SMVS
Page No.
Date : / /

Quantization

* What is Quantization ? Compare Scalar and Vector Quantization.

=> Quantization is a fundamental process in signal processing and data compression.

It is widely used for compression without loss the quality of data.

Quantization is reducing the data size by representing continuous values with a finite set of discrete values.

Quantization leads to bandwidth saving in communication systems.

Quantization is a key component of lossy compression that achieve high compression ratio.

SMVS
Page No.
Date : / /

	Scalar Quantization	Vector Quantization
1	Quantizes individual scalar values	Quantizes Group of values
2	Applied one-dimensional Input signal	Applied multi-dimensional input signal
3	Uses a Single codebook for representative values	Utilize a codebook of Vectors
4	Each input value is quantized independently for Error.	Quantized entire groups of values together for Error.
5	Requires less Memory for store Codebook.	Requires more memory for store codebook.
6	Simple to implement	Complex to implement
7	Use in Pulse Code Modulation in audio encoding	Use in JPEG compression in Image coding

SMVS
Page No.
Date : / /

* Explain Discrete Cosine Transform Method.

=> The DCT plays crucial role in data compression in image and video compression algorithm like JPEG and MPEG.

DCT is a type of transform coding method used to convert spatial domain data into frequency domain data.

=> Steps :

1 Color Space Conversion:

Convert the image From RGB color space to YCbCr color space.

2 Image Partitioning:

Divide the Image into 8 x8 pixels Block.

For each Block, Subtracting a constant value to center the data around zero.

SMVS
Page No.
Date : / /

3 DCT:

Perform DCT on each 8x8 block to convert spatial domain data into frequency domain data.

$$F(u,v) = \frac{1}{4} C(u) C(v) \sum_{x=0}^{7} \sum_{y=0}^{7} \cos\left[\frac{(2x+1)u\pi}{16}\right] \cos\left[\frac{(2y+1)v\pi}{16}\right]$$

4 Quantization:

Apply quantization to the DCT coefficients using quantization matrix.

5 Entropy Encoding:

Use entropy encoding method to compress the quantized DCT coefficients.

6 File Format:

Arrange the compressed data into a structured format.

SMVS
Page No.
Date : / /

=> Application :

1 Image Compression (JPEG) :

In JPEG, DCT is used to transform spatial domain into Frequency domain.

2 Video Compression :

In Video Compression, DCT is applied to blocks of Frames to reduce redundancy.

3 Audio Compression :

In Audio Compression, DCT helps transform audio signals into Frequency domain.

=> Limitations :

1 Lossy Compression :

DCT introduces quantization and information loss, which can give high compression ratio.

SMVS
Page No.
Date : / /

2 Blocking Artifacts:

DCT operates on fixed-size blocks.

3 Computational Complexity:

The computational Complexity of DCT algorithm can be relatively high.

* Explain Difference Between Forward DCT Routine and Inverse DCT

	Forward DCT	Inverse DCT
1	8 x 8 blocks of pixel values input.	8 x 8 blocks of DCT coefficient input.
2	Transforming Spatial domain into Frequency domain data.	Reconstructing Frequency domain into spatial domain data.
3	Uses Frequency indices for DCT computation.	Uses Spatial indices for IDCT computation.

SMVS
Page No.
Date : / /

4	Calculates cosine terms for each Frequency index	Calculates cosine terms for each spatial index.
5	Does not includes inverse coefficient calculation.	Includes Inverse coefficient calculation
6	Produces DCT coefficient in the Frequency domain.	Produces reconstructed pixel values in the spatial domain