Final

Group - A
- Image compression
- Morphological processing

ch - 8

Image Compression : (Contents)

- Defn
- fundamental concepts of data compression & image compression.
- Data Redundancy (Def, Type)
- Image compression Model.
- Image compression Type. (lossy & loss less)
- Fidelity criteria (SNR, RMSE etc.)
- Image compression standards, Format etc.

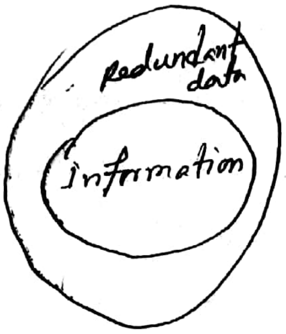
Group - B
- Segmentation
- Image representation
- Pattern recognition

Data Compression

- DC is defined as the process of encoding data using a representation that ~~reduces~~ reduces the overall size of data, The reduction is possible when the original dataset contains some type of redundancy.

26-12-17

Information vs Data:



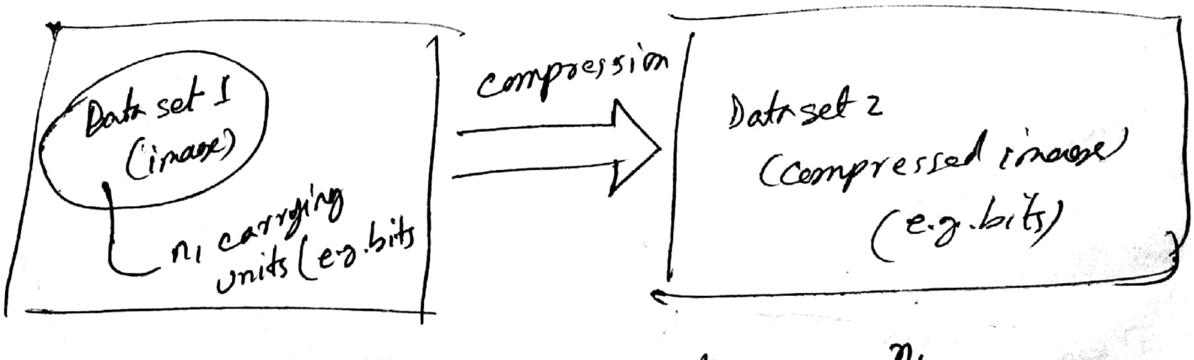
Data = Information + Redundant data

Data Redundancy:

- Let n_1 and n_2 denote the number of datum in two different representation of the same image. The relative data redundancy R_d of the first representation is defined is defined as —

$$R_d = 1 - \left(\frac{1}{C_r}\right)$$ where, R_d = Relative data redundancy

C_r = Compression ratio.



Compression ratio: $C_r = \frac{n_1}{n_2}$

where n_1 = first data

n_2 = second "

1. if $n_1 = n_2$ $C_r = 1$ and $R_d = 0$

2. if $n_2 \ll n_1$ then $C_r \to \alpha$

$R_d = 1$

3. if $n_1 \ll n_2$ then $C_r \to 0$

$R_d \to -\alpha$.

Data redundancy

- (i) coding redundancy
- (ii) Interpixel "
- (iii) Psycho-visual "

Coding redundancy:

- Code: A list of symbols (letters, numbers & bits etc)
- code word: A sequence symbols used to represent a piece of information or an event
- code word length: Number of Symbols in each code word.

Example:

0: 000	4: 100 → length = 3
1: 001	5: 101
2: 010	6: 110
3: 011	7: 111

Mathematical formula of coding redundancy:

$$\text{Average}, L_{avg} = \sum_{k=0}^{L-1} l(r_k)\, P_r(r_k)$$

$N \times M$ = image

r_k = k-th gray level $(0, L-1)$

$p(r_k)$: Probability of r_k

$l(r_k)$: # of bits for r_k

Total number of bits : ~~NM × L~~ avg $NM \times L_{avg}$

case I — constant length of $l(r_k)$

case II — Variable length of $l(r_k)$

Case 1: $l(r_k)$ = constant length

r_k	$Pr(r_k)$	code 1	$l_1(r_k)$
$r_0 = 0$	0.19	000	3
$r_1 = \frac{1}{7}$	0.25	001	3
$r_2 = \frac{2}{7}$	0.21	010	3
$r_3 = \frac{3}{7}$	0.16	011	3
$r_4 = 4/7$	0.08	100	3
$r_5 = 5/7$	0.06	101	3
$r_6 = \frac{6}{7}$	0.03	110	3
$r_7 = 1$	0.02	111	3

$$L_{avg} = \sum_{k=0}^{7} l(r_k)\, Pr(r_k)$$

$$= 3 \times 0.19 + 3 \times 0.25 + \cdots$$

= 3 bits

Total number of bits 3 N×M.

Case - II : $l_2(r_k)$ = Variable length.

r_k	$P_r(r_k)$	Code 1	$l_1(r_k)$	Code 2	$l_2(r_k)$
				11	2
				01	2
				10	2
				001	3
				0001	4
				00001	5
				000001	6
				000000	6

$$L_{avg} = \sum_{k=0}^{7} l(r_k) \cdot P_r(r_k)$$

$= 2 \times 0.19 + 2 \times 0.25 + 2 \times 0.21 + 3 \times 1.6 + \cdots$

$= 2.7$ bits.

$$C_r = \frac{3}{2.7} = 1.11$$

Therefore $R_d = 1 - \frac{1}{C_r} = 1 - \frac{1}{1.11} = 0.099$

[Thus 10% of data in original 8-bit 2D intensity array is redundant

③ Interpixel redundancy:

- If a pixel value can be reasonably predicted from its neighboring pixels the image is said to contain interpixel redundancy.

Types of IR:

- Spatial redundancy.
  → Local: Pixels at neighboring locations have similar intensity.
  → Global: Reoccuring patterns.

- Spatial redundancy: Between color planes.

→ Temporal redundancy: Betn consecutive frame,

③ ~~Interpi~~ psycho visual redundancy:

→ It is a redundancy ~~ac~~ corresponding to different sensitivities to all image signals by human eyes. Therefore, eliminating some less relative important information in our visual processing maybe acceptable.

→ Psychovisually redundant image ~~a~~ information can be identified and removed.

→ a process referred to as quantization.

