Nayem Al Tariq
269-23442

ENGT-9804
Image processing and Applications

Q1] Dimensions of camera chip (D) = 7 mm

Distance (D_1) = 0.5 m

Camera = 35 mm = D_2

We know,

$$\frac{x}{2D_1} = \frac{D}{2D_2}$$

$$\Rightarrow \frac{x}{2(0.5)} = \frac{0.07}{2(0.035)}$$

$$\Rightarrow x = 0.1 \text{ m}$$

now, no of elements = 1024 × 1024

Number of line pairs = $\frac{1}{2}\left(\frac{1024}{100}\right)$

= 5.12

i.e 5 line pairs / mm

Q2)

$$A = \begin{bmatrix} 0.25 & 0.433 & 0 \\ -0.2598 & 0.15 & 0 \\ 50 & 75 & 1 \end{bmatrix} \longleftarrow (1)$$

The transformation matrices are:

$$T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 1 \end{bmatrix} = \text{for translation } (t_x, t_y)$$

$$\text{Rotation}(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{Scale}(s_x, s_y) = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$\therefore H = TRS$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 0 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & \\ 0 & 0 & 1 \end{bmatrix}$$

we get

$$\begin{bmatrix} s_x\cos\theta & -\sin\theta & 0 \\ s_y\sin\theta & s_y\cos\theta & 0 \\ s_x t_x\cos\theta + & -s_x t_y\sin\theta + & 1 \\ s_y t_y\sin\theta & s_y t_y\cos\theta & \end{bmatrix} \quad \text{---(iii)}$$

From (i) & (ii) we get...

$$s_x\cos\theta = 0.25 \quad \text{---(iv)}$$

$$-s_x\sin\theta = 0.433 \quad \text{---(v)}$$

$$s_y\sin\theta = 0.2598 \quad \text{---(vi)}$$

$$s_y\cos\theta = 0.15 \quad \text{---(vii)}$$

$$s_x t_x\cos\theta + s_y t_y\sin\theta = 50 \quad \text{---(viii)}$$

$$-s_x t_y\sin\theta + s_y t_y\cos\theta = 75 \quad \text{---(viii)}$$

PTO ⇒

① Scaling ⇒ Squaring both side equal to (III) & (IV)

$$S_x^2 \cos^2\theta + S_x^2 \sin^2\theta = (0.25)^2 + (0.433)^2$$

$$\Rightarrow S_x^2 (\cos^2\theta + \sin^2\theta) = 0.2499$$

$$\Rightarrow S_x = \sqrt{0.2499}$$

$$\Rightarrow S_x = 0.499 = x\text{-axis}$$

now, squaring both side equ (V) & (VI)

$$S_y^2 \sin^2\theta + S_y^2 \cos^2\theta = (0.259)^2 + (0.15)^2$$

$$\Rightarrow S_y^2 = 0.0899$$

$$\Rightarrow S_y = \sqrt{0.0899}$$

$$\Rightarrow S_y = 0.299 = y\text{ axis.}$$

(2) Rotation → divide eqn (IV) by (III)

$$\frac{-\sin\theta}{\cos\theta} = \frac{0.433}{0.25}$$

$$\Rightarrow \tan\theta = -1.732$$

$$\Rightarrow \theta = \tan^{-1}(-1.732)$$

$$\Rightarrow \theta = -59.9^\circ = [\text{angle of Rotation}]$$

(3) Translation → put S_x and S_y

In equation, we get

$$(0.49)t_x \cos\theta + (0.29)t_y \sin\theta = 50$$

$$(-0.49)t_x \sin\theta + (0.29)t_y \cos\theta = 75$$

multiply (I) by $\sin\theta$ and add $\cos\theta$ in (VI)

