

Date _____

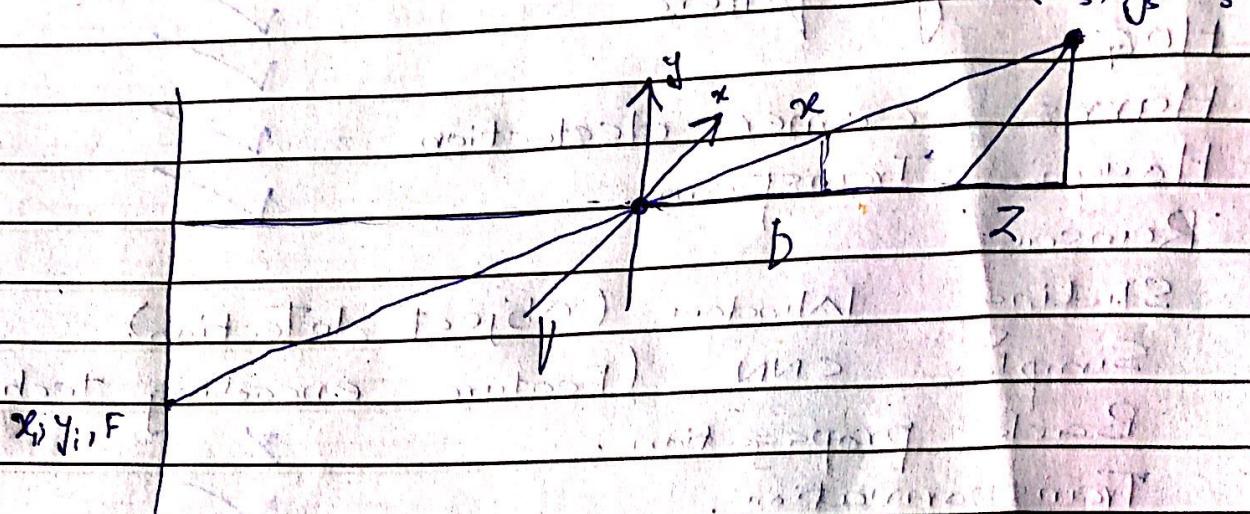
MTWTF

- * Image 3D → 2D ✓
- * Convolving filters ✓
- * HOG ✓
- * Harris corner detection ✓
- * Hough Transform ✓
- * Ransac ✓
- * Sliding Window (Object detection) ✓
- * Simple CNN (Feature encoding techniques)
- * Back propagation ✗
- * Transformation ✓

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Image 3D to 2D -



$$\frac{x_i}{D} = \frac{x_s}{z_s}$$

$$\boxed{\frac{x_i}{D} = \frac{y_s}{z_s}} \rightarrow$$

$$\frac{y_i}{D} = \frac{y_s}{z_s}$$

$$\boxed{\frac{y_i}{D} = \frac{y_s}{z_s}} \rightarrow (ii)$$

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	5	4	3	2	6	
	2	9	8	7	7	
	1	7	6	1	1	
	5	3	1	8	4	
	6	2	9	2	9	

- Mean filter
- Median
- Geometric Mean filters.
- Min, Max
- Mid-Point

$$\Rightarrow \frac{5+4+3+2+9+8+1+7+6}{9} = 5$$

$$\Rightarrow \frac{4+3+2+9+8+7+7+6+1}{9} = 5.22$$

$$\Rightarrow \frac{3+2+6+8+7+7+6+1+1}{9} = 4.55$$

$$\Rightarrow \frac{2+9+8+1+7+6+5+3+1}{9} = 4.66$$

$$\Rightarrow \frac{9+8+7+7+6+1+3+1+8}{9} = 5.55$$

$$\Rightarrow \frac{8+7+7+6+1+1+1+1+8+9}{9} = 4.99$$



Castelli

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$$\Rightarrow 1 + 7 + 6 + 5 + 3 + 1 + 6 + 2 + 9 \Rightarrow 44$$

