Experiment No. 6
Implement 2D Transformations: Translation, Scaling, Rotation.
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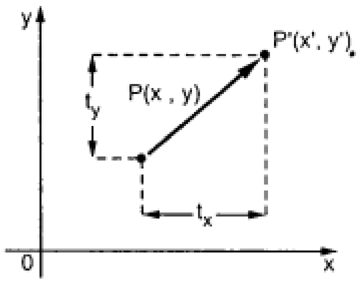
Date of Performance:
Date of Submission:

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.



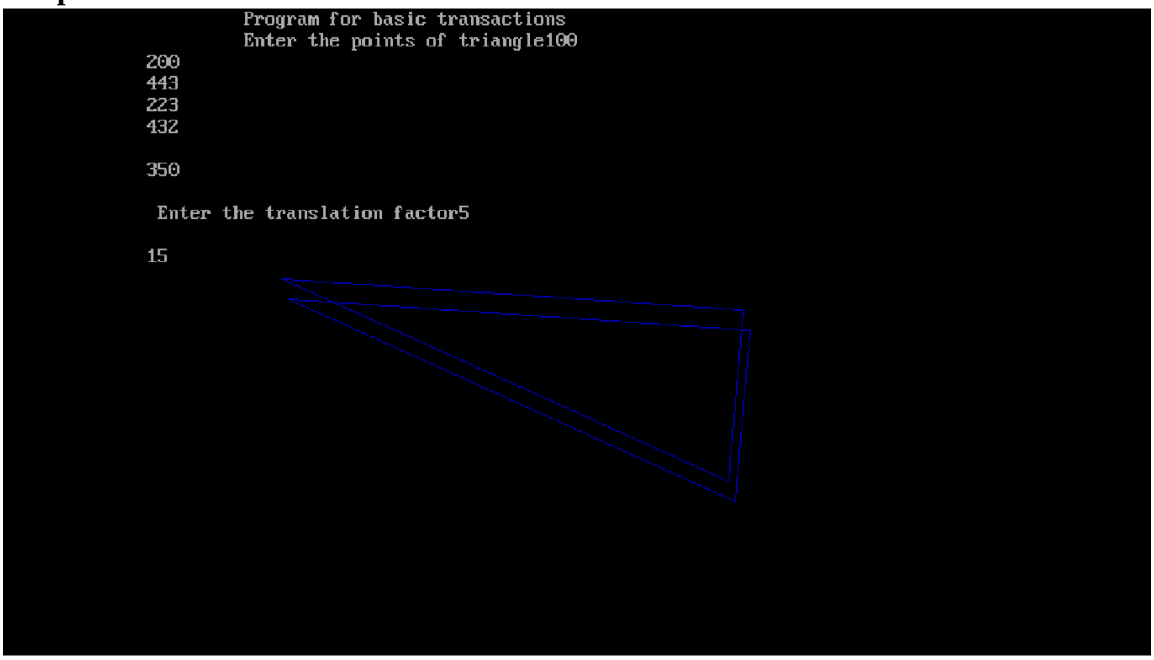
Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:
x' = x + tx
y' = y + ty
We denote translation transformation as P. we express above equations in matrix form as:
P' = P + T , where

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

Program:
```
#include <graphics.h>
#include <stdlib.h>
#include <stdio.h>
#include <conio.h>
#include<math.h>
int main()
{
	int gm;
	int gd=DETECT;
	int x1,x2,x3,y1,y2,y3,nx1,nx2,nx3,ny1,ny2,ny3,c;
	int sx,sy,xt,yt,r;
```

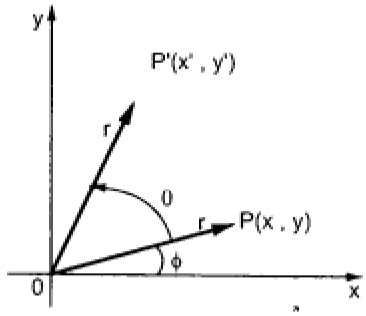
```
        float t;
        initgraph(&gd,&gm,"C:\\TurboC3\\BGI");
        printf("\t Program for basic transactions");
        printf("\n\t Enter the points of triangle");
        setcolor(1);
        scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
        line(x1,y1,x2,y2);
        line(x2,y2,x3,y3);
        line(x3,y3,x1,y1);
        printf("\n Enter the translation factor");
        scanf("%d%d",&xt,&yt);
         nx1=x1+xt;
         ny1=y1+yt;
         nx2=x2+xt;
         ny2=y2+yt;
         nx3=x3+xt;
         ny3=y3+yt;
         line(nx1,ny1,nx2,ny2);
         line(nx2,ny2,nx3,ny3);
         line(nx3,ny3,nx1,ny1);
 getch();
 closegraph();
}
```

