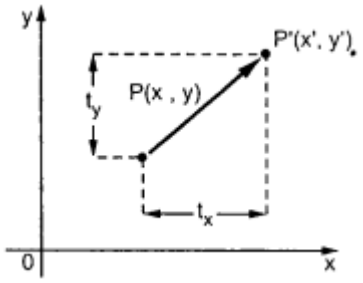
Experiment No. 6

Aim: To implement 2D Transformations: Translation, Scaling, Rotation.

Objective:
To understand the concept of transformation, identify the process of transformation and application of these methods to different object and noting the difference between these transformations.

Theory:
1) Translation –
Translation is defined as moving the object from one position to another position along straight line path. We can move the objects based on translation distances along x and y axis. tx denotes translation distance along x-axis and ty denotes translation distance along y axis.



Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:
x' = x + tx
y' = y + ty
We denote translation transformation as P. we express above equations in matrix form as:
P' = P + T , where

$$P = \begin{bmatrix} x \\ y \end{bmatrix} \quad P' = \begin{bmatrix} x' \\ y' \end{bmatrix} \quad T = \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

Program:

Program for translation:-

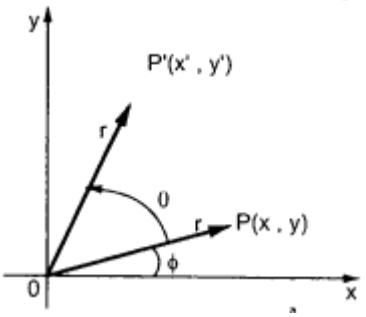
```
#include<stdio.h>

#include<conio.h>

#include<graphics.h>
```

```
#include<math.h>
void main()
{
int gd=DETECT,gm;
int x1,y1,x2,y2,tx,ty,x3,y3,x4,y4;
initgraph(&gd,&gm,"C:\\TurboC3\\BGI");
printf("Enter the starting point of line segment:");
scanf("%d %d",&x1,&y1);
printf("Enter the ending point of line segment:");
scanf("%d %d",&x2,&y2);
printf("Enter translation distances tx,ty:\n");
scanf("%d%d",&tx,&ty);
setcolor(5);
line(x1,y1,x2,y2);
outtextxy(x2+2,y2+2,"Original line");
x3=x1+tx;
y3=y1+ty;
x4=x2+tx;
y4=y2+ty;
setcolor(7);
line(x3,y3,x4,y4);
outtextxy(x4+2,y4+2,"Line after translation");
getch();
}
```

Output –

2) Rotation –

A rotation repositions all points in an object along a circular path in the plane centered at the pivot point. We rotate an object by an angle theta. New coordinates after rotation depend on both x and y.



$$x' = x\cos\theta - y\sin\theta$$
$$y' = x\sin\theta + y\cos\theta$$

The above equations can be represented in the matrix form as given below

$$[x'\ y'] = [x\ \ y]\begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

$$P' = P \cdot R$$

where R is the rotation matrix and it is given as

$$R = \begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

Program:

Program for rotation:-

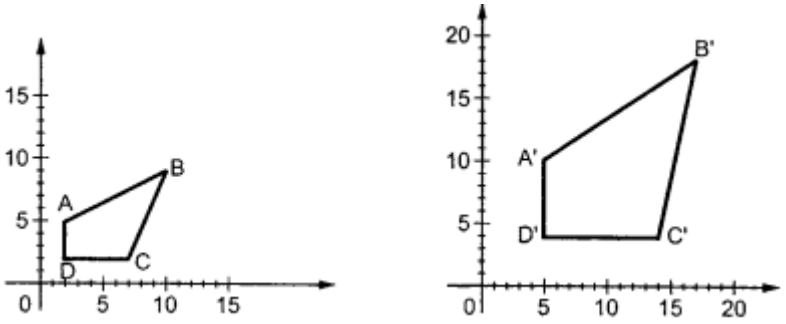
```
#include<stdio.h>
#include<conio.h>
#include<graphics.h>
#include<math.h>
void main()
{
int gd=DETECT,gm;
float x1,y1,x2,y2,x3,y3,x4,y4,a,t;
initgraph(&gd,&gm,"C:\\TurboC3\\BGI");
printf("Enter coordinates of starting point:\n");
```

```
scanf("%f%f",&x1,&y1);
printf("Enter coordinates of ending point\n");
scanf("%f%f",&x2,&y2);
printf("Enter angle for rotation\n");
scanf("%f",&a);
setcolor(5);
line(x1,y1,x2,y2);
outtextxy(x2+2,y2+2,"Original line");
t=a*(3.14/180);
x3=(x1*cos(t))-(y1*sin(t));
y3=(x1*sin(t))+(y1*cos(t));
x4=(x2*cos(t))-(y2*sin(t));
y4=(x2*sin(t))+(y2*cos(t));
setcolor(7);
line(x3,y3,x4,y4);
outtextxy(x3+2,y3+2,"Line after rotation");
getch();
}
```

Output:

3) Scaling -

scaling refers to changing the size of the object either by increasing or decreasing. We will increase or decrease the size of the object based on scaling factors along x and y-axis.



