

# Computer Graphics

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Lecture 13  
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## Tricks

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

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## Modes of OpenGL

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

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## Example

### Init()

```
theRobot = glGenLists(1); // generate one new display list
glNewList(theRobot, GL_COMPILE);
    Commands to build the robot
glEndList();
```

### Display()

```
glCallList(theRobot);
```

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## Display Lists

- See WNDS-Ch 7 for more details

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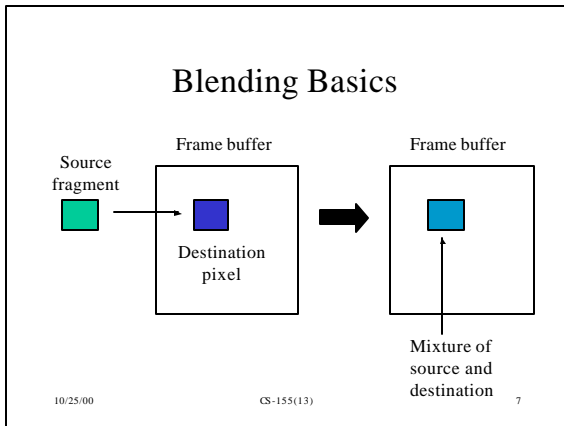
## Blending

- Compositing: special effects
- Semi-transparent objects

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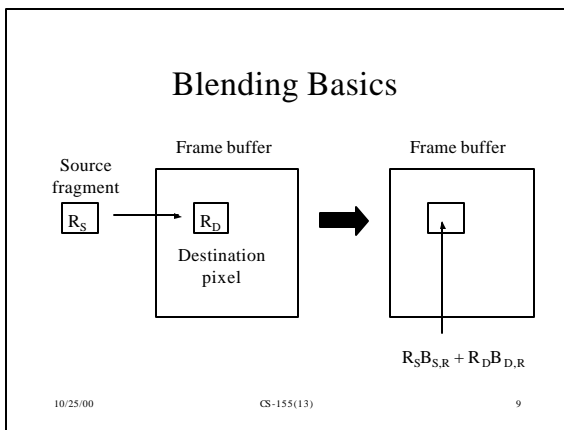
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### Blending Calculation: Red

- Red channel of frame buffer is replaced by:  $R_S B_{S,R} + R_D B_{D,R}$  where
  - $R_S$  is the red value of the source fragment
  - $R_D$  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

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### Blending Factors

- $B_{S,R} = 0$   $B_{D,R} = 1$
- $B_{S,R} = 1$   $B_{D,R} = 0$
- $B_{S,R} = 1$   $B_{D,R} = 1$
- $B_{S,R} = .5$   $B_{D,R} = .5$
- $B_{S,R} = \alpha_S$   $B_{D,R} = 1 - \alpha_S$

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### Example

```

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);
  
```

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### Blending and Hidden Surface Removal

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

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## 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

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## Anti-aliasing (see WNDS pp 233-242)

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

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## 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);`

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## Polygon Offset

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

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## 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

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## 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

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## Using bitmaps

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

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## Imaging Pipeline

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

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