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

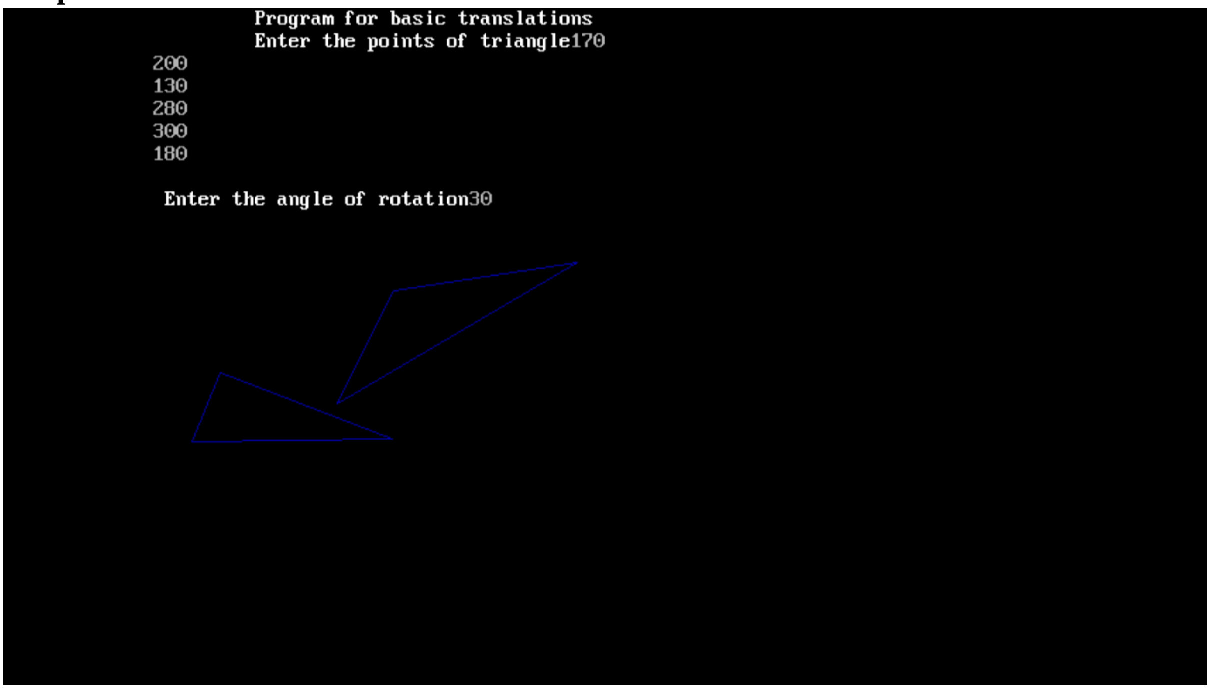
$$R = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

Program:

```
#include <graphics.h>
#include <stdlib.h>
#include <stdio.h>
#include <conio.h>
#include<math.h>
int main()
{
	int gm;
	int gd=DETECT;
	int x1,x2,x3,y1,y2,y3,nx1,nx2,nx3,ny1,ny2,ny3,c;
	int sx,sy,xt,yt,r;
	float t;
	initgraph(&gd,&gm,"C:\\TurboC3\\BGI ");
	printf("\t Program for basic transactions");
	printf("\n\t Enter the points of triangle");
	setcolor(1);
	scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
	line(x1,y1,x2,y2);
	line(x2,y2,x3,y3);
```

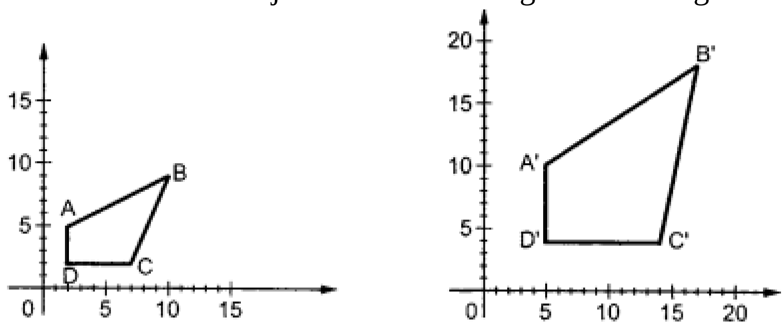
```
        line(x3,y3,x1,y1);
 printf("\n Enter the angle of rotation");
                        scanf("%d",&r);
                        t=3.14*r/180;
                        nx1=abs(x1*cos(t)-y1*sin(t));
                        ny1=abs(x1*sin(t)+y1*cos(t));
                        nx2=abs(x2*cos(t)-y2*sin(t));
                        ny2=abs(x2*sin(t)+y2*cos(t));
                        nx3=abs(x3*cos(t)-y3*sin(t));
                        ny3=abs(x3*sin(t)+y3*cos(t));
                        line(nx1,ny1,nx2,ny2);
                        line(nx2,ny2,nx3,ny3);
                        line(nx3,ny3,nx1,ny1);
                        getch();
  closegraph();
return 0;
}
```

