



Special Module on Media Processing and Communication

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Recap

► Predictive coding

- Loss-less
- Lossy

Reference Material:

Digital Image Processing by Gonzalez and Woods (4e)

Chapter 2 Image Sampling and Quantization

Chapter 8 Fundamentals, Huffman Coding, Predictive Coding,
Transform Coding



Image Compression

Transform Coding

Transformation

- Represent information in another space
- Identify and remove correlation
- Quantization of transform coefficients

Information loss!

Example

time/space frequency
(Fourier Transform)

Inverse transformation

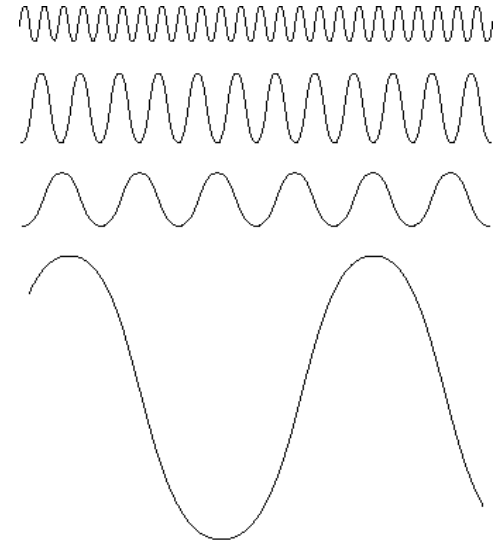
- Bring back information in the original space



Image Compression

Transform Coding

Fourier Transform (Review)



A function as sum of sines and cosines



Image Compression

Transform Coding

Fourier Transform (Review)

Mathematically

Forward

$$F(u) \equiv \mathfrak{F}\{f(x)\} = \int_{-\infty}^{\infty} f(x) e^{-j2\pi ux} dx$$

1-D:

Inverse

$$f(x) \equiv \mathfrak{F}^{-1}\{F(u)\} = \int_{-\infty}^{\infty} F(u) e^{j2\pi ux} du$$

Discrete Fourier Transform

Fast Fourier Transform (FFT)

2-D:

