Experiment - 8: 3D Transformation

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Ques : Perform 3d Transformation on a square

Code : -

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#include <math.h>

#include <GL/glut.h>

#include <stdio.h>

#include <stdlib.h>


typedef float Matrix4x4 [4][4]; Matrix4x4

theMatrix;

float ptsIni[8][3]={{80,80,-100},{180,80,-100},{180,180,-
100},{80,180,100},{60,60,0},{160,60,0},{160,160,0},{60,160,0}};

//Realign above line while execution

// Initial Co-ordinates of the Cube to be Transformed float

ptsFin[8][3]; float refptX,refptY,refptZ;                //Reference points

float TransDistX,TransDistY,TransDistZ;      //Translations along Axes

float ScaleX,ScaleY,ScaleZ;                 //Scaling Factors along Axes float

Alpha,Beta,Gamma,Theta;               //Rotation angles about Axes

float A,B,C;                          //Arbitrary Line Attributes float

aa,bb,cc;                          //Arbitrary Line Attributes

float x1,y11,z1,x2,y2,z2; int choice,choiceRot,choiceRef; void

matrixSetIdentity(Matrix4x4 m)    // Initialises the matrix as Unit Matrix

{  int i,

j;  for

(i=0;

i<4;

i++)
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```
for
(j=0;
j<4;
j++)
m[i][j]
= (i ==
j);
}

void matrixPreMultiply(Matrix4x4 a , Matrix4x4 b)
{// Multiplies matrix a times b, putting result in b
 int i,j;
 Matrix4x4 tmp;
 for (i = 0; i < 4; i++)
for (j = 0; j < 4; j++)
 tmp[i][j]=a[i][0]*b[0][j]+a[i][1]*b[1][j]+a[i][2]*b[2][j]+a[i][3]*b[3][j];
 for (i = 0; i < 4; i++)  for (j
= 0; j < 4; j++)
theMatrix[i][j] = tmp[i][j];
}
void Translate(int tx, int ty, int tz)
{
 Matrix4x4 m;
matrixSetIdentity(m);
m[0][3] = tx;  m[1][3]
= ty;  m[2][3] = tz;
 matrixPreMultiply(m, theMatrix);
}
void Scale(float sx , float sy ,float sz)
```

```
{
 Matrix4x4 m;
matrixSetIdentity(m); m[0][0] = sx;
m[0][3] = (1 - sx)*refptX; m[1][1] =
sy; m[1][3] = (1 - sy)*refptY; m[2][2]
= sz;  m[2][3] = (1 - sy)*refptZ;
matrixPreMultiply(m , theMatrix);
}
void RotateX(float angle)
{
 Matrix4x4 m;
matrixSetIdentity(m);  angle =
angle*22/1260;  m[1][1] =
cos(angle);  m[1][2] = -sin(angle);
m[2][1] = sin(angle);  m[2][2] =
cos(angle);  matrixPreMultiply(m ,
theMatrix);
}
void RotateY(float angle)
{
 Matrix4x4 m;
matrixSetIdentity(m);  angle =
angle*22/1260;  m[0][0] =
cos(angle);  m[0][2] = sin(angle);
m[2][0] = -sin(angle); m[2][2] =
cos(angle); matrixPreMultiply(m ,
theMatrix); }
void RotateZ(float angle)
{
 Matrix4x4 m;
matrixSetIdentity(m);  angle =
angle*22/1260;  m[0][0] =
cos(angle);  m[0][1] = -sin(angle);
m[1][0] = sin(angle);  m[1][1] =
cos(angle);  matrixPreMultiply(m ,
theMatrix);
}
void Reflect(void)
{
 Matrix4x4 m;
matrixSetIdentity(m);
switch(choiceRef)
 {
 case 1: m[2][2] = -1;
break;  case 2:
m[0][0] = -1;  break;
case 3: m[1][1] = -1;
break;
 }
 matrixPreMultiply(m , theMatrix);
}
void DrawRotLine(void)
{
switch(choiceRot)
{
 case 1: glBegin(GL_LINES); glVertex3s(-1000
,B,C); glVertex3s( 1000 ,B,C);  glEnd();  break;
case 2: glBegin(GL_LINES);  glVertex3s(A ,-1000
,C);  glVertex3s(A ,1000 ,C);  glEnd();  break;