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:

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

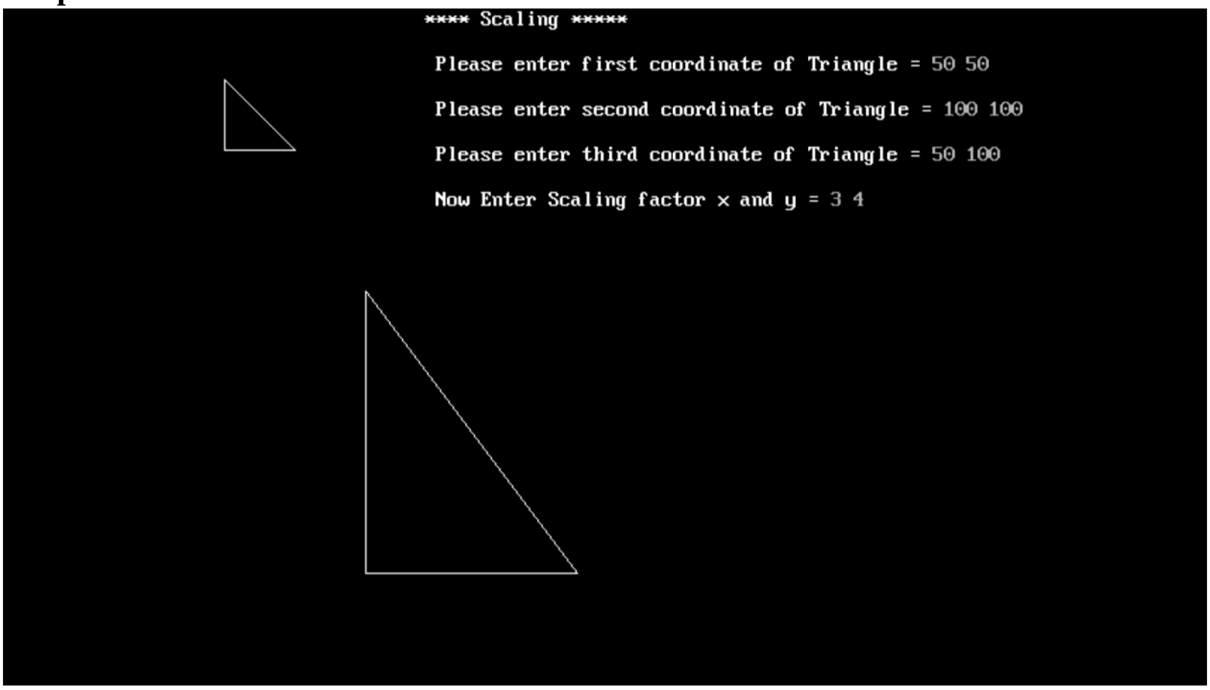
Program:

```
#include<stdio.h>
#include<conio.h>
#include<graphics.h>
void main(){
int x,y,x1,y1,x2,y2;
int scl_fctr_x,scl_fctr_y;
int gd=DETECT,gm;
initgraph(&gd,&gm,"C:\\TURBOC3\\BGI");
printf("\t\t\t**** Scaling *****\n");
printf("\n\t\t\t Please enter first coordinate of Triangle = ");
scanf("%d %d",&x,&y);
printf("\n\t\t\t Please enter second coordinate of Triangle = ");
scanf("%d %d",&x1,&y1);
printf("\n\t\t\t Please enter third coordinate of Triangle = ");
scanf("%d %d",&x2,&y2);
line(x,y,x1,y1);
line(x1,y1,x2,y2);
line(x2,y2,x,y);
```

```
printf("\n\t\t\t Now Enter Scaling factor x and y = ");
scanf("%d %d",&scl_fctr_x,&scl_fctr_y);
x = x* scl_fctr_x;
x1 = x1* scl_fctr_x;
x2 = x2* scl_fctr_x;
y = y* scl_fctr_y;
y1 = y1* scl_fctr_y;
y2= y2 * scl_fctr_y ;

line(x,y,x1,y1);
line(x1,y1,x2,y2);
line(x2,y2,x,y);
getch();
closegraph();
}
```

Output -



Conclusion:

Comment on -
Transformations in computer graphics (scaling, rotation, translation, skewing) are essential for manipulating and rendering objects. They enable dynamic visual effects, positioning, and distortion. They are vital for 3D rendering and animation, crucial in video games, simulations, and special effects.

Matrix-based transformations use matrices for efficient application of transformations. Geometric transformations are simpler but less versatile, relying on direct geometric calculations. Both approaches have their strengths, contributing to immersive visual experiences in computer graphics.