If (x, y) are old coordinates of object, then new coordinates of object after applying scaling transformation are obtained as:

x' = x * Sx

y' = y * Sy

Sx and Sy are scaling factors along x-axis and y-axis. we express the above equations in matrix form as:

$$[x' \; y'] = [x \; y] \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$$
$$= [x \cdot S_x \quad y \cdot Sy]$$
$$= P \cdot S$$

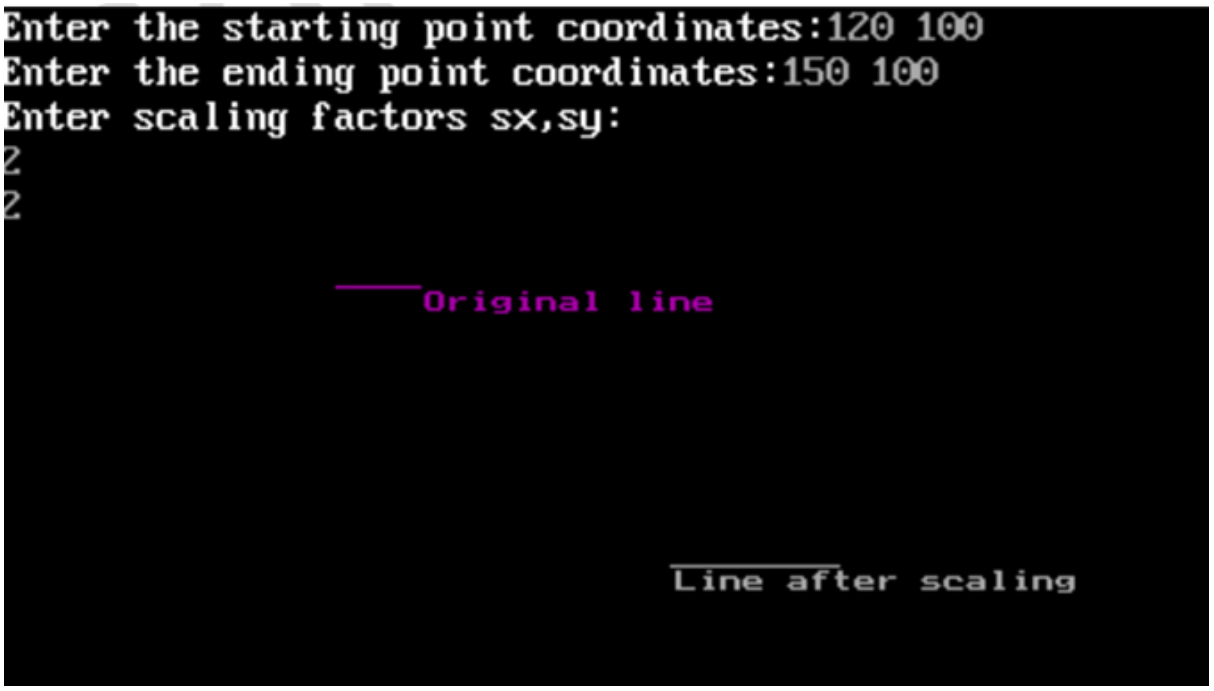
Program:

Program for scaling:-

```
#include<stdio.h>
#include<conio.h>
#include<graphics.h>
#include<math.h>
void main()
{
int gd=DETECT,gm;
float x1,y1,x2,y2,sx,sy,x3,y3,x4,y4;
initgraph(&gd,&gm,"C:\\TurboC3\\BGI");
printf("Enter the starting point coordinates:");
scanf("%f %f",&x1,&y1);
printf("Enter the ending point coordinates:");
scanf("%f %f",&x2,&y2);
printf("Enter scaling factors sx,sy:\n");
scanf("%f%f",&sx,&sy);
setcolor(5);
line(x1,y1,x2,y2);
outtextxy(x2+2,y2+2,"Original line");
```

```
x3=x1*sx;

y3=y1*sy;

x4=x2*sx;

y4=y2*sy;

setcolor(7);

line(x3,y3,x4,y4);

outtextxy(x3+2,y3+2,"Line after scaling");

getch();

}
```

Output -



Conclusion: Comment on :

1. Application of transformation
2. Difference noted between methods
3. Application t different object

1. Application of Transformation: Transformation is a fundamental concept in computer graphics used to change the position, size, orientation, or appearance of objects in a 2D or 3D space. Transformations are applied to achieve various visual effects, such as scaling, rotation, translation, and shearing. They play a crucial role in rendering realistic graphics and animations.

2. Difference Noted Between Methods: There are different methods for applying transformations in computer graphics, including matrix transformations, geometric transformations, and affine transformations. The choice of method depends on the specific requirements of the graphics task. For example, matrix transformations are more versatile and allow combining multiple transformations efficiently, while geometric transformations are simpler and may be used for specific tasks like rotation or scaling.

3. Application to Different Objects: Transformations can be applied to a wide range of objects and elements in computer graphics, including:

- 2D and 3D objects: For resizing, rotating, and repositioning geometric shapes and models.
- Images and textures: To apply distortions, reflections, and other visual effects.
- Cameras and viewpoints: For changing the perspective and view of a scene.
- Animations and characters: To create dynamic and lifelike movements.

Overall, transformations are versatile and are used to manipulate and enhance the appearance and behavior of various objects in the world of computer graphics.