$$F(u, v) = \iint f(x, y) e^{-j2\pi(ux+vy)} dx dy$$

$$f(x, y) = \iint F(u, v) e^{j2\pi(ux+vy)} du dv$$



Image Compression

Transform Coding

Discrete Cosine Transform

Popular transform for its performance and efficiency

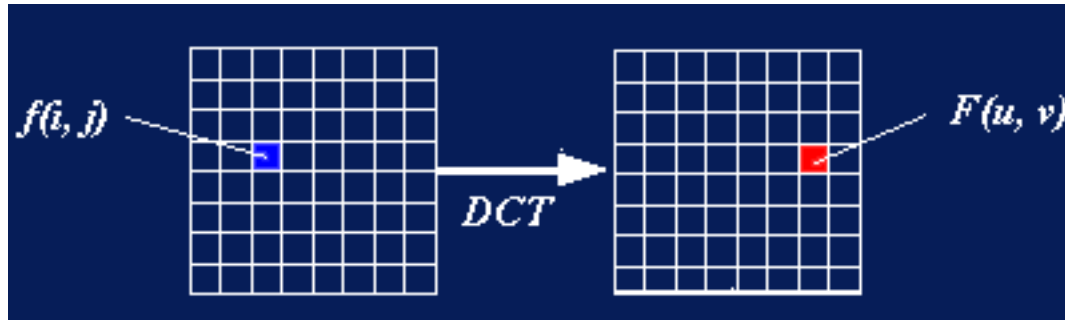




Image Compression

Transform Coding

Discrete Cosine Transform

Forward transform

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

Inverse transform

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



Image Compression

Transform Coding

Discrete Cosine Transform

Energy compaction

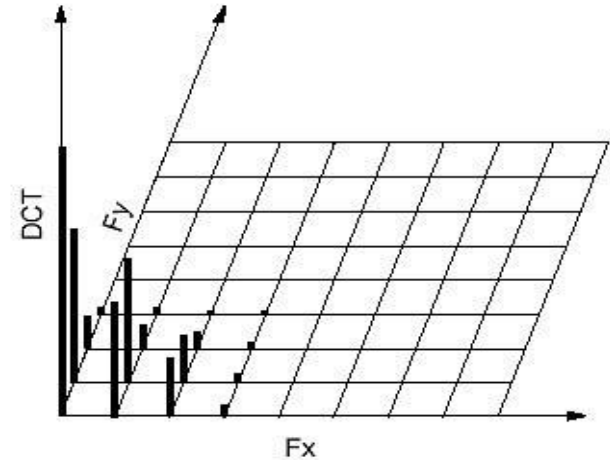
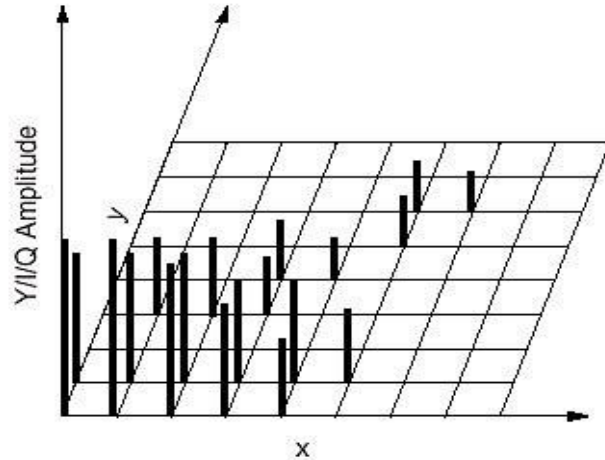
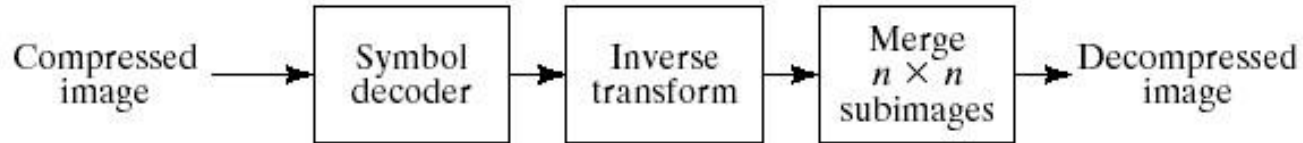
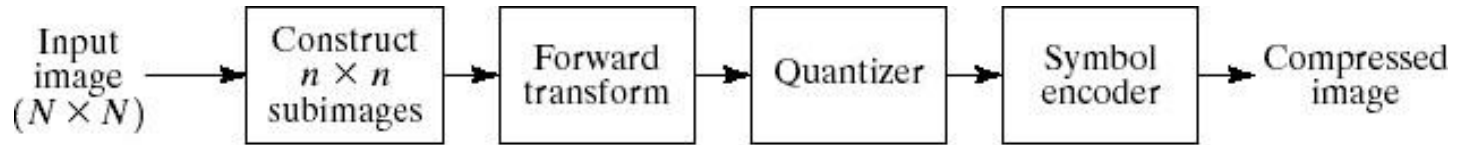




