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CSE - B

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
UCS1712 – GRAPHICS AND MULTIMEDIA LAB

Lab Exercise 8: : 3-Dimensional Transformations in C++ using OpenGL

Perform the following basic 3D Transformations on any 3D Object.
1) Translation
2) Rotation
3) Scaling
Use only homogeneous coordinate representation and matrix multiplication to perform transformations.
Set the camera to any position on the 3D space. Have (0,0,0) at the center of the screen. Draw X , Y and Z axis.

Aim:
To implement 3D transformations on objects using C++ using OpenGL

Algorithm:
1. Get points of the object as input.
2. Draw the object.
3. Transform each vertex of the object.
4. Draw the object with the transformed vertices.

Code:

8.cpp:

```
#include <stdio.h>
#include <GL/glut.h> //Change to <GLUT/glut.h> in Mac
#include <math.h>
#include <string.h>
#include <iostream>
using namespace std;
#define pi 3.142857

typedef float Matrix4[4][4];
Matrix4 theMatrix;
static GLfloat input[8][3] = {{40, 40, -50}, {90, 40, -50}, {90, 90, -50}, {40, 90,
-50}, {30, 30, 0}, {80, 30, 0}, {80, 80, 0}, {30, 80, 0}};
float output[8][3];
float tx = 100, ty = 100, tz = 100;
float sx = -2, sy = 2, sz = 2;
float angle = 60;
int choice, choiceRot;
void setIdentityM(Matrix4 m)
{
  for (int i = 0; i < 4; i++)
    for (int j = 0; j < 4; j++)
```

```
      m[i][j] = (i == j);
}

// PUT SOME FUNCTION HERE

void translate(int tx, int ty, int tz)
{
  for (int i = 0; i < 8; i++)
  {

    output[i][0] = input[i][0] + tx;
    output[i][1] = input[i][1] + ty;
    output[i][2] = input[i][2] + tz;
  }
}
void scale(int sx, int sy, int sz)
{
  theMatrix[0][0] = sx;
  theMatrix[1][1] = sy;
  theMatrix[2][2] = sz;
}
void RotateX(float angle)
{
  angle = angle * 3.142 / 180;
  theMatrix[1][1] = cos(angle);
  theMatrix[1][2] = -sin(angle);
  theMatrix[2][1] = sin(angle);
  theMatrix[2][2] = cos(angle);
}
void RotateY(float angle)
{
  angle = angle * 3.14 / 180;
  theMatrix[0][0] = cos(angle);
  theMatrix[0][2] = -sin(angle);
  theMatrix[2][0] = sin(angle);
  theMatrix[2][2] = cos(angle);
}
void RotateZ(float angle)
{
  angle = angle * 3.14 / 180;
  theMatrix[0][0] = cos(angle);
  theMatrix[0][1] = sin(angle);
  theMatrix[1][0] = -sin(angle);
  theMatrix[1][1] = cos(angle);
}
void multiplyM()
{
  for (int i = 0; i < 8; i++)
  {
    for (int j = 0; j < 3; j++)
    {
      output[i][j] = 0;
      for (int k = 0; k < 3; k++)
      {
        output[i][j] = output[i][j] + input[i][k] * theMatrix[k][j];
      }
    }
  }
}

// To draw the solid
void draw(float a[8][3])
{
  glBegin(GL_QUADS);
  glColor3f(0.7, 0.4, 0.5); // behind
  glVertex3fv(a[0]);
  glVertex3fv(a[1]);
  glVertex3fv(a[2]);
  glVertex3fv(a[3]);
  glColor3f(0.8, 0.2, 0.4); // bottom
  glVertex3fv(a[0]);
  glVertex3fv(a[1]);
  glVertex3fv(a[5]);
  glVertex3fv(a[4]);
  glColor3f(0.3, 0.6, 0.7); // left
  glVertex3fv(a[0]);
  glVertex3fv(a[4]);
  glVertex3fv(a[7]);
  glVertex3fv(a[3]);
  glColor3f(0.2, 0.8, 0.2); // right
  glVertex3fv(a[1]);
  glVertex3fv(a[2]);
  glVertex3fv(a[6]);
  glVertex3fv(a[5]);
  glColor3f(0.7, 0.7, 0.2); // up
  glVertex3fv(a[2]);
  glVertex3fv(a[3]);
  glVertex3fv(a[7]);
  glVertex3fv(a[6]);
  glColor3f(1.0, 0.1, 0.1);
  glVertex3fv(a[4]);
  glVertex3fv(a[5]);
  glVertex3fv(a[6]);
  glVertex3fv(a[7]);
  glEnd();
}

/* This is just to call the functions
 also draw X and Y axis here and use output to label stuff) */
void display(void)
{

  glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
  // black
  glColor3f(0.0, 0.0, 0.0);

  gluLookAt(0, 0, 1, 0, 0, 0, 0, 1, 0); // Camera, Center & Up Vector

  glBegin(GL_LINES); // Plotting X-Axis
  glVertex3d(-1000, 0, 0);
  glVertex3d(1000, 0, 0);
  glEnd();
  glBegin(GL_LINES); // Plotting Y-Axis
  glVertex3d(0, -1000, 0);
  glVertex3d(0, 1000, 0);
  glEnd();
  glBegin(GL_LINES); // Plotting Z-Axis
  glVertex3d(0, 0, -1000);
  glVertex3d(0, 0, 1000);
  glEnd();

  // Call function
  draw(input);
  setIdentityM(theMatrix);
  switch (choice)
  {
  case 1:
    translate(tx, ty, tz);
    break;
  case 2:
    scale(sx, sy, sz);
    multiplyM();
    break;
  case 3:
    switch (choiceRot)
    {
    case 1:
      RotateX(angle);
      break;
    case 2:
      RotateY(angle);
      break;
    case 3:
      RotateZ(angle);
      break;
    default:
      break;
    }
    multiplyM();
    break;
  }
  // gluLookAt(1, 0, 0, 0, 0, 0, 0, 1, 0); // Camera, Center & Up Vector
  draw(output);
  glFlush();

  glFlush();
}

int main(int argc, char **argv)
{
  /*--------WINDOW INITS-------*/
  glutInit(&argc, argv); // Mandatory. Initializes the GLUT library.
  glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
  glutInitWindowSize(1380, 700);          // Set the size of output window (kinda
optional)
```