$$0.29\, t_y (\sin^2\theta + \cos^2\theta) = 50 + 78$$

$$\Rightarrow t_y = \frac{125}{0.29}$$

$$\Rightarrow t_y = 431.03 \quad [y \text{ axis}]$$

now, for t_x,

$$0.49\, t_x (\cos^2\theta + \sin^2\theta) = 50 - 75$$

$$\Rightarrow t_x = \frac{-25}{0.49}$$

$$\Rightarrow t_x = -51.02 \quad [x \text{ axis}]$$

(5)
5.4.5
(a) No, the histograms of the blurred image would not be same or equal because, they are blurred and due to ~~the~~ blurriness, boundary points will increase the ~~a~~ values of ~~the~~ right image. ~~Because~~ Its because the number of boundary points on the right image are much larger between the ridges of ~~black~~ black & white.

P T O →

(b) See Sketch of the 2 histograms →

0 = black pixel

1 = white pixel

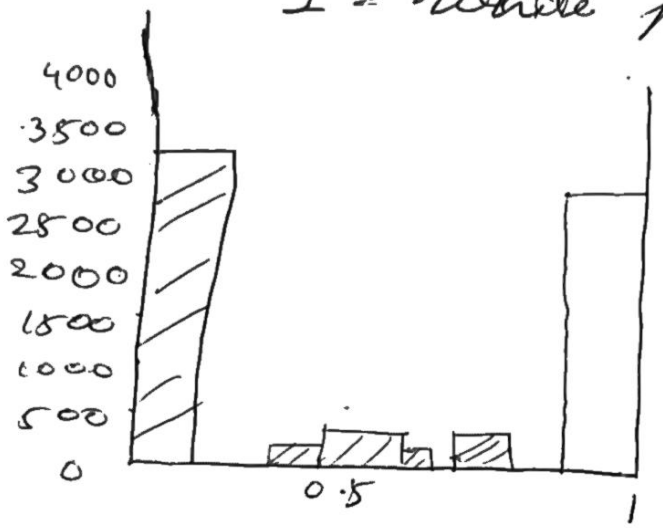


Image (A)

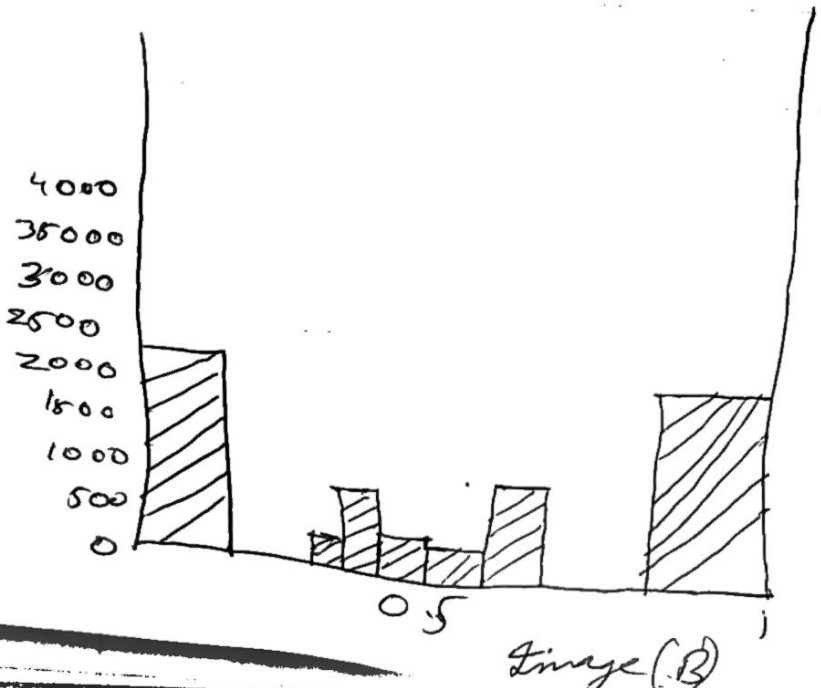
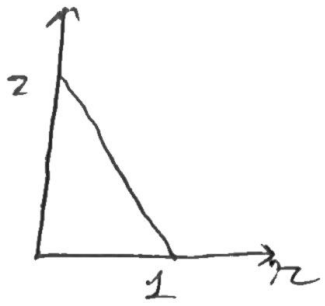
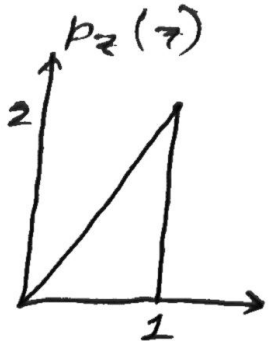