→

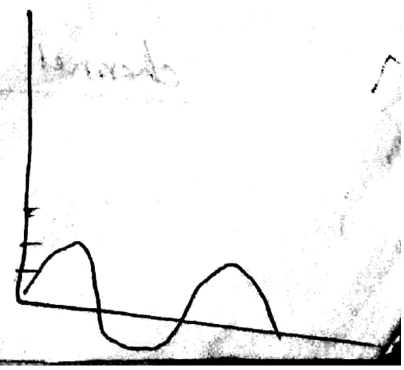
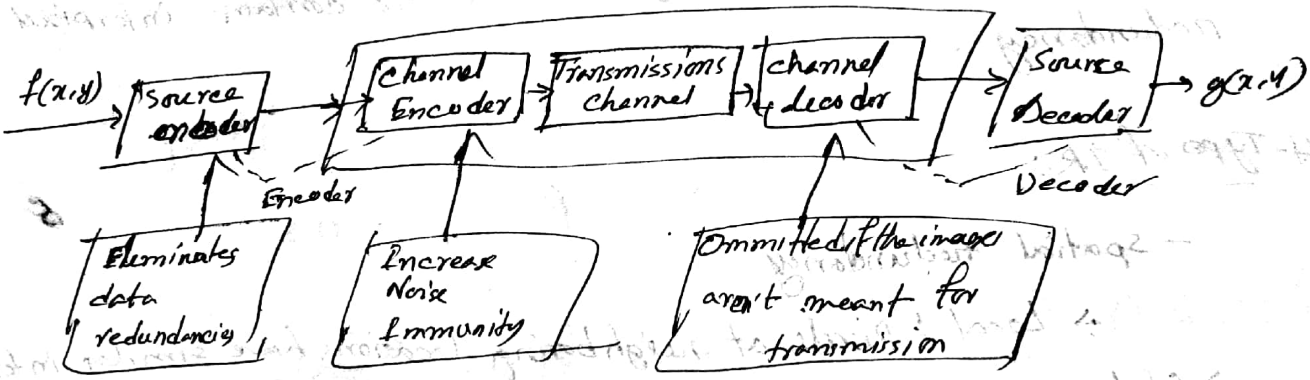
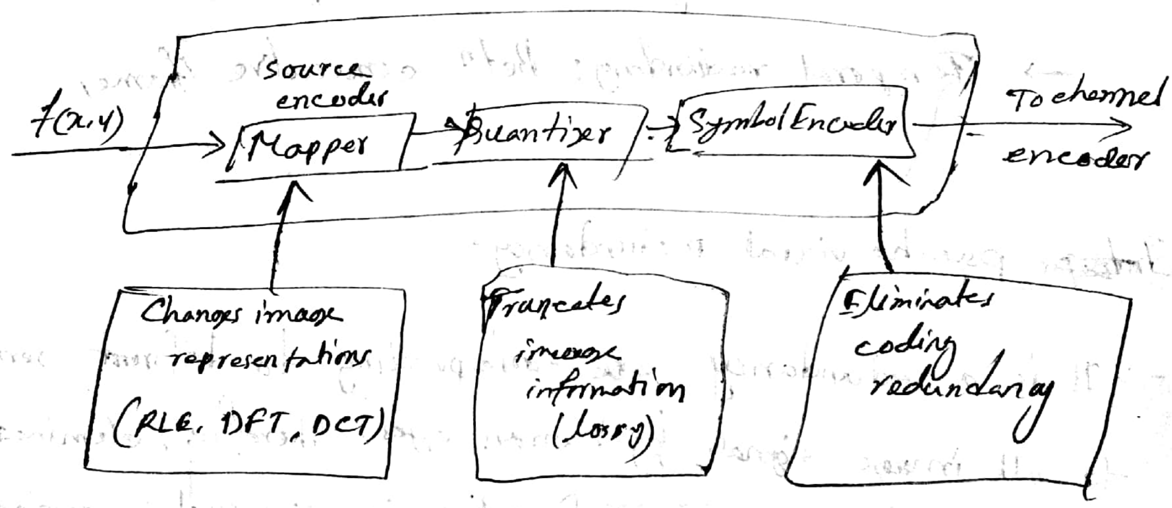


Image Compression Model :

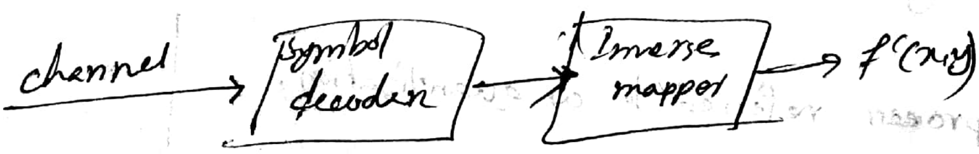
→ A compression scheme can generally be modeled as shown —



* This source encoder is typically modeled as —



(a) Source Encoder Model:



(b) Source decoder model

Mapper: transform the image to a formal design to reduce interpixel redundancies.

Quantizer: Reduces psychovisual redundancies by quantizing deemed less important for visual interpretation.

Symbol encoder:
- codes the data efficiently (typically using some form of variable-length coding ~~st~~ scheme) and aims to reduce coding redundancies.

Error criterion / Fidelity criteria:

— To determine the quality of the image.

Fidelity criteria

- subjective: Based on human observers
- objective: Mathematically defined criteria

① subjective: ~~fidelity~~ fidelity criteria — Book page - 535 Table: 8.2

① Excellent
② fine
③ poor
④ Good

② Objective: fidelity criteria;

~~① Mean-square~~

(i) Mean-square signal to noise ration (SNR)

$$SNR_{ms} = \left[\frac{\sum_{x=1}^{M} \sum_{y=1}^{N} f_2(x,y)^2}{\sum_{x=1}^{M} \sum_{y=1}^{N} (f_2(x,y) - f_1(x,y))^2} \right]$$

where, f_1 = original image

f_2 = Restored image / filtered image

$M \times N$ = size of image

$x \rightarrow$ row & $y \rightarrow$ column

(ii) Root mean square of SNR (RMS-SNR)

$$RMS\text{-}SNR = \sqrt{\left[\frac{\sum_{x=1}^{M} \sum_{y=1}^{N} f_2(x,y)^2}{\sum_{x=1}^{M} \sum_{y=1}^{N} (f_2(x,y) - f_1(x,y))^2} \right]}$$

(iii) Mean square error (MSE)

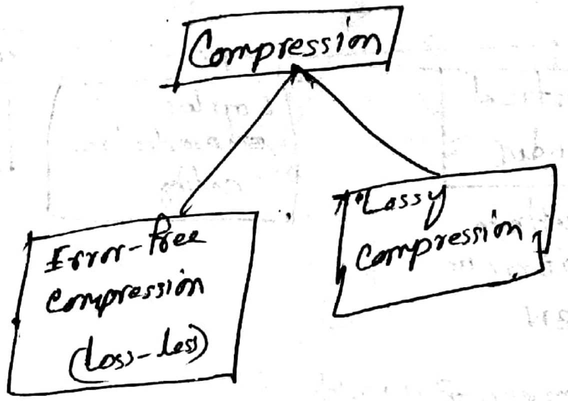
$$MSE = \left[\frac{\sum_{x=1}^{M} \sum_{y=1}^{N} (f_1(x,y) - f_2(x,y))^2}{M \times N} \right]$$

where Root mean square error (RMSE)

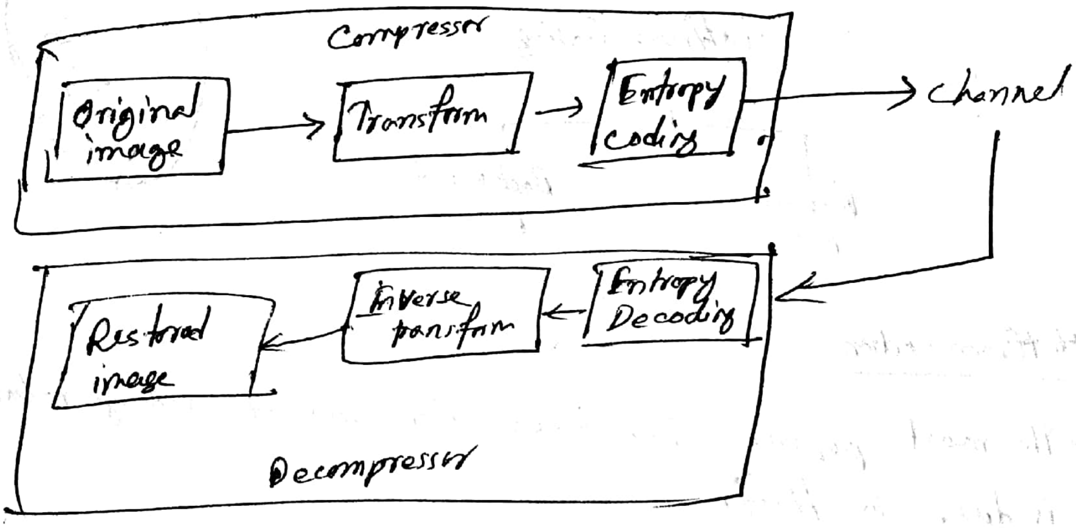
$$RMSE = \sqrt{MSE}$$

08. 01. 18

Types of image compression



Error-free (loss less) compression:



- Loss less compression are usually two-step algorithms.

