13.03.2024 Wednesday

~~$w_b = 0.69$~~ ~~$w_f = 0.31$~~

$\mu_b = \frac{5414}{69} = 78.46$ ~~84.96~~

$\mu_f = \frac{6875}{31} = 221.77$

~~V_b or $\sigma_b^2 = \frac{165537.24}{64} = 2586.5$~~

~~V_f or $\sigma_f^2 = \frac{601996.96}{36}$~~

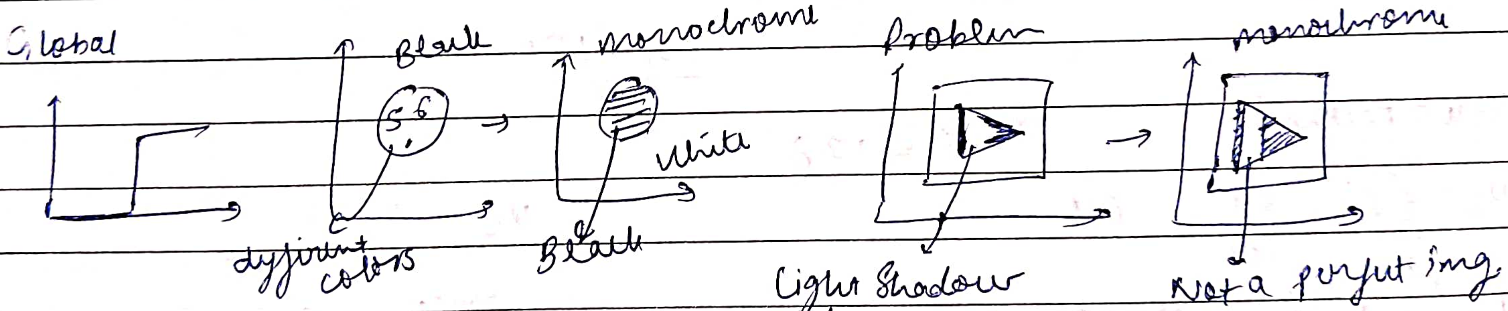
$\sigma_b^2 = \frac{162939.25}{69} = 2361.43$

$\sigma_f^2 = \frac{18679}{31} = 602.25$

Overall $\sigma^2 = w_b \sigma_b^2 + w_f \sigma_f^2$

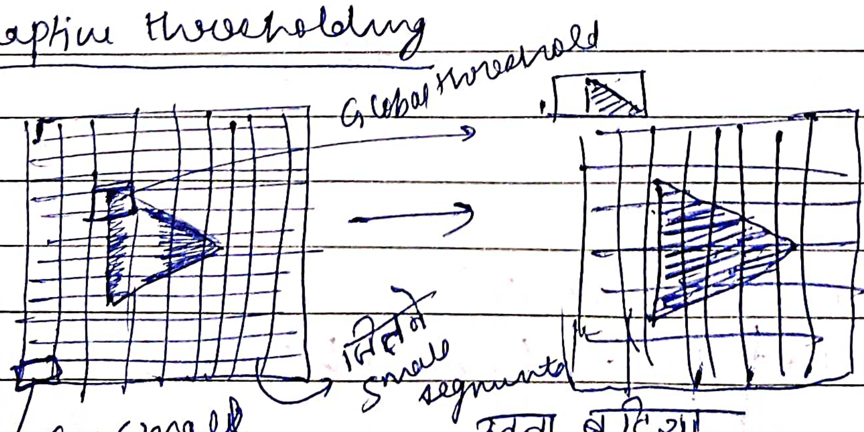
⇒ **Overall $\sigma^2 = 1816.08$ for Th = 175**

Thresholding
→ Global (पहले वाला)
→ Adaptive (आगे वाला) → Comb^n of Thresholding & segmentation



→ Global Thresholding fails.

Adaptive thresholding



left side → 0 (Black)

Δ Adaptive threshold ~~img~~

मत बनाओ वाले !

