Computer Engineering

240-302, Computer Engineering Lab IV (Software)

Introduction to Java 3D (2)

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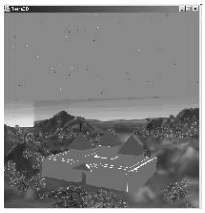

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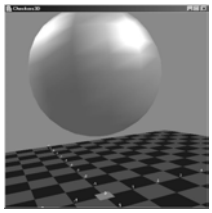
1. Checkers3D Again



- The scene consists of
  - a dark green and blue tiled surface (and red center)
  - labels along the X and Z axes
  - a blue background
  - a floating sphere lit from two different directions
  - the user (viewer) can move through the scene by moving the mouse

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Scene Graph for Checkers3D

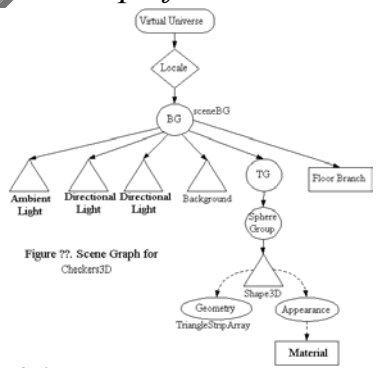

Figure ??. Scene Graph for Checkers3D

view branch not shown

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WrapChecker3D Constructor

```
private SimpleUniverse su;
private BranchGroup sceneBG;  // for content branch
private BoundingSphere bounds;
        :

public WrapCheckers3D()
{ setLayout( new BorderLayout() );
  setOpaque( false );
  setPreferredSize( new Dimension(PWIDTH, PHEIGHT));

  GraphicsConfiguration config =
        SimpleUniverse.getPreferredConfiguration();
  Canvas3D canvas3D = new Canvas3D(config);
  add("Center", canvas3D);
  canvas3D.setFocusable(true);
  canvas3D.requestFocus();

  su = new SimpleUniverse(canvas3D);
        :
```


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```
createSceneGraph();
initUserPosition();      // set user's viewpoint

orbitControls(canvas3D);
      // controls for moving the viewpoint

su.addBranchGraph( sceneBG );

} // end of WrapCheckers3D()
```

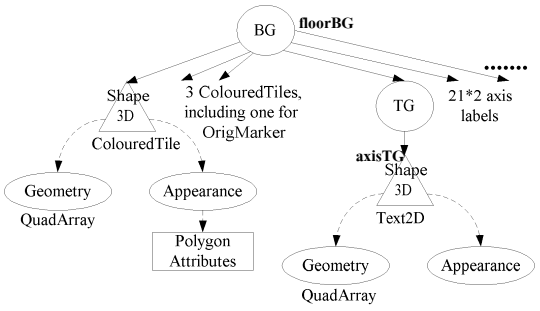
createSceneGraph()

```
private void createSceneGraph()
// initilise the scene below sceneBG
{
  sceneBG = new BranchGroup();
  bounds = new BoundingSphere(new Point3d(0,0,0),
                                    BOUNDSIZE);

  lightScene();         // add the light
  addBackground();      // add the sky
  sceneBG.addChild( new CheckerFloor().getBG() );
        // add the BranchGroup for the floor

  floatingSphere();     // add the floating sphere

  sceneBG.compile();   // fix the scene
} // end of createSceneGraph()
```


2. The Floor

- The floor is made of tiles created with the our `ColouredTiles` class, and axis labels made with the `Text2D` utility class.

Floor Branch of the Scene Graph



CheckerFloor Constructor

```
// constants for various colours
   :
private BranchGroup floorBG;


public CheckerFloor()
// create tiles, add origin marker,
// then the axes labels
{
  ArrayList blueCoords = new ArrayList()
  ArrayList greenCoords = new ArrayList();
  floorBG = new BranchGroup();
            :
```

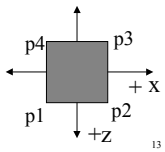


```
boolean isBlue;
for(int z = -FLOOR_LEN/2;
          z <= (FLOOR_LEN/2)-1; z++) {
  isBlue = (z%2 == 0)? true : false;
     // set colour for new row
  for(int x = -FLOOR_LEN/2;
           x <= (FLOOR_LEN/2)-1; x++) {
    if (isBlue)
      createCoords(x, z, blueCoords);
    else
      createCoords(x, z, greenCoords);
    isBlue = !isBlue;
  }
}
     :
```



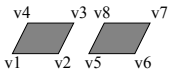
```
  floorBG.addChild(
      new ColouredTiles(blueCoords, blue) );
  floorBG.addChild(
      new ColouredTiles(greenCoords, green) );

  addOriginMarker();
  labelAxes();
}  // end of CheckerFloor()


public BranchGroup getBG()
{  return floorBG;  }
```

```
private void createCoords(int x, int z,
                          ArrayList coords)
// Coords for a single blue or green square,
// its left hand corner at (x,0,z)
{
  // points created in counter-clockwise order
  Point3f p1 = new Point3f(x, 0.0f, z+1.0f);
  Point3f p2 = new Point3f(x+1.0f,0.0f,z+1.0f);
  Point3f p3 = new Point3f(x+1.0f, 0.0f, z);
  Point3f p4 = new Point3f(x, 0.0f, z);

  coords.add(p1); coords.add(p2);
  coords.add(p3); coords.add(p4);
}  // end of createCoords()
```



ColouredTiles Class

- The `ColouredTiles` class extends `Shape3D`, and defines the geometry and appearance of tiles with the same colour.
- The geometry uses a `QuadArray` to represent the tiles as a series of quadlilaterals.



QuadArray Creation

- The constructor is:

```
QuadArray(int vertexCount, int vertexFormat);
```

- In `ColouredTiles`, the `QuadArray` plane is created using:

```
plane = new QuadArray( coords.size(),
                GeometryArray.COORDINATES |
                 GeometryArray.COLOR_3 );
```


Filling the QuadArray

```
// coordinate data
int numPoints = coords.size();
Point3f[] points = new Point3f[numPoints];
coords.toArray( points );
        // ArrayList-->array
plane.setCoordinates(0, points);

// colour data
Color3f cols[] = new Color3f[numPoints];
for(int i=0; i < numPoints; i++)
  cols[i] = col;
plane.setColors(0, cols);
```


Issues

- Counter-clockwise specification of the vertices for each quad
  - makes the top of the quad its 'front'
- Ensure that each quad is a convex, planar polygon.
- Normals or no normals?

Unreflecting Colour

- You can specify a shape's colour in three ways:
  - in the shape's material
    - when the scene is illuminated
  - in the shape's colouring attributes
    - used when the shape is unreflecting
  - in the vertices of the shape's geometry
    - also for unreflecting shapes (used here)

The Axes

- Each axis value is a `Text2D` object, which specifies the string, colour, font, point size, and font style:

```
Text2D message =
  new Text2D("...", white, "SansSerif",
              36, Font.BOLD );
       // 36 point bold Sans Serif
```

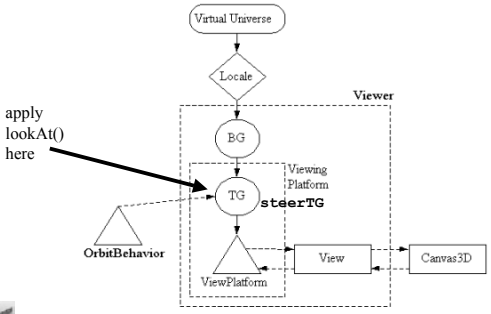

Positioning an Axis Value

```
TransformGroup axisTG = new TransformGroup();
Transform3D t3d = new Transform3D();
t3d.setTranslation( vertex );
   // vertex is the position for the label
axisTG.setTransform(t3d);

axisTG.addChild( message );
```


3. Viewer Positioning

- A simple way of positioning the viewer (the camera) is with the `lookAt()` method. It requires:
  - the viewer's intended position;
  - the point which he is looking at;
  - a vector specifying the upward direction.

View Branch for Checkers3D



Code Fragment

- The view branch is created by the `SimpleUniverse` utility class:

```
su = new SimpleUniverse(canvas3D);
```

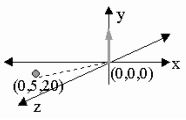
- Access the `TransformGroup` node for the `ViewPlatform`:

```
ViewingPlatform vp = su.getViewingPlatform();
TransformGroup steerTG =
       vp.getViewPlatformTransform();
```

 continued

- Apply `lookAt()` positioning (inverted since the position is relative to the viewer):

```
Transform3D t3d = new Transform3D();
steerTG.getTransform(t3d);

t3d.lookAt(  new Point3d(0,5,20),
             new Point3d(0,0,0),
             new Vector3d(0,1,0) );
t3d.invert();

steerTG.setTransform(t3d);
```



Viewer Movement

- The `OrbitBehavior` class allows a range of moves, rotations, and zooming of the viewer position:

```
OrbitBehavior orbit =
 new OrbitBehavior(c,OrbitBehavior.REVERSE_ALL);
orbit.setSchedulingBounds(bounds);

ViewingPlatform vp = su.getViewingPlatform();
vp.setViewPlatformBehavior(orbit);
```


4. Loader Classes

- `Loader`
  - specifies the elements that should be loaded from a file written in a given 3D format
- `Scene`
  - extracts Java 3D scene graph information from the loaded file

Loader Subclasses

- `Lw3dLoader`
  - for Lightwave 3D scene files
- `ObjectFile`
  - for Wavefront .obj files
- `LoaderBase`
  - implements the `Loader` interface in a generic way to encourage the building of loaders for other 3D formats through subclassing

Other Loaders

- A list of loaders for different file formats:

  `http://www.j3d.org/utilities/loaders.html`
- NCSA Portfolio
  - supports a wide range of formats
  - oldish, currently unsupported, simple
- See chapter 9 of my online book:

  `http://fivedots.coe.psu.ac.th/~ad/jg/ch9/`

ObjLoad Demo

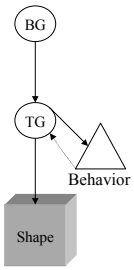
- The `ObjLoad.java` example in the Java 3D demo collection shows how to load a .obj file
  - in `<JAVA HOME>\demo\java3d\ObjLoad`
  - `java ObjLoad galleon.obj`

Loader Example