$$\Rightarrow 7 + 0 + 1 + 3 + 1 + 8 + 2 + 9 + 2 \Rightarrow 33$$

$$\Rightarrow 6 + 1 + 1 + 1 + 8 + 4 + 2 + 9 + 2 \Rightarrow 37$$

S 5.22 4.55

4.66 5.55 4.77

4.44 4.33 3.77

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HOG

-1-

3	7	9	15
8	7	6	13
11	18	14	14
9	6	17	18

$$x = 8 - 6 = 2$$

$$y = 1 - 18 = 17$$

$$\|M\| = \sqrt{(2)^2 + (17)^2} = 17.11$$

$$\alpha = \tan^{-1}\left(\frac{17}{2}\right) \frac{y}{x} = 63.19^\circ$$

~~$x = 7 - 13 = 6$~~

~~$y = 9 - 14 = 5$~~

$$\|M\| = \sqrt{(6)^2 + (5)^2} = 7.81$$

$$\alpha = \tan^{-1}\left(\frac{5}{6}\right) = 39.80^\circ$$

$$x = 11 - 14 = -3$$

$$y = 7 - 6 = 1$$

$$\|M\| = \sqrt{(-11)^2 + (3)^2} = \sqrt{10} = 3.1$$

$$\alpha = \tan^{-1}(3/1) = 71.56^\circ$$

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7	5	2	9	1	2
2	4	7	1	3	
9	7	4	6	7	
5	10	9	11	7	
1	13	9	7	6	

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

$$dy = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$$

$$dx =$$

$$\begin{array}{|c|c|c|} \hline 5 & -3 & -5 \\ \hline -5 & -1 & -1 \\ \hline 4 & 1 & -2 \\ \hline \end{array}$$

$$dy = \begin{bmatrix} 3 \end{bmatrix}$$

$$\begin{array}{|c|c|c|} \hline 2 & 2 & -3 \\ \hline 6 & 2 & 10 \\ \hline 6 & 5 & 1 \\ \hline \end{array}$$

$$(5)^2 + (-3)^2 + (-5)^2 + (-5)^2 \\ + (-1)^2 + (-1)^2 + (4)^2 + (1)^2 + (-2)^2$$

$$(2)^2 + (2)^2 + (-3)^2 \\ + (6)^2 + (2)^2 + (10)^2 + (8)^2 + \\ (5)^2 + (19)^2$$

$$= 107$$

$$= 218$$

$$(5)(2) + (-3)(2) + (-5)(-3) + (-5)(6) + (-1)(2) \\ (-1)(10) + (4)(6) + (11)(5) + (-2)(1)$$

$$= 4$$

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$$H = \begin{bmatrix} 107 & 4 \\ 4 & 218 \end{bmatrix}$$

$$\det(H) = K \cdot \text{track}(H)^2$$

$$K = 0.04$$

$$\det(H) = (107)(218) - (4)(4)$$

$$= 23310$$

$$\text{track}(H) = 107 + 218$$

$$= 325$$

$$23310 \cdot 8 - 0.04 \cdot (325)^2$$

$$= 19085$$

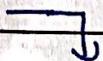
positive so here is corner.

