State, Color, and 1D-Attributes

CS116A

Chris Pollett

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Introduction

- Attribute Parameters
- OpenGL State Variables
- Color and Gray Scale
- Point Attributes
- Line Attributes

Attribute Parameters

- A parameter that affects how rather than where a primitive is displayed is called an attribute parameter.
- For example: color, size, and special conditions like visibility are all attribute parameters.

Strategies for Specifying Attribute Parameters

- Add additional slots to our draw function calls.
- Have a notion of *current draw state* -- whenever one draws something use the attribute parameters of the current draw state.

If use the latter scheme, as OpenGL does, the attribute parameters are sometimes called **state variables** or **state parameters**.

OpenGL State Variables

Examples include: color, current matrix mode, elements of the model-view matrix, current position in the frame buffer, lighting, etc.

- All have default values
- Changing an attribute only affects things drawn after the change
- Can be specified within glBegin/glEnd sections

Color and Gray Scale

- Color is an example parameter attribute.
- Number of bits per pixel used to store color information determines the number of simultaneous colors can be in a frame.
- If one uses RGB/RGBA values take 24/32 bits
- It is also common to use a look up table to actually determine which RGB color corresponds to which setting of the bits for a pixel. This scheme is called using a color map or color palette.

3-bit Color Map Example

Color Code of Pixel	RGB value	Color Shown
0	0 0 FF blue	
1	0 FF 0 green	
2	FF 0 0 red	
3	FF FF FF	white
…		
7	FF FF 0	yellow

Often rather than using ranges 0-FF like above use float between 0 and 1.0.

Gray Scale

- Color maps used to specify gray scale.
- Use equal R G B values to specify a tone of gray.

Other Color Parameters

- Sometimes other color schemes used to specify a color. Often printers use cyan, magenta, and yellow to specify colors.
- Sometimes specify lightness/darkness of a color.
- Sometimes specify *intensity* which is the amount of energy level.
- Sometimes specify *luminance* which is the perceived brightness of the light.
- We’ll talk more about this later.

OpenGL Color Functions

- Can set the **color display mode** using

  glutInitDisplayMode(GLUT_SINGLE |
    GLUT_RGB);

- Could use GLUT_RGBA or GLUT_INDEX -- the latter says we're using a color map

Setting the Color State --RGB mode

- We’ll talk first about RGB mode.
- Here you specify a 3d-vector of the color:

```
glGolor3f(0.0, 1.0, 1.0);
glColor3fv(myColor);
glColor3i(0,255,255);
```

Setting the Color State Color-Index mode

- To specify values in the color map can use:

  glutSetColor(index, red, green, blue);

  These values are between 0 and 1.0
- To specify which index value to use:

  glIndexi(196).
- Size of palette is always a power of 2 such as 256 ot 1024.

Color Blending

- Can mix the colors of two objects.
- This mode is toggled in OpenGL using:
  glEnable(GL_BLEND)/glDisable(GL_BLEND);
- Blending is done by taking a linear combination of the components of the source and target color values.
- For example, the red component might be blended according to S_rR_s + D_rR_d.
- The blending factor coeeficients can be set with glBlendFunc(sFactor, dFactor) where sFactor and dFactor are 4D-vectors.

OpenGL Color Arrays

- Can specify color values of a scene in tandem with coordinate values in a vertex array:

```
typedef GLint vertex3[3], color3[3];
vertex3 pt[8]= {{0,0,0},{0,1,0},{1,0,0},
      {1,1,0}, {0,0,1}, {0,1,1},{1,0,1},{1,1,1}};
color3 hue[8] = {{1,0,0},{1,0,0},{0,0,1},
      {0,0,1},{1,0,0},{1,0,0},{0,0,1},{0,0,1}};
glEnableClientState(GL_VERTEX_ARRAY);
glEnableClientState(GL_COLOR_ARRAY);

glVertexPointer(3, GL_INT, 0, pt);
glColorPointer(3,GL_INT,0,hue);
```

Other OpenGL Color Functions

- For Color maps use:

  glIndexPointer(type, stride, colorIndex);

- Some other useful functions:

  glClearColor(r,g,b,a); // sets screen color for all //buffers

  glClear(GL_COLOR_BUFFER_BIT); //redraws //buffers using screen color

  glClearIndex(index); //how you do it in index mode

Point Attributes

- Can set color and size.
- Color is set with either RGB values or indexes into a color map
- Point size is an integer multiple of pixel size.

Line Attributes

- Attributes for straight lines include:
  - color
  - width
  - style

Line Width

- Line drawing algorithms can be modified to draw lines of greater width by plotting several pixels rather than just one at each column value for slopes <1 and several pixel for each row value for slopes >1. (Centered of course on what would have been the value in the single pixel case).
- Also might choose between butt caps, round caps, or projecting caps, and between joins of type miter, round, or bevel, if thickness is greater than one.

Line Style

- Might apply a **pixel mask** to the line to achieve various kinds of dashed, dotted, etc lines.
- Pixel masks can also be used to achieve various kinds of pen and brush effects.