Image Compression

Transform Coding Pipeline

Compression



Decompression



Image Compression

Transform Coding

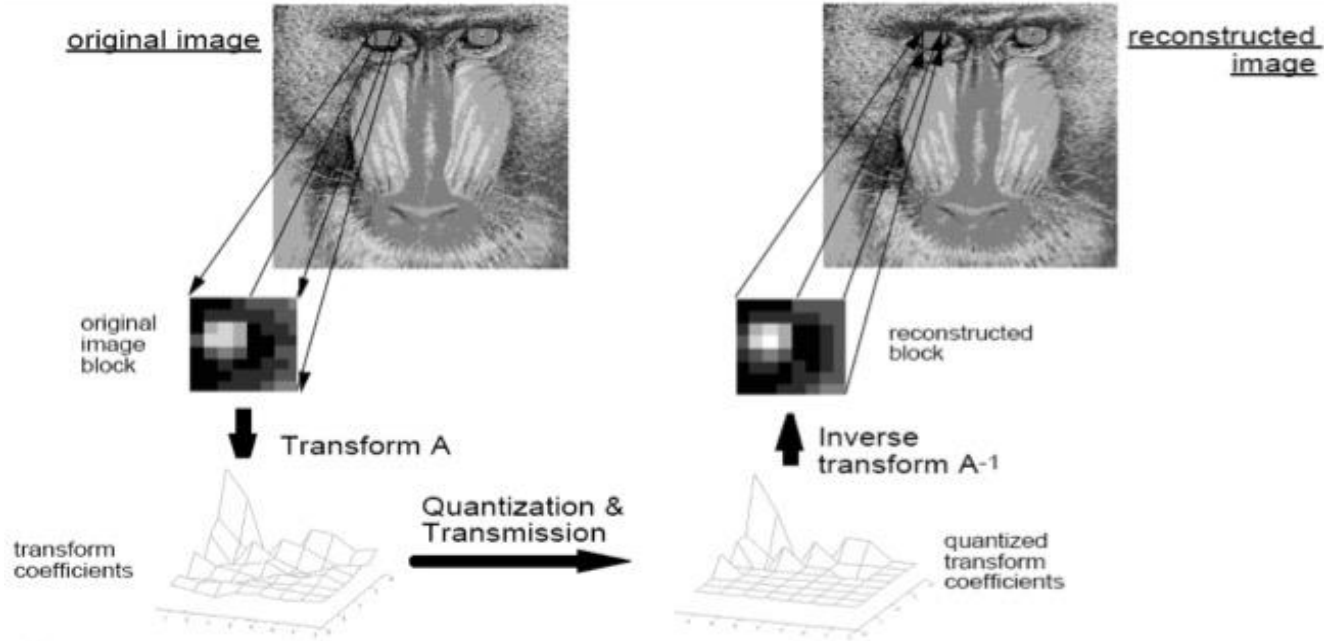




Image Compression

Transform Coding

Why sub image (nxn)?

- Computational benefit
- Typically 8x8, 16x16
- Error is not very high

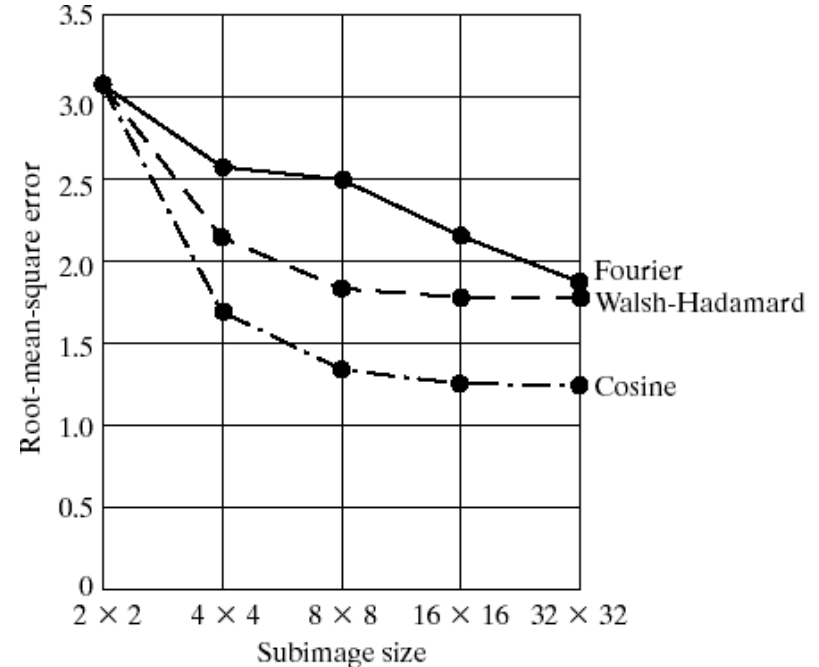




Image Compression

Transform Coding

Why sub image (nxn)?

- Computational benefit
- Typically 8x8, 16x16
- Error is not very high

Which transform?

- Low error for the same number of coefficients
- Computationally fast
- DCT is preferred