Hough Transform

$(1, 2), (7, 9), (4, 3), (8, 1) \rightarrow (7, 0)$

$$y = mx + c$$

$$\boxed{c = y - mx}$$



$$m = \frac{y - c}{x}$$

put $m = 0$

put $c = 0$

$$\boxed{c = y}$$

$(1, 2)$

$$c = 2$$

$(7, 9)$

$$c = 9$$

$(4, 3)$

$$c = 3$$

$(8, 1)$

$$c = 1$$

$(9, 0)$

$$c = 0$$

$$\boxed{m = \frac{y}{x}}$$

$$(1, 2) \quad m = 2/1 = 2$$

$(7, 9) =$

$$m = 9/7 = 1.2$$

$(4, 3) =$

$$m = 3/4 = 0.75$$

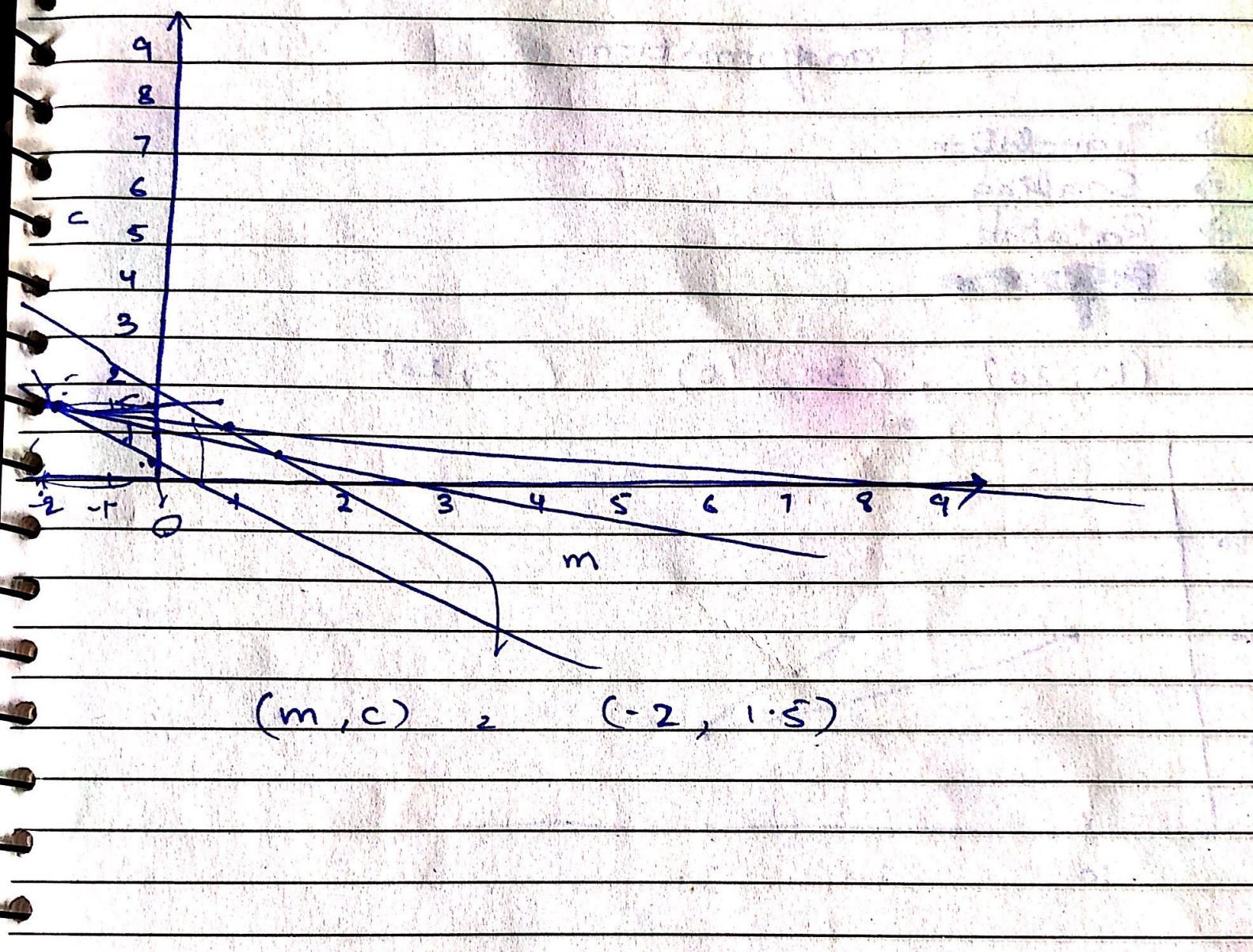
$(8, 1) =$

$$m = 1/8 = 0.12$$

$(9, 0) =$

$$m = 0$$

$(2, 2), (9, 1.2), (3, 0.75), (1, 0.12), (0, 0)$



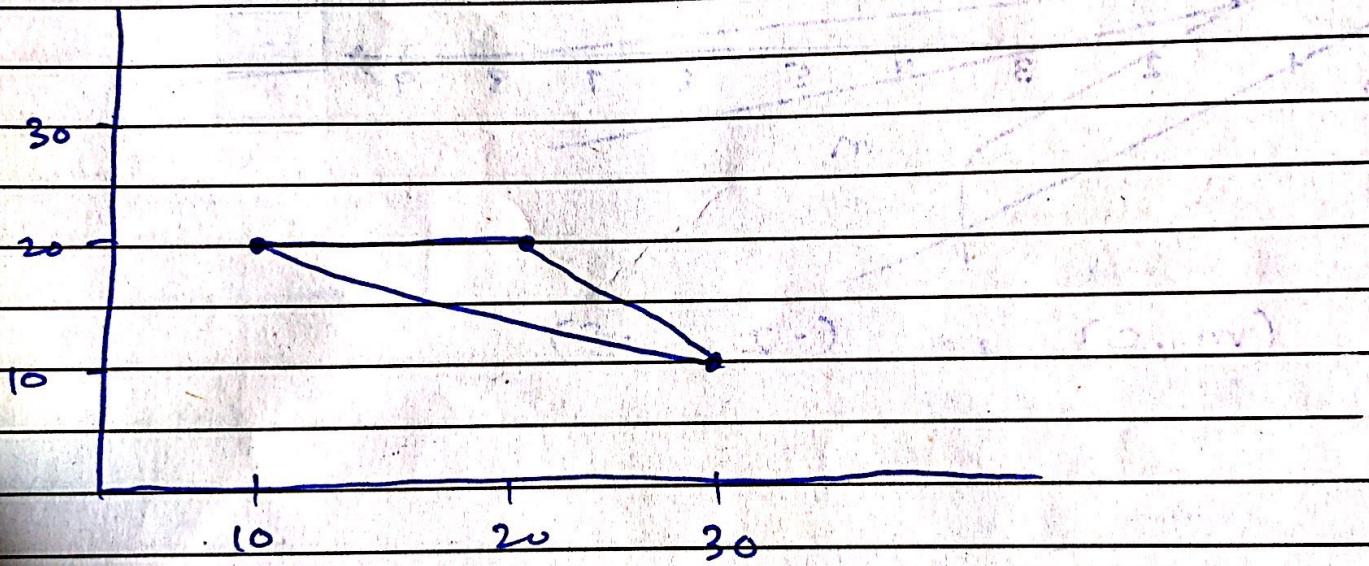
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Transformation.

- Translation
- Scaling
- Rotation
- ~~Reflection~~

$$(10, 20), (30, 10) \quad (20, 20)$$



① Translation :

$$x' = t_x + x$$

$$y' = t_y + y$$

$$t_x = 10, \quad t_y = 15$$

$$(10, 20)$$