Divide in two parts for adaptive thresholding

Adaptive → Threshold

I			II		
4	3	7	1	2	5
2	3	4	1	2	4
5	6	5	6	3	2
1	7	2	2	1	4
6	4	1	2	3	4
2	3	5	2	5	7
III			IV		

I)

p_i	0	1	2	3	4	5	6	7
f_i	0	0	1	2	2	2	1	1
$p_i f_i$	0	0	2	6	8	10	6	7

$T_1 = \frac{\Sigma p_i f_i}{\Sigma f_i} = \frac{39}{9} = 4.33 \approx 4$

$u_1 = \frac{16}{5} = 3 \qquad u_2 = \frac{23}{4} = 5.75 \approx 5$

$T_2 = \frac{1}{2}(u_1 + u_2) = 4$

$T_1 = T_2$ ✓

No need for small images of u_1 & u_2. Direct T_1

II: $T_2 = \frac{\Sigma p_i f_i}{\Sigma f_i} = \frac{2+6+4+3+5+6}{9}$

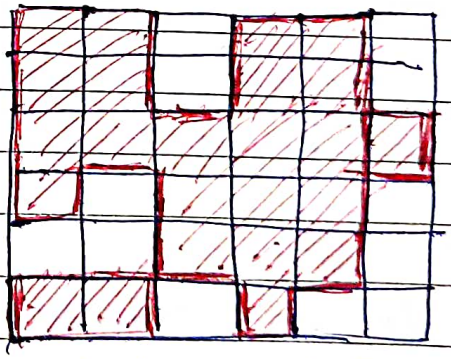
$T_2 = \frac{26}{9} = 2.8 = 3$

III: ② $T_3 = \frac{2+4+4+3+5+7}{9} = \frac{25}{9} = 2.5 \approx 3$

IV: $T_4 = \frac{1\times1 + 2\times3 + 3 + 4\times2 + 5 + 7}{9} = \frac{1+6+3+8+5+7}{9} = \frac{30}{9} = 3.4 \approx 3$

4	3	7	1	2	5
2	3	4	1	2	4
5	6	5	6	3	2
1	7	2	2	1	4
6	4	1	2	3	4
2	3	5	2	5	7

$\Rightarrow$



Th <= B

4 > W

0.5 → 0 4.5 → 4

दो करना ceil लेना।

Otsu Method

HW Apply 5×5 Adaptive thresholding on Whatsapp image 12.03.2024 (Wednesday)

02.04.2024 Tuesday

$\frac{100}{6} \times 3 = 16.67$

@ 0.33

DATE PAGE

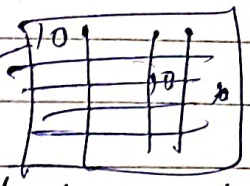
HUFFMAN CODING

↳ Lossless

used → jpeg, mpeg

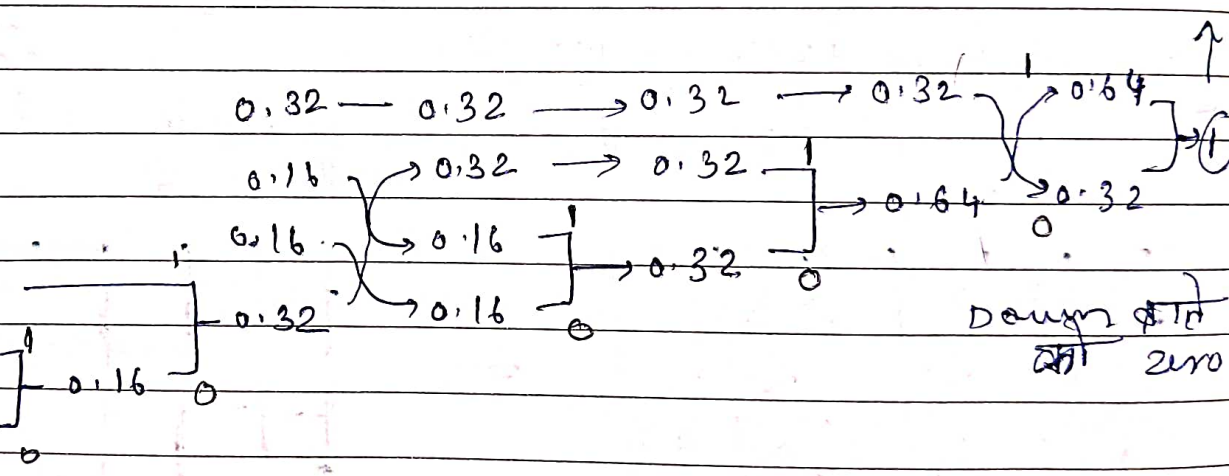
40 Mbps = 40 mega bits per second

frames = 30, 45, 60



Intensity	% share	Arrange in decreasing order
10 → a_1	10/60 = 0.16	a_3 0.32
10 → a_2	10/60 = 0.16	a_1 0.16
20 → a_3	20/60 = 0.32	a_2 0.16
5 → a_4	5/60 = 0.08	a_6 0.16
5 → a_5	5/60 = 0.08	a_4 0.08
10 → a_6	10/60 = 0.16	a_5 0.08

