UCS1712 – GRAPHICS AND MULTIMEDIA LAB

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

CODE:

```
#include<gl/glut.h>
#include<iostream>
#include<utility>
#include<vector>
#include<math.h>
constexpr auto PI = 3.14;

using namespace std;

vector<vector<GLfloat>> coords(8,vector<GLfloat>(3));
int tx, ty, tz;
int ch;
double sx, sy, sz;
int xf, yf, zf;
int RotAxis;
int ang;
float rad;


void myInit()
{
	glClearColor(1.0, 1.0, 1.0, 1.0);
	glLoadIdentity();
	glOrtho(-500.0, 500.0, -500.0, 500.0, -500.0, 500.0);
	glEnable(GL_DEPTH_TEST);
}

void drawCube() {
	glBegin(GL_QUADS);

	glColor3f(1, 0, 0);
	glVertex3f(coords[0][0], coords[0][1], coords[0][2]);
	glVertex3f(coords[1][0], coords[1][1], coords[1][2]);
	glVertex3f(coords[2][0], coords[2][1], coords[2][2]);
	glVertex3f(coords[3][0], coords[3][1], coords[3][2]);


	glColor3f(0, 1, 0);
	glVertex3f(coords[4][0], coords[4][1], coords[4][2]);
	glVertex3f(coords[5][0], coords[5][1], coords[5][2]);
	glVertex3f(coords[6][0], coords[6][1], coords[6][2]);
	glVertex3f(coords[7][0], coords[7][1], coords[7][2]);


	glColor3f(0, 0, 1);
	glVertex3f(coords[0][0], coords[0][1], coords[0][2]);
	glVertex3f(coords[1][0], coords[1][1], coords[1][2]);
	glVertex3f(coords[5][0], coords[5][1], coords[5][2]);
	glVertex3f(coords[4][0], coords[4][1], coords[4][2]);


	glColor3f(1, 0, 1);
	glVertex3f(coords[0][0], coords[0][1], coords[0][2]);
```

```
	glVertex3f(coords[4][0], coords[4][1], coords[4][2]);
	glVertex3f(coords[7][0], coords[7][1], coords[7][2]);
	glVertex3f(coords[3][0], coords[3][1], coords[3][2]);


	glColor3f(0, 1, 1);
	glVertex3f(coords[1][0], coords[1][1], coords[1][2]);
	glVertex3f(coords[2][0], coords[2][1], coords[2][2]);
	glVertex3f(coords[6][0], coords[6][1], coords[6][2]);
	glVertex3f(coords[5][0], coords[5][1], coords[5][2]);


	glColor3f(1, 1, 0);
	glVertex3f(coords[2][0], coords[2][1], coords[2][2]);
	glVertex3f(coords[3][0], coords[3][1], coords[3][2]);
	glVertex3f(coords[7][0], coords[7][1], coords[7][2]);
	glVertex3f(coords[6][0], coords[6][1], coords[6][2]);

	glEnd();

}

void Axis() {
	glBegin(GL_LINES);
	glColor3f(0, 0, 1);

	glVertex3f(0, 0, 0);
	glVertex3f(0, 0, 500);

	glColor3f(1, 0, 0);

	glVertex3f(0, 0, 0);
	glVertex3f(500, 0, 0);

	glColor3f(0, 1, 0);

	glVertex3f(0, 0, 0);
	glVertex3f(0, 500, 0);
	glEnd();
}

void translate() {
	vector<vector<GLfloat>> T(4, vector<GLfloat>(4, 0));
	T[0][0] = 1;
	T[1][1] = 1;
	T[2][2] = 1;
	T[3][3] = 1;
	T[0][3] = tx;
	T[1][3] = ty;
	T[2][3] = tz;
	for (int c = 0; c < coords.size(); c++)
	{
		vector<GLfloat> P(4),N(4,0);
		P[0] = coords[c][0];
		P[1] = coords[c][1];
		P[2] = coords[c][2];
		P[3] = 1;
		for (int i = 0; i < 4; i++) {
			for (int j = 0; j < 1; j++) {
				N[i] = 0;
				for (int k = 0; k < 4; k++) {
					N[i] += T[i][k] * P[k];
```