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$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_4 \\ 0 & 1 & t_5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 10 \\ 0 & 1 & 15 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 10 \\ 20 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 10+0+10 \\ 0+20+15 \\ 0+0+1 \end{bmatrix} = \begin{bmatrix} 20 \\ 35 \\ 1 \end{bmatrix}$$

for $(30, 10)$

$$\begin{bmatrix} 1 & 0 & t_4 \\ 0 & 1 & t_5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 10 \\ 0 & 1 & 15 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 30 \\ 10 \\ 1 \end{bmatrix} = \begin{bmatrix} 40 \\ 25 \\ 1 \end{bmatrix}$$

for $(20, 20)$

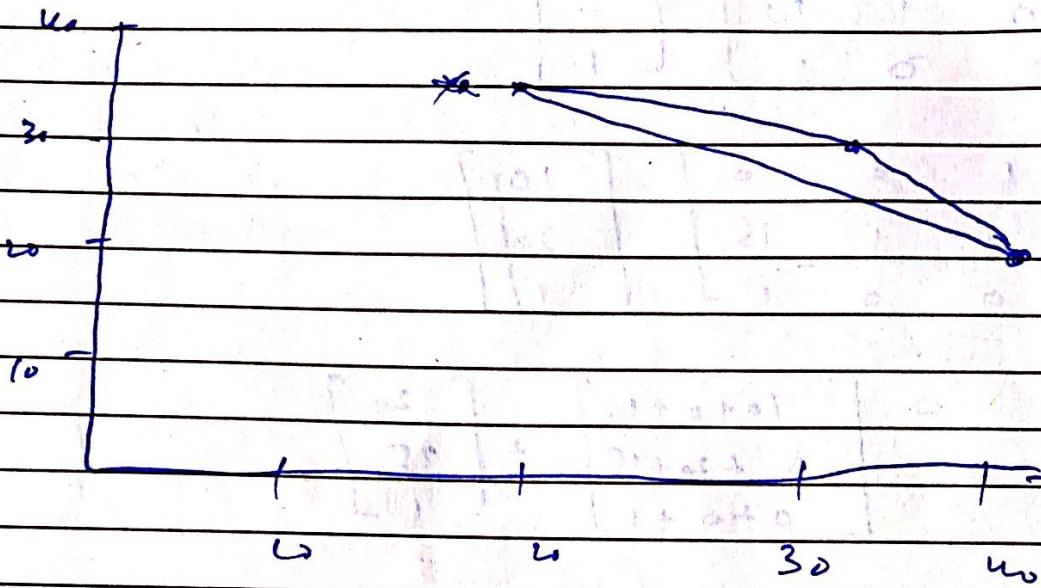
$$\begin{bmatrix} 1 & 0 & 10 \\ 0 & 1 & 15 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 20 \\ 20 \\ 1 \end{bmatrix} = \begin{bmatrix} 30 \\ 35 \\ 1 \end{bmatrix}$$

