Tricks

- Display lists
- Blending
  - Anti-aliasing
  - Fog
- Polygon Offset
- Bitmaps
- Images
- Textures (next time)

Modes of OpenGL

- Immediate mode
- Display list:
  - Named sequence of OpenGL commands that is stored for later execution
  - Advantages: Improved efficiency and simplified code

Example

```c
Init()
theRobot = glGenLists(1); // generate one new display list
GlNewList(theRobot,GL_COMPILE);
  // Commands to build the robot
  glEndList();
Display()
  glCallList(theRobot);
```

Display Lists

- See WNDS-Ch 7 for more details

Blending

- Compositing: special effects
- Semi-transparent objects
Blending Basics

Blending Calculation: Red

- Red channel of frame buffer is replaced by:
  \[ R_b S_R + R_b D_R \]
  where
  - \( R_b \) is the red value of the source fragment
  - \( R_s \) is the red value of the destination pixel
  - \( B_{S,R} \) is the “blending factor” for source fragment red
  - \( B_{D,R} \) is the “blending factor” for destination pixel red

Blending Basics

Blending Factors

- \( B_{S,R} = 0 \quad B_{D,R} = 1 \)
- \( B_{S,R} = 1 \quad B_{D,R} = 0 \)
- \( B_{S,R} = 1 \quad B_{D,R} = 1 \)
- \( B_{S,R} = .5 \quad B_{D,R} = .5 \)
- \( B_{S,R} = \alpha_s \quad B_{D,R} = 1 - \alpha_s \)

Example

```c
Init()
    glEnable(GL_BLEND);
    glClearColor(0.0,0.0,0.0,0.0);
Display()
    glClear(GL_COLOR_BUFFER_BIT);
    glBlendFunc(GL_ONE,GL_ZERO);
    glColor4f(1.0,0.0,0.75);
    glRectf(0,0,1,1);
    glBlendFunc(GL_SRC_ALPHA,GL_ONE_MINUS_SRC_ALPHA);
    glColor4f(0.0,0.0,1.0,0.25);
    glRectf(0.5,0.5,1.5,1.5);
```

Blending and Hidden Surface Removal

- The order in which objects are drawn matters!!!!
- Which is in front: semi-transparent or opaque
Blending strategy

- Draw opaque objects as usual
- Draw semi-transparent objects with z-buffer set to “read only”
  - `glDepthMask(GL_FALSE)` makes z-buffer read-only
  - `glDepthMask(GL_TRUE)` restores write privilege

Anti-aliasing
(see WNDS pp 233-242)

- `glHint(GL_LINE_SMOOTH_HINT, GL_NICEST);`
- blending

Fog

- Blending factor depends on depth
- Example:
  - `glEnable(GL_FOG);`
  - `glFog(GL_FOG_MODE, GL_LINEAR);`
  - `glFog(GL_FOG_START, start);`
  - `glFog(GL_FOG_END, end);`

Polygon Offset

- Tattoos, decals, outlining, etc.
- “Raise this object slightly”

Bitmaps

```
0 0 0 0 0 0 0 0
0 1 1 1 1 1 0 0
0 0 0 0 1 0 0 0
0 0 0 1 0 0 0 0
0 0 1 0 0 0 0 0
0 1 1 1 1 1 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
```

```
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
```
Using bitmaps

- Set raster position
  - glRasterPos(…)
- Draw bit map
  - glBitmap(…)

Imaging Pipeline

- Pixel operations:
  - Read, Draw, Copy
  - Magnify, Reduce
  - General Filters