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Lossless Image Compression

* Explain JPEG Compression.

=> JPEG stands for Joint Photographic Experts Group compression is a widely used method for compressing digital images.

It reduces file sizes and allowing for faster compression of image.

JPEG is used document management systems to store scanned documents.

=> Step for JPEG Compression:

1 Color Space Conversion:

Convert the image from RGB color space to YCbCr color space

2 Block Splitting:

Divide the image into 8 x 8 pixel blocks.

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3 Discrete Cosine Transform (DCT):

Apply the DCT to each 8 x 8 block. The DCT converts spatial domain data into frequency domain data (-127 to 127)

4 Quantization:

Quantize the DCT coefficients using quantization matrix.

5 Entropy Encoding:

Perform entropy encoding using Huffman coding on the quantized coefficients.

=> Decoding Step:

1 Entropy Decoding (Huffman Decoding)

2 Dequantization

3 Inverse DCT

4 Color Space Conversion back to RGB.

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=> Application:

1 Web and Digital Media:

JPEG is widely used for compressing images on websites, social media platforms

2 Document Management:

JPEG compression is used in document Management system to store scanned documents and other digitized paperwork.

3 Mobile Applications:

JPEG is utilized in mobile apps for image sharing, editing and storage.

=> Limitations:

1 Lossy Compression:

JPEG is a lossy compression method which means image quality is loss.

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2 Recompression Loss:

Repeatedly compressing and decompressing JPEG images can lead to loss the quality of data.

* Explain CALIC.

=> CALIC stands for Context-Based Adaptive Lossless Image compression used to get high quality image compression.

It was developed as an improvemen over traditional lossless compression.

CALIC uses context modeling to capture the statistical dependencies

CALIC employs adaptive coding to adjust encoding parameters.

CALIC uses predication method to estimate the values of pixels.

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=> Compression Process :

1 Context Modeling:

Initialize context models based on the image structure.

2 Predication:

Use Predictive modeling method to estimate pixel values based on context information.

3 Predication Error Calculation:

Calculate the prediction error by subtracting predicted values from actual pixel values.

4 Adaptive Coding:

Apply Adaptive arithmetic coding method to encode predication errors.

5 Output Compression:

Output the compressed data stream.

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=> Application :

1 Medical Imaging :

CALIC is used in medical imaging systems for compressing medical images.

2 Document Management system :

CALIC is used in Document Management system to store Document.

3 Scientific Data Analysis :

CALIC is used in Scientific Data compression for sensor reading.

=> Limitation :

1 Complexity

2 Memory Requirements

3 Less Effective for Natural Images

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* Explain Burrows Wheeler Transform algorithm.

=> The BWT is a data compression algorithm that reorders the characters in a string to make it more compressible.

It is used as a preprocessing step in compression algorithm.

=> Steps:

1 Input String:

The algorithm takes an input string S of length n as input.

2 Circular Rotation:

Create a Matrix M of all cyclic rotations of S. Each row of M represents a rotation of S.

3 Burrows-Wheeler Transform:

Arrange the whole matrix into the lexicographically.

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4 Output:

The Last column of matrix is answer of algorithm.

Ex. String : BANANA

=> Here, We have to create n x n Matrix.

There are 6 Character in string, So, Matrix size is 6 X 6

Matrix with Circular Rotation:

$$M = \begin{bmatrix} b & a & n & a & n & a \\ a & n & a & n & a & b \\ n & a & n & a & b & a \\ a & n & a & b & a & n \\ n & a & b & a & n & a \\ a & b & a & n & a & n \end{bmatrix}$$

Order : a b n

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Sorted Matrix:

M =

b	a	n	a	n	a
a	b	a	n	a	n
a	n	a	b	a	n
a	n	a	n	a	b
n	a	b	a	n	a
n	a	n	a	b	a

Here, Last column will be Answer.

BWT(BANANA) = annbaa