case 3: glBegin(GL_LINES);  glVertex3s(A ,B ,-

1000);  glVertex3s(A ,B ,1000);  glEnd();  break;

case 4: glBegin(GL_LINES);  glVertex3s(x1-

aa*500 ,y11-bb*500 , z1-cc*500);

glVertex3s(x2+aa*500 ,y2+bb*500 , z2+cc*500);

 glEnd();

break;

 }

}

void TransformPoints(void)

{ int

 i,k;

float tmp ; for(k=0

; k<8 ; k++) for (i=0

; i<3 ; i++)

ptsFin[k][i] = theMatrix[i][0]*ptsIni[k][0] + theMatrix[i][1]*ptsIni[k][1] +
theMatrix[i][2]*ptsIni[k][2] + theMatrix[i][3];

// Realign above line while execution

}

void Axes(void)

{

 glColor3f (0.0, 0.0, 0.0);              // Set the color to BLACK

glBegin(GL_LINES);                     // Plotting X-Axis

 glVertex2s(-1000 ,0);  glVertex2s( 1000 ,0);

glEnd();  glBegin(GL_LINES);                     //

Plotting Y-Axis

 glVertex2s(0 ,-1000);

glVertex2s(0 , 1000);  glEnd();
```

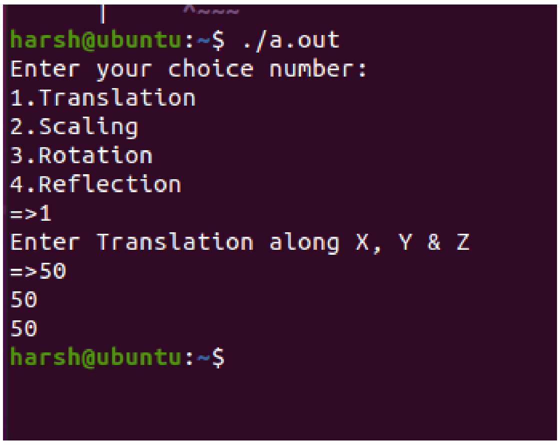
```
}
void Draw(float a[8][3])                //Display the Figure
{  int
i;
 glColor3f (0.7, 0.4, 0.7);
 glBegin(GL_POLYGON);
 glVertex3f(a[0][0],a[0][1],a[0][2]);
glVertex3f(a[1][0],a[1][1],a[1][2]);
glVertex3f(a[2][0],a[2][1],a[2][2]);
glVertex3f(a[3][0],a[3][1],a[3][2]);
glEnd();  i=0;  glColor3f (0.8, 0.6,
0.5);
 glBegin(GL_POLYGON);
 glVertex3s(a[0+i][0],a[0+i][1],a[0+i][2]);
glVertex3s(a[1+i][0],a[1+i][1],a[1+i][2]);
glVertex3s(a[5+i][0],a[5+i][1],a[5+i][2]);
glVertex3s(a[4+i][0],a[4+i][1],a[4+i][2]);
glEnd();  glColor3f (0.2, 0.4, 0.7);
 glBegin(GL_POLYGON);
 glVertex3f(a[0][0],a[0][1],a[0][2]);
glVertex3f(a[3][0],a[3][1],a[3][2]);
glVertex3f(a[7][0],a[7][1],a[7][2]);
glVertex3f(a[4][0],a[4][1],a[4][2]);
glEnd();  i=1;  glColor3f (0.5, 0.4,
0.3);
 glBegin(GL_POLYGON);
 glVertex3s(a[0+i][0],a[0+i][1],a[0+i][2]);
glVertex3s(a[1+i][0],a[1+i][1],a[1+i][2]);
glVertex3s(a[5+i][0],a[5+i][1],a[5+i][2]);
```

