Page No.
Date

Module 5: Morphology & Image Compression.

☆ Morphological Operations

Image processing techniques that processes images based on their shapes & structures. These operations apply a structuring element to an input image to generate an output image.

1] Dilation

Fills small holes.
Repairs breakes.
Enlarges objects.
Repairs intrusions.

$$A \oplus B = \{ x \mid (\hat{B})_x \cap A \neq \phi \}$$

2] Erosion

Shrinks the objects.
Removes noise.
Seperates connected objects.
Makes shapes uniform & clean by removing small bumps, extension, ~~protrusio~~ protrusions.

$$A \ominus B = \{ x \mid (B)_x \cap A^c = \phi \}$$

3] **Opening**

Erosion followed by dilation
~~Fills small holes~~, removes gaps, small objects

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

4] **Closing**

Dilation followed by erosion
Fills small holes.

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

5] **Hit & Miss Transform** :-

Used for template or pattern matching.
Involves two template sets :- ① B
② (W-B)

B is used to match foreground image.
W-B is used to match background image.

Hit or miss transform is intersection of erosion of foreground & erosion of background.

$HM(X, B) = (X \ominus B) \cap (X^c \ominus (W-B))$

Foreground → White square (1)
Background → Black squares (0)

★ Image Compression

Reduction of amount of data required to represent a digital image by removing redundant data.

Reduces the size of image data files, while retaining necessary information.

Compression Ratio → C_R

$$C_R = \frac{\text{Uncompressed Image Size}}{\text{Compressed Image Size}}$$

Eg:- (256×256)

Redundancy :- $R_D = 1 - \frac{1}{C_R}$

Image data redundancies

1] Coding Redundancy – occurs when the data used to represent the image are not ~~oth~~ utilised in an optimal manner.

2] Interpixel Redundancy – occurs because pixels tend to ~~be~~ highly correlated.

3] ~~Phy~~ Psychovisual Redundancy – some info is less imp to human visual system

Page No.
Date

(Coding Redundancy)

★ Huffman Coding (Steps in easy words).

① Calculate ~~___~~ probability of each

② Sort them descending order

③ Keep adding the last two & sorting them until you reach 1

④ Make a tree starting from 1 & splitting with edges as 1 on left & 0 on right always

⑤ Assign the values of 1, 0 ~~a~~ to the probability values according to the tree.

⑥ Avg length $= \sum_{i=1}^{n}$ probability × No. of bits.

⑦ Total bits to be transmitted = No. of pixels × Avg length.

⑧ Entropy $= \sum_{i=1} P(x_i) \times \log_2 (P(x_i))$

★ Run-Length EnCoding (RLE). (Interpixel Redundancy)

RLE is lossless compression technique where sequences that represent redundant data are stored as a single data value representing that repeated block & no. of time it appears in the image.

Works best with simple images & animations that have lot of redundant pixels. Useful for black & white image in particular.

Eg:- a a a b c c c c

$\downarrow$ RLE

a 3 b 1 c 4.

★ IGS Quantization (~~Pr~~ Psycho Visual Redundancy)

Psychovisual Redundancy is distinctly vision related and its elimination does result in loss of information, there is objectionable graininess and contowing effect. IGS quantization can be used to reduced the graininess. ~~Imp~~

Improved Grey Scale (IGS) quantization. breaks up the edges & contours & makes them less apparent. IGS adds a pseudo numbers generated by a low order bit. If the MSBs are all 1 the 0s are added. The MSBs become the coded value.

★ Fidelity Criteria:

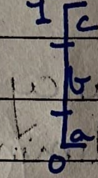
Removal of psychovisually redundant data results in loss of real or quantitative visual information.

Two general classes of criteria are used:-
1] Objective Fidelity criteria.
2] Subjective Fidelity criteria.

★ **Arithmetic Coding** (Simple steps)

① Each frequency range is given for each element (probability).

② Represent them on a scale from 0 to 1.



③ A message will be given, take the first element, enlarge the range of probabilities.

④ Compute the probabilities for this new range.

⑤ Repeat this until message is over.

⑥ The final limits is the answer.

① difference in the HL & LL.
② Multiply the difference with each probability value given.

Page No.
Date

☆ Vector Quantization (VQ).

VQ is process of mapping a vector that can have many values to a vector that has a smaller (quantized) number of values.

For image compression, vector corresponds to a small ~~image~~ subimage or block.

