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Experiment No - 7

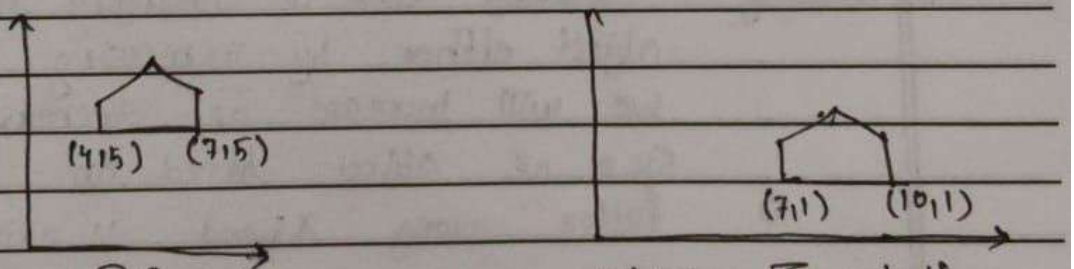
Aim → Implement 2D Transformation : Translation scaling, Rotation, Reflection, shearing.

Resources Required → Turbo C, Wordpad, ~~Notepad~~ pointer

Theory : We have to perform 2D transformation on 2D object. Here we perform transformation on line segment.

The 2D Transformation are → 1) Translation
2) Scaling
3) Rotation.

1) **Translation →** Translation is defined as moving object from one position to another position along straight line path.



Before Translation

After Translation.

We can move the object based on translation distances along x and y axis. tx denotes translation distance along x - axis and ty denotes translation distance along y - axis.

Translation Distance → It is nothing but how much unit we should translate the object from one point to another along x-y axis.

Consider (x, y) are old coordinates of point A. Then the new coordinates of that same point (x', y') can be obtained as follows →

$x' = x + tx$

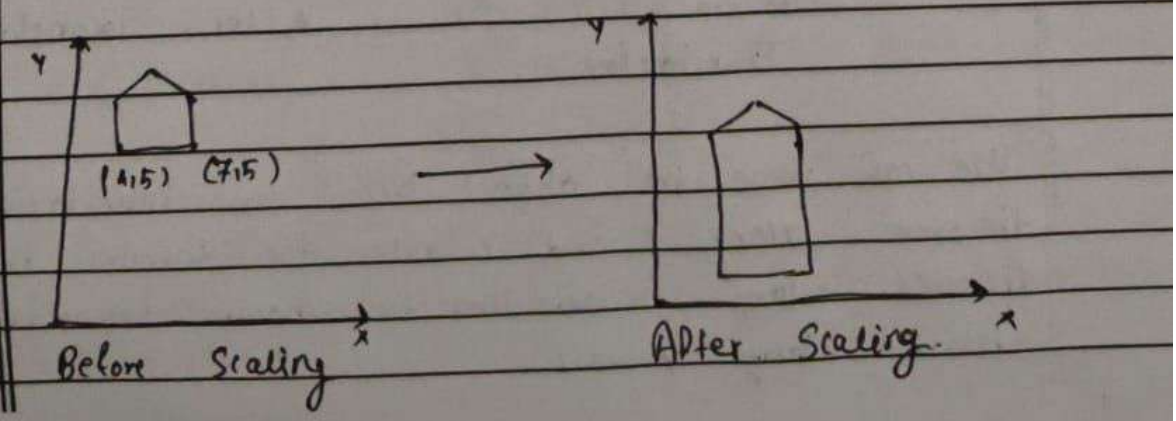
$y' = y + ty$

We denote translation transformation as P.

$P' = P + T$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} tx \\ ty \end{bmatrix}$$

2] Scaling → Scaling refer to changing the size of object either by increasing or decreasing we will increase or decrease the size of object based on scaling factor along x and y axis.



If (x,y) are old coordinate of object & the new coordinate of object after applying scaling transformation as as follows →

$X_2 = X_1 * S_x$ {S_x and S_y are scaling factors along X-axis and Y-axis.}
$Y_2 = Y_1 * S_y$

$$\begin{bmatrix} X_2 \\ Y_2 \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} X_1 \\ Y_1 \end{bmatrix}$$

3) ~~Rotation → A rotation is defined~~

3) Rotation → It is defined as repositioning of all points of an object in a plane along ~~ator~~ a circular path plane centred at pivot point. We rotate an object by an angle theta (θ).

New Coordinate after rotation depend on both X and Y.