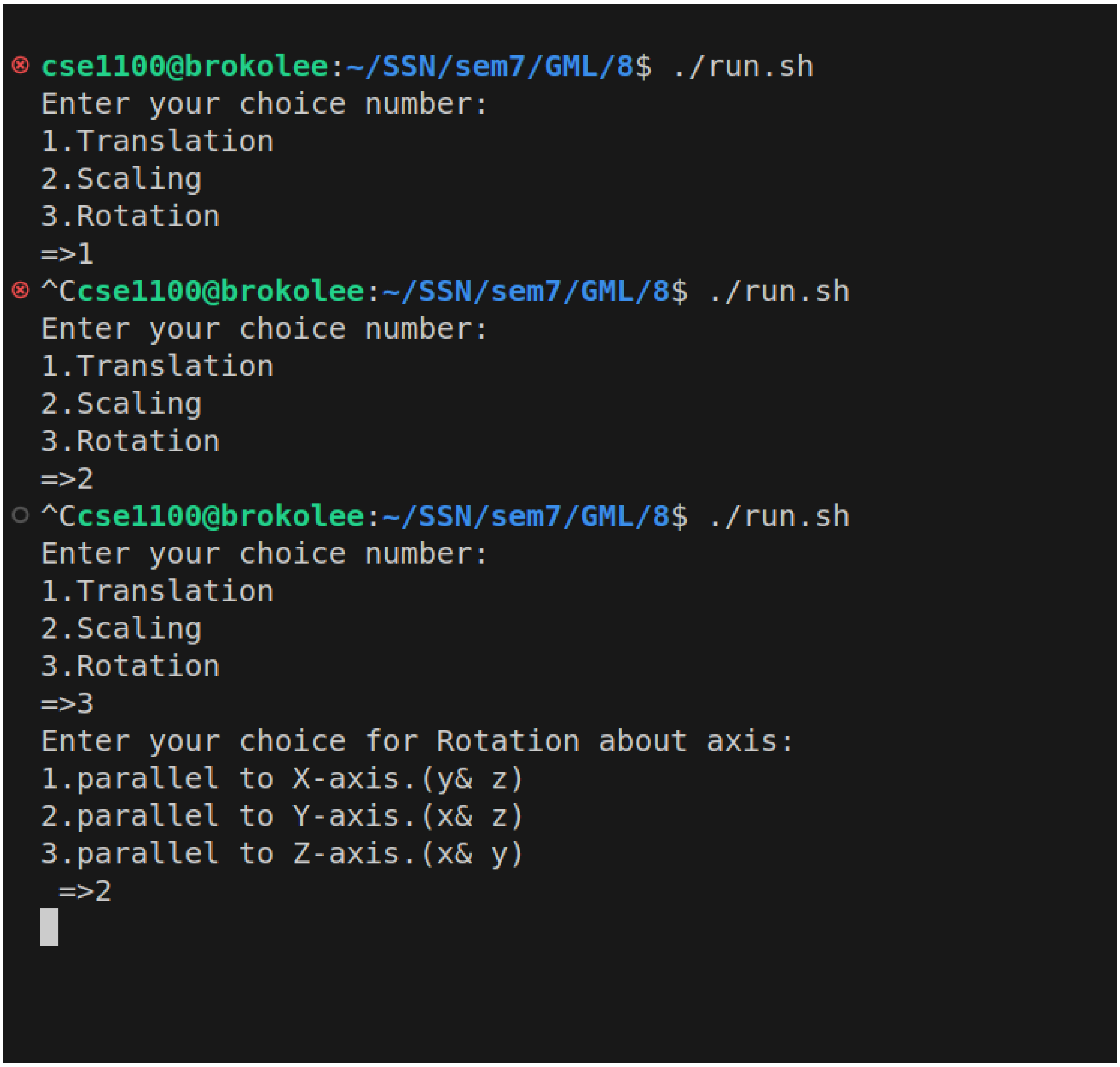
```
  glutInitWindowPosition(200, 200);        // position of output window on screen
(optional)
  glutCreateWindow("3D TRANSFORMATIONS"); // Giving name to window

  /*-------OTHER INITS-------*/
  glClearColor(1.0, 1.0, 1.0, 1.0); // Clear the buffer values for color AND set
these values
  /*can set initial color here also*/
  glMatrixMode(GL_PROJECTION); // Uses something called "projection matrix" to
represent
  glLoadIdentity();            // load the above matrix to fill with identity values
  glOrtho(-454.0, 454.0, -250.0, 250.0, -250.0, 250.0);
  gluPerspective(100, 100, 100, 100);
  glEnable(GL_DEPTH_TEST);
  cout << "Enter your choice number:\n1.Translation\n2.Scaling\n3.Rotation\n=>";
  cin >> choice;
  switch (choice)
  {
  case 1:
    break;
  case 2:
    break;
  case 3:
    cout << "Enter your choice for Rotation about axis:\n1.parallel to X-axis."
         << "(y& z)\n2.parallel to Y-axis.(x& z)\n3.parallel to Z-axis."
         << "(x& y)\n =>";
    cin >> choiceRot;
    break;
  default:
    break;
  }
  glutDisplayFunc(display); // sets the display callback for the current window
  glutMainLoop();           // Enters event processing loop. Compulsory
  return 0;
}
```