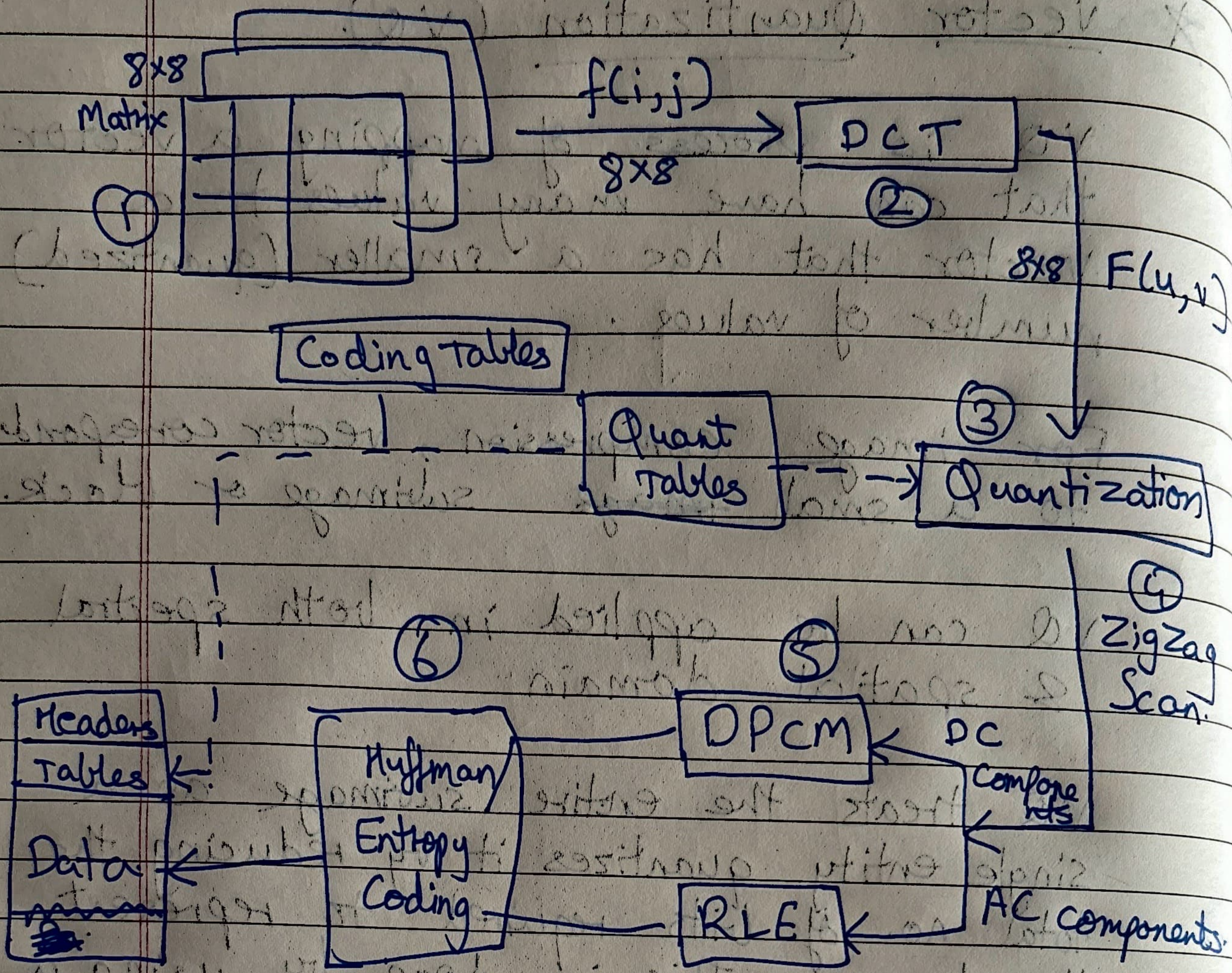
VQ can be applied in both spectral & spatial domain

VQ treats the entire subimage as a single entity quantizes it by reducing the total no. of bits required to represent the subimage. This is done by using a codebook, which stores a fixed set of vectors, then codes the subimage by the index (address) into the codebook.

☆ JPEG Image Compression.

Lossy compression.
Used for image & audio compression.
Uses transform coding.

Steps for JPEG Coding



① Represent in a 8×8 matrix.

② Perform DCT transform to convert from spatial domain to frequency domain

③ Perform Quantization to reduce the number of bits per sample

④ Do zigzag scanning to group low frequency coefficients in top of vector and high frequency coefficients at bottom.

⑤ **DPCM** - Differential Pulse Code Modulation on DC components.
Encodes the difference between the current & previous 8x8 matrix.

RLE - Run Length encoding on AC components.

⑥ Entropy Coding finally.

JPEG Modes

1] **Sequential Mode** - Image encoded in single left → right, top - bottom scan.
Supports only 8-bit images.

2] **Lossless Mode** - Predictive coding mechanism (predictive difference)

3] **Progressive Mode** - coarse version of image is transmitted at low rate
(i) Spectral Selection (DC then AC).
(ii) Successive Approximation.

4] **Hierarchical Mode** - Supports multiple resolutions of the same image which can be chosen from depending the target's capabilities.