  # The first step transform the original image to some other format in which the interpixel redundancy is reduced.

  # The second step uses an entropy encoder to remove the coding redundancy. The lossless decompressor is a perfect inverse process of the lossless compressor.

Ex: Typically, medical images can be compressed loss lessly to about 50% of their original size.

Error Free compression (Loss-less)

- Repetitive sequence encoding
  - RLE
- Statistical Encoding
  - Huffman
  - Arithmetic
  - LZW → Lempen-Zir-Welch
- Loss less predictive coding
- Bit plane encoding

VC

Huffman Coding

- forword pass
- Backword pass

Huffman coding:

- The most popular techniqne for removing coding redundancy is due to Huffman

Forword pass:

(i) sort probabilities per symbol.

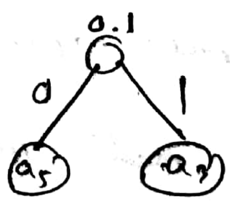
(ii) Combine the lowest two probabilities

(iii) Repeat stepz until only two " remain

symbol:	a_2	a_6	a_1	a_4	a_3	a_5
probability:	0.4	0.3	0.1	0.1	0.06	0.04

step-01:

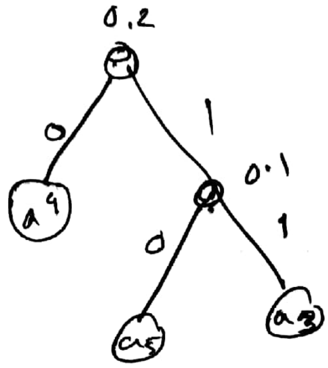
a_2	a_6	a_1	a_4
0.4	0.3	0.1	0.1



step-02:

a_2 a_6

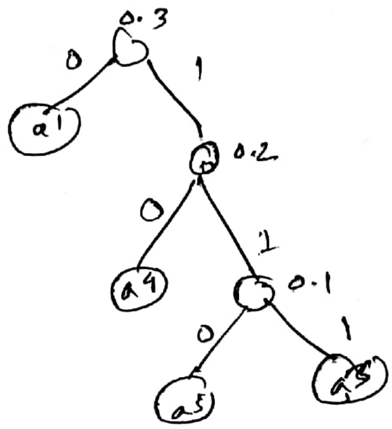
0.4 0.3



step-03

a_2 a_6 a_1

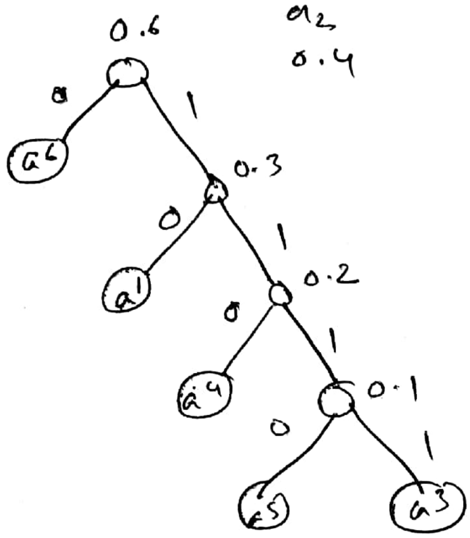
0.4 0.3 0.1



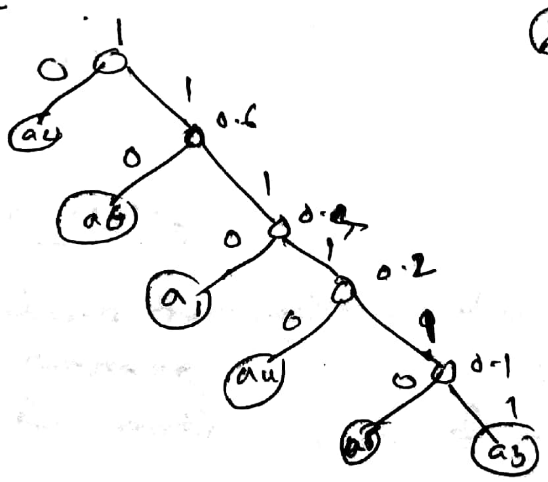
step-04 :

a_2

0.4



st 05:



Scanned by CamScanner

Run Length Encoding (RLE)

- RLE is a very simple form of data compression.
- Stored as a single data value and count

Ex : AAA BB CCC AA

Sol^n : 3A 2B 3C 2A

Arithmetic Coding:

Adv. – Slower than Huffman coding but typically achieve better compression.

– An entire sequence of source symbols (MSG) is assigned a single arithmetic code.

- Code word defines an integer of real numbers betn 0 and 1.

Basic Arithmetic coding process

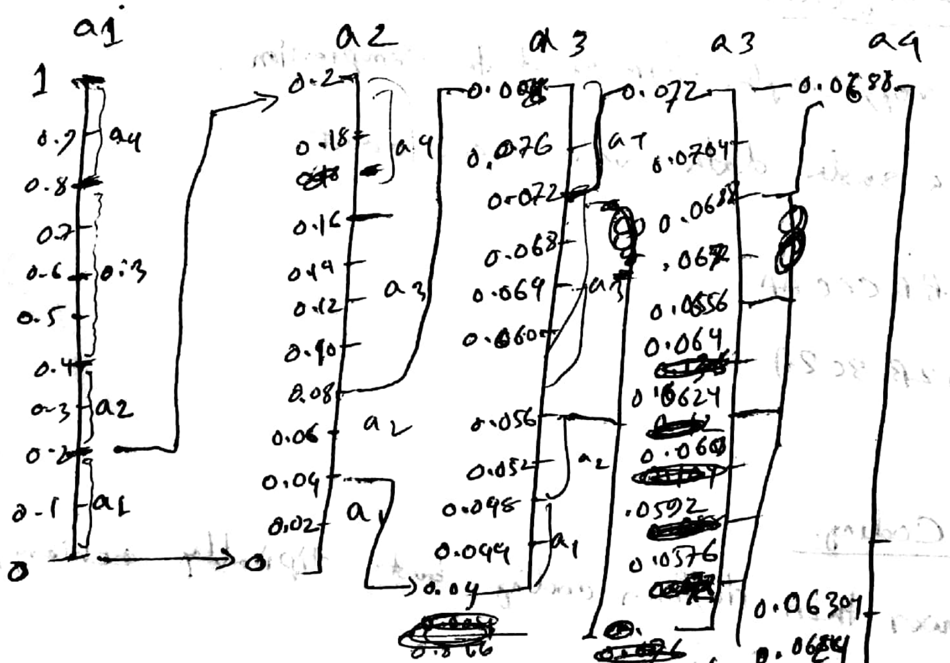
5 symbol message, $a_1 a_2 a_3 a_3 a_4$ from 4 symbol source is code.

Source symbol	Probability	Initial subinterval
a1	0.2	[0.0 0.2)
a2	0.2	[0.2 0.4)
a3	0.4	[0.4 0.8)
a4	0.2	[0.8 1.0)
	1	

[0, 1)
half open
0 to 1

$\frac{0.08-0.07}{10} = 0.007$

Encoding sequence:



firstly $\frac{0.2-0.0}{10} = 0.02$

secondly $= \frac{0.08-0.04}{10} = 0.004$

$\frac{0.072-0.056}{10} = 0.0016$

$= \frac{0.0688-0.0624}{10} = 0.00064$

$[0.06752, 0.0688] \rightarrow 0.068$

Therefore 3 decimal digits are used to represent the ~~five~~ 5 symbol message.

Problem 8.17 / 8.18

Given a 4 Symbol.