```
glVertex3s(a[4+i][0],a[4+i][1],a[4+i][2]);
glEnd();  i=2;  glColor3f (0.5, 0.6, 0.2);
 glBegin(GL_POLYGON);
 glVertex3s(a[0+i][0],a[0+i][1],a[0+i][2]);
 glVertex3s(a[1+i][0],a[1+i][1],a[1+i][2]);
 glVertex3s(a[5+i][0],a[5+i][1],a[5+i][2]);
 glVertex3s(a[4+i][0],a[4+i][1],a[4+i][2]);
 glEnd(); i=4;
glColor3f (0.7, 0.3, 0.4);
glBegin(GL_POLYGON);
 glVertex3f(a[0+i][0],a[0+i][1],a[0+i][2]);
glVertex3f(a[1+i][0],a[1+i][1],a[1+i][2]);
glVertex3f(a[2+i][0],a[2+i][1],a[2+i][2]);
glVertex3f(a[3+i][0],a[3+i][1],a[3+i][2]);  glEnd();
}

void display(void)
{
 glClear (GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
 Axes();  glColor3f (1.0, 0.0, 0.0);              // Set the
color to RED  Draw(ptsIni);
matrixSetIdentity(theMatrix);  switch(choice)
 {
 case 1:   Translate(TransDistX , TransDistY ,TransDistZ);
break;  case 2:   Scale(ScaleX, ScaleY, ScaleZ);  break;
case 3:   switch(choiceRot)
 {
case 1: DrawRotLine(); Translate(0,-B,-C);
RotateX(Alpha);
Translate(0,B,C); break;
case 2: DrawRotLine();
Translate(-A,0,-C);
 RotateY(Beta);
Translate(A,0,C);
break;  case 3:
DrawRotLine();
Translate(-A,-B,0);
 RotateZ(Gamma);  Translate(A,B,0);  break;  case 4: DrawRotLine();
float MOD =sqrt((x2-x1)*(x2-x1) + (y2-y11)*(y2-y11) + (z2-z1)*(z2-z1));
