE, RC_SHININESS, RC_SPECULAR, RC_SPECULAR_LEVEL, RC_REFLECTION, RC_TRANSMITTANCE, RC_REFRACTION_INDEX)
<i>params</i>	The pointer to an array of data to be returned

Error Codes

RC_INVALID_ENUM : *face* or *pname* is an invalide value

Related Functions

rcBindMaterial, rcGenMaterial, rcMaterial

Attention

In RayCore® API, there is only one material shared by the front and back. Therefore querying RC_FRONT, querying RC_BACK, and querying RC_RONT_AND_BACK will always return the same value.

Explanation

The following is the description of the returned value on the information parameter of the material object *pname*.

- RC_AMBIENT
Returns the ambient RGBA reflectance of the material object.
- RC_DIFFUSE
Returns the diffuse RGBA reflectance of the material object.
- RC_REFLECTION
Returns the reflectance of the material object.
- RC_REFRACTION_INDEX
Returns the refraction index of the material object.
- RC_SHININESS
Returns the specular exponent of the material object.
- RC_SPECULAR
Returns the specular RGBA reflectance of the material object.

- **RC_SPECULAR_LEVEL**
Returns the specular intensity of the material object.
- **RC_TRANSMITTANCE**
Returns the transmittance of the material object.

2.26 rcGetPointerv

void rcGetPointerv(RCenum pname, RCvoid ** params);	
Returns the memory address of a pointer to the current array	
pname	The type of the pointer to the current array (RC_COLOR_ARRAY_POINTER, RC_MATRIX_INDEX_ARRAY_POINTER_OES , RC_NORMAL_ARRAY_POINTER, RC_TEXTURE_COORD_ARRAY_POINTER, RC_VERTEX_ARRAY_POINTER, RC_WEIGHT_ARRAY_POINTER_OES)
params	The memory address of the pointer specified by pname

Error Codes

RC_INVALID_ENUM : pname is an invalid value

Related Functions

rcBindBuffer, rcDrawArrays, rcMatrixIndexPointerOES, rcNormalPointer, rcTexCoordPointer, rcVertexPointer, rcWeightPointerOES

2.27 rcGetString

```
const RCubyte * rcGetString(RCenum name);
```

Returns a string describing RayCore® API

<i>name</i>	The information type (RC_VENDOR, RC_RENDERER, RC_VERSION)
-------------	---

Error Codes

RC_INVALID_ENUM : *name* is an invalid value

Attention

If an error occurs, rcGetString returns NULL.

Explanation

All strings are null-terminated. The following is the description of the returned string on the information type *name*.

- RC_VENDOR
Returns the name of the company that implements RayCore® API.
- RC_RENDERER
Returns the name of the renderer.
- RC_VERSION
Returns the version number. The form of this string is "RayCore API <major>.<minor>", where <major> and <minor> are integers. "RayCore API 1.0" will have 1 for <major> and 0 for <minor>.

2.28 rcGetTexParameter

```
void rcGetTexParameterfv(RCenum target, RCenum pname, RCfloat * params);
void rcGetTexParameteriv(RCenum target, RCenum pname, RCint * params);
void rcGetTexParameterxv(RCenum target, RCenum pname, RCfixed * params);
```

Returns the information of the texture target

target	The texture target to request for information (RC_TEXTURE_2D, RC_TEXTURE_2D_NORMAL)
pname	The information parameter of the texture target (RC_TEXTURE_WRAP_S, RC_TEXTURE_WRAP_T, RC_GENERATE_MIPMAP)
params	The pointer to an array of data to be returned

Error Codes

RC_INVALID_ENUM : target or pname is an invalid value

Related Functions

rcTexParameter

Explanation

The following is the description of a returned value on the information parameter of the texture target *pname*.

- RC_TEXTURE_WRAP_S
Returns the information of the wrapping function for texture coordinate *s*.
(RC_CLAMP_TO_EDGE, RC_REPEAT)
- RC_TEXTURE_WRAP_T
Returns the information of the wrapping function for texture coordinate *t*.
(RC_CLAMP_TO_EDGE, RC_REPEAT)
- RC_GENERATE_MIPMAP
Returns the active state of the automatic mipmap level update. (See rcTexParameter)

2.29 rcHint

```
void rcHint(RCenum target, RCenum mode);
```

Sets the hint for a behavior to be controlled

<i>target</i>	The type of the behavior to be controlled (RC_RENDERING_HINT, RC_RAYBOUNCE_THRESHOLD_HINT, RC_MIPMAP_HINT)
<i>mode</i>	The state of the desired behavior (RC_FASTEST, RC_NICEST, RC_FASTEST_AND_NICEST, RC_THRESHOLD_LEVEL _{<i>i</i>} , RC_DONT_CARE) RC_THRESHOLD_LEVEL _{<i>i</i>} (0 ≤ <i>i</i> < RC_MAX_THRESHOLD_LEVELS)

Error Codes

RC_INVALID_ENUM : *target* or *mode* is an invalid value

Attention

RC_THRESHOLD_LEVEL_{*i*} and RC_THRESHOLD_LEVEL0+*i* are the same.

Explanation

Some behavior can be controlled with hints in RayCore® API. Following is a description of the desired behavior state, *mode*.

- RC_FASTEST
Selects the state of the most efficient behavior.
- RC_NICEST
Selects the state of the behavior that represents the most highest quality.
- RC_FASTEST_AND_NICEST
Selects the state of the behavior that represents the most efficient and highest quality.
- RC_DONT_CARE
Selects the default state of the behavior.

The initial value for each *target* is RC_DONT_CARE. The following is the interpretation of the behavior state, *mode*, by each behavior type *target*.