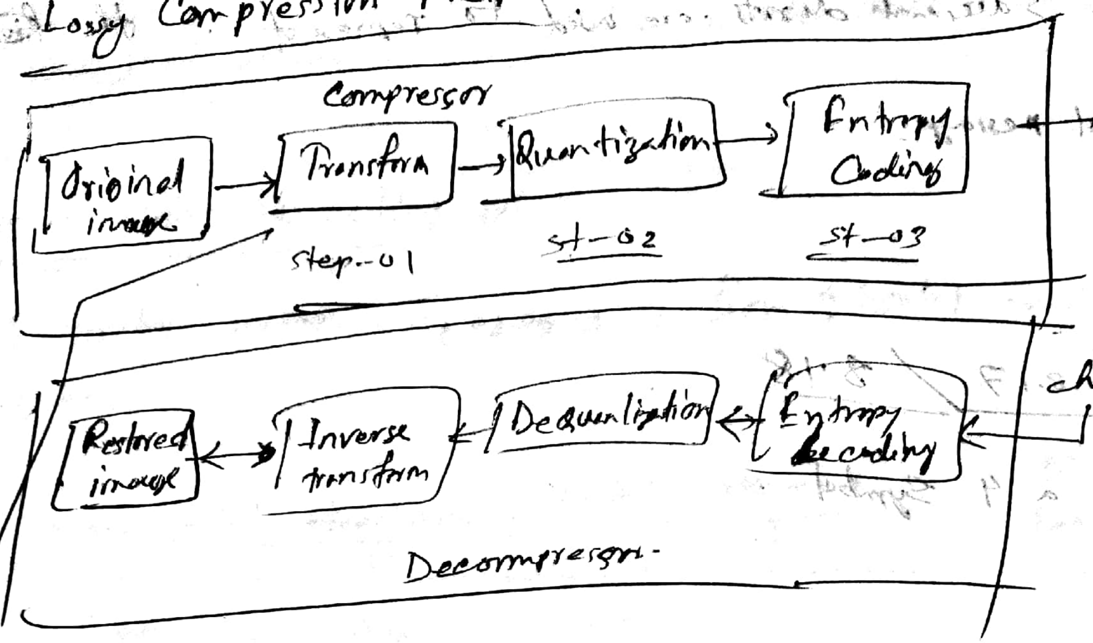
15-01-18

Presentation topic

1. Lempen-ziv-Welch (LZW) Coding
2. Quad ~~tt~~ tree Coding
3. Lossless Predictive Coding.

fundamenta of DIP by Anil K. jain.

Lossy Compression Methods



Removes interpixel redundancy

Lossy compression
1. Transform Coding
2. Block Trancation Compression
3. Vector Quantization "
4. Lossy Pedictive coding
5. Wavelet Coding

(1) Transform Coding: Transform Coding is a general sheme for lossy image compression. It uses a reversible and linear transform to decorrelate the original image into a set of coefficients in transform domain.

The coefficients are then quantized and coded sequentially in transform domain.

Eg: DFT, FFT, DCT, etc.

② Block Truncation Compression:

- BTC is a type of lossy image compression technique for gray scale images. It divides the original image into blocks and then uses a quantizer to reduce the number of gray levels in each block whilst maintaining the same mean and standard deviation.

Figure 8.6 pg - - 538

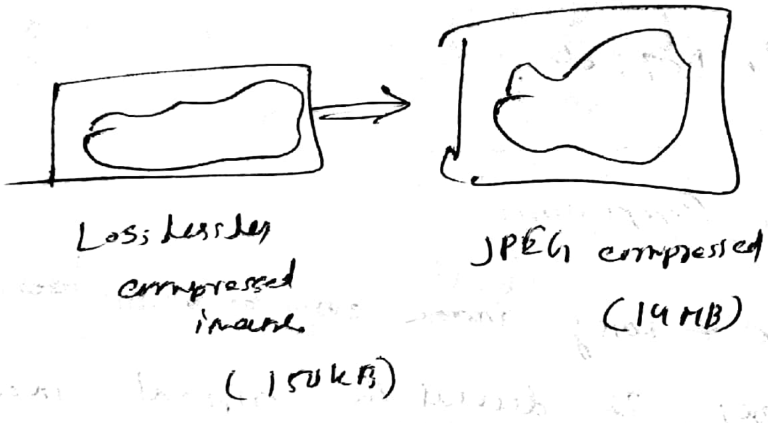
Image compression standard formats

Image compression standards:

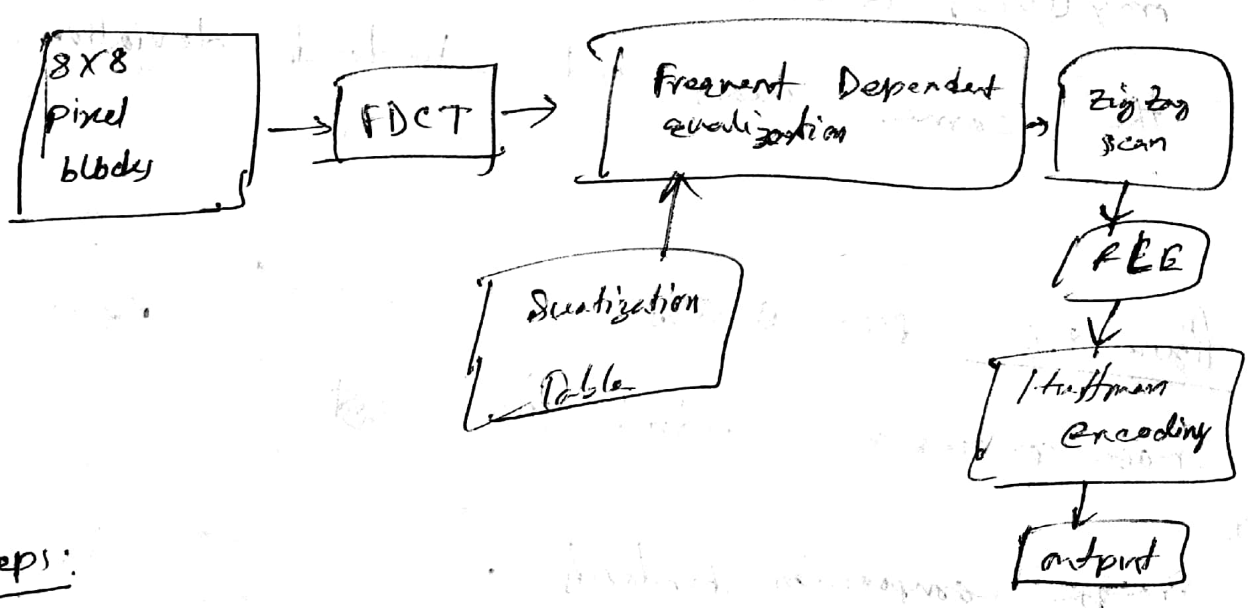
What is JPEG:

- Joint photographic Expert Group: voted as international standard in 1992
- Works with color and gray scale images
  e.g. satellite, Medical

- Lossy and Loss-less compression method



JPEG Algo:



steps:

① Divide image 8X8 pixel blocks.

② Apply 2D Fourier Discrete Cosine Transform (FDCT) transform

③ Apply coarse quantization to high spatial frequency component.

④ Compress resulting data losslessly and store

⑪ Video compression standards.

01 Video teleconferencing standards..

→ H.261 (Px64)

→ H.261

→ H.263 (10 to 30 k bit/s)

→ H.320 (ISDN bandwidth

(02) Multimedia standards

→ MPEG-1 (1.5 Mbit/s)

→ MPEG-2 (2-10 MB/s)

→ MPEG-4 (5 to 64 kb/s for mobile).

531^r 81.4

Information theory

- It studies the evaluation storage and communication of info

- To find fundamental limits on signal processing and communication operations such as data compression

why need?

chap-9

Morphological Image processing

- MIP
  - Dialation
  - Erosion
  - Opening
  - closing
  - Hit & missing.

MIP: A Branch in biology that deals with the form or shape & structure of animals and plants.