aa = (x2-x1)/MOD;  bb = (y2-y11)/MOD;  cc = (z2-z1)/MOD;  Translate(-
x1,-y11,-z1);  float ThetaDash;
 ThetaDash = 1260*atan(bb/cc)/22;
 RotateX(ThetaDash);
 RotateY(1260*asin(-aa)/22);
 RotateZ(Theta);
 RotateY(1260*asin(aa)/22);
 RotateX(-ThetaDash);
 Translate(x1,y11,z1); break;
}
break;
case 4:    Reflect();
break;
}
TransformPoints(); Draw(ptsFin);
glFlush();
}
void init(void)
```

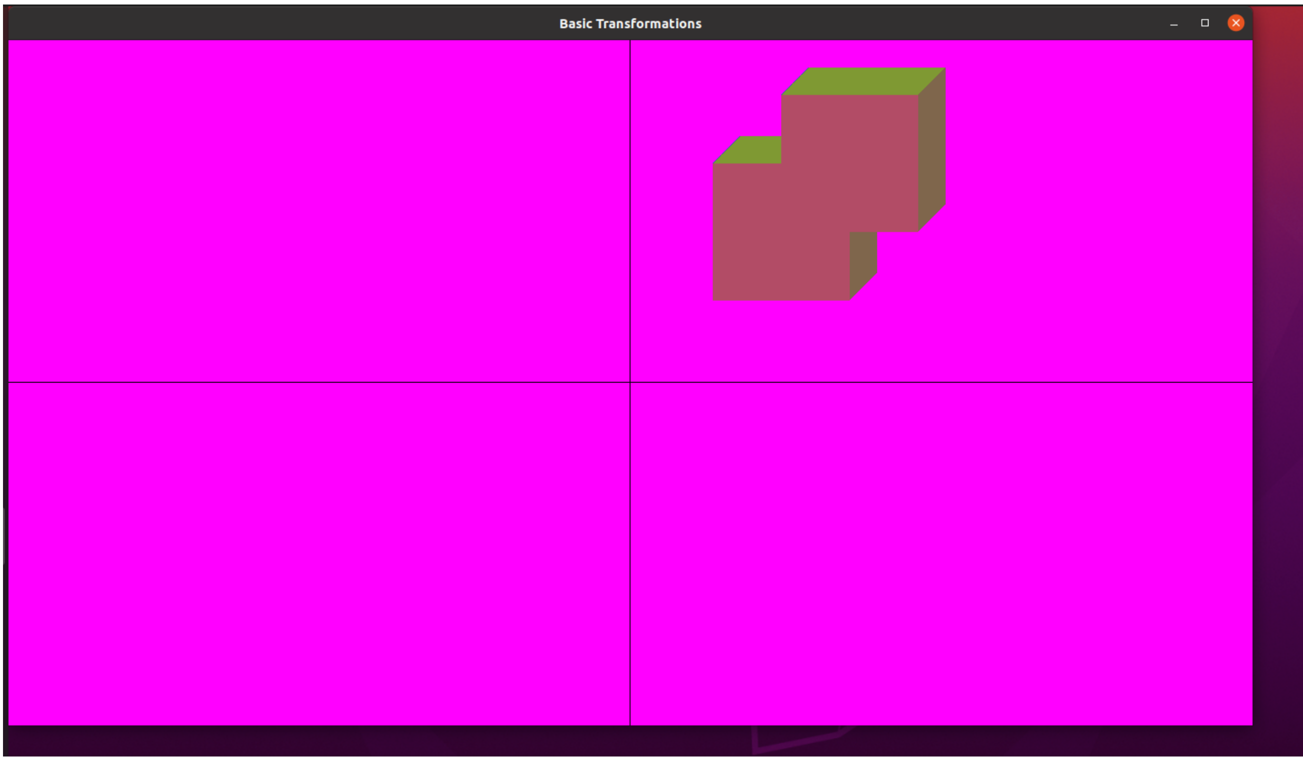
```
 {
 glClearColor (1.0, 1.0, 1.0, 1.0);      // Set the
Background color to WHITE  glOrtho(-454.0, 454.0,
-250.0, 250.0, -250.0, 250.0);
    // Set the no. of Co-ordinates along X & Y axes and their gappings
glEnable(GL_DEPTH_TEST);
    // To Render the surfaces Properly according to their depths
 }
int main (int argc, char *argv)
{
 glutInit(&argc, &argv);
 glutInitDisplayMode (GLUT_SINGLE | GLUT_RGB | GLUT_DEPTH);
glutInitWindowSize (1362, 750);  glutInitWindowPosition (0, 0);
glutCreateWindow (" Basic Transformations ");
 init ();
 printf("Enter your choice
number:\n1.Translation\n2.Scaling\n3.Rotation\n4.Reflection\n=>");
scanf("%d",&choice);  switch(choice)
 {
 case 1:printf("Enter Translation along X, Y & Z\n=>");
scanf("%f%f%f",&TransDistX , &TransDistY , &TransDistZ);  break;