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$$(20, 35), (40, 25) (30, 35)$$



$$\begin{bmatrix} u' \\ v' \\ 1 \end{bmatrix} = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} \quad \text{Scaling}$$

$$\begin{bmatrix} u' \\ v' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} \quad \text{Rotation}$$

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Scaling

$$\delta x = 10$$

$$\delta y = 15$$

$$(n_1, y) = (10, 20)$$

$$\left[\begin{array}{ccc|c} 10 & 0 & 0 & 10 \\ 0 & 15 & 0 & 20 \\ 0 & 0 & 1 & 1 \end{array} \right]$$

$$\left[\begin{array}{ccc|c} 100+0+0 & & & 100 \\ 0+300+0 & = & 200 \\ 0+0+1 & & & 1 \end{array} \right]$$

$$(n_2, y) (30, 10)$$

$$\left[\begin{array}{ccc|c} 30 & 0 & 0 & 30 \\ 0 & 15 & 0 & 10 \\ 0 & 0 & 1 & 1 \end{array} \right]$$

$$\left[\begin{array}{c} 300 \\ 150 \\ , \end{array} \right]$$

$$(n_3, y) = (20, 20)$$

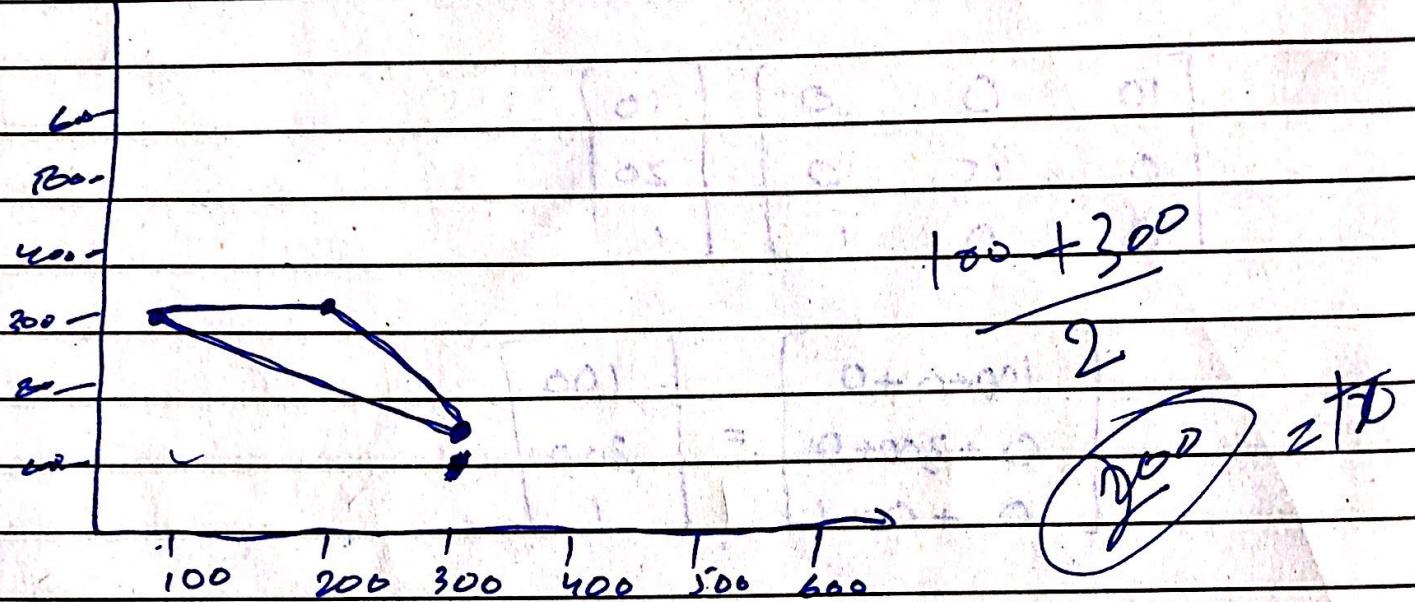
$$\left[\begin{array}{ccc|c} 10 & 0 & 0 & 20 \\ 0 & 15 & 0 & 20 \\ 0 & 0 & 1 & 1 \end{array} \right] \Rightarrow \left[\begin{array}{c} 200 \\ 300 \\ , \end{array} \right]$$

