Coursework 2

Scene Design

Scene contains several examples of hierarchical models, animations, user interaction and textures. Moreover, it consists of a room containing textures for ceiling, floor, and three walls. The ceiling has a spinning fan attached to it with controllable speed. In the middle, there is a table with a body figure spinning around it. The body figure is sitting on a chair and doing two things. Oscillating a globe sideways and tapping on the table with the other hand.

Instancing

Body Figure

The scene contains a lot instancing as in the body figure , each arm and leg is made from spheres to make joints while longer bones are made from cylinders. Cylinders and Spheres were scaled to make reasonable body part sizes.

Fan

The fan was made from cones (base connected to ceiling and main part), cylinders (connecting main part to. cone in ceiling) and 3 fan blades. Shown In figures 1,2 and 3.

```
void SceneWidget::fan(){
    this->cone();
    this->smallCylinder1();
    this->smallCylinder2();
    this->bigFanPart();
    glPushMatrix();
        glScalef(4,4,1);
        this->smallCylinder1();
    glPopMatrix();
    glPushMatrix();
        glTranslatef(0,0,2);
        glScalef(5,5,1);
        this->smallCylinder1();
    glPopMatrix();
    glPushMatrix();
        glTranslatef(0,12,1.5);
        glRotatef(0, 0.,0, 1.);
        glScalef(4.1,17.4,1);
        this->fanBlade();
    glPopMatrix();
    glPushMatrix();
        glTranslatef(-10.5,-6,1.5);
        glRotatef(120, 0.,0, 1.);
        glScalef(4.1,17.4,1);
        this->fanBlade();
    glPopMatrix();
    glPushMatrix();
        glTranslatef(10.5,-6,1.5);
        glRotatef(240, 0.,0, 1.);
        glScalef(4.1,17.4,1);
        this->fanBlade();
    glPopMatrix();
}
```

Figure 1:Small Cylinder used to make fan

```
void SceneWidget::smallCylinder1(){
  materialStruct* p_front = &chromeMaterials;

  glMaterialfv(GL_FRONT, GL_AMBIENT,    p_front->ambient);
  glMaterialfv(GL_FRONT, GL_DIFFUSE,    p_front->diffuse);
  glMaterialfv(GL_FRONT, GL_SPECULAR,   p_front->specular);
  glMaterialf(GL_FRONT, GL_SHININESS,   p_front->shininess);

  GLUquadricObj *smallCylinder = gluNewQuadric();
  gluDisk(smallCylinder,0, 1,20,1);
}
```

Figure 2:Fan made form 3 fan blade instances, cylinders and cones

```
void SceneWidget::fanBlade(){
    materialStruct* p_front = &chromeMaterials;
    glMaterialfv(GL_FRONT, GL_AMBIENT,    p_front->ambient);
    glMaterialfv(GL_FRONT, GL_DIFFUSE,    p_front->diffuse);
    glMaterialfv(GL_FRONT, GL_SPECULAR,   p_front->specular);
    glMaterialf(GL_FRONT, GL_SHININESS,   p_front->shininess);
    GLfloat normals[][3] = { {0., 0., 1.},{0., 0., -1.} ,{1., 0. ,0.}
                           , {-1., 0., 0.},{0., 1, 0.},{0., -1., 0.} };

    // BOTTOM
    glNormal3fv(normals[0]);
    glBegin(GL_POLYGON);
     glVertex3f(  0.5, -0.5, 0.5 );
     glVertex3f(  0.5,  0.5, 0.5 );
     glVertex3f( -0.5,  0.5, 0.5 );
     glVertex3f( -0.5, -0.5, 0.5 );
    glEnd();

    // TOP
    glNormal3fv(normals[1]);
    glBegin(GL_POLYGON);
     glVertex3f(  0.5, -0.5, -0.5 );
     glVertex3f(  0.5,  0.5,-0.5 );
     glVertex3f( -0.5,  0.5,- 0.5 );
     glVertex3f( -0.5, -0.5,- 0.5 );
    glEnd();

    //SIDES
    glNormal3fv(normals[2]);
    glBegin(GL_POLYGON);
     glVertex3f( 0.5, -0.5, -0.5 );
     glVertex3f( 0.5,  0.5, -0.5 );
     glVertex3f( 0.5,  0.5,  0.5 );
     glVertex3f( 0.5, -0.5,  0.5 );
    glEnd();

    glNormal3fv(normals[3]);
    glBegin(GL_POLYGON);
     glVertex3f( -0.5, -0.5,  0.5 );
     glVertex3f( -0.5,  0.5,  0.5 );
     glVertex3f( -0.5,  0.5, -0.5 );
     glVertex3f( -0.5, -0.5, -0.5 );
    glEnd();

    // FRONT
    glNormal3fv(normals[4]);
    glBegin(GL_POLYGON);
     glVertex3f(  0.5,  0.5,  0.5 );
     glVertex3f(  0.5,  0.5, -0.5 );
     glVertex3f( -0.5,  0.5, -0.5 );
     glVertex3f( -0.5,  0.5,  0.5 );
    glEnd();

    // BACK
    glNormal3fv(normals[5]);
    glBegin(GL_POLYGON);
     glVertex3f(  0.5, -0.5, -0.5 );
     glVertex3f(  0.5, -0.5,  0.5 );
     glVertex3f( -0.5, -0.5,  0.5 );
     glVertex3f( -0.5, -0.5, -0.5 );
    glEnd();

}
```