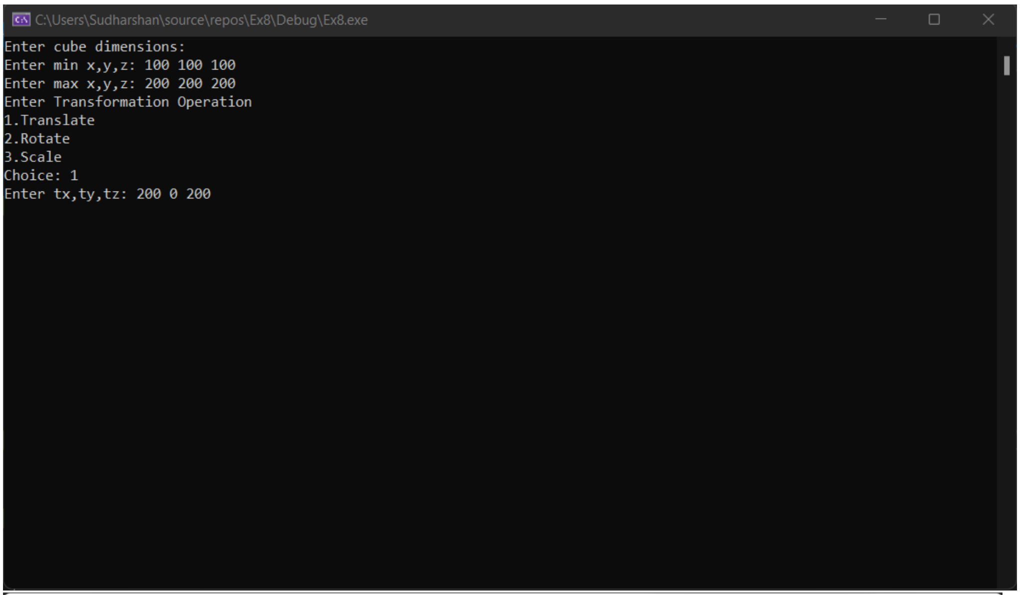
```
                                        }
                                }
                        }
                        coords[c][0] = N[0];
                        coords[c][1] = N[1];
                        coords[c][2] = N[2];
                }
        }

        void scale() {
                vector<vector<GLfloat>> T(4, vector<GLfloat>(4, 0));
                T[0][0] = sx;
                T[1][1] = sy;
                T[2][2] = sz;
                T[3][3] = 1;
                T[0][3] = (1 - sx) * xf;
                T[1][3] = (1 - sy) * yf;
                T[2][3] = (1 - sz) * zf;
                for (int c = 0; c < coords.size(); c++)
                {
                        vector<GLfloat> P(4), N(4, 0);
                        P[0] = coords[c][0];
                        P[1] = coords[c][1];
                        P[2] = coords[c][2];
                        P[3] = 1;
                        for (int i = 0; i < 4; i++) {
                                for (int j = 0; j < 1; j++) {
                                        N[i] = 0;
                                        for (int k = 0; k < 4; k++) {
                                                N[i] += T[i][k] * P[k];
                                        }
                                }
                        }
                        coords[c][0] = N[0];
                        coords[c][1] = N[1];
                        coords[c][2] = N[2];
                }
        }

        void rotate() {
                vector<vector<GLfloat>> T(4, vector<GLfloat>(4, 0));
                switch (RotAxis) {
                case 1:         T = {
                                                {1, 0, 0, 0},
                                                {0, cos(rad), -1*sin(rad), 0},
                                                {0, sin(rad), cos(rad), 0},
                                                {0, 0, 0, 1}
                                        };
                                        break;

                case 2: T = {
                                                {cos(rad), 0, sin(rad), 0},
                                                {0, 1, 0, 0},
                                                {-1*sin(rad), 0, cos(rad), 0},
                                                {0, 0, 0, 1}
                                        };
                                        break;

                case 3: T = {
                                                {cos(rad), -1*sin(rad), 0, 0},
                                                {sin(rad), cos(rad), 0, 0},
                                                {0, 0, 1, 0},
```