Mathematical morphology:

- As a tool for extracting image components that are useful in the representation & description of region shape.

- The language of mathematical morphology is -

set theory: $A \to A^c$; $A \to \hat{A}$

1) Reflection : $\hat{B} = \{w \mid w = -b, \forall b \in B\}$

2) Translation $(A)_z = \{c \mid c = a+z, \forall a \in A\}$

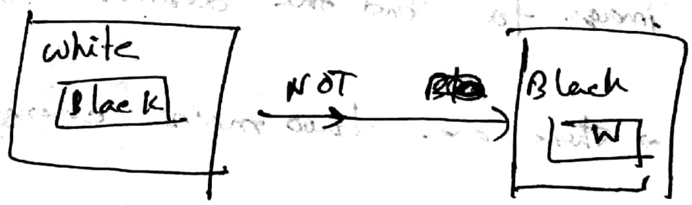
- Basic concepts in set theory:

1) Subset : $A \subseteq B$
2) Union : $A \cup B$ (or opr)
3) Intersection : $A \cap B$ [And opr]
4) Complement : $(A)^c = \{w \mid w \notin A\}$ [NOT opr]
5) Difference : $A - B = \{w \mid w \in A, w \notin B\} = A \cap B^c$

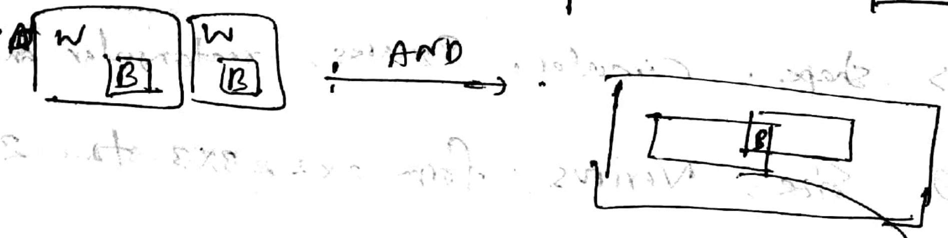
* Implementation of set theory by using image:

If A and B are two sets, Then

① NOT (complement) :



②



(A) AND (B)

only visualizing the common portion from both img ($A \cap B$)

③

④

*. Application of Morphology :

①:> Common usages include
- Edge detection
- Noise removal
- Image enhancement
- Image segmentation

②> forcing shapes onto region edges.

③> To count regions

④ To estimate sizes of regions.

Scanned by CamScanner

• Structural element (SE):

- SE is the mask or window which are place on original image to find the desired output.

→ There are two main characteristics of SE:

1) shape : circular, Squares, rectangular and triangle.
2) Size : Various form 2x2, 3X3 to 21X21.

MATLAB

Se = strel (shape, parameters)
where,
shape

1	1	1
1	1	0
1	1	1

SE-01

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

SE-02

Basic Morphological operations:

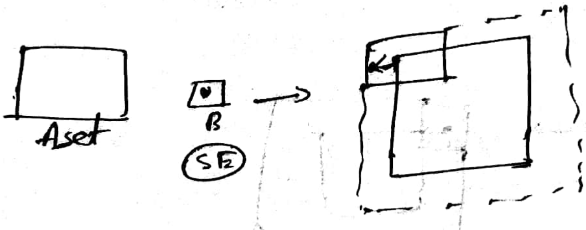
1) Dialation
2) Erosion

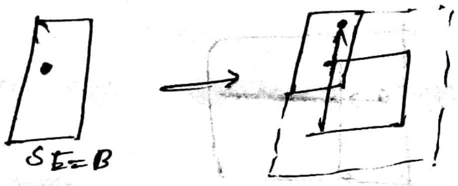
• Dilation :

→ Dilation adds pixels to the boundaries of objects in an image.

– Dialation is used for expanding an element A by using SE B.

Ex:





Dilation in MATLAB:

Syntax: Y = imdilate (A,B) where

A → input img

B → SE

Y - Dilated img.

Simple program of Dilation:

BW = zeros (9,10).

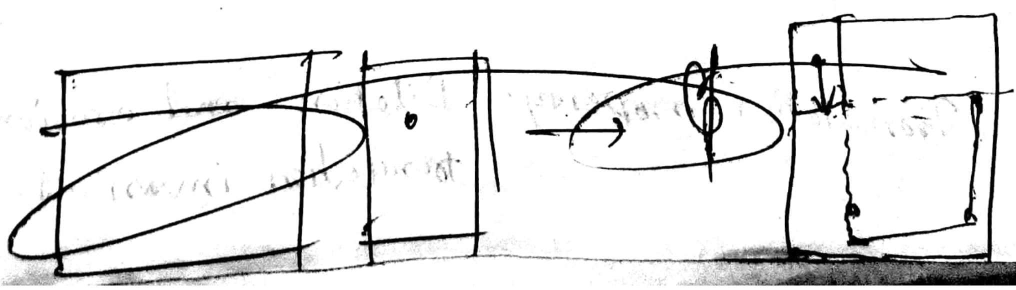
BW (4:6 ,4:7) = 1

SE = strel ('square', 3)

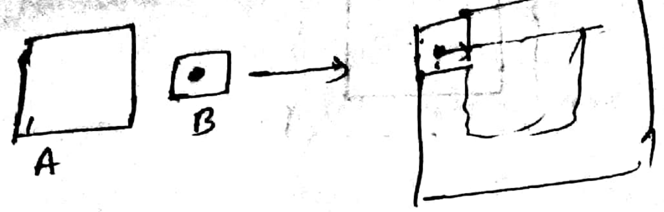
BW2 = imdilate(BW, SE)

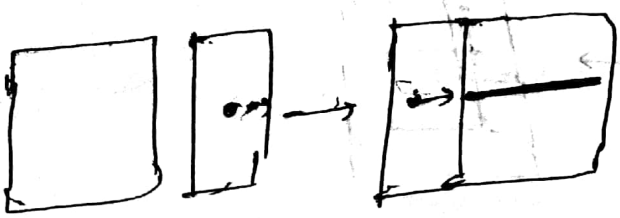
Erosion:

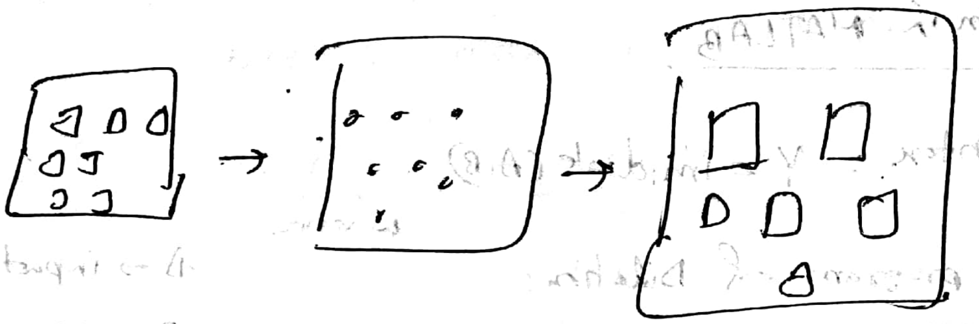
- Erosion removes pixels on object boundaries
- Erosion is used for shrinking of of element A by using element B.