- RC_RENDERING_HINT
Indicates the rendering quality of the pixel sampling. Hinting RC_DONT_CARE, RC_FASTEST, RC_NICEST, or RC_FASTEST_AND_NICEST can result in per-pixel rendering of sampling effects.
- RC_RAYBOUNCE_THRESHOLD_HINT

Indicates the threshold level of ray bounce for pixel value. If a threshold level is not applied, hinting `RC_DONE_CARE`. Otherwise hinting `RC_THRESHOLD_LEVELi` can result in per-pixel rendering of the threshold level effects.

- `RC_MIPMAP_HINT`

Indicates the texture quality of rendering the material object. Hinting `RC_DONT_CARE`, `RC_FASTEST`, or `RC_NICEST` can result in using the mipmap level per material texture.

2.30 rcIsBuffer

RCboolean rcIsBuffer(RCuint <i>buffer</i>);
--

Returns if a buffer object that has been created with the name, <i>buffer</i> , is present
--

<i>buffer</i>	The name of the buffer object
---------------	-------------------------------

Related Functions

rcBindBuffer, rcBufferData, rcBufferSubData, rcDeleteBuffers, rcGenBuffers

Explanation

Returns RC_TRUE if *buffer* is currently the name of the buffer object that has been created. Otherwise, returns RC_FALSE when *buffer* is non-zero.

2.31 rcIsEnabled

RCboolean rcIsEnabled(RCenum *cap*);

Returns the active state for the various capabilities of RayCore® API

<i>cap</i>	The capability of RayCore® API
-------------------	--------------------------------

Error Codes

RC_INVALID_ENUM : *cap* is an invalid value

Error Codes

rcEnable, rcEnableClientState

Attention

If an error occurs, rcIsEnabled returns 0.

Explanation

The following is the description of RayCore® API capability *cap*.

Capability	See function:
RC_LIGHTi	rcLight
RC_LIGHTING	rcLight, rcMaterial
RC_MATRIX_INDEX_ARRAY_OES	rcEnableClientState
RC_MATRIX_PALETTE_OES	rcEnable
RC_NORMAL_ARRAY	rcNormalPointer
RC_TEXTURE_2D	rcEnable, rcTexImage2D, rcMaterial
RC_TEXTURE_2D_NORMAL	rcEnable, rcTexImage2D, rcMaterial
RC_TEXTURE_COORD_ARRAY	rcTexCoordPointer
RC_USE_COLOR_SHADOW	rcEnable
RC_USE_SHADOW	rcEnable
RC_USE_TEXTURE_ALPHA_SHADOW	rcEnable
RC_USE_TEXTURE_ONLY	rcEnable
RC_USE_TRANSMITTANCE_SHADOW	rcEnable
RC_VERTEX_ARRAY	rcVertexPointer
RC_WEIGHT_ARRAY_OES	rcEnableClientState

2.32 **rcIsMaterial**

RCboolean rcIsMaterial(RCuint <i>material</i>);	
Returns if a material object that has been created with the name, <i>material</i> , is present	
<i>material</i>	The name of the material object
Related Functions	
rcBindMatreial, rcDeleteMaterials, rcGenMaterials	

Explanation

Returns RC_TRUE if *material* is currently the name of the material object that has been created. Ortherwise, returns RC_FALSE when *material* is non-zero.

2.33 rcIsTexture

RCboolean rcIsTexture(RCuint <i>texture</i>);
--

Returns if a texture object that has been created with the name, *texture*, is present

<i>texture</i>	The name of the texture object
-----------------------	--------------------------------

Related Functions

rcBindTexture, rcDeleteTextures, rcGenTextures, rcTexImage2D, rcTexParameter

Explanation

Returns RC_TRUE if *texture* is currently the name of the texture object that has been created. Otherwise, returns RC_FALSE when *texture* is non-zero.

2.34 rcLight

```
void rcLightf(RCenum light, RCenum pname, RCfloat param);
void rcLightx(RCenum light, RCenum pname, RCfixed param);
```

Sets the information of a light source

<i>light</i>	The light source to which the information is set, RC_LIGHT <i>i</i> (0 ≤ <i>i</i> < RC_MAX_LIGHTS) (The maximum number of supported light source is 8.)
<i>pname</i>	The information parameter of the light source (RC_SPOT_EXPONENT, RC_SPOT_INNER_CONE, RC_SPOT_OUTER_CONE, RC_SPOT_CUTOFF, RC_START_ATTENUATION, RC_END_ATTENUATION, RC_CONSTANT_ATTENUATION, RC_LINEAR_ATTENUATION, RC_QUADRATIC_ATTENUATION)
<i>param</i>	The value which is set to the information parameter of the light source

```
void rcLightfv(RCenum light, RCenum pname, const RCfloat * params);
void rcLightxv(RCenum light, RCenum pname, const RCfixed * params);
```

Sets the information of a light source

<i>light</i>	The light source to which the information is set, RC_LIGHT <i>i</i> (0 ≤ <i>i</i> < RC_MAX_LIGHTS) (The maximum number of supported light source is 8.)
<i>pname</i>	The information parameter of the light source (RC_AMBIENT, RC_DIFFUSE, RC_SPECULAR, RC_POSITION, RC_SPOT_DIRECTION, RC_SPOT_EXPONENT, RC_SPOT_INNER_CONE, RC_SPOT_OUTER_CONE, RC_SPOT_CUTOFF, RC_START_ATTENUATION, RC_END_ATTENUATION, RC_CONSTANT_ATTENUATION, RC_LINEAR_ATTENUATION, RC_QUADRATIC_ATTENUATION)
<i>params</i>	The pointer to an array of data which is set to the information parameter of the light source

Error Codes

RC_INVALID_ENUM : *light* or *pname* is an invalid value

RC_INVALID_VALUE

: The spot exponent value is negative.

: The spot cutoff is outside the range [0, 90] (except for the special value 180)

: The attenuation coefficient is negative

Related Functions

rcEnable, rcMaterial

Attention

RC_LIGHT*i* and RC_LIGHT0+*i* are the same. The alpha value is used in the lighting equation of RayCore®.