case 2:printf("Enter Scaling ratios along X, Y & Z\n=>");
scanf("%f%f%f",&ScaleX , &ScaleY , &ScaleZ); break;
case 3:printf("Enter your choice for Rotation about axis:\n1.parallel to X-axis.(y=B &
z=C)\n2.parallel to Y-axis.(x=A & z=C)\n3.parallel to Z-axis.(x=A & y=B)\n4.Arbitrary line
passing through (x1,y1,z1) & (x2,y2,z2)\n =>"); //Realign above line while execution
scanf("%d",&choiceRot);  switch(choiceRot)
 {
 case 1:  printf("Enter B & C: ");
scanf("%f %f",&B,&C);  printf("Enter
Rot. Angle Alpha: ");
scanf("%f",&Alpha);  break;  case 2:
printf("Enter A & C: ");  scanf("%f
%f",&A,&C);  printf("Enter Rot.
Angle Beta: ");  scanf("%f",&Beta);
break;  case 3:  printf("Enter A & B:
");  scanf("%f %f",&A,&B);
printf("Enter Rot. Angle Gamma: ");
scanf("%f",&Gamma);
 break;  case 4:  printf("Enter values of x1 ,y1 &
z1:\n");  scanf("%f %f %f",&x1,&y11,&z1);
printf("Enter values of x2 ,y2 & z2:\n");
scanf("%f %f %f",&x2,&y2,&z2);  printf("Enter
Rot. Angle Theta: "); scanf("%f",&Theta);
break;
}
break;
 case 4:     printf("Enter your choice for reflection about plane:\n1.X-Y\n2.Y-
Z\n3.XZ\n=>");  scanf("%d",&choiceRef);  break;  default:    printf("Please enter a
valid choice!!!\n");  return 0;
 }
 glutDisplayFunc(display);
glutMainLoop();
 return 0;
}
------------------------