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$$(100, 300) \quad (300, 150) \quad (200, 300)$$



$$x' = 5n * x$$

$$y' = 5y * y$$

TO CHECK

$$(m, y)(10, 20) ; (l, n, y) (10, 15)$$

$$x' = 10 \times 10 = 100$$

$$y' = 15 \times 20 = 300$$

$$\begin{aligned} &+ x \\ &+ y \\ &\hline 225 \end{aligned}$$

$$225 + 225$$

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CNN

Pooling layer = down Sampling

- Max = Max Value extract & put in Feature Map
- Min = Min
- Avg = Avg

4	3	$\sqrt{7}$	2
9	1	4	6
3	1	1	$\sqrt{9}$
2	$\sqrt{4}$	7	6

2²

Max : (2×2)

9	7
4	9

stride = 2, pad = 0

Flatten layer :

9
7
4
9

~~28 x 28 x 3~~

~~4 x 4~~

~~Min~~

~~Con 2~~

~~Con 2~~ ~~flat~~

~~Con~~

~~Con~~

~~Pooling~~

~~Flat~~

Q

~~Plucker
(dense)~~

$$\frac{(28 - 3) + 0}{1} + 1$$

$$\frac{25}{1} + 1 \Rightarrow 26 \times 26 \times 1$$

$$\frac{(26 - 3) + 0}{1} + 1 \Rightarrow \frac{23}{1} + 1$$

$$2 \quad 24 \times 24 \times 1$$

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(3)

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$$\frac{(24 - 2) + 0}{2} + 1$$

$$\xrightarrow[2]{22 + 0} + 1 \Rightarrow \frac{22 + 2}{2}$$

$$\frac{24}{2} = 12 \times 12 \times 1$$

$$\frac{(12 - 3) + 0}{1} + 1 \Rightarrow 10 \times 10 \times 1$$

$$\frac{(10 - 3) + 0}{1} + 1 \Rightarrow 8 \times 8 \times 1$$

$$\frac{(8 - 2) + 0}{2} + 1 \Rightarrow \frac{6}{2} + 1$$

$$\Rightarrow \frac{6 + 2}{2} \Rightarrow \frac{8}{2} = 4 \times 4 \times 1$$

Fictitious $4 \times 4 \times 1$

$\approx 16.$

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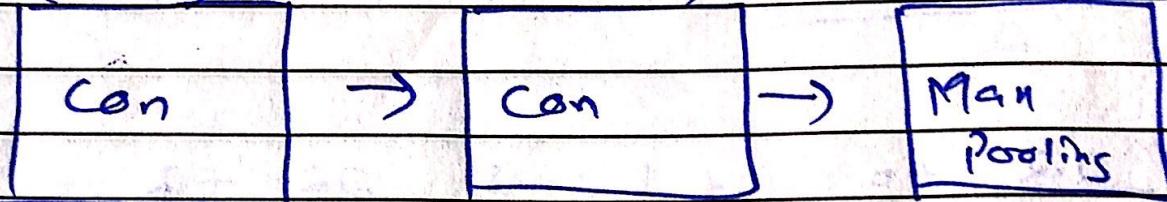


$(28 \times 28 \times 3)$ $(24 \times 24 \times 1)$ $(12 \times 12 \times 1)$

(3×3)

(3×3)

(2×2)



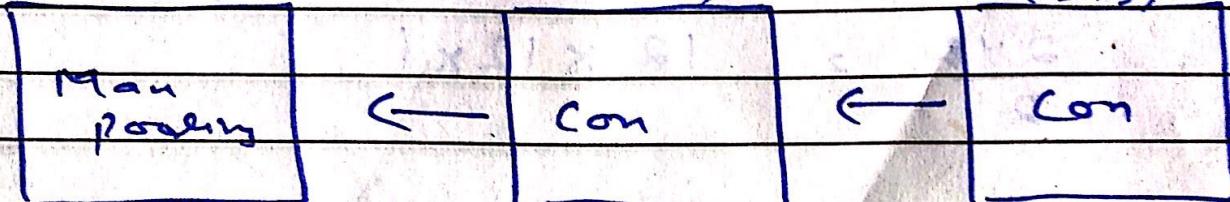
$(4 \times 4 \times 1)$

$(8 \times 8 \times 1)$

\downarrow
 $(12 \times 12 \times 1)$
 (3×3)