Explanation

Light sources that are enabled contribute to the lighting calculation only when the lighting is enabled. (See `rcEnable` and `rcDisable`) The following is the description of the information parameter of the light source *pname*.

- **RC_AMBIENT**
Sets the the ambient RGBA intensity of the light source. The initial ambient light intensity is (1, 1, 1, 0). Specified values are clamped to the range [0, 1].
- **RC_DIFFUSE**
Sets the the diffuse RGBA intensity of the light source. The initial value for `RC_LIGHT0` is (0.1, 0.1, 0.1, 0). For other lights, the initial value is (0.1, 0.1, 0.1, 0). Specified values are clamped to the range [0, 1].
- **RC_SPECULAR**
Sets the the specular RGBA intensity of the light source. The initial value for `RC_LIGHT0` is (0, 0, 0, 0). For other lights, the initial value is (0, 0, 0, 0). Specified values are clamped to the range [0, 1].
- **RC_POSITION**
Sets the position and type of the light source. The position, first 3 values, is transformed by the modelview matrix, and it is stored in the eye coordinate system. If the type *w*, last fourth value, of the light source is 0, the light source is treated as a directional light source. If the type *w* is 1, the light source is treated as a point light source. If the light source is based on the direction vector and the actual position in the eye coordinate system, the light attenuation can be used. The initial position and type is (0, 0, 1, 0); thus, the initial light source is directional, parallel to, and in the direction of the - *z* axis.
- **RC_SPOT_DIRECTION**
Sets the direction vector of the light source in the object coordinate system. The direction vector is transformed by the modelview matrix, and it is stored in the eye coordinate system. It is significant only when `RC_SPOT_CUTOFF` is not 180, which it is initially. The initial direction vector is (0, 0, 0).
- **RC_SPOT_EXPONENT**
Sets the spot exponent of the light source that is related the intensity distribution. Let Θ be the angle between the direction vector of the light source and the direction from the light to the vertex being lighted. The intensity distribution of the light source is attenuated by the cosine of the angle Θ , raised to the power of the spot exponent. Thus, higher spot exponents result in a more focused light source. The initial spot exponent is 0, resulting in uniform light distribution.
- **RC_SPOT_INNER_CONE**
Sets the attenuated start angle of the light source. If the angle between the direction of the light and the direction from the light to the vertex being lighted is greater than the spot inner cone angle, the attenuation of light begins. This attenuation intensity is determined by the spot exponent and the attenuation coefficient. Only values in the range [0, 90] and the special value 180 are accepted. The initial value is 0.

- **RC_SPOT_OUTER_CONE, RC_SPOT_CUTOFF**
Sets the maximum spread angle of the light source. If the angle between the direction of the light and the direction from the light to the vertex being lighted is less than the spot cutoff angle, the light is continuously attenuated; otherwise, the light is completely masked. This attenuation intensity is determined by the spot exponent and the attenuation coefficient. Only values in the range [0, 90] and the special value 180 are accepted. The initial value is 180, resulting in uniform light distribution.
- **RC_ATTENUATION_RANGE**
Sets the distance range from the light position that is attenuated. First value is the start distance, and second value is the end distance.
- **RC_START_ATTENUATION**
Sets the distance from the light source to begin the intensity attenuation. The initial value is 0.
- **RC_END_ATTENUATION**
Sets the distance from the light source to end the intensity attenuation. The initial value is 0.
- **RC_CONSTANT_ATTENUATION, RC_LINEAR_ATTENUATION, RC_QUADRATIC_ATTENUATION**
Sets one of the three attenuation coefficient on the intensity of the light source. These values must be nonnegative and are related the position of the light source. Let r be the distance between the light source and the vertex. The intensity of the light source is attenuated by the reciprocal of the sum of the constant factor, the linear factor times r and the quadratic factor times r . The initial attenuation factors are (1, 0, 0), thus the intensity of the light source according to the distance is uniform.

2.35 rcLoadIdentity

```
void rcLoadIdentity(void);
```

Replaces the matrix of the current matrix mode with the 4x4 identity matrix

Related Functions

rcLoadMatrix, rcMatrixMode, rcMultMatrix, rcPushMatrix

rcGet

RC_MATRIX_MODE

RC_MODELVIEW_MATRIX

RC_PROJECTION_MATRIX

RC_TEXTURE_MATRIX

RC_MATRIX_PALETTE_OES

Explanation

It is semantically equivalent to calling rcLoadMatrix with the 4x4 identity matrix.

The matrix of the current matrix mode is one of the projection matrix, modelview matrix, texture matrix and palette matrix. (See rcMatrixMode)

2.36 rcLoadMatrix

```
void rcLoadMatrixf(const RCfloat * m);
void rcLoadMatrixx(const RCfixed * m);
```

Replaces the matrix of the current matrix mode with the specific matrix to which *m* is set

<i>m</i>	The pointer of an array with 16 values which is the elements of a 4x4 column-major matrix
----------	---

Related Functions

rcLoadIdentity, rcMatrixMode, rcMultMatrix, rcPushMatrix

rcGet

RC_MATRIX_MODE
RC_MODELVIEW_MATRIX
RC_PROJECTION_MATRIX
RC_TEXTURE_MATRIX
RC_MATRIX_PALETTE_OES

Explanation

The matrix *M* of the current matrix mode is replaced with the specified array *m* as follows.

$$M = \begin{bmatrix} m[0] & m[4] & m[8] & m[12] \\ m[1] & m[5] & m[9] & m[13] \\ m[2] & m[6] & m[10] & m[14] \\ m[3] & m[7] & m[11] & m[15] \end{bmatrix}$$

The matrix of the current matrix mode is one of the projection matrix, modelview matrix, texture matrix and palette matrix. (See rcMatrixMode)