Figure 3:Fan Blade made from polygons

Hands

Each hand was made with 4 instances of finger object. Each finger object is made from instances of cylinders and spheres. Shown in figure 4 .

```
void SceneWidget::hand(){
    glPushMatrix();
        glRotatef(90,0,1,0);
        glRotatef(24,1,0,0);
        glTranslatef(-52,1,-21);
        this->thumb(5);
    glPopMatrix();
    glPushMatrix();
        double lowangle = 30*sin(0.2*_tapSpeed) + 30;
        this->finger(lowangle);
    glPopMatrix();
    glPushMatrix();
        double lowangle2 = 30*sin(0.2*_tapSpeed+30) + 30;
        glTranslatef(22,1,1);
        this->finger(lowangle2);
    glPopMatrix();
    glPushMatrix();
        double lowangle3 = 30*sin(0.2*_tapSpeed+60) + 30;
        glTranslatef(43,1,1);
        this->finger(lowangle3);
    glPopMatrix();
    glPushMatrix();
        double lowangle4 = 30*sin(0.2*_tapSpeed+90) + 30;
        glTranslatef(66,1,1);
        this->finger(lowangle4);
    glPopMatrix();
}
```

Figure 4:Hand object made from instances of finger object

Specular and Diffusive Light

Normalization was enabled for all GLU objects while polygons had normal calculated and added (shown in figure 3). The light is placed behind and slightly to the left of the camera facing the room. Material Properties were used to reflect light with different shininess.
Body figure contains a lot of examples of specular and diffusive light.