$(2,2)$

(3×3)



$(4 \times 4 \times 1)$

$(8 \times 8 \times 1)$

\downarrow
 $(10 \times 10 \times 1)$
 (3×3)

$(2,2)$

(3×3)

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Input image = $28 \times 28 \times 3$

feature Map = 4×4

apply min = 2 Con layer

& = 1 pooling layer

for mula =

= $(\text{input-image-size} - \text{filter_size}) \times 2 (\text{padding}) + \text{Stride}$

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Harris Connor deletion.

$$\begin{matrix} 6 & 1 & 1 & 1 & 1 \\ 4 & 2 & 3 & 5 & 0 \\ 2 & 5 & 2 & 9 & 1 \\ 1 & 9 & 6 & 1 & 0 \\ 0 & 5 & 7 & 3 & 0 \end{matrix}$$

$$x = -1 \quad 0 \quad + 1, \quad y = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix}$$

$$dx = \begin{bmatrix} -1 & 3 & -3 \\ 0 & 4 & -1 \\ 5 & -8 & -6 \end{bmatrix}, \quad dy = \begin{bmatrix} 4 & 1 & 8 \\ 7 & 3 & -4 \\ 0 & 5 & -6 \end{bmatrix}$$

$$= 161 \quad = 216$$

$$-4 + 3 - 24 + 0 + 12 + 4 + 0 = 40 + 36$$

$$= -13$$

$$h = \begin{bmatrix} 161 & -13 \\ -13 & 216 \end{bmatrix}$$

$$\det(h) - K \operatorname{trace}(h)^2$$

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$$\det(h) = (161)(216) - 10(-13)(-13)$$

$$34776 - 169$$

$$= 34607$$

$$\text{trace} = (161) + (216)$$

$$377$$

put in formula

$$k = 0.04$$

$$= 34607 - (0.04)(377)^2$$

$$= 28921$$

positive so Corridor!

Hough Transformation:-

$(1,5)$; $(2,9)$, $(5,4)$, $(3,6)$

$$C = y - mx$$

$$m=0$$

$$\boxed{C=y}$$

$(1,5)$

$$C=5$$

$(2,9)$

$$C=9$$

$(5,4)$

$$C=4$$

$(3,6)$

$$C=6$$

$$m=5$$

$$m=4.5$$

$$m=0.8$$

$$m=2$$

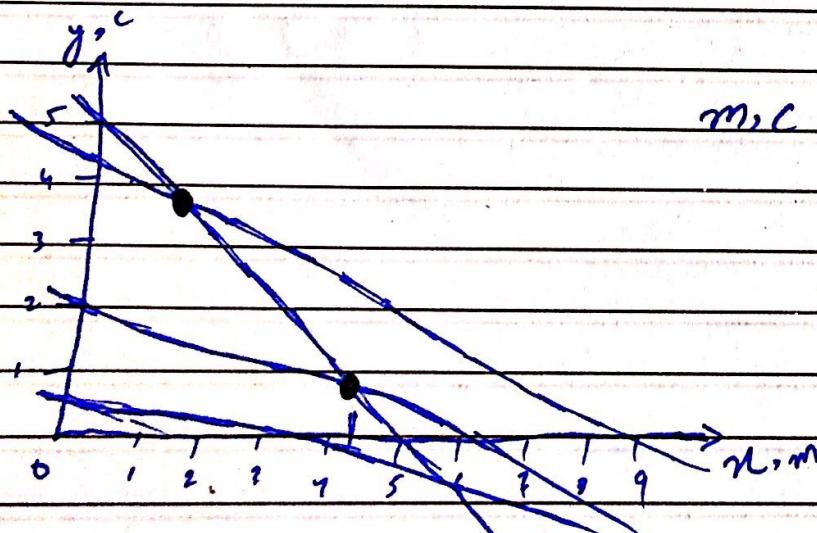
$$C = y - mx$$

$$l=0$$

$$0 = y - mx$$

$$\boxed{\frac{y}{x} = m}$$

$(5,5)$ $(9,4.5)$ $(4,0.8)$ $(6,2)$



$$m, c = (4.2, 1.9)$$