2.37 rcMaterial

```
void rcMaterialf(RCenum face, RCenum pname, RCfloat param);  
void rcMaterialx(RCenum face, RCenum pname, RCfixed param);
```

Sets the information of the current material object

<i>face</i>	The face of the current material object to which the information is set (RC_FRONT_AND_BACK)
<i>pname</i>	The information parameter of the material object (RC_REFLECTION, RC_REFRACTION_INDEX, RC_SHININESS, RC_SPECULAR_LEVEL, RC_TRANSMITTANCE)
<i>param</i>	The value which is set to the information parameter of the material object

```
void rcMaterialfv(RCenum face, RCenum pname, const RCfloat * params);  
void rcMaterialxv(RCenum face, RCenum pname, const RCfixed * params);
```

Sets the information of the current material object

<i>face</i>	The face of the current material object to which the information is set (RC_FRONT_AND_BACK)
<i>pname</i>	The information parameter of the material object (RC_AMBIENT, RC_AMBIENT_AND_DIFFUSE, RC_DIFFUSE, RC_REFLECTION, RC_REFRACTION_INDEX, RC_SHININESS, RC_SPECULAR, RC_SPECULAR_LEVEL, RC_TRANSMITTANCE)
<i>params</i>	The pointer to an array of data which is set to the information parameter of the material object

Error Codes

RC_INVALID_ENUM : *face* or *pname* is an invalid value

RC_INVALID_VALUE

: the specular exponent value is negative

: the specular intensity value is negative

Related Functions

rcEnable, rcGetMaterial, rcLight

Attention

The alpha value is used in the lighting equation of RayCore®.

Explanation

The information of a material object is used in the lighting equation that is applied to the related primitive. The following is the description of the information parameter of the material object *pname*.

- RC_AMBIENT

Sets the ambient RGBA reflectance of the material object. The initial ambient reflectance is (0.2, 0.2, 0.2, 0). Specified values are clamped to the range [0, 1].

- **RC_AMBIENT_AND_DIFFUSE**
Equivalent to calling rcMaterial with the same parameter values for each RC_AMBIENT and RC_DIFFUSE.
- **RC_DIFFUSE**
Sets the diffuse RGBA reflectance of the material object. The initial diffuse reflectance is (0.8, 0.8, 0.8, 0). Specified values are clamped to the range [0, 1].
- **RC_REFLECTION**
Sets the reflectance of the material object. The initial reflectance is 0.
- **RC_REFRACTION_INDEX**
Sets the refraction index of the material object. The initial refraction index is 1.
- **RC_SHININESS**
Sets the specular exponent of the material object. The initial specular exponent is 0.
- **RC_SPECULAR**
Sets the specular RGBA reflectance of the material object. The initial specular reflectance is (0, 0, 0, 0). Specified values are clamped to the range [0, 1].
- **RC_SPECULAR_LEVEL**
Sets the specular intensity of the material object. The initial specular intensity is 0.
- **RC_TRANSMITTANCE**
Sets the transmittance of the material object. The initial transmittance is 0.

2.38 rcMatrixMode

```
void rcMatrixMode(RCenum mode);
```

Sets the current matrix mode for a matrix to be the current matrix

<i>mode</i>	The matrix mode to which the current matrix is set (RC_MODELVIEW, RC_PROJECTION, RC_TEXTURE)
-------------	--

Error Codes

RC_INVALID_ENUM : *mode* is an invalid value

Related Functions

rcLoadMatrix, rcMultMatrix, rcPushMatrix

rcGet

RC_MATRIX_MODE

Explanation

If the current matrix mode is set, the current matrix and matrix stack are determined and used in subsequent matrix operations. The initial matrix mode is RC_MODELVIEW. The following is the description of a matrix mode *mode*.

- RC_MODELVIEW
Applies subsequent matrix operations to the current model view matrix and matrix stack.
- RC_PROJECTION
Applies subsequent matrix operations to the current projection matrix and matrix stack.
- RC_TEXTURE
Applies subsequent matrix operations to the current texture matrix and matrix stack.
- RC_MATRIX_PALETTE_OES
Applies subsequent matrix operations to the current palette matrix and matrix stack.

2.39 rcMultMatrix

```
void rcMultMatrixf(const RCfloat * m);
void rcMultMatrixx(const RCfixed * m);
```

Multiplies the matrix of the current matrix mode with the specific matrix to which *m* is set

<i>m</i>	The pointer of an array with 16 values which is the elements of a 4x4 column-major matrix
----------	---

Related Functions

rcLoadIdentity, rcLoadMatrix, rcMatrixMode, rcPushMatrix

rcGet

RC_MATRIX_MODE

RC_MODELVIEW_MATRIX

RC_PROJECTION_MATRIX

RC_TEXTURE_MATRIX

RC_MATRIX_PALETTE_OES

Explanation

The matrix of the current matrix mode is one of the projection matrix, modelview matrix and texture matrix. (See rcMatrixMode) By multiplying the matrix *M* of the current matrix mode with the matrix which is composed of the array *m*, the new matrix *M'* of the current matrix mode is created.

$$M' = \begin{bmatrix} M[0] & M[4] & M[8] & M[12] \\ M[1] & M[5] & M[9] & M[13] \\ M[2] & M[6] & M[10] & M[14] \\ M[3] & M[7] & M[11] & M[15] \end{bmatrix} \begin{bmatrix} m[0] & m[4] & m[8] & m[12] \\ m[1] & m[5] & m[9] & m[13] \\ m[2] & m[6] & m[10] & m[14] \\ m[3] & m[7] & m[11] & m[15] \end{bmatrix}$$

2.40 rcNormalPointer

```
Void rcNormalPointer(RCenum type, RCsizei stride, const RCvoid * pointer);
```