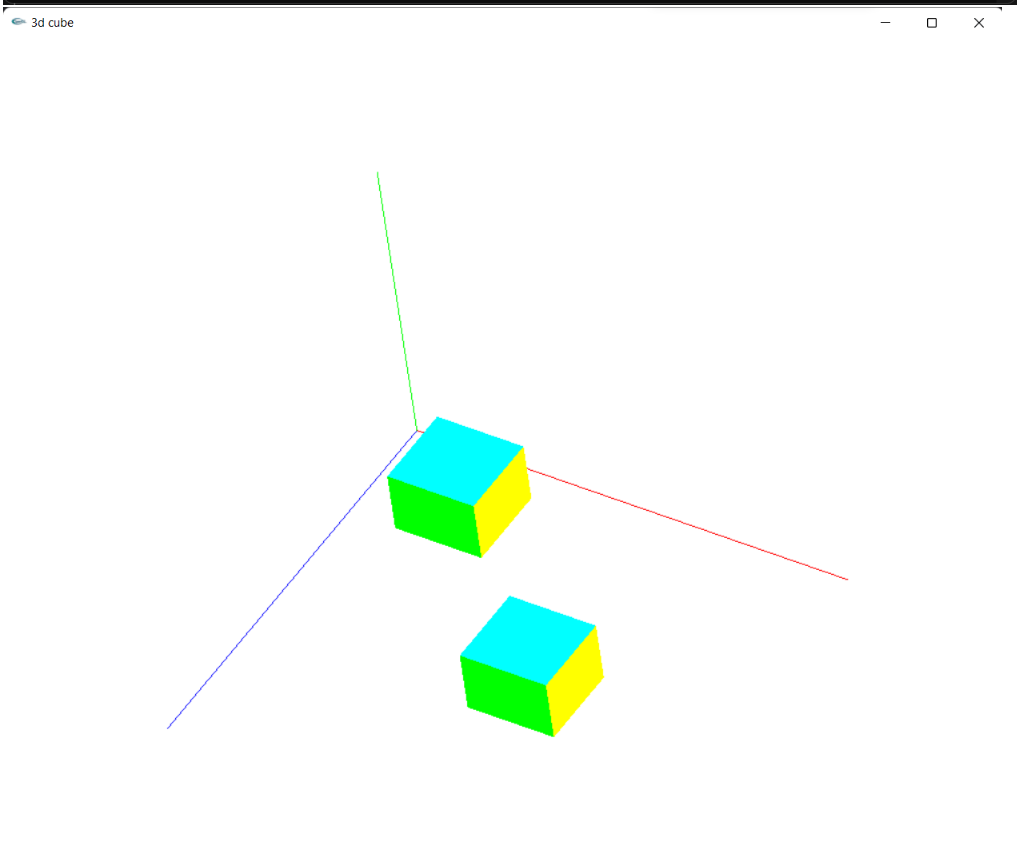
```
                                        {0, 0, 0, 1}
                                };
                                break;
        default: T = {
                                        {1,0,0,0},
                                        {0,1,0,0},
                                        {0,0,1,0},
                                        {0,0,0,1}
                                };
                                break;

        }
        for (int c = 0; c < coords.size(); c++)
        {
                vector<GLfloat> P(4), N(4, 0);
                P[0] = coords[c][0];
                P[1] = coords[c][1];
                P[2] = coords[c][2];
                P[3] = 1;
                for (int i = 0; i < 4; i++) {
                        for (int j = 0; j < 1; j++) {
                                N[i] = 0;
                                for (int k = 0; k < 4; k++) {
                                        N[i] += T[i][k] * P[k];
                                }
                        }
                }
                coords[c][0] = N[0];
                coords[c][1] = N[1];
                coords[c][2] = N[2];
        }
}

void myDisplay()
{
        glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
        glColor3f(0.0f, 0.0f, 0.0f);
        glRotatef(-45, 0, 1, 0);
        glRotatef(45, 1, 0, 0);
        glRotatef(-30, 0, 0, 1);
        glTranslatef(-100, 0, 0);
        Axis();
        drawCube();
        switch (ch) {
        case 1:translate();
                drawCube();
                break;
        case 2: rotate();
                drawCube();
                break;
        case 3:scale();
                drawCube();
                break;
        }
        glFlush();
}
int main(int argc, char* argv[])
{
        GLfloat x1=100, Y1=100, z1=100,x2=200,y2=200,z2=200;
        cout << "Enter cube dimensions:" << endl;
        cout << "Enter min x,y,z: ";
        cin >> x1>> Y1>> z1;
```

```
	cout << "Enter max x,y,z: ";
	cin >> x2>> y2>> z2;

	cout << "Enter Transformation Operation" <<endl<< "1.Translate" << endl << 
"2.Rotate" << endl << "3.Scale" << endl;
	cout << "Choice: ";
	cin >> ch;

	switch (ch) {
	case 1: cout << "Enter tx,ty,tz: ";
		      cin >> tx >> ty >> tz;
		      break;
	case 2: cout << "Enter Axis to rotate about X(1), Y(2), Z(3): ";
		cin >> RotAxis;
		cout << "Enter rotation ang: ";
		cin >> ang;
		rad = ang * PI / 180;
		break;
	case 3: cout << "Enter sx,sy,sz: ";
		cin >> sx >> sy >> sz;
		cout << "Enter point to scale about x,y,z: ";
		cin >> xf >> yf >> zf;
		break;
	default: cout << "invalid";
	}

	coords[0][0] = x1;
	coords[0][1] = Y1;
	coords[0][2] = z1;

	coords[1][0] = x1;
	coords[1][1] = y2;
	coords[1][2] = z1;

	coords[2][0] = x2;
	coords[2][1] = y2;
	coords[2][2] = z1;

	coords[3][0] = x2;
	coords[3][1] = Y1;
	coords[3][2] = z1;

	coords[4][0] = x1;
	coords[4][1] = Y1;
	coords[4][2] = z2;

	coords[5][0] = x1;
	coords[5][1] = y2;
	coords[5][2] = z2;

	coords[6][0] = x2;
	coords[6][1] = y2;
	coords[6][2] = z2;

	coords[7][0] = x2;
	coords[7][1] = Y1;
	coords[7][2] = z2;


	glutInit(&argc, argv);
	glutInitDisplayMode(GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
	glutInitWindowSize(1000, 1000);
```

