Project 2 – Spatial Data Structure

CSE 168: Rendering Algorithms, Spring 2014

Description

Add a spatial data structure (such as an AABB tree) to your renderer. It should be derived off of the Object base class and be instance-able. Also, add cast shadows to the renderer. It should be able to run the code listed below in the *Project 2 Function* section, and generate the image in the *Sample Image* section.

In addition, add some timing functions to both the BoxTree::Construct() and Camera::Render() functions and output the resulting times to the console. For the sample data provided, it should only take a few seconds to generate the data structure and a few more seconds to render.

Mesh Format and Sample Data

You can use the dragon.ply file from the Stanford model library. A simple PLY file loader is also provided below.

Project 2 Function

Project 2 should be able to be run with the following sample code (or something very similar):

```
void project2() {
	// Create scene
	Scene scn;
	scn.SetSkyColor(Color(0.8f, 0.8f, 1.0f));

	// Create ground
	MeshObject ground;
	ground.MakeBox(5.0f,0.1f,5.0f);
	scn.AddObject(ground);

	// Create dragon
	MeshObject dragon;
	dragon.LoadPLY("dragon.ply");
	dragon.Smooth();

	BoxTreeObject tree;
	tree.Construct(dragon);
	scn.AddObject(tree);

	// Create instance
	InstanceObject inst(tree);
	Matrix34 mtx;
	mtx.MakeRotateY(PI);
	mtx.d.Set(-0.05f,0.0f,-0.1f);
	inst.SetMatrix(mtx);
```

```
        scn.AddObject(inst);

        // Create lights
        DirectLight sunlgt;
        sunlgt.SetBaseColor(Color(1.0f, 1.0f, 0.9f));
        sunlgt.SetIntensity(1.0f);
        sunlgt.SetDirection(Vector3(2.0f, -3.0f, -2.0f));
        scn.AddLight(sunlgt);

        PointLight redlgt;
        redlgt.SetBaseColor(Color(1.0f, 0.2f, 0.2f));
        redlgt.SetIntensity(0.02f);
        redlgt.SetPosition(Vector3(-0.2f, 0.2f, 0.2f));
        scn.AddLight(redlgt);

        PointLight bluelgt;
        bluelgt.SetBaseColor(Color(0.2f, 0.2f, 1.0f));
        bluelgt.SetIntensity(0.02f);
        bluelgt.SetPosition(Vector3(0.1f, 0.1f, 0.3f));
        scn.AddLight(bluelgt);

        // Create camera
        Camera cam;
        cam.LookAt(Vector3(-0.1f,0.1f,0.2f),Vector3(-0.05f,0.12f,0.0f));
        cam.SetFOV(40.0f);
        cam.SetAspect(1.33f);
        cam.SetResolution(800,600);

        // Render image
        cam.Render(scn);
        cam.SaveBitmap("project2.bmp");
}
```

Sample Image

The sample code above should generate the following image:

Grading

This project is worth 12 points:

- Write code to build & traverse data structure	2
- Image renders correctly using data structure	4
- Construction & render time displayed	1
- Render with correct shadows	2
- Total runtime under 1 minute	3
- Total	12