Sets the information of a normals array to be used in rendering

<i>type</i>	The data type of a normals array (RC_BYTE, RC_SHORT, RC_FLOAT, RC_FIXED)
<i>stride</i>	The byte length between two adjacent normals (If this value is 0, the normals are tightly arranged in the array.)
<i>pointer</i>	The data pointer of the first component for the first normal in the array

Error Codes

RC_INVALID_ENUM : *type* is an invalid value

RC_INVALID_VALUE : *stride* is negative

Related Functions

rcDrawArrays, rcDrawElements, rcEnable, rcTexCoordPointer, rcVertexPointer

Explanation

The information of normals can be used after being packed into a single array or stored in separate arrays along with colors, vertices, normals, and texture coordinates. If enabled, the normals array is used when rcDrawArrays or rcDrawElements is called. (See rcEnableClientState and rcDisableClientState)

2.41 rcPushMatrix, rcPopMatrix

```
void rcPushMatrix(void);
void rcPopMatrix(void);
```

Pushes and pops the matrix stack of the current matrix mode

Error Codes

RC_STACK_OVERFLOW : The current matrix stack is full when rcPushMatrix is called

RC_STACK_UNDERFLOW : The current matrix stack is empty when rcPopMatrix is called

Related Functions

rcLoadIdentity, rcLoadMatrix, rcMatrixMode, rcMultMatrix, rcRotate, rcScale, rcTranslate
rcGet

RC_MAX_MODELVIEW_STACK_DEPTH

RC_MAX_PROJECTION_STACK_DEPTH

RC_MAX_TEXTURE_STACK_DEPTH

RC_MAX_TEXTURE_UNITS

Explanation

rcPushMatrix pushes the current matrix stack down by one, duplicating the current matrix.

rcPopMatrix pops the current matrix stack, replacing the current matrix with the the matrix on top of the current matrix stack. Initially, each of the stacks is empty.

2.42 rcRotate

```
void rcRotatef(RCfloat angle, RCfloat x, RCfloat y, RCfloat z);
void rcRotatex(RCfixed angle, RCfixed x, RCfixed y, RCfixed z);
```

Multiplies the matrix of the current matrix mode with a rotation matrix

<i>angle</i>	The angle of rotation, in degrees
<i>x, y, z</i>	The <i>x</i> , <i>y</i> , and <i>z</i> coordinates of a vector that is the basis of rotation

Related Functions

rcMatrixMode, rcMultMatrix, rcPushMatrix, rcScale, rcTranslate

rcGet

RC_MATRIX_MODE

RC_MODELVIEW_MATRIX

RC_PROJECTION_MATRIX

RC_TEXTURE_MATRIX

Attention

This rotation follows the right-hand rule in RayCore® API, so if the vector (*x*, *y*, *z*) points toward the user, the direction of rotation is counterclock wise.

Explanation

The matrix of the current matrix mode is one of the projection matrix, modelview matrix and texture matrix. (See rcMatrixMode) The defined rotation matrix *R* is the angle of rotation in degrees, *angle*, around the vector (*x*, *y*, *z*). The size of the vector (*x*, *y*, *z*) is normalized to 1. Let *a* be cos(*angle*), and *b* be sin(*angle*). The rotation matrix *R* can be expressed as follows:

$$R = \begin{bmatrix} (1-a)x^2 + a & (1-a)xy - bz & (1-a)xz + by & 0 \\ (1-a)xy + bz & (1-a)y^2 + a & (1-a)yz - bx & 0 \\ (1-a)xz - by & (1-a)yz + bx & (1-a)z^2 + a & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

rcPushMatrix and rcPopMatrix can be used to save and restore the unrotated coordinate system when needed.

2.43 rcScale

void rcScalef(RCfloat x, RCfloat y, RCfloat z); void rcScalex(RCfixed x, RCfixed y, RCfixed z);	
Multiplies the matrix of the current matrix mode with a scaling matrix	
x, y, z	The scale coefficients along the x, y and z axes

Related Functions

rcEnable, rcMatrixMode, rcMultMatrix, rcPushMatrix, rcRotate, rcTranslate
rcGet

- RC_MATRIX_MODE
- RC_MODELVIEW_MATRIX
- RC_PROJECTION_MATRIX
- RC_TEXTURE_MATRIX

Attention

If the scaling matrix is applied to the modelview matrix, the information of the light source often appears wrong.

Explanation

The matrix of the current matrix mode is one of the projection matrix, modelview matrix and texture matrix. (See rcMatrixMode) The defined scaling matrix produces a nonuniform scaling along the x, y and z axes. The scaling matrix *S* can be expressed as follows:

$$S = \begin{bmatrix} x & 0 & 0 & 0 \\ 0 & y & 0 & 0 \\ 0 & 0 & z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

rcPushMatrix and rcPopMatrix can be used to save and restore the unscaled coordinate system when needed.

2.44 rcTexCoordPointer

```
void rcTexCoordPointer(RCint size, RCenum type, RCsizei stride, const RCvoid * pointer);
```

Set the information of a texture coordinates array to be used in rendering

<i>size</i>	The count of components per texture coordinate (Only 2)
<i>type</i>	The data type of a texture coordinates array (RC_BYTE, RC_SHORT, RC_FLOAT, RC_FIXED)
<i>stride</i>	The byte length between two adjacent texture coordinates (If this value is 0, the texture coordinates are tightly arranged in the array.)
<i>pointer</i>	The data pointer of the first component for the first texture coordinate in the array

Error Codes

RC_INVALID_VALUE : *size* is not 2

RC_INVALID_ENUM : *type* is an invalid value

RC_INVALID_VALUE : *stride* is negative

Related Functions

rcDrawArrays, rcDrawElements, rcEnable, rcNormalPointer, rcVertexPointer

Explanation

The information of texture coordinates may be stored in a single array or separate arrays, along with colors, vertices, normals, and texture coordinates. If enabled, the texture coordinates array is used when rcDrawArrays or rcDrawElements is called. (See rcEnableClientState and rcDisableClientState)