Total = 60



Avg. Code length = $(0.32 \times 1) + (0.16 \times 2) + (0.16 * 3) + (0.16 \times 4) + (0.08 * 5) + (0.08 \times 5)$

$= 0.32 + 0.32 + 0.48 + 0.64 + 0.4 + 0.4$

$= 2.56$ bit/s (not necessary)

Entropy, $H = 0.32 \times \log_2 0.32 + (0.16 \times \log_2 0.16) \times 3 + (0.08 \times \log_2 0.08) \times 2$

$= -2.3781$

08.04.2024 Monday

$\log_2 a$

0 — 1
B W

Dilation + opening → Closing → opposite theory

$Coef = \frac{H}{L} \times 100 = \frac{+2.37}{2.56} \times 100 = 92.57\%$

↳ Coefficient

Msg → Encode → Channel

Msg ← Decode ← [ ]

10,000 | 10000,00000 → a1a4a5a5 (encode)

a_1 a_4 a_5 a_5

Morphological

→ Shape & size of image

↳ Arithmetic opr +, −, *, / → convolution
↳ Logical opr &, |, ~ → Not / complement
↳ special opr

① Dilation ② Erosion ③ Opening ④ closing

① Dilation :- (i) Expanding image
0 → bg object → 1

(ii) Brightening image (clear info. of image) → increasing no. of pixels of 1

② Erosion :- (i) Shrinking image (opp. of Dilation)
↳ hiding information

→ Enhancing boundary (Dilation)
Removing boundary change (Erosion)

Truth table

A	B	A∧B	A∨B
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	1

0 - 255

200 → Complement 256 − 200 = 56

Dilation:

① Substitute Model
② Vector Addition model } Imp

Dilation operator / ~~not x or P~~

↑

A ⊕ B = C

image (original) | Substitute | final output

origin image / Structural element

origin

A = | 0 | 1 | 0 |
| 1 | 0 | 0 |
| 0 | 0 | 0 |

First 1 is origin

B = | 1 | 1 |
| 0 | 0 |

A ⊕ B = | 0 | 1 | 0 |
| 1 | 0 | 0 |
| 0 | 0 | 0 |

I Stage

0	1	1	0
1	1	1	0
0	0	0	0

IV Stage

0	1	1	0
1	1	0	0
0	0	0	0

III Stage

0	1	1	1
1	0	0	0
0	0	0	0

II Stage

0	1	1	1
1	1	1	1
0	0	0	0

V Stage

Req. size ~~it~~ change

0	1	1
1	1	1
0	0	0

C

No. of 1's (after Dilation)

No. of 1's (before Dilation)

Brightness ↑ ho jaati hai

B

| 0 | 1 |
| 1 | 0 |

upar it Expand

0	1	0
1	0	0
0	0	0

→

0	1	0
1	0	0
0	0	0

B.

| 0 | 0 |
| 1 | 1 |

→ | 1 | 1 |

② Vector Addition

A = | 0 | 1 | 0 |
| 1 | 0 | 0 |
| 2 | 0 | 0 | 0 |

B = | 1 | 1 |
| 0 | 0 |

A = {(0,1), (1,0)}

B = {(0,0), (0,1)}

↳ write coordinates of 1 in A & B

Set Cross product but vector add

a = (0,1) + (0,0) = (0,1)

b = (0,1) + (0,1) = (0,2)

c = (1,0) + (0,0) = (1,0)

d = (1,0) + (0,1) = (1,1)

Repetition ~~ho~~ to single time

09.04.2024 Tuesday

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	0	1	2
0	0	1	1
1	1	1	0
2	0	0	0

No. of 1's (after dilation) ≥ No. of 1's (before dilation)