Ex:







$Y = \text{imerode}(A, B)$

Properties of Dilation and erosion:

① Commutative property:

$$A \oplus B = B \oplus A$$
$$A \ominus B = B \ominus A$$

② Associative property:

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

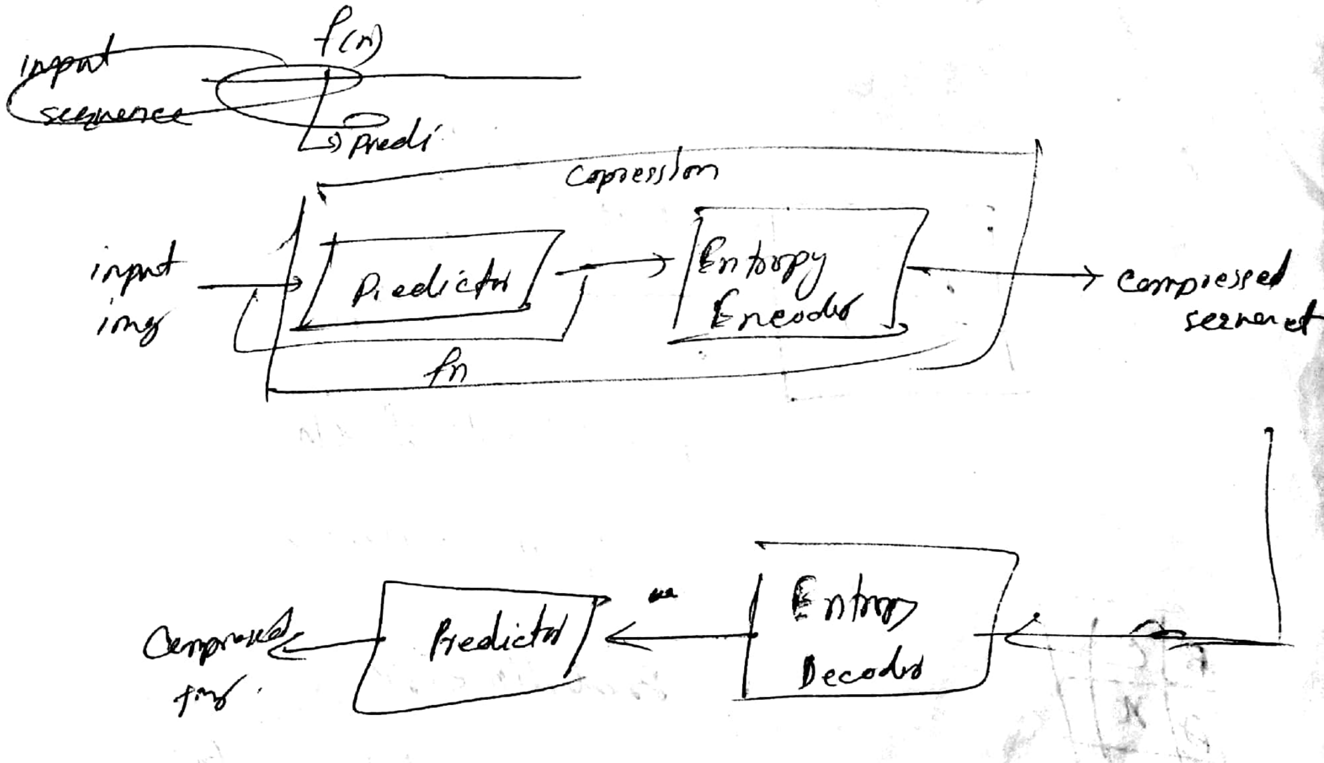
$$(A \ominus B) \ominus C \neq A \ominus (B \ominus C)$$

③ Translation property: Dilation and erosion are translation invariant.

Lossless predictive coding

→ The decoder renders an exact reproduction of the original digital image.

→ Image processing & Quantization use a predictive technique instead of transforming encoding technique.



Predictors

0 No prediction

1 $f(i,j) = f(i-1,j)$

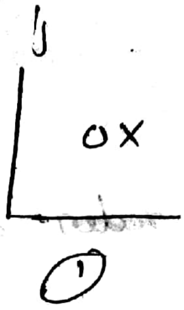
2 $\hat{f}(i,j) = f(i,j-1)$

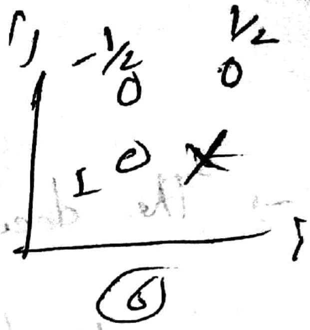
3 $\hat{f}(i,j) = f(i-1,j-1)$

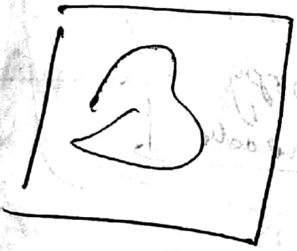
4 $\hat{f}(i,j) = f(i,j-1) + f(i-1,j) - f(i-1,j-1)$

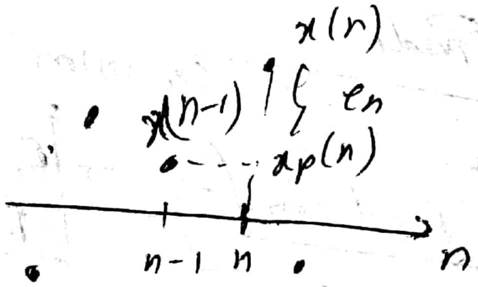
5 $\hat{f}(i,j) = f(i,j-1) + (f(i-1,j) - f(i-1,j-1))/2$

6. $\hat{f}(i,j) = f(i-1,j) + (f(i,j-1) - f(i-1,j-1))/2$









Predicted value of $x(n)$

$$x_p(n) = x(n-1)$$

Prediction error

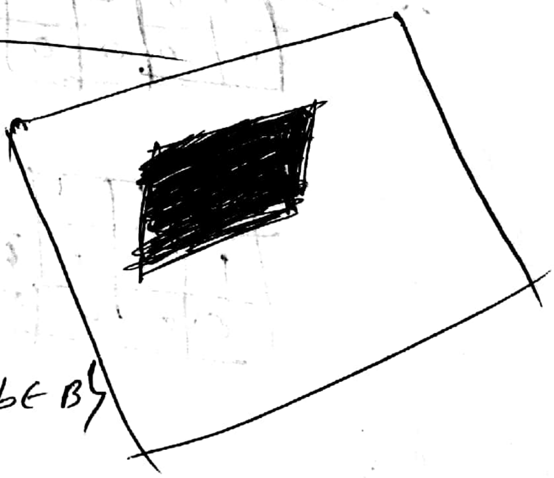
$$e_n = x(n) - x_p(n)$$

$$= x(n) - x(n-1)$$

~~Statistic~~

Selection value	Prediction
0	No prediction
1	$x = A$
2	$x = B$
3	$x = C$
4	$x = A + B + C$
5	$x = A + (B - C)/2$
6	$x = B + (A - C)/2$
7	$x = (A + B)/2$

23-01-18



Diation :

— Mathematically expressed as–

$$x \oplus B = \{ p \in z^2 \mid p = x + b,\ x \in X,\ b \in B \}$$

original Img — strel — pixel — gray

To perform dialation there are two method.