2.45 rcTexImage2D

```
void rcTexImage2D(RCenum target, RCint level, RCint internalformat, RCsizei width,
RCsizei height, RCint border, RCenum format, RCenum type, const RCvoid * pixels);
```

Sets the two-dimensional texture image to the current texture object

target	The texture target (RC_TEXTURE_2D, RC_TEXTURE_2D_NORMAL)
level	The level number of LOD(level-of-detail) (Only 0)
internalformat	The type of the color components in the texture (RC_RGB, RC_RGBA)
width	The width of the texture image (Must be a multiple of 2, At least a minimum of 16, and Up to RC_MAX_TEXTURE_SIZE or less)
height	The height of the texture image (Must be a multiple of 2, At least a minimum of 16, and Up to RC_MAX_TEXTURE_SIZE or less)
border	The width of the border (Only 0)
format	The type of the color components in the pixel data (RC_RGB, RC_RGBA)
type	The data type of the pixel data (RC_BYTE, RC_UNSIGNED_BYTE, RC_SHORT, RC_UNSIGNED_SHORT)
pixels	The memory address where the pixel data is loaded

Error Codes

RC_INVALID_ENUM

: *target* is an invalid value

: *internalformat* or *format* is an invalid value : *type* is an invalid value

RC_INVALID_VALUE

: *level* is not zero

: *width* or *height* is less than 16 or greater than RC_MAX_TEXTURE_SIZE, or is not a multiple of 2

: *border* is not zero

RC_INVALID_OPERATION : *internalformat* and *format* are not the same

Related Functions

rcBindTexture,

rcGet

RC_MAX_TEXTURE_SIZE

Attention

If *pixels* is NULL, texturing cannot be applied.

Explanation

If the type of the color components is RC_RGB, it is converted and assembled into an RGBA element by attaching an alpha value which is specified by calling rcTextureAlpha in RayCore® API. The types of the color components, *internalformat* and *format*, are as follows:

- **RC_RGB**
Each color is composed of an RGB (the red, green and blue values).
- **RC_RGBA**
Each color is composed of an RGBA (the red, green, blue and alpha values).

2.46 rcTexParameter

```
void rcTexParameterf(RCenum target, RCenum pname, RCfloat param);
void rcTexParameteri(RCenum target, RCenum pname, RCint param);
void rcTexParameterx(RCenum target, RCenum pname, RCfixed param);
```

Sets the information of a texture target

<i>target</i>	The texture target to which information is set (RC_TEXTURE_2D, RC_TEXTURE_2D_NORMAL)
<i>pname</i>	The texture target to which information is set (RC_TEXTURE_WRAP_S, RC_TEXTURE_WRAP_T, RC_GENERATE_MIPMAP)
<i>param</i>	The value which is set to the information parameter of the texture target

```
void rcTexParameterfv(RCenum target, RCenum pname, RCfloat * params);
void rcTexParameteriv(RCenum target, RCenum pname, RCint * params);
void rcTexParameterxv(RCenum target, RCenum pname, RCfixed * params);
```

Sets the information of a texture target

<i>target</i>	The texture target to which information is set (RC_TEXTURE_2D, RC_TEXTURE_2D_NORMAL)
<i>pname</i>	The information parameter of the texture target (RC_TEXTURE_WRAP_S, RC_TEXTURE_WRAP_T, RC_GENERATE_MIPMAP)
<i>params</i>	The pointer to an array of data which is set to the information parameter of the texture target

Error Codes

RC_INVALID_ENUM : *target* or *pname* is an invalid value

Related Functions

rcBindTexture, rcEnable, rcTexImage2D, rcTexSubImage2D

Explanation

The following is the description of the information parameter of the texture target *pname*.

- RC_TEXTURE_WRAP_S
Sets the wrap parameter for texture coordinate *s* to either RC_CLAMP_TO_EDGE or RC_REPEAT. The initial value is RC_REPEAT.
- RC_CLAMP_TO_EDGE
It causes *s* coordinates to be clamped to the range $[1/2N, 1 - 1/2N]$, where *N* is the size of the texture in the direction of clamping.
- RC_REPEAT
It causes the integer part of the *s* coordinate to be ignored; only the fractional part is used, thereby creating a repeating pattern.
- RC_TEXTURE_WRAP_T

Sets the wrap parameter for texture coordinate t to either `RC_CLAMP_TO_EDGE` or `RC_REPEAT`. See the discussion under `RC_TEXTURE_WRAP_S`. The initial value is `RC_REPEAT`.

- `RC_GENERATE_MIPMAP`

Sets the automatic mipmap generation parameter. If set to `RC_TRUE`, all levels of a mipmap array should be automatically updated when any modification to the base level mipmap is done. The initial value is `RC_TRUE`.

2.47 rcTranslate

```
void rcTranslatef(RCfloat x, RCfloat y, RCfloat z);
void rcTranslatex(RCfixed x, RCfixed y, RCfixed z);
```

Multiplies the matrix of the current matrix mode with a translation matrix	
x, y, z	The x, y, and z coordinates of a translation vector

Related Functions

rcMatrixMode, rcMultMatrix, rcPushMatrix, rcRotate, rcScale
rcGet
RC_MATRIX_MODE
RC_MODELVIEW_MATRIX
RC_PROJECTION_MATRIX
RC_TEXTURE_MATRIX

Explanation

The matrix of the current matrix mode is one of the projection matrix, modelview matrix and texture matrix. (See rcMatrixMode) The defined translation matrix *T* produces a translation by vector (x, y, z). The translation matrix *T* can be expressed as follows:

$$T = \begin{bmatrix} 1 & 0 & 0 & x \\ 0 & 1 & 0 & y \\ 0 & 0 & 1 & z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

rcPushMatrix and rcPopMatrix can be used to save and store the untranslated coordinate system when needed.