Q) A =

	0	1	2
0	0	1	0
1	0	0	1
2	0	1	0

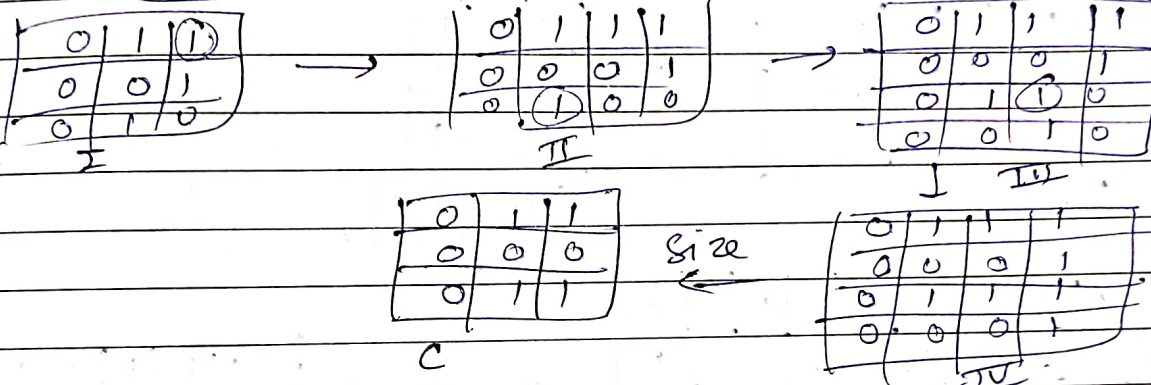
B =

	0	1
0	1	1
1	0	1

use dis substitution & vector add^n

Sol:

Substitution



vector add^n

A = {(0,1), (1,2), (2,1)}

B = {(0,0), (0,1), (1,1)}

Repeat ourside 0

C = {(0,1), (0,2), (1,2), (1,2), (1,3), (2,3), (2,1), (2,2), (3,2)}

C =

	0	1	2	
0	0	1	1	0
1	0	0	1	1
2	0	1	1	1
	0	0	1	0

C =

0	1	1
0	0	1
0	1	1

② Erosion

A ⊖ B → erosion opr

Q) A =

	1	1	1	1	1	1	1
1	1	1	0	1	0	0	1
	0	1	1	1	1	1	1

B =

origin →	1
	0
	1

Find exact copy of this in A

Sol:

	0	0	0	1	1	0	0
1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0

* where there is pattern put '1' on origin & everywhere else '0'

Holes & gaps in enhancing boundary

3×3

1	1	1
1	1	0
1	1	1

origin

2×2 first pixel

→ Gap filling के लिए use होता है | Opening

~~Closing~~ :-

3) Opening

(A ∘ B)

(dot but like disc)

Gap Identification in image.
If Gaps are blurry then opening will make it clear cut distinction

$$(A \circ B) = ((A \oplus B) \ominus B)$$

(i) Dilation (ii) erosion

Q) origin put on this

A =

1	1	1	1	1	1	1	
1	1	1	0	1	1	1	
1	1	1	1	1	1	1	

B =

1	1	1
1	1	1
1	1	1

→ center origin pixel

Structural element

C =

1	1	1	1	1	1	1	1	1	
1	1	1	1	1	1	1	1	1	
1	1	1	1	1	1	1	1	1	
1	1	1	1	1	1	1	1	1	
1	1	1	1	1	1	1	1	1	

(A ⊕ B)

⊖ B =

1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1

Structural element is can be different for different & generally it is different

(4)

Opening :- $(A \circ B) = ((A \ominus B) \oplus B)$

Q)

A =

1	1	1	1	1	1	1
1	1	1	0	1	1	1
1	1	1	0	1	1	1

B =

1	1	1
1	1	1
1	1	1

Find opening

$(A \circ B) = ((A \ominus B) \oplus B)$

Sol:

$(A \ominus B) =$

0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0

$((A \ominus B) \oplus B) =$

1	1	1	0	1	1	1
1	1	1	0	1	1	1
1	1	1	0	1	1	1

Gap Identification.

10.04.2024
Wednesday

Dilation ने Updated Img पर operate करता है। Opening में Dialation पर Image पहले सिर्फ Dilation operation करें

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All operations

1. Dilation = $A \oplus B$ = $D(A)$
2. Erosion = $A \ominus B$ = $E(A)$
3. Opening = $((A \ominus B) \oplus B)$ = $(A \circ B)$ = $E(D(A))$ (Erosion → Dilation)
4. Closing = $((A \oplus B) \ominus B)$ = $(A \circ B)$ = $D(E(A))$

Q) $A = (B \oplus C)$ $B = (A \ominus B)$ $D = (A \oplus B)$. Given A, B & C, Find D in series of operation.

