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CS411 - Assignment 2

2A) Given 2D point (1,1), translate by (2,3)

Transformation Matrix:

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

(2DH) (2DH) //

2B) Given 2D point (1,1), transform by scale (2,2)

Transformation Matrix:

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

(2DH) (2DH) //

2C) Given 2D point (1,1) → rotate by (2,2)

Transformation Matrix:

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

(2DH) (2DH) //

2D) Given 2D point (1,1), find 2DH

2D point = (1,1)

2DH point = (1,1,1)

2E) Given 2DH (1,1,2) find 2D point

2DH point : (1, 1, 2)

2D point : $\left(\frac{1}{2}, \frac{1}{2}\right)$

2F) Given 2DH (1,2,3) find other 2DH point with same 2D point:

2DH : (1, 2, 3)

2DH other : $\left(\frac{1}{3}, \frac{2}{3}, \frac{3}{3}\right)$ = (0.33, 0.66, 1) //

2G) Given 2DH point (1,2,3) find 2D point.

2DH : (1, 2, 3)

2D point : $\left(\frac{1}{3}, \frac{2}{3}\right)$ = (0.33, 0.66) //

2H) what is 2DH (1,1,0)?

The point (1,1,0) in 2DH doesn't exist because $w=0$. It represents a line having the direction of (1,1).

2I) Given 2D point (2,5), rotate by 30° around origin.

2D point (2,5) → 2DH (2,5,1)

Transformation Matrix:

$$\begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 2(\cos 30 - \sin 30) \\ 5(\sin 30 + \cos 30) \\ 0+0+1 \end{bmatrix} = \begin{bmatrix} -0.679 \\ 5.330 \\ 1 \end{bmatrix}$$ //

2J) Given 2D point (2,5) rotate by 30° at point (1,2)

2D(2,5) → 2DH(2,5,1)

Transformation = T(1, 2) R(30°) T(-1, -2)

Transformation Matrix:

$$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \sqrt{3}/2 & -1/2 & 0 \\ 1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \sqrt{3}/2 & -1/2 & 0.134 \\ 1/2 & \sqrt{3}/2 & -2.232 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \sqrt{3}/2 & -1/2 & 1.134 \\ 1/2 & \sqrt{3}/2 & -0.232 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_M \times 2DH = \begin{bmatrix} \sqrt{3}/2 & -1/2 & 1.134 \\ 1/2 & \sqrt{3}/2 & -0.232 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.366 \\ 5.098 \\ 1 \end{bmatrix}$$

2DH = (0.366, 5.098, 1)

2D → (0.366, 5.098) //.

2K) Given 2D point (2,5) translate (3,4) rotate (45).

2DH (2,5,1) //

Transformation: T_M = R(45) T(3,4)

$$= \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 4.949 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_M \times 2DH = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 4.949 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} -2.8284 \\ 9.899 \\ 1 \end{bmatrix}$$ //.

2DH → 2D = (-2.828, 9.899) //

2L) Given 2D (2,5) rotate by 45°, then translate (3,4)

2D → 2DH(2,5,1)

Transformation $T_M = T(3,4)R(45°)$

$$= \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 3 \\ 1/\sqrt{2} & 1/\sqrt{2} & 4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_M \times 2DH = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & 3 \\ 1/\sqrt{2} & 1/\sqrt{2} & 4 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.8786 \\ 8.9497 \\ 1 \end{bmatrix}$$

2DH → 2D = (0.8786, 8.9497) //

2M) Convert (5,6) world to camera. camera translate by (1,2) rotate (45°)

2D → 2DH(5,6,1)

Transform $T_M = R(45)T(1,2)$

$$= \begin{bmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2.121 \\ 0 & 0 & 1 \end{bmatrix}$$

$$T_M \times 2DH = \begin{bmatrix} 1/\sqrt{2} & -1/\sqrt{2} & -1/\sqrt{2} \\ 1/\sqrt{2} & 1/\sqrt{2} & 2.121 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 5 \\ 6 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} \sqrt{2} \\ 9.898 \\ 1 \end{bmatrix} \rightarrow 2D(\sqrt{2}, 9.898) //$$

(4)

(5)

2N) Transformation Matrix = $T(T_x, T_y)\,R(\theta)$ //

2O) $w_1 \rightarrow (1,1)(2,2)$ to $VP(3,3)(4,5)$ //

$$w_1 2V_p = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$$= T(V_{min}, V_{max})\, S\left(\frac{V_{max} - V_{min}}{X_{max} - X_{min}}, \frac{V_{max} - V_{min}}{Y_{max} - Y_{min}}\right) T(-x_{min}, -y_{min})$$

$$w_1 2V_p = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix} N.$$

2P) LS $\rightarrow (1,1)(2,2)$
P $\rightarrow (1,1)$
W $\rightarrow (0,0)(1,1)$

$x_{min} = 0, \quad y_{min} = 0$
$x_{max} = 1 \quad y_{max} = 1$

L=0 $(x \geq x_{min})$
R=0 $(x \leq x_{max})$
B=0 $(y \geq y_{min})$
T=0 $(y \leq y_{max})$

Binary Code(1, 1) = 0000 N.

2Q) Let Line segment start point = L_S
end point = L_E

find binary code for L_S & L_E

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(x < x_min) ? L = 1 : L = 0;
(x > x_max) ? R = 1 : R = 0;
(y < y_min) ? B = 1 : R = 0;
(y > y_max) ? T = 1 : R = 0;
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if (binary(Ls) | binary(LE)) == 0   // inside
if (binary(Ls) && binary(LE) != 0   // outside //
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