① Substitution method

② Addition

① Sub. net

$$A = \begin{array}{|c|c|c|} \hline 0 & 1 & 0 \\ \hline 1 & 0 & 0 \\ \hline 0 & 0 & 0 \\ \hline \end{array}$$

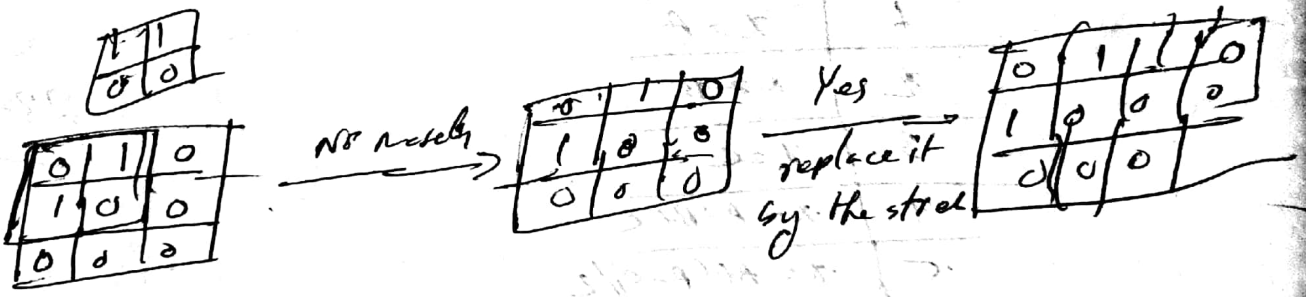
origin Image

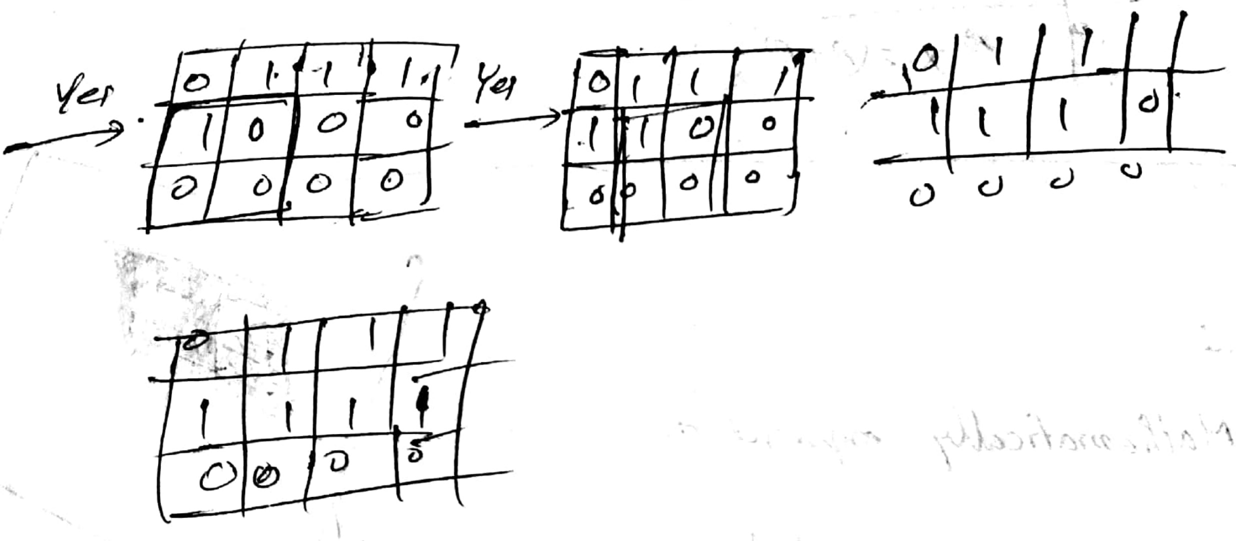
$$B = \begin{array}{|c|c|} \hline 1 & 1 \\ \hline 0 & 0 \\ \hline \end{array}$$

origin

step 1 – Match the strel with the image value.

2 – if origin of strel matched then





② Vector Add:

$$A = \begin{array}{c|ccc} & 0 & 1 & 2 \\ \hline 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 2 & 0 & 0 & 0 \end{array} \qquad B = \begin{array}{c|cc} & 0 & 1 \\ \hline 0 & 1 & 1 \\ 1 & 0 & 0 \end{array}$$

SE

Now position of 1's:

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

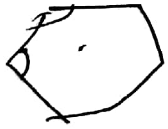
$B = \{(0,0), (0,1)\}$

Scanned by CamScanner

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

$A \oplus B = \{(0,1),(1,0),(0,2),(1,1)\}$

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



Finally we can say that:

→ Connect area that are separated.

→ In gray scan image dilation increase the brightness of the object.

778

usefulation & segmentation

representation & Description.

RLE.

shape factor (math)

Signature & skeleton - define

Convex hull —

thinning ~~th~~ thickening

~~object~~ object

syntax hull statistical model

decision theoritic approch (math)

pattern recognition cycle / syntactic model

Application /

supervise vs

Minimum distance classifier.

Artificial Neural Net — define (layers, class) boundary related math.

bounding box.

Image

Erosion

- Completely opposite of dilation
- Denoted by $A \ominus B$

let,

$$A = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

Original ~~image~~ image

Origin

$$B = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$$

SE

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \xrightarrow{\text{No match}} \begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \xrightarrow{\text{match}}$$

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

$\xrightarrow{\text{No match}}$

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

$\xrightarrow{\text{last step}}$

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

output image

Opening and closing

- can be performed by performing combinations of erosions and dilations.

Combine to : keep general shape but smooth with respect to

Opening ——— object
closing ——— background.

Opening - An erosion followed by a dilation

closing - A dilation followed by an erosion.

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Opening - Opening of set A by SE B, denoted $A \circ B$, is defined as —

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

Thus, Opening A by B is the erosion of A by B, followed by a dilation of the result by B.

Closing

- The closing of set A by SE B, denoted $A \cdot B$ is defined as —

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

which says the closing of A by B is simply the dilation of A by B, followed by the erosion of the result by B.

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

$A =$

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

Original Image

$B =$

1	1	1
1	1	1
1	1	1

SE

B এর সাথে মিলে গেলে শুধু Center value change হয়।

$A \ominus B$

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

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

1	1	1
1	1	1
1	1	1

$\rightarrow$

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

29-01-18

The - Hit or Miss Transformation:

→ It is a morphological operation where we mainly focus on finding patterns of foreground and backoround object.

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

1 – represent foreground
0 – represent – Background

→ For this we use two conditions.

→ **Hit condition:**
– If the foreground and background pixels in the SEs exactly matches with the foreground and background pixels in the img then it is hit condition and pixels below the origin of SE is set to the foreground colour.

→ **Miss condition:**
→ if forground and background pixels in element doesn't match exactly it is miss condition.

Mathematically defined as :

$$A \otimes = (A \ominus B) \cap (A^c \ominus B_2)$$

$$\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix} \xrightarrow{\text{complent}} \begin{bmatrix} 0 & 0 \\ 1 & 1 \end{bmatrix}$$

(A)

Let $W = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

$$B_2 = W - B = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Now,

$$\begin{bmatrix}1&0\\0&1\end{bmatrix} \cap \begin{bmatrix}1&1\\0&0\end{bmatrix} = \begin{bmatrix}1&0\\0&0\end{bmatrix}$$

Let,

$$A = \begin{bmatrix}1&1&1&0\\1&1&0&1\\1&1&0&0\end{bmatrix} \qquad \begin{bmatrix}1&0\\0&1\end{bmatrix}$$

org. img centre

$$A \ominus B = \begin{bmatrix}0&0&1&0\\0&0&0&0\\0&0&0&0\end{bmatrix}$$

$$A^c = \begin{bmatrix}0&0&0&1\\0&0&1&0\\0&0&1&1\end{bmatrix}$$

Let, $W = \begin{bmatrix}1&1\\1&1\end{bmatrix}$

$$B_2 = W - B = \begin{bmatrix}1&1\\1&1\end{bmatrix} - \begin{bmatrix}1&0\\0&1\end{bmatrix} = \begin{bmatrix}0&1\\1&0\end{bmatrix}$$

$$A^c \ominus B_2 = \begin{bmatrix}0&0&0&1\\0&0&1&0\\0&0&1&1\end{bmatrix} \ominus \begin{bmatrix}0&1\\1&0\end{bmatrix} = \begin{bmatrix}0&0&1&0\\0&0&0&0\\0&0&0&0\end{bmatrix}$$

Therefore, $A \circledast B = (A \ominus B) \cap (A^c \ominus B_2)$

$$= (A \ominus B) \cap (A^c \ominus (W - B))$$

$$= \begin{bmatrix}0&0&1&0\\0&0&0&0\\0&0&0&0\end{bmatrix} \cap \begin{bmatrix}0&0&1&0\\0&0&0&0\\0&0&0&0\end{bmatrix}$$

$$A \circledast B = \begin{bmatrix}0&0&1&0\\0&0&0&0\\0&0&0&0\end{bmatrix}$$ → output is Hit.