Sol: Find A & B as A, B, C [Given]
Then evaluate D using A & B

Q) A =

1	1	1	1	1	1	1
1	0	1	0	0	1	1
1	1	1	1	1	1	1

B =

1	1
0	1
1	1

Take B =

1	1
0	1

Sol: B = 1 1 / 0 1 / 1 1

1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	1

$A \oplus B$ =

1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	1

$A \ominus B$ =

0	1	0	0	1	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

$A \circ B$ (Opening) = $((A \ominus B) \oplus B)$ =

0	1	1	1	1	1	1	1
0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0

0	1	1	0	1	1	0
0	0	1	0	0	1	0
0	0	0	0	0	0	0

$A \circ B$ (Closing) = $((A \oplus B) \ominus B)$ =

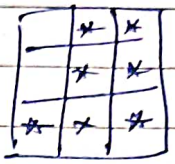
0	0	0	0	0	0	1
0	0	0	0	0	0	0
0	0	0	0	0	0	1

HIT
MISS
FIT

HIT, MISS, FIT :-

A =

B =



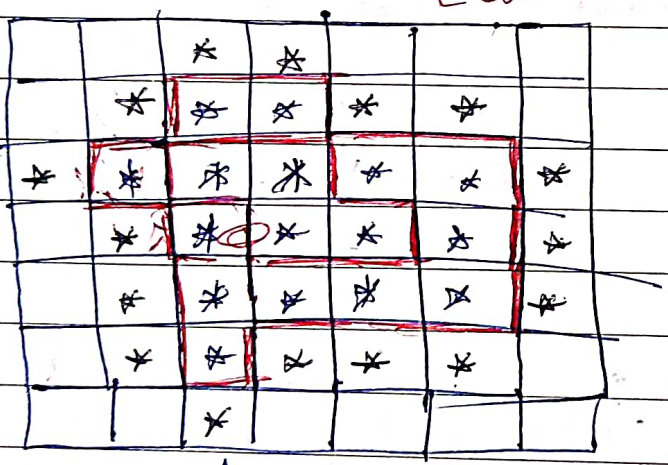
Substructure element

HIT → कोई भी 1 मिल जाए ।
MISS → कोई भी नहीं मिले ।
FIT → सब 1 मेल जाए * पर

} जहाँ * है B

Morphological : Boundary detection

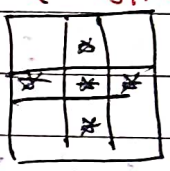
→ zero पर नहीं करेंगे ।



A

Cross structural element ↓ ↳ Boundary

B =



Structural image (same for whole image)

Apply
$(A \ominus B) \cap A$
↳ intersection
set difference

$(A \ominus B) \cap A$

Red के अंदर वाले को 1 लिख दो ।
Black Border same रहने दो ।

Intersection का Answer यह है ।

$\star = 1$

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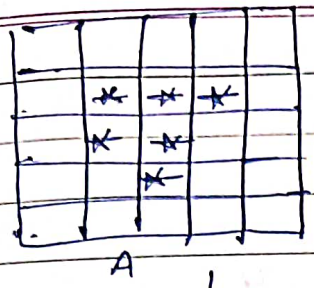
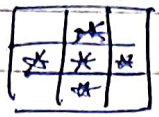
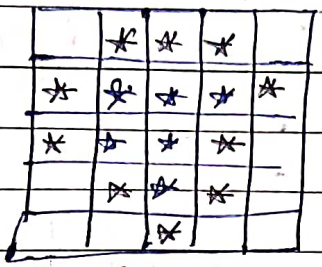
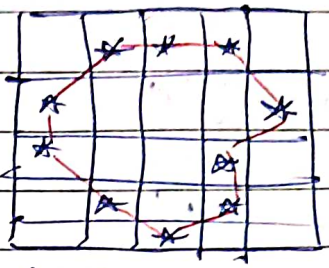
Q) Find boundary. or $B(A)$



