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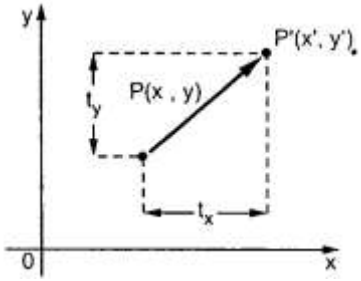
Date of Performance:
Date of Submission:

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.



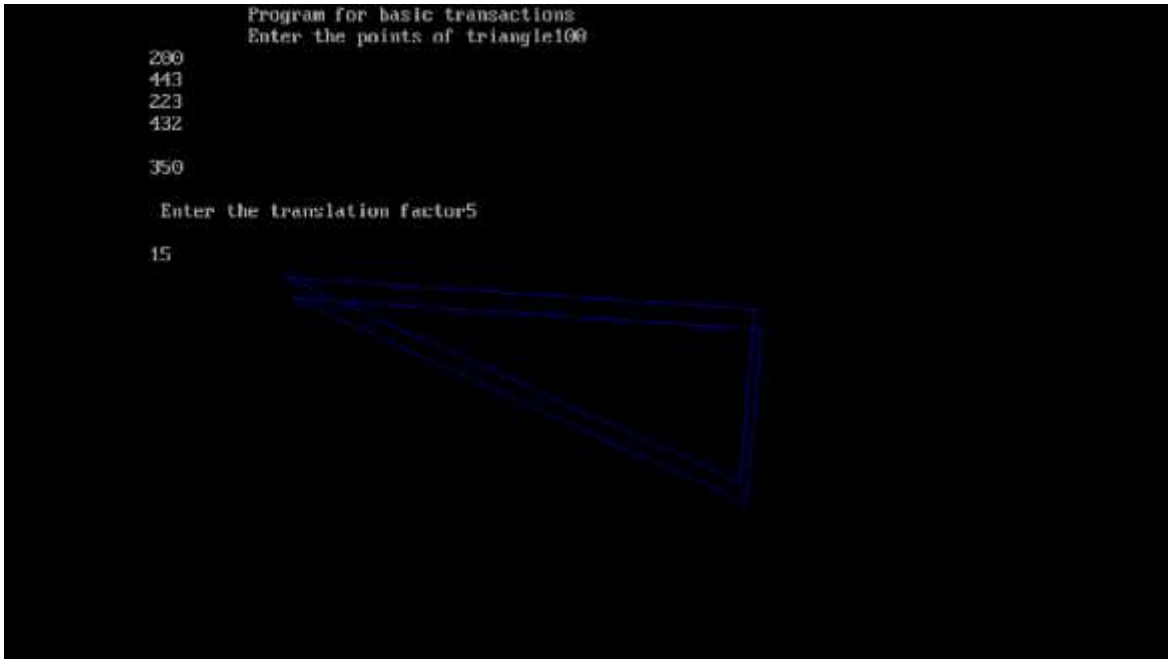
Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:
x' = x + tx
y' = y + ty
We denote translation transformation as P. we express above equations in matrix form as:
P' = P + T , where

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

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;
```

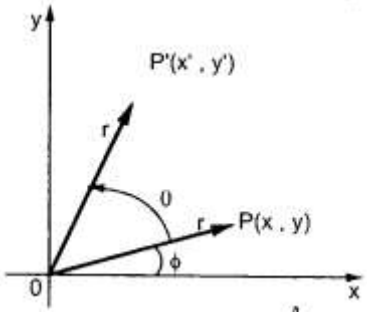
```
        float t;
        initgraph(&gd,&gm,"C:\\TurboC3\\BGI");
        printf("\t Program for basic transactions");
        printf("\n\t Enter the points of triangle");
        setcolor(1);
        scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
        line(x1,y1,x2,y2);
        line(x2,y2,x3,y3);
        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