$X_2 = X_1 \cos\theta - Y_1 \sin\theta$
$Y_2 = X_1 \sin\theta + Y_1 \cos\theta$

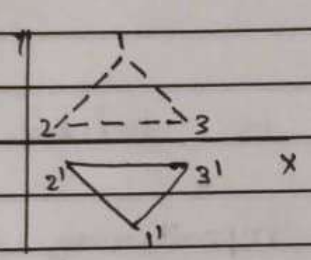
or Matrix form →

$$\begin{bmatrix} X_2 \\ Y_2 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} X_1 \\ Y_1 \end{bmatrix}$$

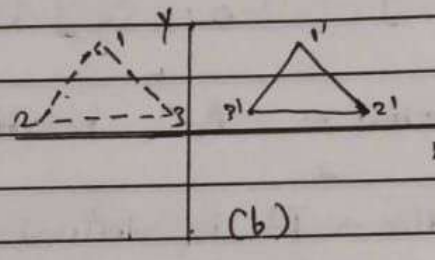
Conclusion → Implementation for 2D transformation is done for rotation, scaling and translation which helps us move, rotate and change shapes easily.

4) Reflection → Reflection is the mirror image of original objects. In other words, we can say that it is a rotation operation with 180°. In reflection transformation, the size of the object does not change.

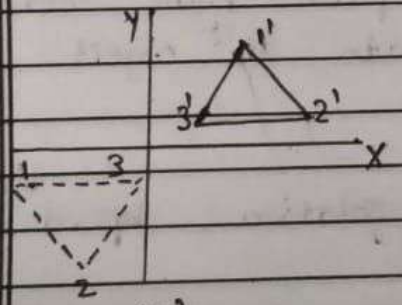
The following figures ~~with~~ show reflection w.r.t. X and Y. axes →



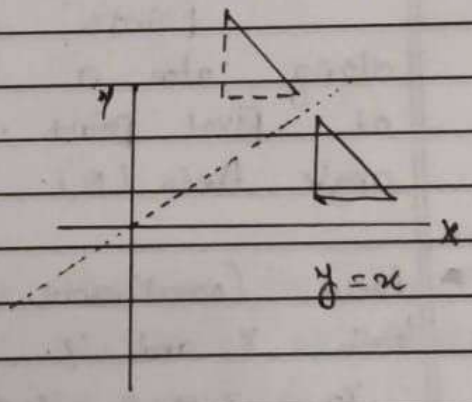
(a)



(b)



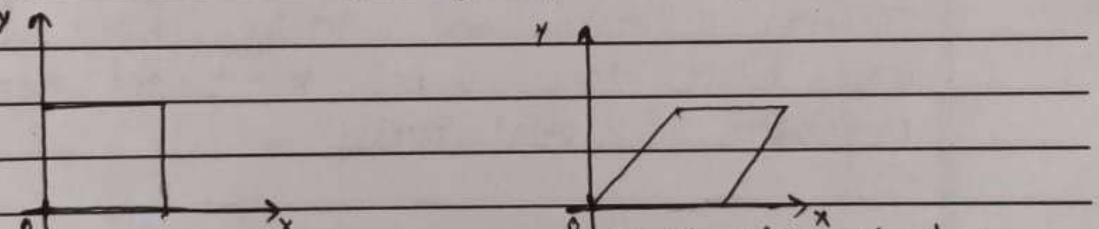
(c)



5) Shear → A transformation that slants the shape of an object is called the shear transformation. There are two shear transformation X-Shear and Y shear

2) Shear → A transformation that slants the shape of an object is called the shear transformation. There are two shear transformations X-Shear and Y-Shear. One shifts X coordinates value and other shifts Y coordinate values. However, in both the cases only one coordinate change its coordinates other preserves its values. Shearing is also termed as skewing.

i) X-shear preserves the Y coordinate and changes are made to X-coordinates, which causes the vertical lines to tilt right or left as shown in figure



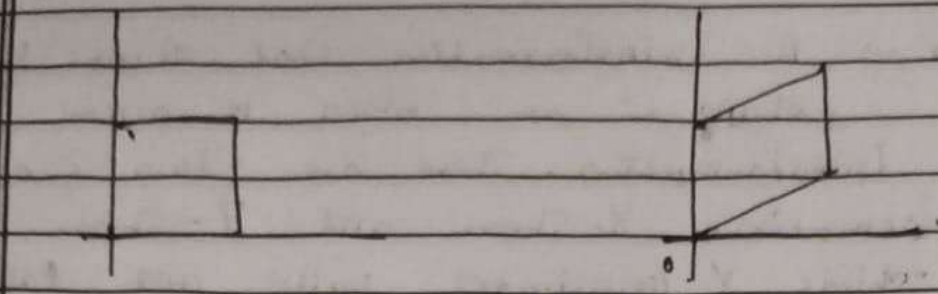
(a) Original Object (b) Object after X-shear.

The transformation can be represented as →

$X' = X + Shx \cdot Y$

$y' = y$

ii) Y shear preserves the X coordinates and changes the Y coordinates which causes the horizontal lines to transform into lines which slopes up or down as shown in the following figure →



(a) Orisinal Object (b) Object after y shear

The Y - Shear can be represented as →

$Y' = Y + Shy \cdot X$

$X' = X$.

Conclusion → Implementation for 2-D transformation is done for ~~rotat~~ translation, rotation, scaling, reflection and scaling which helps us move, rotate, change shape, reflect and shear the coordinates of object easily.