```

Output are as Follows ; -

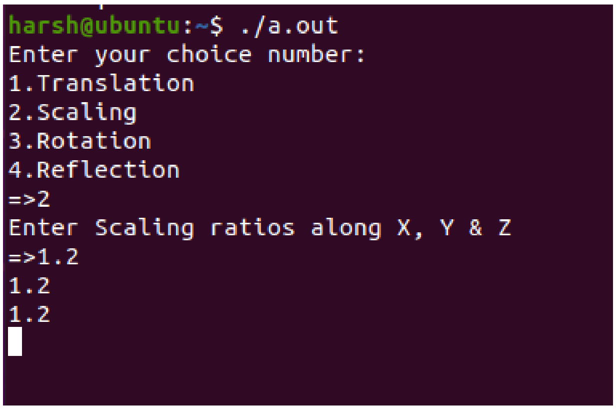
1.) Translation



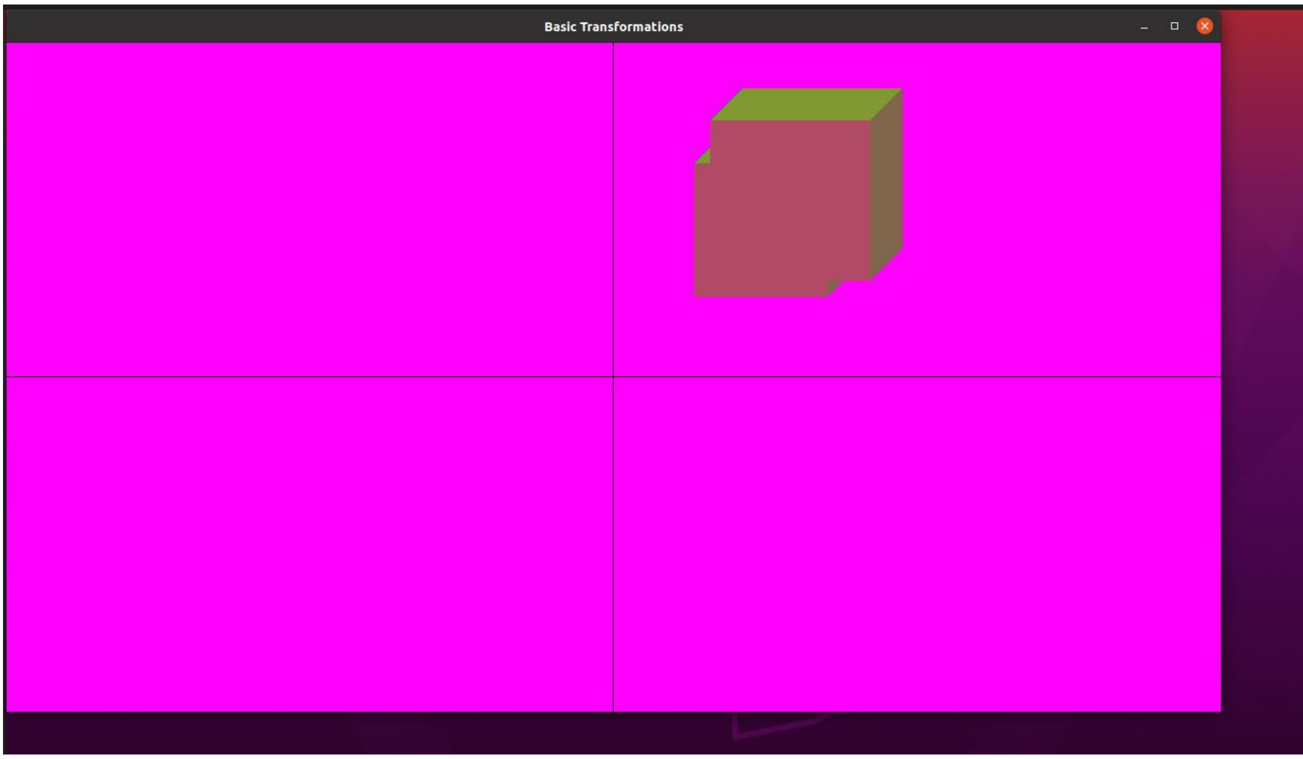
```
harsh@ubuntu:~$ ./a.out
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
4.Reflection
=>1
Enter Translation along X, Y & Z
=>50
50
50
harsh@ubuntu:~$
```



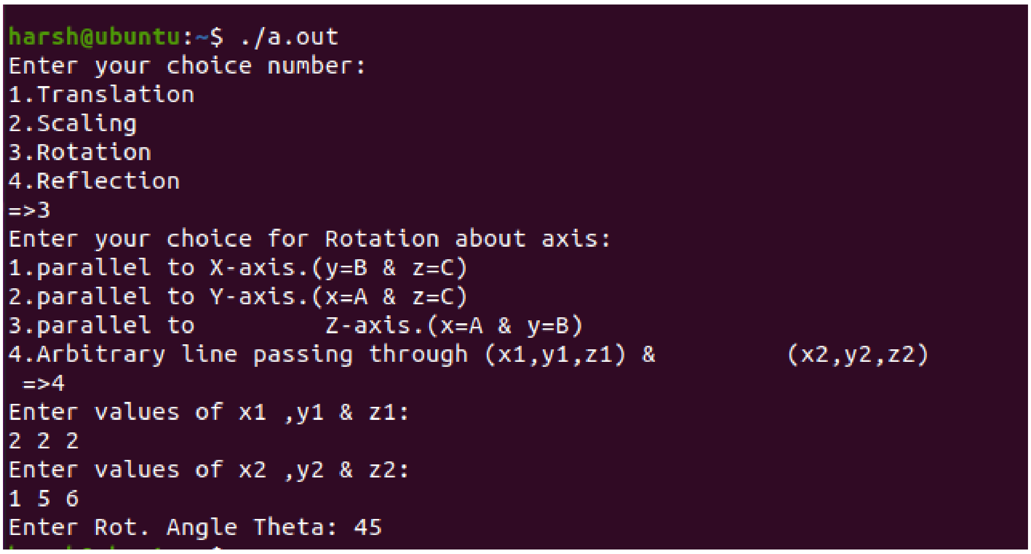
2.) Scaling



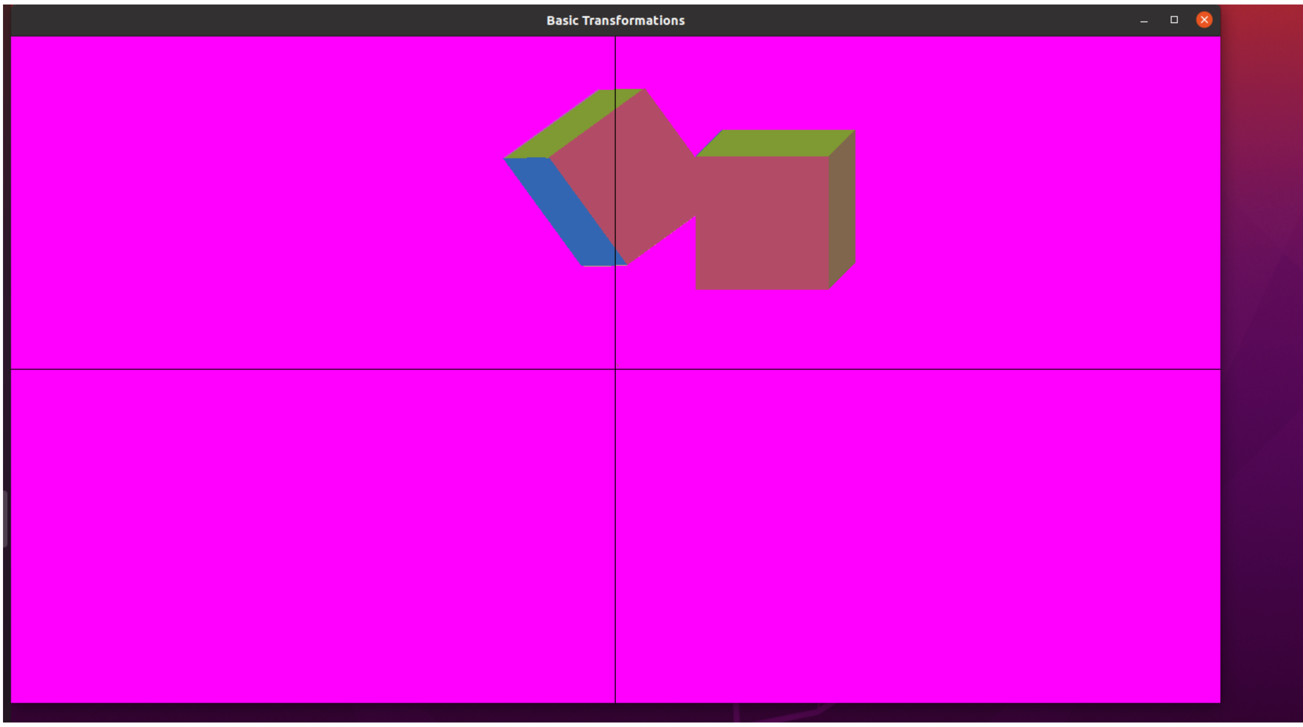
```
harsh@ubuntu:~$ ./a.out
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
4.Reflection
=>2
Enter Scaling ratios along X, Y & Z
=>1.2
1.2
1.2
```



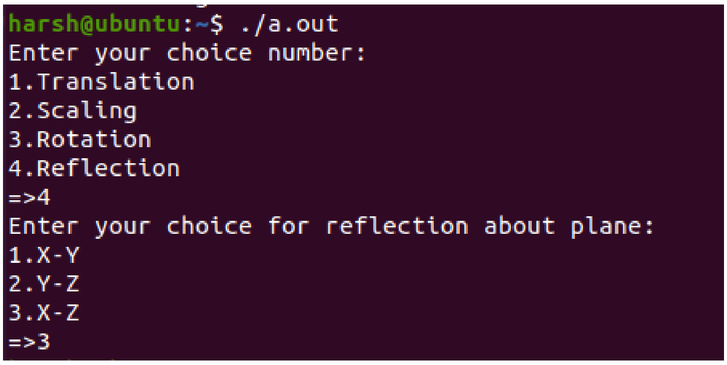
3.) Rotation



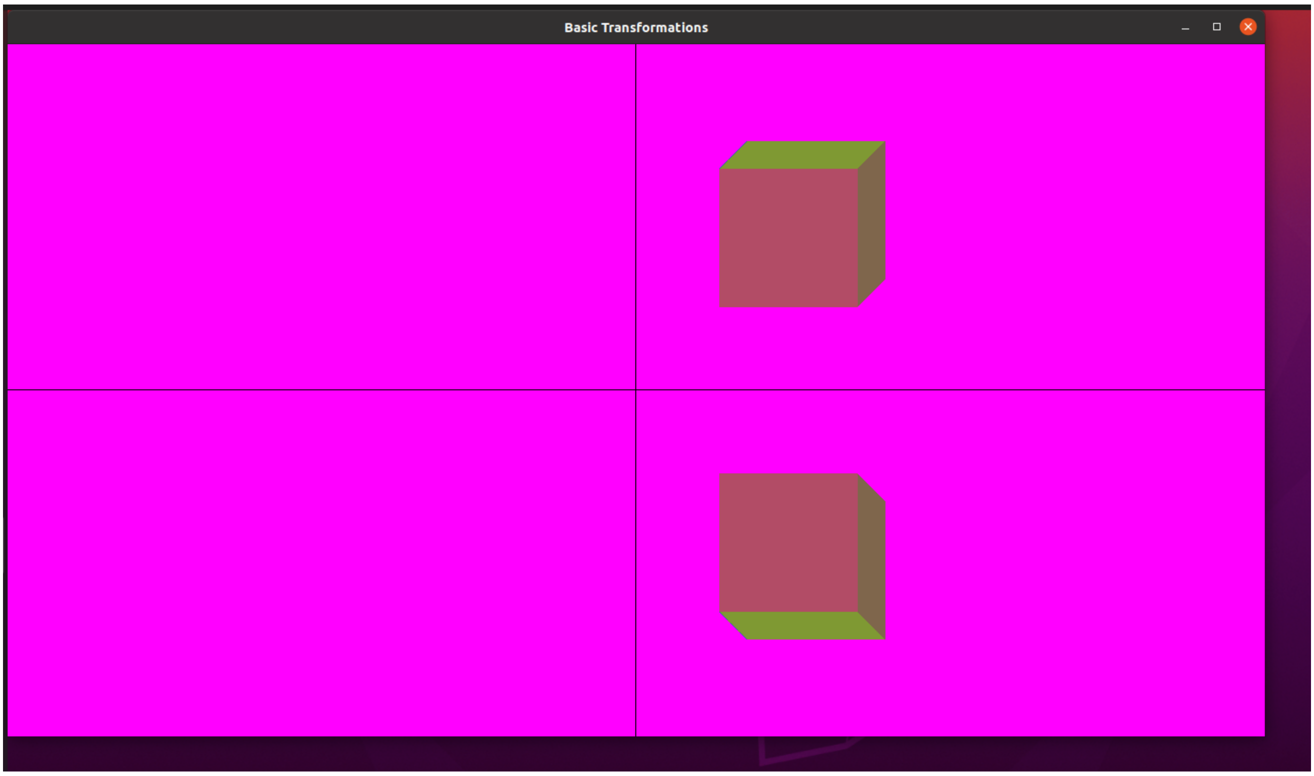
```
harsh@ubuntu:~$ ./a.out
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
4.Reflection
=>3
Enter your choice for Rotation about axis:
1.parallel to X-axis.(y=B & z=C)
2.parallel to Y-axis.(x=A & z=C)
3.parallel to         Z-axis.(x=A & y=B)
4.Arbitrary line passing through (x1,y1,z1) &         (x2,y2,z2)
 =>4
Enter values of x1 ,y1 & z1:
2 2 2
Enter values of x2 ,y2 & z2:
1 5 6
Enter Rot. Angle Theta: 45
```



4.) Reflection



```
harsh@ubuntu:~$ ./a.out
Enter your choice number:
1.Translation
2.Scaling
3.Rotation
4.Reflection
=>4
Enter your choice for reflection about plane:
1.X-Y
2.Y-Z
3.X-Z
=>3
```


Basic Transformations