SNS COLLEGE OF ENGINEERING

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Department of Information Technology

Course Name – COMPUTER GRAPHICS

III Year / V Semester

Unit 1 – MODELING AND TRANSFORMATIONS OF OBJECTS

Topic :Matrix Representation

3.1.4 Matrix Representation

- We can now write down a general formula for the transformation of points,

$$x' = a \cdot x + b \cdot y + c$$
$$y' = d \cdot x + e \cdot y + f$$

Where a, b, c, d, e and f are all constants. The expressions for x' and y' are linear functions for x and y. This can be re-expressed using matrices as:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ d & e \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} c \\ f \end{bmatrix}$$

- Now include all of the constants in one matrix,

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

- A square matrix is much easier to deal with, so the matrix is extended to as 3×3 matrix, as given below:

$$\begin{bmatrix} x' \\ y' \\ \omega' \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

- A column vectors representing points now have an extra entry. If the bottom row of the matrix is [0 0 1] then ω' will be 1 and we can ignore it. The effect of setting the bottom row of the matrix to values other than [0 0 1].
- The formulae for each of the different types of transformation can now be rewritten using this matrix notation:
  - **Translate:** $\begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$
  - **Scale:** $\begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$

- **Rotate:** $\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$
- **Shear:** $\begin{bmatrix} 1 & a & 0 \\ b & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

- There is a special matrix which leaves the co-ordinates x' and y' equal to x and y. This is known as the unit or identity matrix:

$$\begin{bmatrix} x' \\ y' \\ \omega' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$x' = x$$
$$y' = y$$
$$\omega' = 1$$

THANK YOU