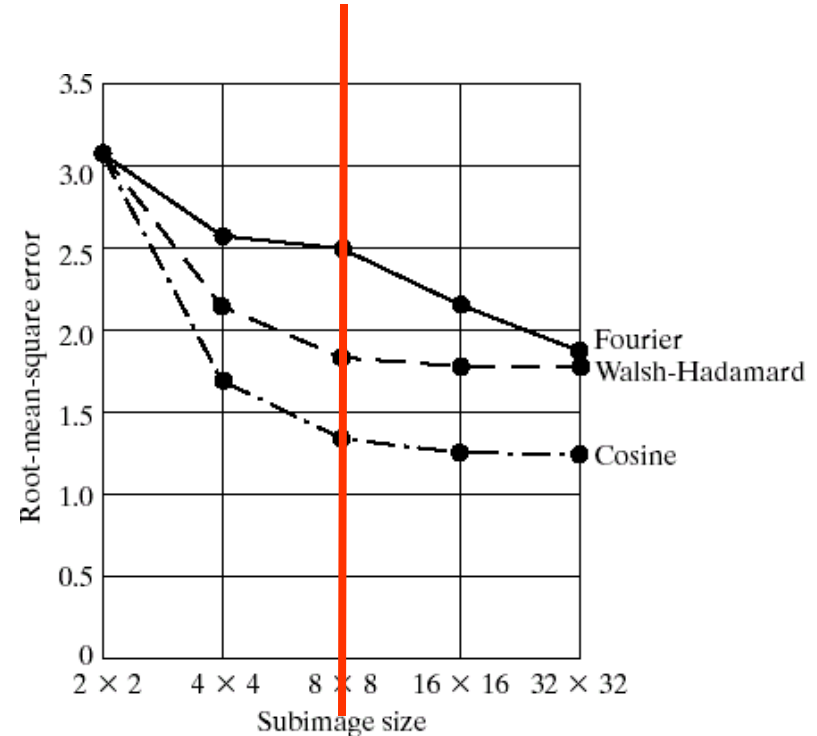




Image Compression

Transform Coding Quantization Schemes

- Global thresholding
- Local thresholding
- For each block M out of N coefficients to retain

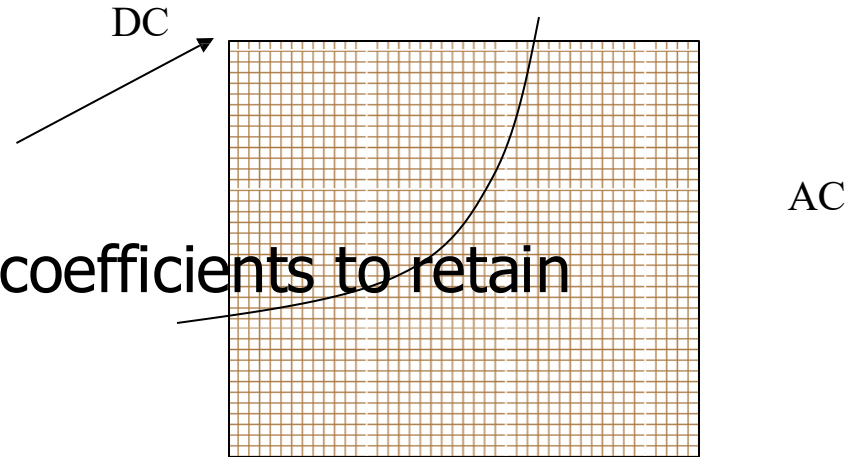
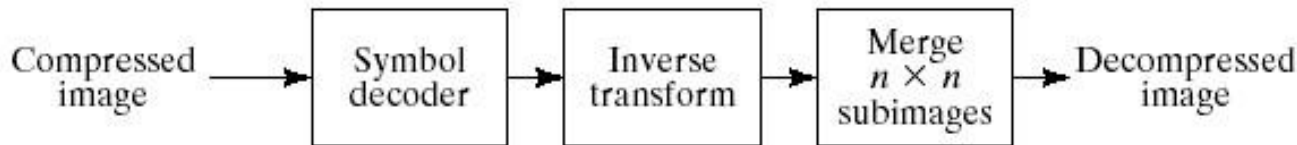
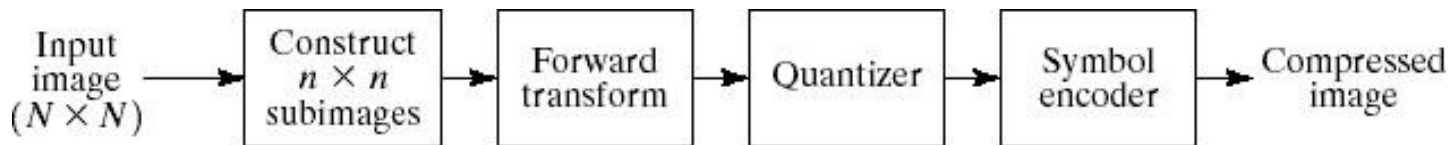




Image Compression

Transform Coding Pipeline

Compression



Decompression