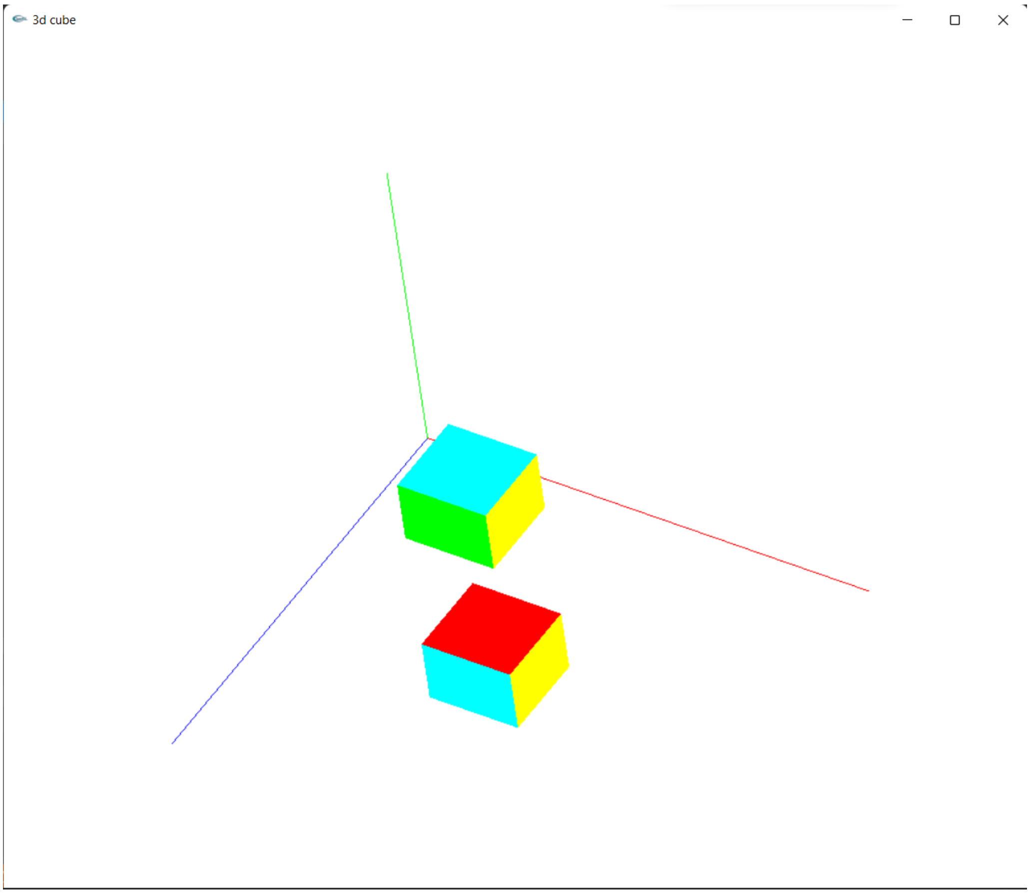
```
        glutCreateWindow("3d cube");
        glutDisplayFunc(myDisplay);
        myInit();
        glutMainLoop();
        return 1;
}
```