Figure 5:Examples of Specular light

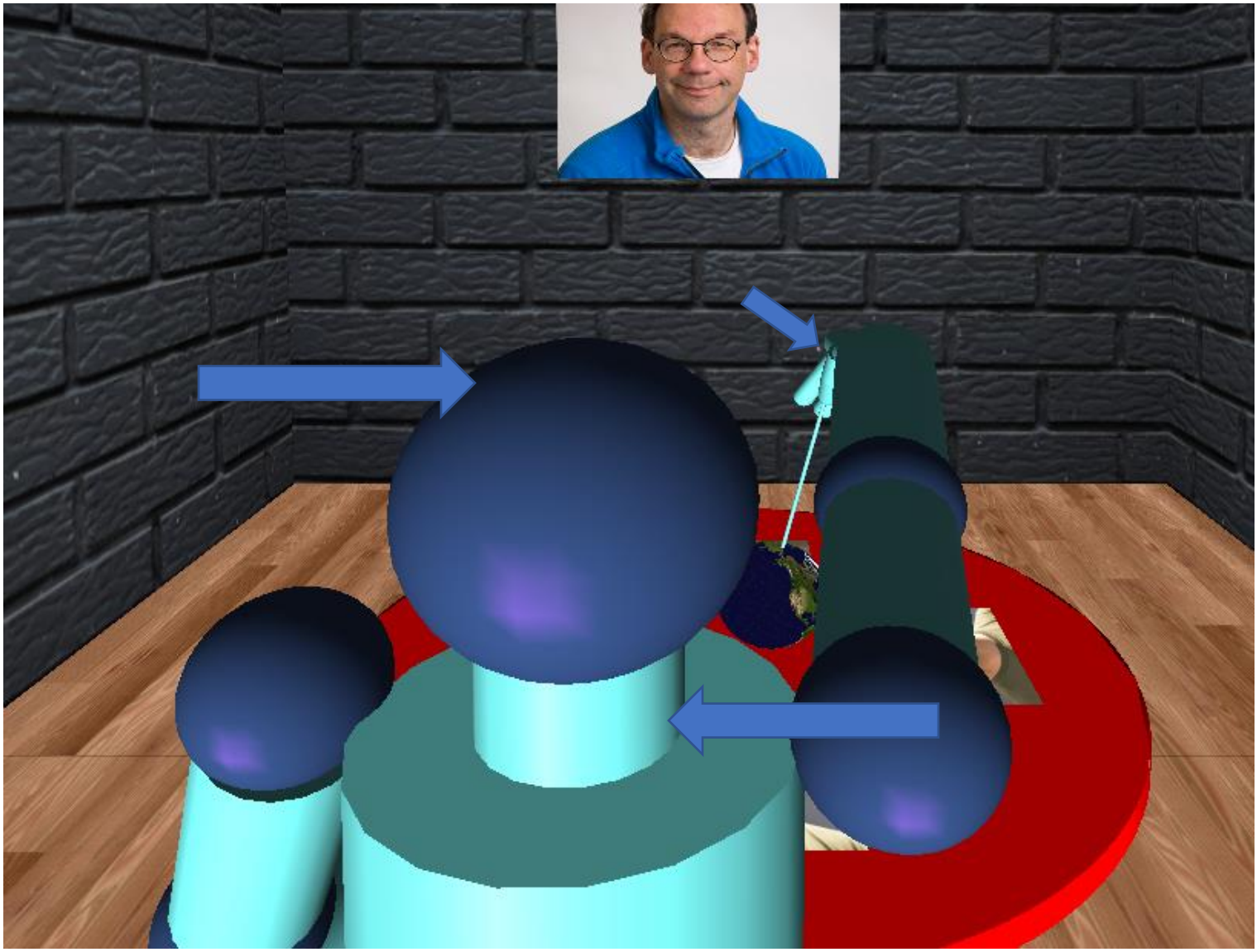

Figure 6:Examples of Diffusive light

Animation

Scene contains different types of animations. First, it contains 2 spinning objects (globe and fan). The main body figure is moving in a circular motion around the table.

Moreover, it contains 2 animated objects which used sin and cos functions to be animated as seen in figure 4:

1. A hand tapping on the table repetitively, where each finger is going up and down with a delay between each finger.
2. A hand holding a globe using a string and moving it sideways repeatedly.

Texture Mapping

Scene contains all provided textures with other additional textures. All textures are loaded in the constructor as when doing so in methods decreased lag significantly and animations were not smooth. Each texture has its own method where QImage was used to load, swap RGB values for ppm textures and flip the textures vertically. Flat texture vertices were added on a square polygon with a very shiny white material. The Mercator map was mapped on a sphere to make a globe.

Convex Object

Fan blades was made as a cuboid with 6 faces and each face had a normal as seen in 3. Three instances of this object were used to make the fan. The chair is made from 5 convex objects (4 legs and 1 seat).

Hierarchical Model

The body figure is moving around the table while sitting on the chair. The body figure is made from head, neck, shoulder, feet, legs, arms and two different hand objects (Figure 7,8 and 9). First, the tapping hand is made from four finger objects, rectangular palm and a thumb while each of these objects are made of more basic (simpler)

objects. The fingers are moving up and down which makes the hand appear as it is tapping on the table. Second, the hand holding the globe by a string is made from the string(rope) attached to the globe, four finger objects, thumb and cone shaped palm. The hand is rotating sideways while holding the string making the figure appear as if it is moving the globe sideways like a hypnotist with a clock.

```
829 void SceneWidget::figureBody(){
830     materialStruct* p_front = &customShinyMaterials;
831     glMaterialfv(GL_FRONT, GL_AMBIENT,    p_front->ambient);
832     glMaterialfv(GL_FRONT, GL_DIFFUSE,    p_front->diffuse);
833     glMaterialfv(GL_FRONT, GL_SPECULAR,   p_front->specular);
834     glMaterialf(GL_FRONT, GL_SHININESS,   p_front->shininess);
835
836     glPushMatrix();
837         glPushMatrix();
838             glTranslatef(0,0,-2-_cx);
839             glScalef(12,12,12);
840             this->circularBodyPart();
841             glPopMatrix();
842             //NECK
843             glPushMatrix();
844                 glScalef(7,7,5+_cx);
845                 this->cylinderBodyPart();
846             glPopMatrix();
847         glPopMatrix();
848         //SHOULDERS
849         glPushMatrix();
850
851             glScalef(7,7,7);
852             glTranslatef(0,3,2);
853             this->circularBodyPart();
854         glPopMatrix();
855         glPushMatrix();
856             glScalef(7,7,7);
857             glTranslatef(0,-3,2);
858             this->circularBodyPart();
859         glPopMatrix();
860         //BODY
861         glPushMatrix();
862             glScalef(15,15,15);
863             glTranslatef(0,0,1);
864             this->cylinderBodyPart();
865             GLUquadricObj *smallCylinder = gluNewQuadric();
866             gluDisk(smallCylinder,0, 1,20,1);
867         glPopMatrix();
868         //UPPER ARMS
869         glPushMatrix();
870             glRotatef(-105,0,1,0);
871             glTranslatef(16,-21,-2);
872             glScalef(6,6,9);
873             this->cylinderBodyPart();
874         glPopMatrix();
875         glPushMatrix();
876             glTranslatef(0,21,17);
877             glRotatef(-21,0,1,0);
878             glRotatef(-21,1,0,0);
879             glScalef(6,6,9);
880             this->cylinderBodyPart();
881         glPopMatrix();
882         //LOWER ARMS
883         glPushMatrix();
884         glRotatef(-105,0,1,0);
885             glTranslatef(16,-21,28);
886             glScalef(6,6,9);
887             this->cylinderBodyPart();
888             glTranslatef(0,0,3);
889             gluDisk(smallCylinder,0, 1,20,1);
890         glPopMatrix();
891         glPushMatrix();
892             glTranslatef(-10,32,47);
893             glRotatef(70,1,0,0);
894             glRotatef(-73,0,1,0);
895             glScalef(6,6,9);
896             this->cylinderBodyPart();
897         glPopMatrix();
898         //ELBOWS
```