$B =$ 

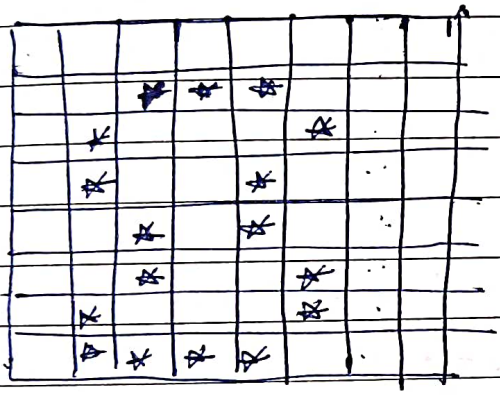
$A \ominus B$, 

$(A \ominus B) \cap A$ 

$(A \ominus B) \cap A$
Boundary of Image

#Morphological Region Filling :-

Find fill of A or fill A or ~~Fill (A)~~ or $F(A)$

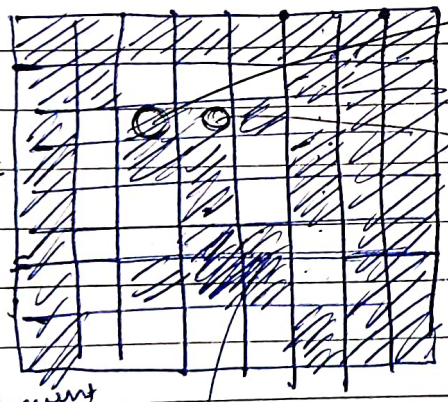


$A =$

$X_0 = A$

$X_k = X_{k-1} \oplus B \cap A^c$ (prev.)

↳ तब तक तब तक, पिछले last के बराबर नहीं तब तक।



$A^c =$

Complement of A

X_1 → इसके operation करेंगे

$X_1 = X_0 \oplus B \cap A^c$

↓

$X_1 \neq X_0$

$X_2 = X_1 \oplus B \cap A^c$

↓

$X_2 \neq X_1$

.
.
.

$X_k = X_{k-1} \oplus B \cap A^c$

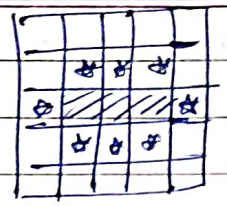
$X_k = X_{k-1}$

Done

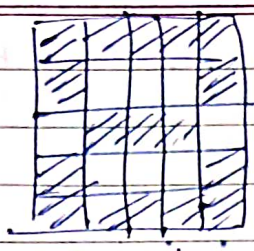
↳ Inside ~~colored~~ field

15.04.2024
Monday

Q) A =



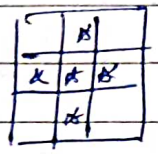
A^c =



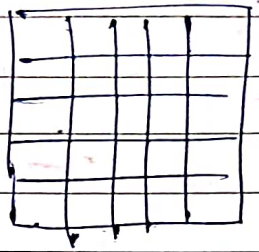
• Fill(A) = ?

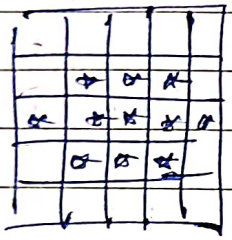
Boundary को छोड़कर सब even inside

B =



$X_0 = A$ =





Fill (A)

memory

CONVEX HULL : get Polygon shape (image) → contains data.

→ on big image (20 × 20 type)

{HIT, MISS, FIT}.

$$X_k = (X_{k-1} \circledast B_i) \cup A$$

$X_0 = A$ $\quad i = 1, 2, 3, 4$

$X_1 = (X_0 \circledast B_1) \cup A$

$X_2 = (X_1 \circledast B_2) \cup A$

$X_3 = (X_2 \circledast B_3) \cup A$

$X_4 = (X_3 \circledast B_4) \cup A$

0	0	0	0	0	0
0	1	0	0	1	0
0	0	1	1	1	0
0	0	1	1	0	0
0	1	1	1	1	0
0	0	0	0	0	0

$B_1 = \begin{matrix} 1 & x & x \\ 1 & 0 & x \\ 1 & x & x \end{matrix}$

90° rotate CW

$B_2 = \begin{matrix} 1 & 1 & 1 \\ x & 0 & x \\ x & x & x \end{matrix}$ → rot(90° CW) → $B_3 = \begin{matrix} x & x & 1 \\ x & 0 & 1 \\ x & x & 1 \end{matrix}$ → rot(90° CW) → $\begin{matrix} x & x & x \\ x & 0 & x \\ 1 & 1 & 1 \end{matrix}$

Short technique.

① Apply B_i in order completely.

② find part where all 1's matches to put zero '0' where there is scope.

③ Apply all operations on updated image. (not on previous one)

—— Repeat for B_i's in order.