2.48 rcVertexPointer

```
void rcVertexPointer(RCint size, RCenum type, RCsizei stride, const RCvoid * pointer);
```

Sets the information of a vertices array to be used in rendering

<i>size</i>	The count of coordinates per vertex (Only 3)
<i>type</i>	The data type of a vertices array (RC_BYTE, RC_SHORT, RC_FLOAT, RC_FIXED)
<i>stride</i>	The byte length between two adjacent vertices (If this value is 0, the vertices are tightly arranged in the array.)
<i>pointer</i>	The data pointer of the first coordinate for the first vertex in the array

Error Codes

RC_INVALID_ENUM : *type* is an invalid value

RC_INVALID_VALUE

: *size* is not 3

: *stride* is negative

Related Functions

rcDrawArrays, rcDrawElements, rcEnable, rcNormalPointer, rcTexCoordPointer

Explanation

The information of vertex coordinates may be stored in a single array or separate arrays, along with colors, vertices, normals, and texture coordinates.

If enabled, the vertex coordinates array is used when rcDrawArrays or rcDrawElements is called. (See rcEnableClientState and rcDisableClientState)

2.49 rcViewport

```
void rcViewport(RCint x, RCint y, RCsizei width, RCsizei height);
```

Sets the screen information of a viewport

<i>x, y</i>	The pixel coordinates of the lower left corner in the viewport rectangle (Only (0, 0))
<i>width, height</i>	The width and height of the viewport rectangle in pixels

Error Codes

RC_INVALID_VALUE : *width* or *height* is negative

Related Functions

rcGet

Explanation

width and *height* are screen resolution, from which the number of ray to be generated is determined. By calling rcGet with argument RC_MAX_VIEWPORT_DIMS, it queries the range to which the width and height of the viewport are clamped.

Chapter 3

Extended Function List

This chapter covers the extended function list of RayCore® API. Most of the functions are similarly defined as those of OpenGL ES 1.1 with some of them added or modified for RayCore®.

3.1 rcuLookAt

```
void rcuLookAt(RCfloat eyex, RCfloat eyey, RCfloat eyez, RCfloat centerx, RCfloat centery, RCfloat centerz, RCfloat upx, RCfloat upy, RCfloat upz);
```

Sets the camera coordinate system with viewing information

<i>eyeX, eyeY, eyeZ</i>	The position of the eye point
<i>centerX, centerY, centerZ</i>	The position of the reference point, indicating the center of the scene
<i>upX, upY, upZ</i>	The direction of the <i>UP</i> vector

Related Functions

rcFrustum , rcuPerspective

Explanation

The camera coordinate system is defined from an eye point, a reference point, and an *UP* vector. In the camera coordinate system, *X*-axis is called *RIGHT* vector, *Y*-axis is called *UP* vector, and *Z*-axis is called *GAZE* vector.

Let

$$G = \begin{bmatrix} eyeX - centerX \\ eyeY - centerY \\ eyeZ - centerZ \end{bmatrix}$$

Let *UP* be the vector (*upX*, *upY*, *upZ*).

Then normalize as follows:

$$g = \frac{G}{||G||}$$

$$u = \frac{UP}{||UP||}$$

Finally, let *R* be the cross product of *u* and *f*.

$$R = u \times f$$

$$r = \frac{R}{||R||}$$

These represent the reference axes of a camera coordinate system. *r* is the unit vector for *X*-axis, *u* is the unit vector for *Y*-axis, and *f* is the unit vector for *Z*-axis.

3.2 rcuPerspective

```
void rcuPerspective(RCfloat fovy, RCfloat aspect, RCfloat zNear, RCfloat zFar);
```

Sets the viewing frustum into the world coordinate system

<i>fovy</i>	The field of view angle, in degrees, in the y direction
<i>aspect</i>	The aspect ratio that determines the field of view in the <i>x</i> direction (The ratio of <i>x</i> (width) to <i>y</i> (height))
<i>zNear</i>	The distance from the viewer to the near clipping plane (always positive)
<i>zFar</i>	The distance from the viewer to the far clipping plane (always positive)

Error Codes

RC_INVALID_VALUE

: *zNear* or *zFar* is not positive

: *zNear* is equal to *zFar*

Related Functions

rcFrustum, rcLoadIdentity, rcMultMatrix

Attention

zNear must never be 0.

Explanation

The aspect ratio should match the aspect ratio of the viewport. *aspect*=2.0 means that the viewer's angle of view is twice as wide in *x* as it is in *y*. If the viewport is twice as wide as it is tall, it displays the image without distortion.

Given *f* is defined as follows:

$$f = \text{tangent} \left(\frac{fovy}{2} \right)$$

Let the width of a screen be *Xmax*, and the height of a screen be *Ymax*.

$$Ymax = 2 \times zNear \times f$$

$$Xmax = Ymax \times aspect$$

The size in pixels of a clipping plane which represents the screen is caculated with these values. Here, *zNear* is a distance from the camera to the screen. *zFar* is not used.

3.3 rcCurrentPaletteMatrixOES

void rcCurrentPaletteMatrixOES(RCuint index);	
Sets the current palette matrix that is used on subsequent matrix operations	
index	The index of palette matrices
Error Codes	
RC_INVALID_VALUE : index is greater than RC_MAX_PALETTE_MATRICES_OES – 1	
Related Functions	
rcLoadPaletteFromModelViewMatrixOES, rcMatrixIndexPointerOES, rcMatrixMode, rcWeightPointerOES	

Explanation

rcCurrentPaletteMatrixOES can be used when the current matrix mode is RC_MATRIX_PALETTE_OES.