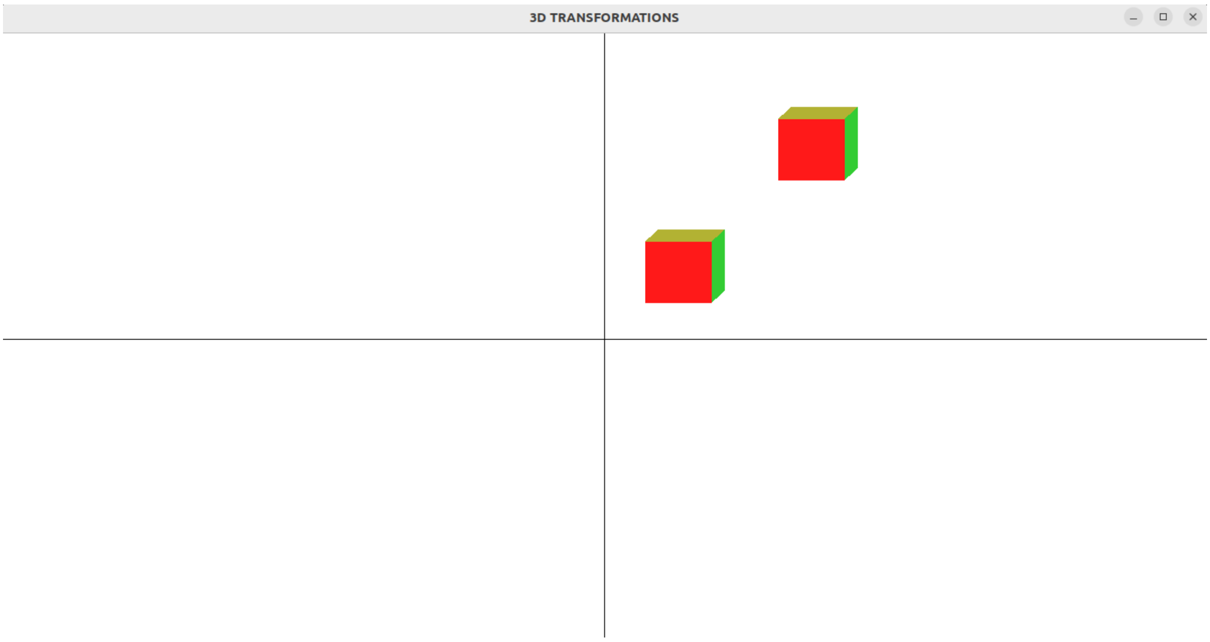
run.sh:

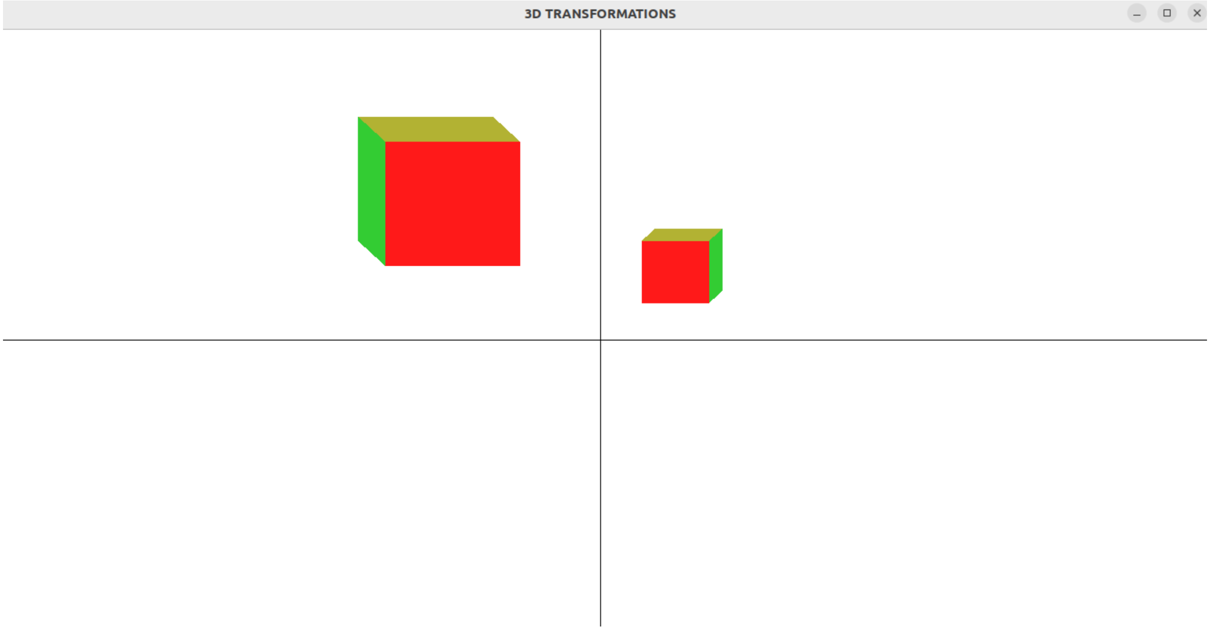
```
g++ 8.cpp -lGL -lglut -lGLU
./a.out
```