Figure 7:Figure Body Part 1 containing objects making bigger body parts

```
898         //ELBOWS
899         glPushMatrix();
900         glRotatef(-105,0,1,0);
901             glTranslatef(16,-21,25);
902             glScalef(7,7,7);
903             this->circularBodyPart();
904         glPopMatrix();
905         glPushMatrix();
906             glTranslatef(-10,32,44);
907             glRotatef(70,1,0,0);
908             glRotatef(-73,0,1,0);
909             glScalef(7,7,7);
910             this->circularBodyPart();
911         glPopMatrix();
912         glPushMatrix();
913             glTranslatef(-45,21,46);
914             glRotatef(10,1,0,0);
915             glRotatef(63,0,1,0);
916             glRotatef(77,0,0,1);
917             glScalef(0.15,0.15,0.15);
918             this->hand();
919             this->palm();
920         glPopMatrix();
921         glPushMatrix();
922             glTranslatef(16,0,66);
923             glRotatef(-90, 0.,1., 0.);
924             //THIGH JOINTS
925             glPushMatrix();
926                 glTranslatef(0,-7,19);
927                 glScalef(7,7,7);
928                 this->circularBodyPart();
929             glPopMatrix();
930             glPushMatrix();
931                 glTranslatef(0,7,19);
932                 glScalef(7,7,7);
933                 this->circularBodyPart();
934             glPopMatrix();
935             //UPPER LEGS
936             glPushMatrix();
937                 glTranslatef(0,-7,17);
938                 glScalef(6,6,9);
939                 this->cylinderBodyPart();
940             glPopMatrix();
941             glPushMatrix();
942                 glTranslatef(0,7,17);
943                 glScalef(6,6,9);
944                 this->cylinderBodyPart();
945             glPopMatrix();
```

Figure 8:Figure Body Part 2

```
945                 glPopMatrix();
946                 glPushMatrix();
947                     //LOWER LEGS and FEET
948                     glRotatef(90,0,1,0);
949                     glTranslatef(-44,0,-41);
950                     glPushMatrix();
951                         glTranslatef(0,-7,47);
952                         glScalef(6,6,9);
953                         this->cylinderBodyPart();
954                         glTranslatef(0,0,3);
955                         this->circularBodyPart();
956                         glTranslatef(-0.65,0,0);
957                         glScalef(1.7,1,1);
958                         this->feet();
959                     glPopMatrix();
960                     glPushMatrix();
961                         glTranslatef(0,7,47);
962                         glScalef(6,6,9);
963                         this->cylinderBodyPart();
964                         glTranslatef(0,0,3);
965                         this->circularBodyPart();
966                         glTranslatef(-0.65,0,0);
967                         glScalef(1.7,1,1);
968                         this->feet();
969                     glPopMatrix();
970                     //KNEES
971                     glPushMatrix();
972                         glTranslatef(0,-7,44);
973                         glScalef(7,7,7);
974                         this->circularBodyPart();
975                     glPopMatrix();
976                     glPushMatrix();
977                         glTranslatef(0,7,44);
978                         glScalef(7,7,7);
979                         this->circularBodyPart();
980                     glPopMatrix();
981                 glPopMatrix();
982             glPopMatrix();
983             this->pinchingHand();
984
985         }
```

Figure 9 :Figure Body Part 3

User Interaction

Several types of user interaction including being able to change speed of fan, tapping hand, oscillations and globe. In addition, user can zoom in and/or change viewing angles such as looking up, down, left and right using sliders. The user can also use spin boxes to change size of the globe or increase length figure's neck. A slider can also be used to increase oscillation size. Lastly, the user can use a dropdown menu to choose 2 other textures which are mapped on front, left and right walls (Figures 10 and 11).

Figure 10:Examples of User interaction using sliders and spin boxes

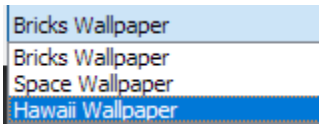

Figure 11:Dropdown Box