CSE 423 – Computer Graphics

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Two dimensional transformation

- Translation
- Scaling
- Rotation

Translation

- Moving object from one position to another position
- Change the position of objects
- Parameters for translation are:
  - t_x - if we move the position with respect to x – axis
  - t_y - If we move the position with respect to y – axis

Calculate Translation

If we have –

- Original point is $P(x, y)$
- Translated parameters are t_x and t_y
- Object translated point is $P'(x', y')$

Matrix representation

$$[x'y'] = [x\ y] + [t_x\ t_y]$$

Or,

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

Then,

Translated x – axis is measured by $x' = t_x + x$

Translated y – axis is measured by $y' = t_y + y$

Scaling

- Resizing the object
- Do maximizing and minimizing the object
- Parameters for scaling are:
  - s_x - if we move the position with respect to x – axis
  - s_y - If we move the position with respect to y – axis

Property	**Result**
In between 0 and 1	Point is closer to origin and size will be decreased
s_x and s_y are greater than 1	Point is away from origin and size will be increase
s_x = s_y	Uniformly increases or decreases

Calculate Scaling

If we have –

- Original point is $P(x, y)$
- Scaled parameters are s_x and s_y
- Object scaled point is $P'(x', y')$

Then,

Scaled x – axis is measured by $x' = s_x . x$

Scaled y – axis is measured by $y' = s_y . y$

Matrix representation

$$[x' \quad y'] = [x \quad y] \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix}$$

Rotation

- Rotate the object with a specific angle, θ
- Two types of rotation
  - Clockwise direction and
  - Anti clockwise direction

Clockwise

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

Or,

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

AntiClockwise

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

Or,

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

Problem

Q: (a) Find the matrix that represents the rotation of an object by 30^o by the origin.

(b) What's the new coordinate of the point $\mathrm{P}(2, -4)$ after the rotation?

Solution

(a) The matrix $R_{30^o} = \begin{bmatrix} \cos 30^o & -\sin 30^0 \\ \sin 30^0 & \cos 30^o \end{bmatrix}$

(b) New rotated points

$$[x' \quad y'] = [2 \quad -4] \begin{bmatrix} \cos 30^o & -\sin 30^0 \\ \sin 30^0 & \cos 30^o \end{bmatrix}$$

Problem

Q: Transform $(2,1),(3,4)$ and $(5,3)$points using translation and scaling factors 6 along x-axis and 9 along y-axis.

Solution:

Translation for coordinates $\mathrm{A}(2,1)$

The new coordinate will be $A'(x', y')$

Translation factors are $t_x = 6$ and $t_y = 9$

Therefore,

$$x' = 6 + 2 = 8$$
$$y' = 9 + 1 = 10$$

Thus, the new coordinate for the point $\mathrm{A}(2,1)$ is $A'(8, 10)$

Complete rest part of the problem yourself