Ans:

0 0 0 0 0 0
0 1 0 0 0 0
0 0 1 1 0
0 0 0 0 0 0
0 1 1 1 0
0 0 0 0 0 0

Q)

	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	1	0	1	1	1	1	0
2	0	0	1	1	1	1	1	0
3	0	1	1	1	1	1	1	0
4	0	0	1	1	1	1	1	0
5	0	0	0	1	1	1	1	0
6	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0

0 0 0 0 0 0 0 0
0 1 0 1 1 1 1 0
0 0 1 1 1 1 1 0
0 1 1 1 1 1 1 0
0 0 1 1 1 1 1 0
0 0 0 1 1 1 1 0
0 0 0 1 0 0 0
0 0 0 0 0 0 0 0

center bit { 1 when we want to thin
0 Thick

THICKNESS & THINNESS

$B_1 =$ 0 0 0 / x x / 1 1 1

↓ rot (45° cw)

$B_2 =$ x 0 0 / 1 0 / 1 1 x

↓ rot (45° cw)

$B_3 =$ 1 x 0 / 1 0 / 1 x 0

↓ rot (45° cw)

$B_4 =$ 1 1 x / 1 0 / x 0 0

rot (45° cw)

$B_5 =$ 1 1 1 / x x / 0 0 0

↓ rot (45° cw)

$B_6 =$ x 1 1 / 0 1 / 0 0 x

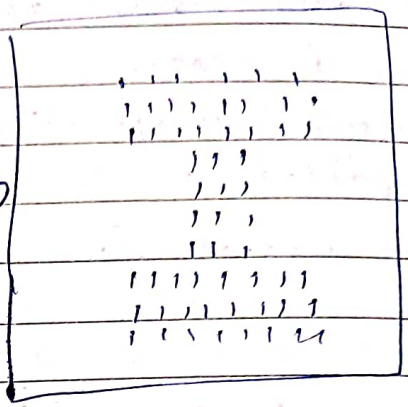
↓ rot (45° cw)

$B_7 =$ 0 x 1 / 0 1 / 0 x 1

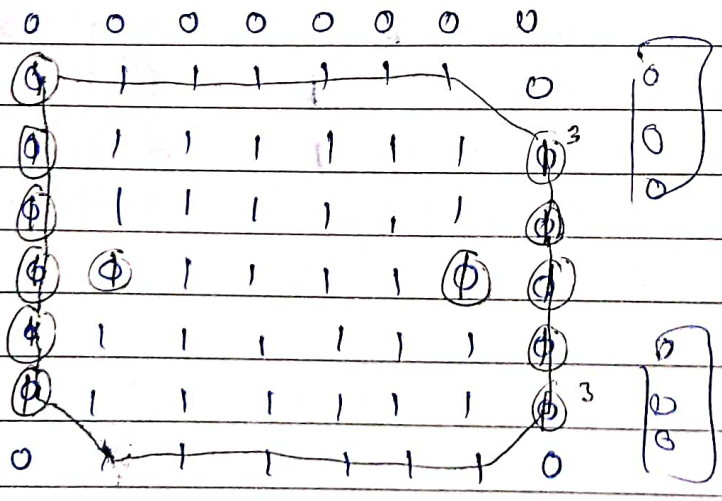
↓ rot (45° cw)

$B_8 =$ 0 0 x / 0 1 / x 1 1

Image

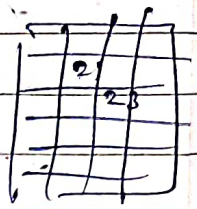


{ Operation
center
but
के अलावा
1's & 0's
fit होने
चाहिए }



16.04.2024 Monday

Shannon Fano → loss less compression



intensity	21	24	37	42	22	10	15
message	m_1	m_2	m_3	m_4	m_5	m_6	m_7
frequency	25	15	30	12	8	5	5

① m_1 25/100 = 0.25
m_2 15/100 = 0.15
m_3 = 0.30
m_4 = 0.12
m_5 = 0.08
m_6 = 0.05
m_7 = 0.05

② $m_3 = 0.30$
$m_1 = 0.25$
$m_2 = 0.15$
$m_4 = 0.12$
$m_5 = 0.08$
$m_6 = 0.05$
$m_7 = 0.05$