3.4 rcLoadPaletteFromModelViewMatrixOES

```
void rcLoadPaletteFromModelViewMatrixOES(void);
```

Copies the current model view matrix to the current palette matrix

Related Functions

rcCurrentPaletteMatrixOES, rcMatrixIndexPointerOES, rcMatrixMode, rcWeightPointerOES

Explanation

The current palette matrix is assigned by rcCurrentPaletteMatrixOES.

3.5 rcMatrixIndexPointerOES

void rcMatrixIndexPointerOES(RCint <i>size</i>, RCenum <i>type</i>, RCsizei <i>stride</i>, const RCvoid *<i>pointer</i>);	
Sets the information of a matrix indices array to be used in rendering	
<i>size</i>	The count of matrix indices per vertex (The maximum count is RC_MAX_VERTEX_UNITS_OES)
<i>type</i>	The data type of a matrix indices array (RC_UNSIGNED_BYTE, RC_UNSIGNED_INT)
<i>stride</i>	The byte length between two adjacent matrix indices (If this value is 0, the matrix indices are tightly arranged in the array.)
<i>pointer</i>	The data pointer of the first matrix index for the first vertex in the array

Error Codes	
RC_INVALID_ENUM : <i>type</i> is an invalid value	
RC_INVALID_VALUE	
: <i>size</i> is 0, negative, or greater than RC_MAX_VERTEX_UNITS_OES	
: <i>stride</i> is negative	
Related Functions	
rcCurrentPaletteMatrixOES, rcDrawArrays, rcDrawElements, rcLoadPaletteFromModelViewMatrixOES, rcMatrixMode, rcWeightPointerOES	

Explanation

These matrix indices are used to mix corresponding matrices for a given vertex. The enabled matrix indices array is used when rcDrawArrays or rcDrawElements is called. (See rcEnableClientState and rcDisableClientState)

3.6 rcWeightPointerOES

```
void rcWeightPointerOES(RCint size, RCenum type, RCsizei stride, const RCvoid
*pointer);
```

Sets the information of a weights array to be used in rendering

<i>size</i>	The count of weights per vertex (The maximum count is RC_MAX_VERTEX_UNITS_OES)
<i>type</i>	The data type of a weights array (RC_FIXED, RC_FLOAT)
<i>stride</i>	The byte length between two adjacent weights (If this value is 0, the weights are tightly arranged in the array.)
<i>pointer</i>	The data pointer of the first weight for the first vertex in the array

Error Codes

RC_INVALID_ENUM : *type* is an invalid value

RC_INVALID_VALUE

: *size* is 0, negative, or greater than RC_MAX_VERTEX_UNITS_OES

: *stride* is negative

Related Functions

rcCurrentPaletteMatrixOES, rcDrawArrays, rcDrawElements,
rcLoadPaletteFromModelViewMatrixOES, rcMatrixIndexPointerOES, rcMatrixMode

Explanation

These weights are used to mix corresponding matrices for a given vertex. The enabled weights array is used when rcDrawArrays, or rcDrawElements is called. (See rcEnableClientState and rcDisableClientState)

3.7 rcSceneAllInit

void rcSceneAllInit(void);

Initializes both static and dynamic scene data

Related Functions

rcStaticSceneBegin, rcStaticSceneEnd, rcFinish

Explanation

rcSceneAllInit initializes the rendering data of all primitives in the static scene, which is delimited in between rcStaticSceneBegin and rcStaticSceneEnd.

To redraw all the scenes, call rcSceneAllInit.

3.8 rcStaticSceneBegin, rcStaticSceneEnd

```
void rcStaticSceneBegin(void);  
void rcStaticSceneEnd(void);
```

Delimits the vertices, material and texture of the primitive or a group of the primitives in the static scene

Related Functions

rcVertexPointer, rcTexCoordPointer, rcNormalPointer, rcDrawArrays, rcDrswElements, rcBindMaterial, rcMaterial, rcBindTexture, rcFinish

Attention

rcStaticSceneEnd must be called after rcStaticSceneBegin is called. Once the primitives in the static scene are delimited, they are rendered continuously until rcSceneAllInit or rcStaticSceneBegin is called again.

Explanation

rcStaticSceneBegin and rcStaticSceneEnd delimit the vertices of the primitive or a group of the primitives.

Only a subset of RC commands can be used between rcStaticSceneBegin and rcStaticSceneEnd. The commands are rcVertexPointer, rcTexCoordPointer, rcNormalPointer, rcDrawArrays, rcDrswElements, rcBindMaterial, rcMaterial and rcBindTexture.

There is no limit to the number of vertices that can be defined between rcStaticSceneBegin and rcStaticSceneEnd. Triangles and quadrilaterals that are incompletely specified are not drawn.

The minimum specification of vertices for each primitive is as follows:

- 3 for a triangle and 4 for a quadrilateral.
- Modes that require a certain multiple of vertices are RC_TRIANGLES(3), RC_TRIANGLE_STRIP(3), RC_TRIANGLE_FAN(3), and RC_QUADS(4).

3.9 rcTextureAlpha

```
void rcTextureAlpha(RCbyte value);
```

Specifies an alpha value for the alpha channel of texture with RGB data format

<i>value</i>	The additional alpha value used when the material texture is without its alpha value (Initial value : 16)
--------------	---

Related Functions

rcBindMaterial, rcMaterial, rcBindTexture, rcTexImage2D

Explanation

rcTextureAlpha specifies the alpha value used by rcTexImage2D to set the additional alpha value of RGB format texture without the alpha value. Values specified by rcTextureAlpha are clamped to the range [0, 255].

3.10 rcDepthBounce

void rcDepthBounce(RCuint <i>value</i>);

Sets the depth of the ray bounce

<i>value</i>	The depth of the ray bounce used when the ray is generated in ray tracing. (Initial value : 10)
---------------------	--

Related Functions

rcFinish

Explanation

rcDepthBounce specifies the maximum bounce depth of the ray generated by the ray tracing rendering process. Values specified by rcDepthBounce are clamped to the range [0, 14].