30-1-18

Ch-10 – Image segmentation (non-trivial)

Image segmentation:

- Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels).
- segmentation subdivides an image into its ~~consistent~~ constituent [illegible] regions or objects

Goal of segmentation:

① – The purpose of image segmentation is to partition an image into a meaningful regions with respect to a particular application.

② – The segmentation is based on measurements taken from the image and might be grey level, colour, ~~texture~~, depth, or motion.

③ – Image segmentation is to reduce the number of colours in the input reference image and then group neighbouring pixels of similar colour together to form bounded segments.

Types of segmentation:

① Discontinuity

1. point detection
2. line detection
3. Edge "
4. Edge linking algo
   1. Local processing
   2. Regional processing
   3. Global processing using Hough transform
   4. " " " group theoric approach.

② Similarity

② Similarity.

(a) Region extraction
- Region based approach
  - Region growing
  - R " splitting and merging

(b) Pixel based approach.

(c) Thresholding

08-02-18

Point detection:

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

A point is detected a location where the mask is centered, if $|R| > T$, where R = response of the point detection mask at the point, T = non negative thresold

$$R = w_1 z_1 + w_2 z_2 + \cdots + w_9 z_9$$
$$= \sum_{k=1}^{9} w_k z_k$$

z_k is the intensity of kth pixel

Line detection:

$$\begin{bmatrix} -1 & -1 & -1 \\ 2 & 2 & 2 \\ -1 & -1 & -1 \end{bmatrix} \quad \begin{bmatrix} -1 & 2 & -1 \\ -1 & 2 & -1 \\ -1 & 2 & -1 \end{bmatrix} \quad \begin{bmatrix} -1 & -1 & 2 \\ -1 & 2 & -1 \\ 2 & -1 & -1 \end{bmatrix} \quad \begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{bmatrix}$$

Horizontal line — Vertical line — 45° line — −45° line

Let R_1, R_2, R_3, R_4 be the responses of the mask. If at a certain point in the image $|R_i| > |R_j|$ for all $i <> j$ then that point is said to be associated with line in the direction of mask i.

$R_1 > R_2$

$R_3 > R_4$

$R_i \neq R_j$

Scanned by CamScanner

Discontinuity: To partition an image based on abrupt changes in intensity (such as edges).

The principal areas of interest within this category are detection of isolated points, lines and edges in an image.

⇒ Edge detection.

> **Edge linking:**
>
> - Local processing.
> - Regional processing.

Local processing:

step 01: Apply edge detection

step 02: Analyze the characteristic of pixels in a small neighborhood (3X3, 5X5) for every point in the image.

step-03: link the similar points.

(i) Strength of response of gradient.

$$|\nabla f(x,y) - \nabla f(x_0,y_0)| \le E.$$

(ii) The direction of the gradient vector

$$|\alpha(x,y) - \alpha(x_0,y_0)| < A.$$

Local processing:

~~of~~ if the distance of a point is larger than the thresold value, then ~~it~~ it must be connected, otherwise ~~not~~ not.

first connect two points ; and find the distance of other pixels from the line and the counting ~~will~~ will be clockwise.

Similarity

Region extraction

Region based approach

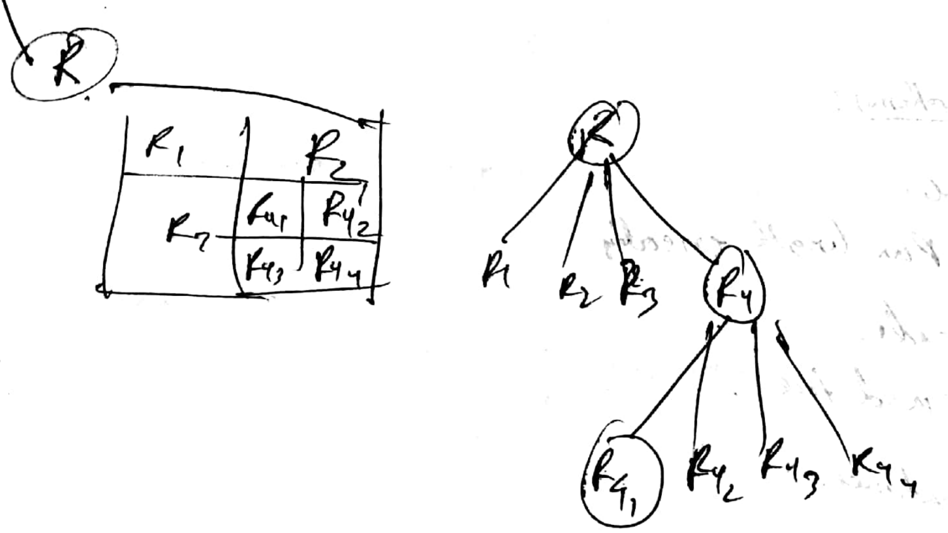
- Region growing
- Region splitting and merging.

Region growing is a procedure that groups pixels or sub regions into large regions based on predefined criteria.

Basic approach is to start with a set of seed points and from these grow ~~a~~ regions by appending - to each data those neighbouring pixels have properties similar to the seed.

Region splitting and merging :

- Sub devide an image initially into a set of arbitrary, disjointed regions and then merge and/or split the regions in an attempt to satisfy the conditions ~~sate~~ stated earliers.



- Pixel based approach
- Thresholding
- 10.6
- use of motion in segmentation
  - page - 778.

Chapter - 11

Representation and Description

→ Identification ~~on~~ representing of inherent characteristic (features) of objects found in an image

Features → Perimeter, area, Xmax, Xmin, Ymax, Ymin, shape factoring etc.

Representation can be one of two choices:

- Represent the region in terms of external characteries (boundary):

  its primary focus on shape characteristics:

- Represent the region in terms of its internal char (pixels of the region).

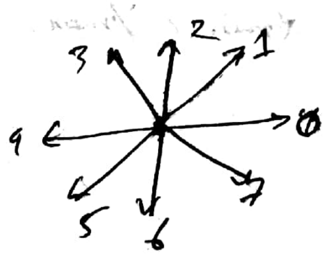
  → primary focus on regional properties. like ~~can~~ color, texture etc.

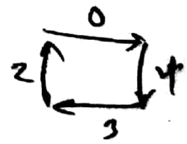
Representation schemes:

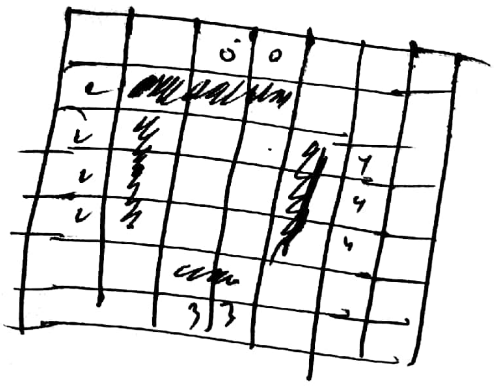
1. Run code:
   RLE - Run length encoding
2. chain code.
3. ~~Dual~~ Quad tree.
4. Signatures.
5. Skeleton.
6. Convex hull
7. Thinning.

chain code:

chain code is used to represent a boundary by a connected seqence of straight line segments of specified length and boundary







using 1st code : 0044473 2222

using 2nd code : 007665~~4~~43222

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-799

perimeter ; P = event count + $\sqrt{2}$ odd count

$= 8 + \cancel{0}\sqrt{2} \times 3$

$= 8 + 3\sqrt{2}$

shape factor = $(\text{perimeter})^2 / \text{area}$

Area .

code	Area	New Y value
0	$A = A + Y$	$Y = Y$
1	$A = A + (Y + 0.5)$	$Y = Y + 1$
2		
3		
4		
5		
6		
7		