Arrange in ↓ using order m_i's

$fr_i P = \frac{f_i}{\Sigma f_i}$

m_3 0.30 → 1
m_1 0.25 → 0
0.55

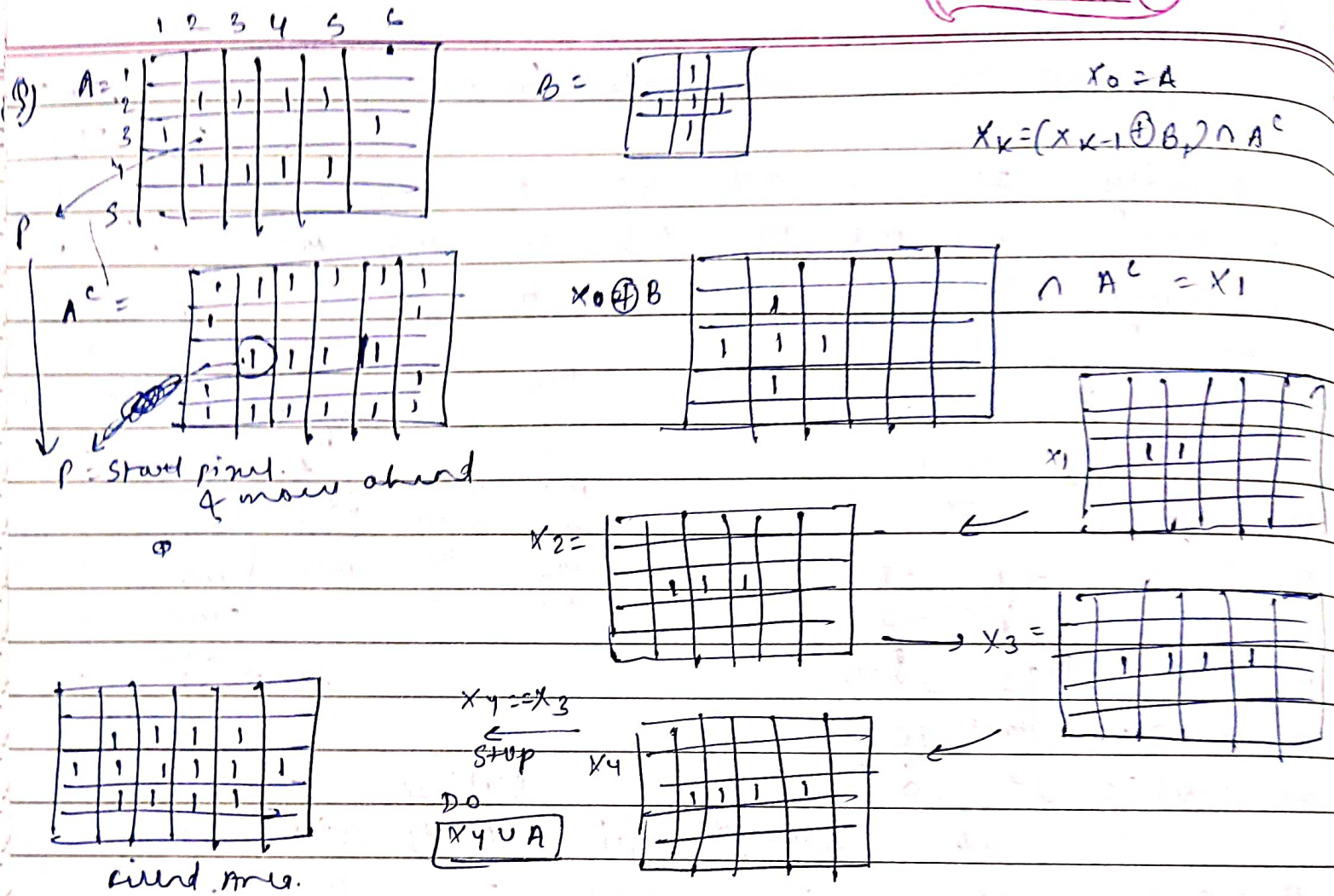
m_2 0.15 → 0
m_4 0.12 → 0
0.25
m_5 0.08 → 1
0.45

m_6 0.05 → 0
m_7 0.05 → 1
0.10
0.18

	code	code length	f_i	intensity	$(I_i)(l_i)$	$(l_i)(f_i)$
	m_3	11	2	0.30	2	4	0.60
m_2	m_1	10	2	0.25	7	14	3.5
m_3	m_2	011	3	0.15	3	9	
m_4	m_4	010	3	0.12	4	12	
m_1	m_5	001	3	0.08	5	15	
	m_6	0001	4	0.05	6	24	
	m_7	0000	4	0.05	0	0	

$L =$

$L = \Sigma(f_i)(l_i)$ $H = \Sigma f_i \log_2 f_i$ $\eta = \frac{H}{L} \times 100$


1 2 3 4 5 6
A =
B =
$X_0 = A$
$X_K = (X_{K-1} \oplus B) \cap A^c$
P
S
A^c =
P : Start pixel & move around
$X_0 \oplus B$
$\cap A^c = X_1$
X_1
X_2 =
X_3 =
$X_4 = X_3$
Stop
X_4
Do
$X_4 \cup A$
Final Image.