1811000116 Deepraj Bhosale
Batch-A

CG Tutorial - 5

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1. Initial Line :

(0,0) ; (3,5)

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-0}{3-0} = 1.6$$

$|m| > 1$

$\therefore x_{k+1} = x_k + 1/m \; ; \; y_{k+1} = y_k + 1$

$(x_0, y_0) = 0,0$

$x_1 = x_0 + 1/m = 0 + 0.63 = 0.63$

$y_1 = y_0 + 1 = 1$

$(x_1, y_1) = 0,1$

$(x_2, y_2) = (1,2)$

$(x_3, y_3) = (2,3)$

$(x_4, y_4) = (3,4)$

$(x_5, y_5) = (3,5)$

(a) Translation matrix :

$$T = \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}$$

Scaling Matrix

$$S = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$\therefore$ Transformation matrix

$$T' = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & -4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 3 & 0 & -6 \\ 0 & 2 & -4 \\ 0 & 0 & 1 \end{bmatrix}$$

Now Points are

$$\begin{bmatrix} x_1 \\ y_1 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 & 0 & -6 \\ 0 & 2 & -4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} -6 \\ -2 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x_2 \\ y_2 \\ 1 \end{bmatrix} = \begin{bmatrix} -3 \\ 0 \\ 1 \end{bmatrix} \quad \therefore \begin{bmatrix} x_4 \\ y_4 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 4 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x_3 \\ y_3 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 8 \\ 1 \end{bmatrix} \quad \therefore \begin{bmatrix} x_5 \\ y_5 \\ 1 \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \\ 1 \end{bmatrix}$$

(b) Translation Matrix

$$T = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

∴ New points are

$$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix} + \begin{bmatrix} 2 \\ 3 \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} x_2 \\ y_2 \end{bmatrix} = \begin{bmatrix} 5 \\ 5 \end{bmatrix} \quad \begin{bmatrix} x_3 \\ y_3 \end{bmatrix} = \begin{bmatrix} 4 \\ 6 \end{bmatrix} \quad \begin{bmatrix} x_4 \\ y_4 \end{bmatrix} = \begin{bmatrix} 5 \\ 7 \end{bmatrix}$$

$$\begin{bmatrix} x_5 \\ y_5 \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \end{bmatrix}$$

(c) Rotation Matrix

$$R = \begin{bmatrix} \cos 60 & -\sin 60 \\ \sin 60 & \cos 60 \end{bmatrix} = \begin{bmatrix} 0.5 & -0.86 \\ 0.87 & 0.5 \end{bmatrix}$$

∴ New Points are :-

$$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} 0.5 & -0.9 \\ 0.9 & 0.5 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} -0.9 \\ 0.5 \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} x_2 \\ y_2 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix} \quad \begin{bmatrix} x_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} -2 \\ 3 \end{bmatrix} \quad \begin{bmatrix} x_4 \\ y_4 \end{bmatrix} = \begin{bmatrix} 2 \\ 5 \end{bmatrix} \quad \begin{bmatrix} x_5 \\ y_5 \end{bmatrix} = \begin{bmatrix} 2 \\ 6 \end{bmatrix}$$

2. (a) Relationship Matrix :

$$R = \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 0 \\ 1/\sqrt{2} & 1/\sqrt{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$A' = RA = R \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$A' = (0,0)$$

$$B' = RB = R \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ \sqrt{2} \\ 1 \end{bmatrix}$$

$$B' = (0, \sqrt{2}) = (0,1)$$

$$C' = RC = R \begin{bmatrix} 5 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 3/\sqrt{2} \\ 7/\sqrt{2} \\ 1 \end{bmatrix}$$

$$C' = (3/\sqrt{2}, 7/\sqrt{2}) = (2,5)$$

(b) Rotation Matrix

$$R = \begin{bmatrix} \cos 45 & -\sin 45 & (1-\cos 45)+\sin 45 \\ \sin 45 & \cos 45 & 1-\cos 45-\sin 45 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 1 \\ 1/\sqrt{2} & 1/\sqrt{2} & 1-\sqrt{2} \\ 0 & 0 & 1 \end{bmatrix}$$

$$A' = RA = R \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1-\sqrt{2} \\ 1 \end{bmatrix}$$

$$A' = (1, 1-\sqrt{2}) = (1,0)$$

$$B' = RB = R \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

$$\therefore B' = (1,1)$$

$$e' = Re = R\begin{bmatrix} 5 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 3/\sqrt{2} + 1 \\ 9/\sqrt{2} + 1 \\ 1 \end{bmatrix}$$

$e' = (3, 3)$