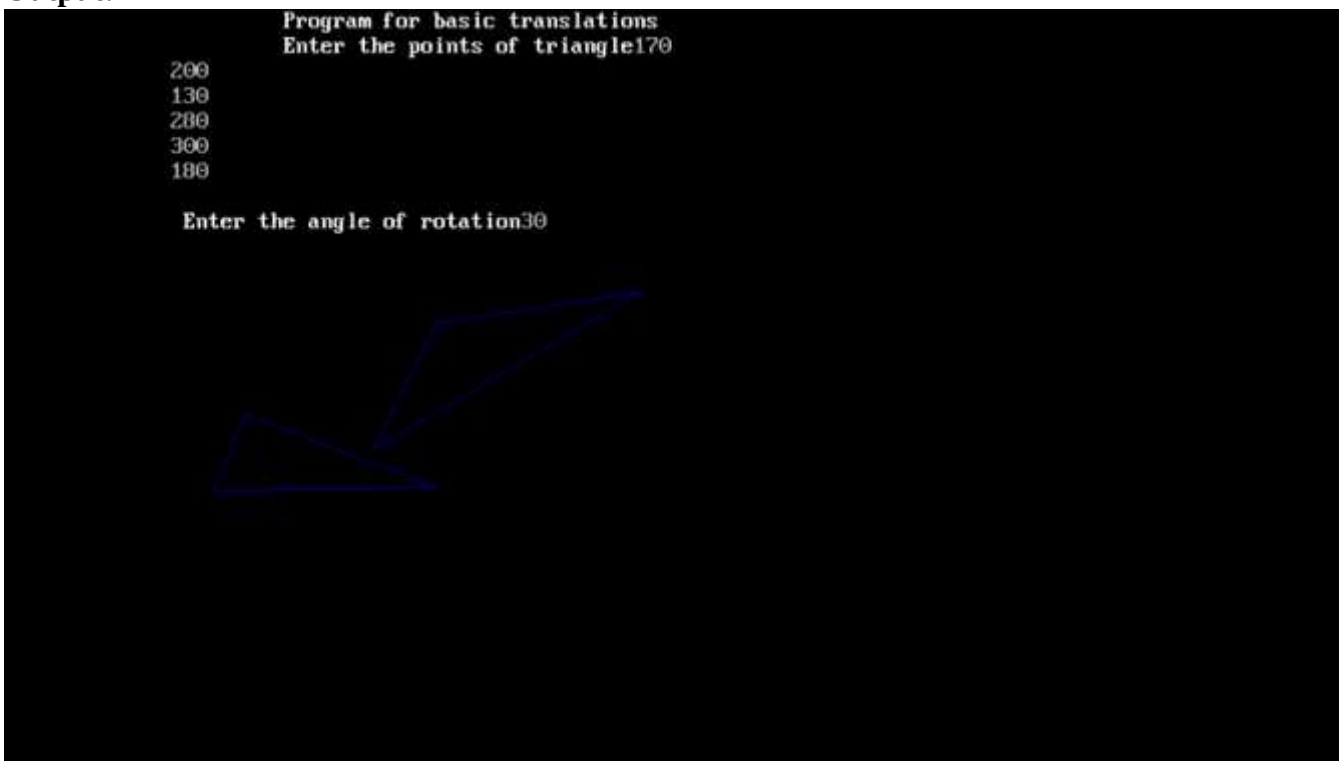
$$R = \begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

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);
```

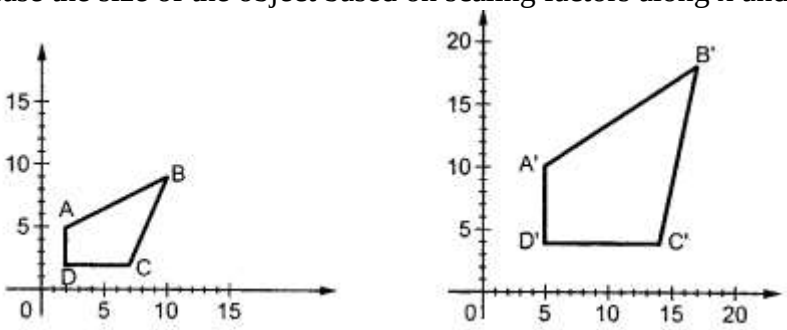
```
        line(x2,y2,x3,y3);
        line(x3,y3,x1,y1);
 printf("\n Enter the angle of rotation");
                        scanf("%d",&r);
                        t=3.14*r/180;
                        nx1=abs(x1*cos(t)-y1*sin(t));
                        ny1=abs(x1*sin(t)+y1*cos(t));
                        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:

$$[x' \; y'] = [x \; y] \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$$

$$= [x \cdot S_x \quad y \cdot Sy]$$

$$= P \cdot S$$

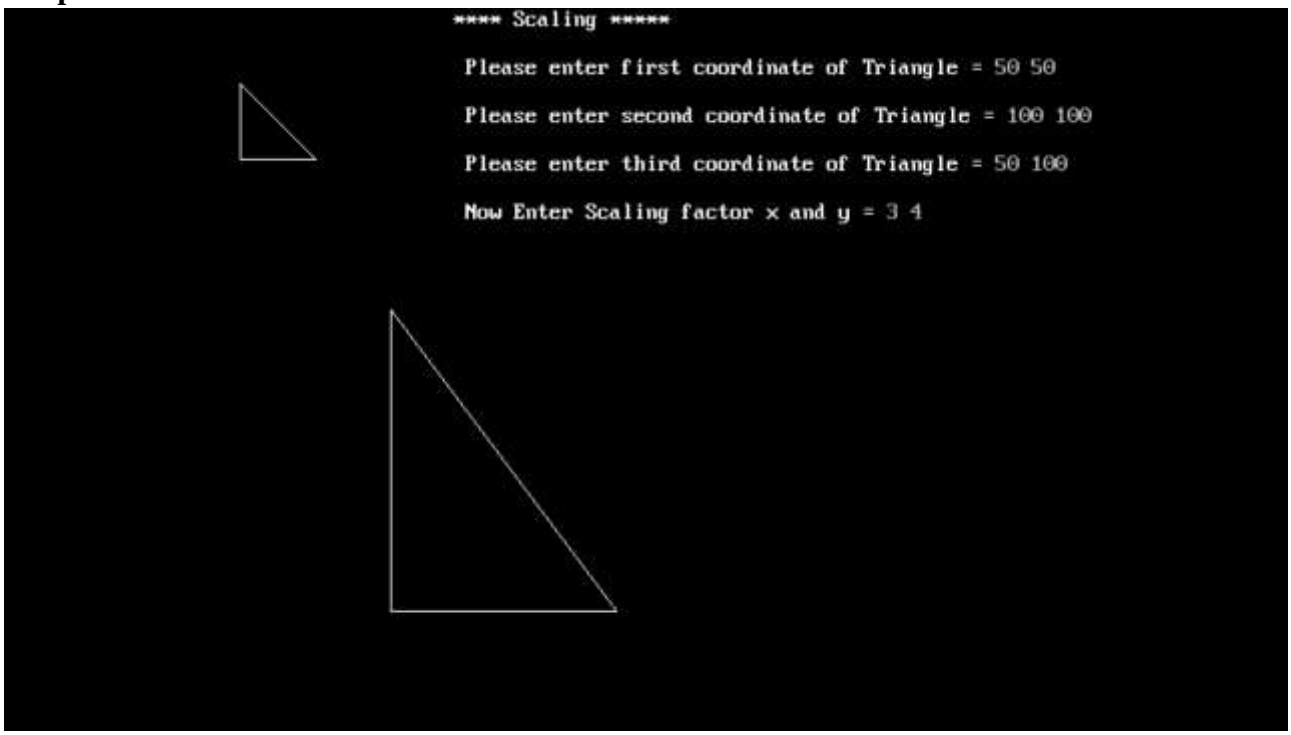
Program:

```
#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:

Transformations form the bedrock of computer graphics, serving as the linchpin for the manipulation and presentation of objects in diverse manners. Their indispensability is evident in various critical functions, including scaling, rotation, translation, and skewing. Scaling permits the resizing of objects, while rotation introduces dynamic and captivating visual effects. Translation, on the other hand, ensures precise positioning of objects within a given scene. Skewing, a more artistic tool, adds distortions for the sake of perspective or aesthetic impact.

These transformations extend their reach into the domain of 3D rendering, where they are pivotal in the process of projecting three-dimensional scenes onto two-dimensional screens. Their contribution doesn't stop there; they are the underpinning for animation, seamlessly guiding transitions between different states. This attribute makes transformations indispensable in arenas like video games, simulations, and the creation of special effects in the film industry.

Furthermore, matrix-based transformations provide an efficient methodology. By representing transformations through matrices, they allow for the effective blending and application of multiple transformations to objects.

Conversely, geometric transformations opt for direct geometric calculations, simplifying the conceptual approach but potentially limiting their versatility when compared to matrix-based techniques.