```
// OBJ Loader classes
import com.sun.j3d.loaders.objectfile.ObjectFile;
import com.sun.j3d.loaders.Scene;
    :

// load OBJ file
ObjectFile of = new ObjectFile(ObjectFile.RESIZE);
Scene scene = null;
try {
  scene = of.load("galleon.obj");
}
catch (Exception e) {
  System.err.println(e);
  System.exit(1);
}
// add loaded model to scene
BranchGroup modelBG = scene.getSceneGroup();
sceneBG.addChild( modelBG );
```

5. Behavior Objects

- Both interaction and animation are specified with `Behavior` objects
- A `Behavior` object changes the scene graph in response to events
  - key presses, mouse moves, object collisions, passage of time, etc.



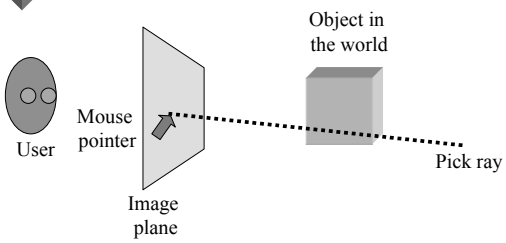
Some Behavior Classes

- `KeyNavigatorBehavior`
- `MouseBehavior`
- User-defined `Behavior` classes
  - triggered by `WakeupCondition` objects
- `PickMouseBehavior`
- `Interpolator`

WakeupConditions

- mouse, keyboard input
- collision
- time and frame change
- object movement
- camera movement
- sensor activity (input devices)

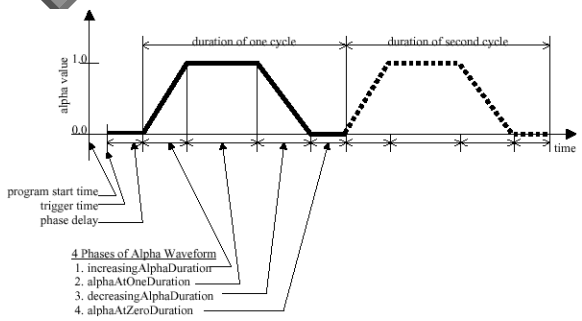
Picking



6. Animation

- Animation is implemented using time-based interpolation (or morphing)
  - time is specified using the `Alpha` class

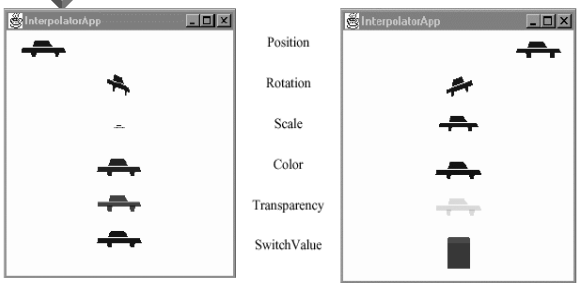
Alpha



Interpolator Behavior

- Position, Rotation, Scale
  - `PositionInterpolator, RotationInterpolator, ScaleInterpolator`
- Color and Transparency
  - `ColorInterpolator`
  - `TransparencyInterpolator`
- Object
  - `SwitchValueInterplator`

Interpolator Examples

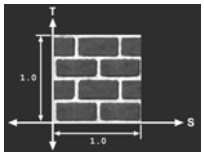


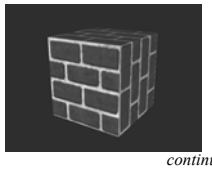
Morphing

- Morphing is the process of gradually deforming a shape into another one.
- For example:
  - changing a pyramid into a cube
  - changing a cat into a dog
  - making a hand grasp
- See the `Morph` class

7. Textures

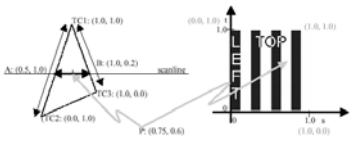
- Create the illusion of detail by wraping a complex image (texture) around a simple geometry
  - realism is increased without the need for a complex shape





continued

- 2D and 3D textures are supported
- Textures an be attached to shapes in a variety of predefined ways, or linked to specific coordinates in the shape.



8. Sound

- Sounds are obtained from audio files
  - typically ".au" or ".wav"
- Possible to modify the volume, left/right balance, and intramural delay of the audio emission
  - but... this is a buggy part of Java 3D

continued

- PointSound
  - radiate sound uniformly in all direction
- ConeSound
  - extend PointSound to create a sound that can be directed along a 3D vector
- BackgroundSound
  - similar to PointSound but does not have a location in space