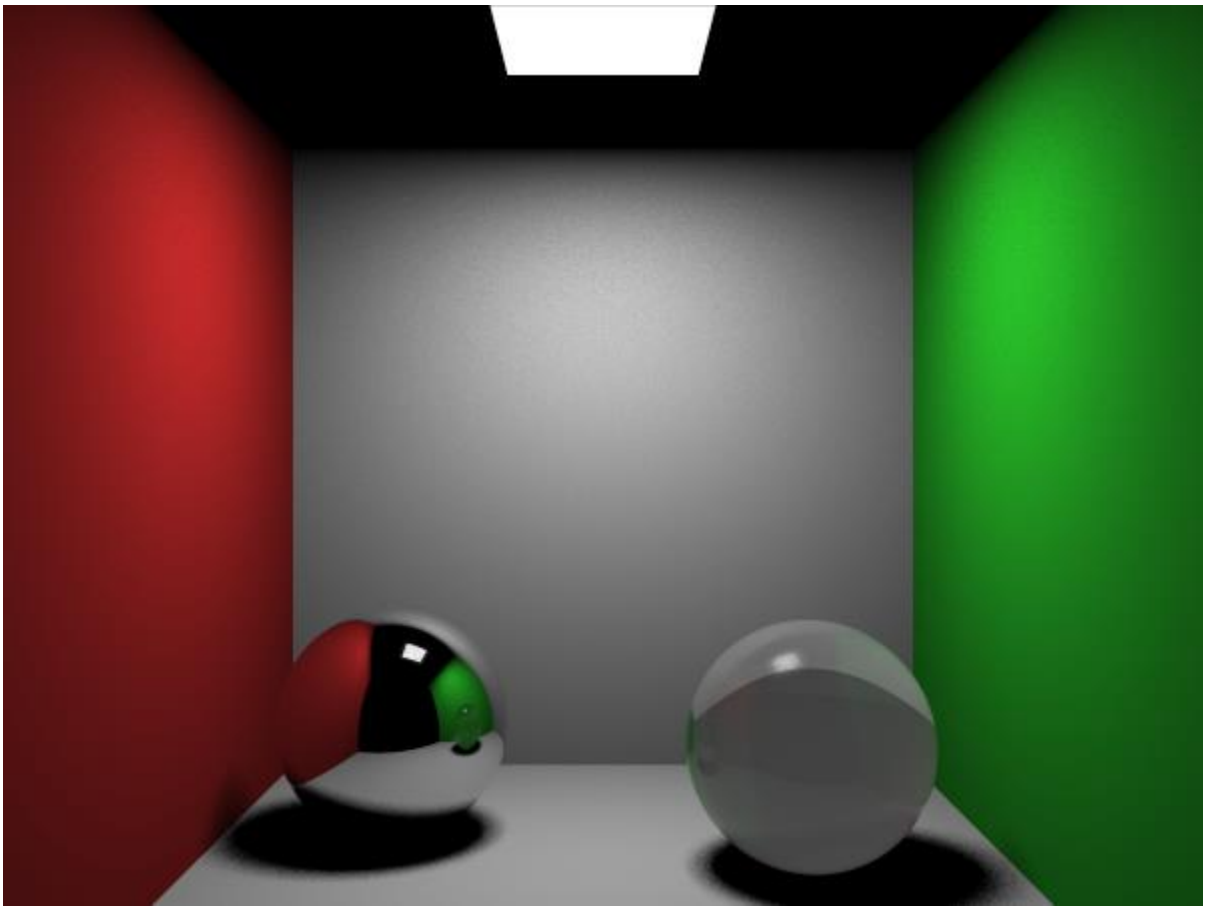
Extra Credit

For 1 extra credit point total, you must do *all* of the following:

- Add area lights

- Add Fresnel dielectrics and metals
- Add pixel supersampling for antialiasing

And then render an image something like this:



PLY File Loader

Here is a basic PLY file loader. It compiles in VisualStudio but hasn't been tested on other systems. You may need to move the #define line above any other #include's at the top of the file.

```
#define _CRT_SECURE_NO_WARNINGS

bool MeshObject::LoadPLY(const char *filename,Material *mtl) {
	// Open file
	FILE *f=fopen(filename,"r");
	if(f==0) {
		printf("ERROR: MeshObject::LoadPLY()- Can't open '%s'\n",filename);
		return false;
	}

	// Read header
	char tmp[256];
	int numverts=0,numtris=0;
```

```
	int posprop=-99,normprop=-99;
	int props=0;
	while(1) {
		fgets(tmp,256,f);
		if(strncmp(tmp,"element vertex",14)==0)
			numverts=atoi(&tmp[14]);
		if(strncmp(tmp,"element face",12)==0)
			numtris=atoi(&tmp[12]);
		if(strncmp(tmp,"property",8)==0) {
			int len=strlen(tmp);
			if(strncmp(&tmp[len-3]," x",2)==0) posprop=props;
			if(strncmp(&tmp[len-3],"nx",2)==0) normprop=props;
			props++;
		}
		if(strcmp(tmp,"end_header\n")==0) break;
	}
	if(posprop==-1) {
		printf("ERROR: MeshObject::LoadPLY()- No vertex positions found\n");
		fclose(f);
		return false;
	}

	// Read verts
	int i=0;
	if(numverts>0) {
		NumVertexes=numverts;
		Vertexes=new Vertex[NumVertexes];

		for(i=0;i<NumVertexes;i++) {
			fgets(tmp,256,f);
			char *pch=strtok(tmp," ");
			int prop=0;
			while(pch) {
				if(prop==posprop) Vertexes[i].Position.x=float(atof(pch));
				if(prop==posprop+1) Vertexes[i].Position.y=float(atof(pch));
				if(prop==posprop+2) Vertexes[i].Position.z=float(atof(pch));
				if(prop==normprop) Vertexes[i].Normal.x=float(atof(pch));
				if(prop==normprop+1) Vertexes[i].Normal.y=float(atof(pch));
				if(prop==normprop+2) Vertexes[i].Normal.z=float(atof(pch));
				pch=strtok(0," ");
				prop++;
			}
		}
	}

	// Read tris
	if(numtris>0) {
		if(mtl==0) mtl=new LambertMaterial;
		NumTriangles=numtris;
		Triangles=new Triangle[numtris];
		for(i=0;i<numtris;i++) {
			int count,i0,i1,i2;
			fscanf(f,"%d %d %d %d\n",&count,&i0,&i1,&i2);
			if(count!=3) {
				printf("ERROR: MeshObject::LoadPLY()- Only triangles are
supported\n");
				fclose(f);
				return false;
```

```
                        }
                        Triangles[i].Init(&Vertexes[i0],&Vertexes[i1],&Vertexes[i2],mtl);
                }
        }

        // Smooth
        if(normprop<0) Smooth();

        // Close file
        fclose(f);
        printf("Loaded %d triangles from file '%s'\n",numtris,filename);
        return true;
}


void MeshObject::Smooth() {
        int i,j;
        for(i=0;i<NumVertexes;i++)
                Vertexes[i].Normal.Zero();
        for(i=0;i<NumTriangles;i++) {
                Triangle &tri=Triangles[i];
                Vector3 e1=tri.GetVtx(1).Position-tri.GetVtx(0).Position;
                Vector3 e2=tri.GetVtx(2).Position-tri.GetVtx(0).Position;
                Vector3 cross;
                cross.Cross(e1,e2);
                for(j=0;j<3;j++)
                        tri.GetVtx(j).Normal.Add(cross);
        }
        for(i=0;i<NumVertexes;i++)
                Vertexes[i].Normal.Normalize();
}
```