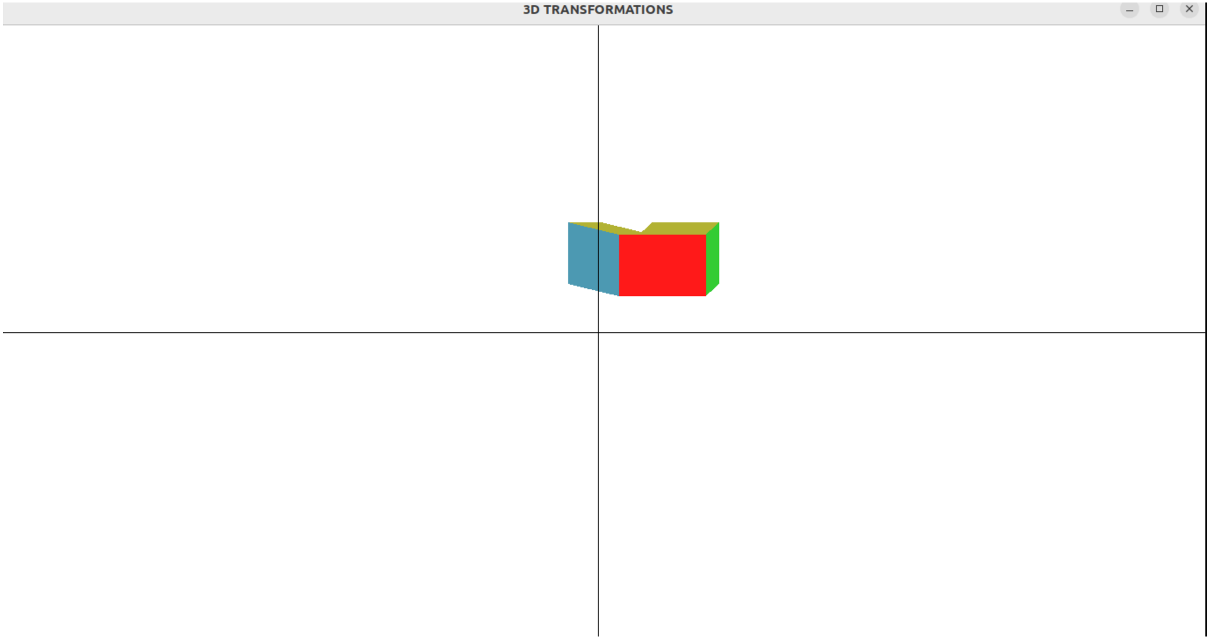
Sample I/O:



```
cse1100@brokolee:~/SSN/sem7/GML/8$ ./run.sh
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
=>1
^Ccse1100@brokolee:~/SSN/sem7/GML/8$ ./run.sh
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
=>2
^Ccse1100@brokolee:~/SSN/sem7/GML/8$ ./run.sh
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
=>3
Enter your choice for Rotation about axis:
1.parallel to X-axis.(y& z)
2.parallel to Y-axis.(x& z)
3.parallel to Z-axis.(x& y)
 =>2
```







Learning Outcomes:

Thus, 3D Transformations has been implemented on objects using OpenGL.