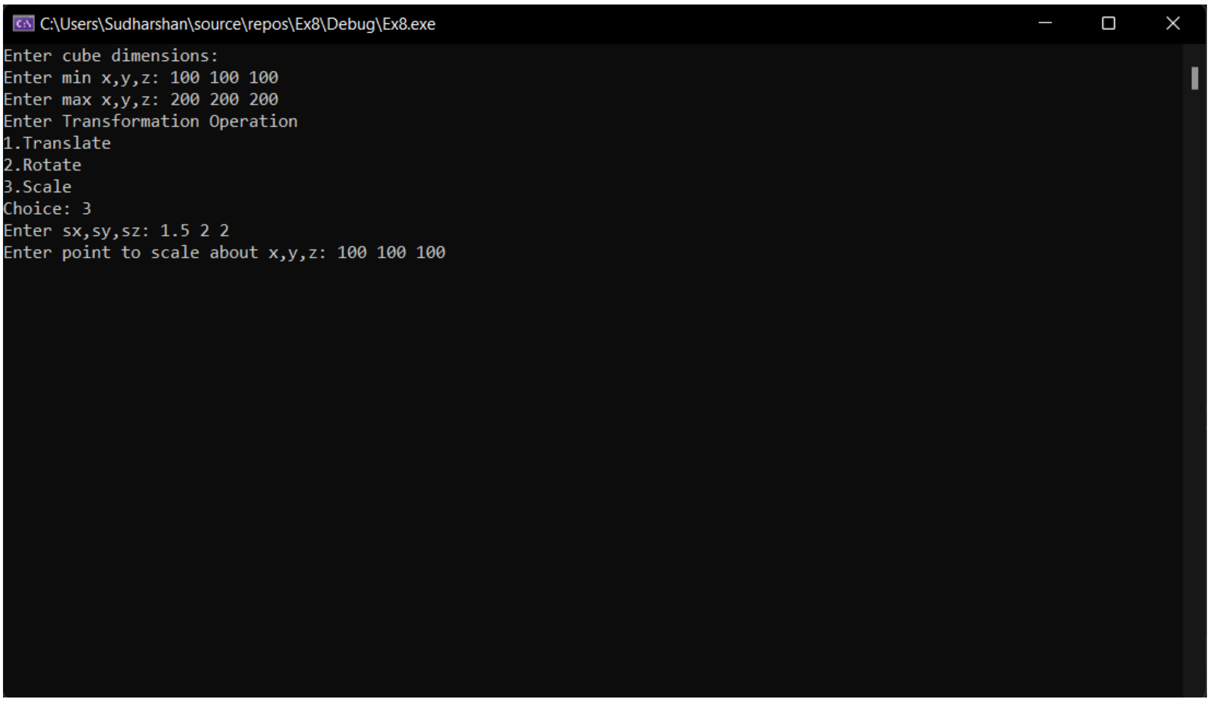
OUTPUT:

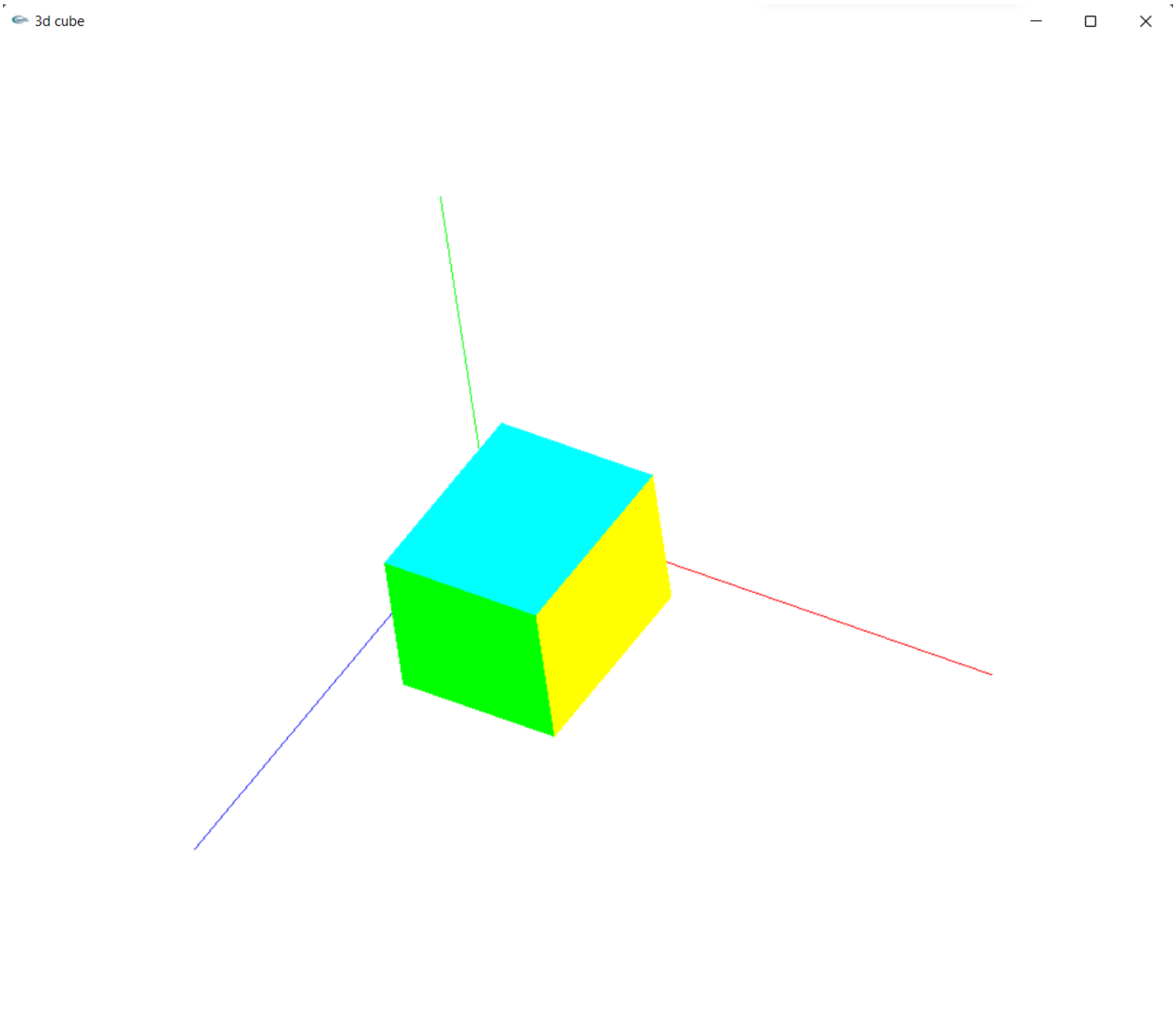





C:\Users\Sudharshan\source\repos\Ex8\Debug\Ex8.exe
Enter cube dimensions:
Enter min x,y,z: 100 100 100
Enter max x,y,z: 200 200 200
Enter Transformation Operation
1.Translate
2.Rotate
3.Scale
Choice: 2
Enter Axis to rotate about X(1), Y(2), Z(3): 1
Enter rotation ang: 90


3d cube


C:\Users\Sudharshan\source\repos\Ex8\Debug\Ex8.exe
Enter cube dimensions:
Enter min x,y,z: 100 100 100
Enter max x,y,z: 200 200 200
Enter Transformation Operation
1.Translate
2.Rotate
3.Scale
Choice: 3
Enter sx,sy,sz: 1.5 2 2
Enter point to scale about x,y,z: 100 100 100


3d cube