Image (B)

5.4





$$S = T(r)$$

$$= \int_0^r p_r(\omega)\, d\omega$$

$$= \int_0^r (-2\omega + 2)\, d\omega$$

$$S = -r^2 + 2r$$

$$V = G(z)$$

$$= \int_0^z p_z(\omega)\, d\omega$$

$$= \int_0^z p_z(\omega)\, d\omega$$

$$= \int_0^z 2w \, dw$$

$$v = z^2$$

$$z = G^{-1}(v) = \pm\sqrt{v} = z$$

$$z = \sqrt{-r^2 + 2r}$$

(Solved)

Q5)

(a) (i) if intensity of the center pixel of a 3×3 region is larger than the intensity of all of it's neighbours then it's decremented.

(ii) If Intensity of the center ~~pixel~~ pixel of a 3×3 region is smaller than the intensity of all of its neighbours, then ~~once~~ increment.

(ii) else, do nothing.

b) the three fuzzy statements are:-

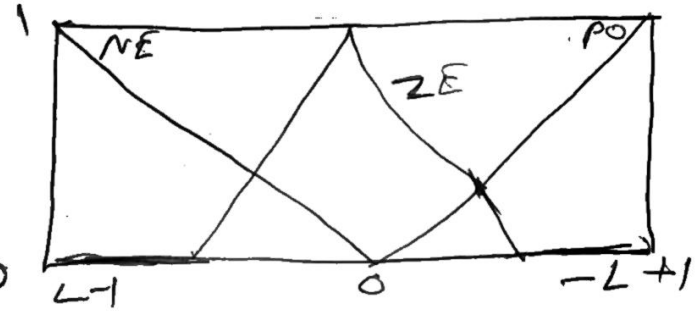
① the fuzzy relation is a higher type

② (i) It is interval valued

(ii) It contains a "blank" or don't know components.

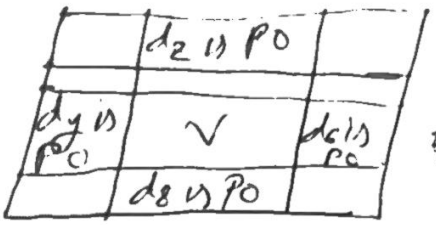
③ Specify the membership functions graphically.

PO ~~that~~ starts after O
NE comes before O
ZE will lie on O



1) The graphical representation of rule set:

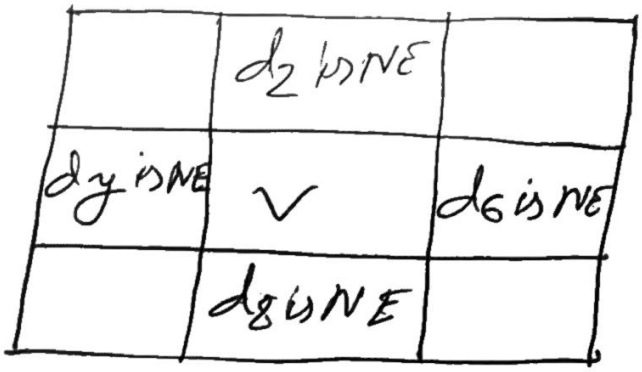
If



Then

$V = PO$

If



$\therefore V = NE$

& otherwise,

$V \longrightarrow ZE$