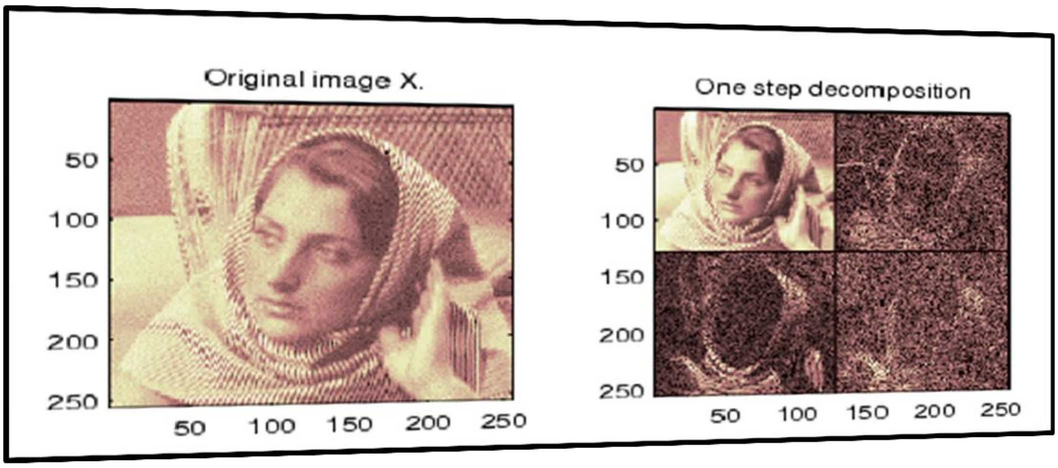
DCT

DWT and DFT

Techniques of

Image



As we know, digital media such as image, video, audio can be load or save on disk. The storage to save this digital media become a major issue in digital image processing. Therefore the concept of image compression required to solve this above issue.

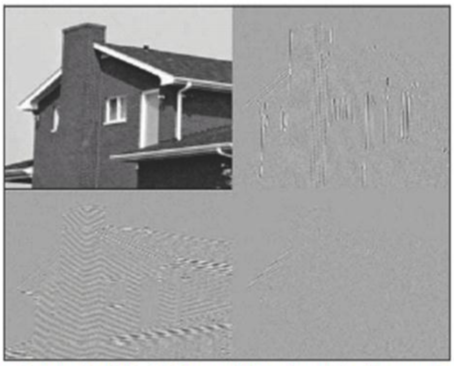
Transforms Types Are:

1. **DWT (Discrete Wavelet Transform)**
2. **DCT (Discrete Cosine Transform)**
3. **FT (Fourier Transform)**

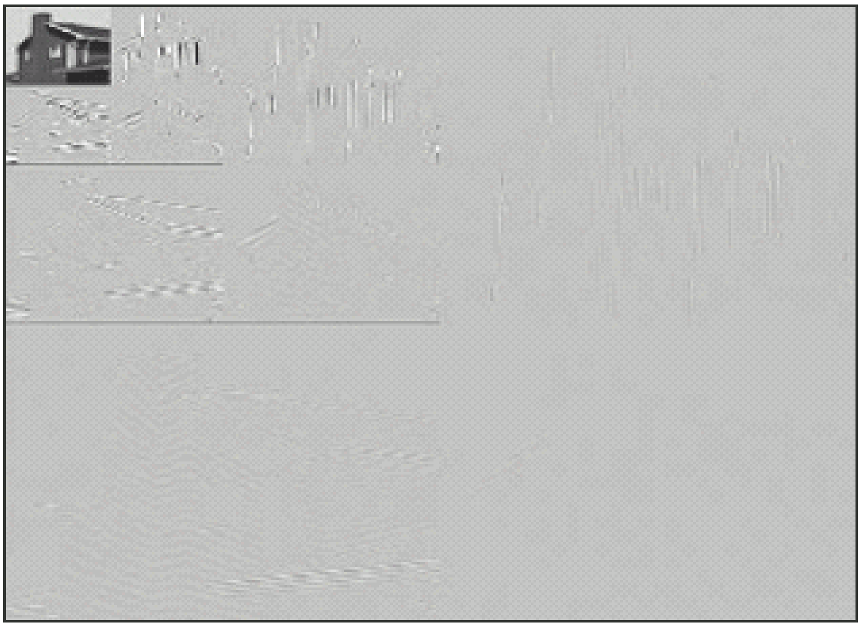
1. <u>Discrete Wavelet Transform (DWT)</u>

The discrete wavelet transform (DWT) refers to wavelet transforms for which the wavelets are discretely sampled. A transform which localizes a function both in space and scaling and has some desirable properties compared to the Fourier transform. The transform is based on a wavelet matrix, which can be computed more quickly than the analogous Fourier matrix. Most notably, the discrete wavelet transform is used for signal coding, where the properties of the transform are exploited to represent a discrete signal in a more redundant form, often as a preconditioning for data compression. The discrete wavelet transform has a huge number of applications in Science, Engineering, Mathematics and Computer Science.

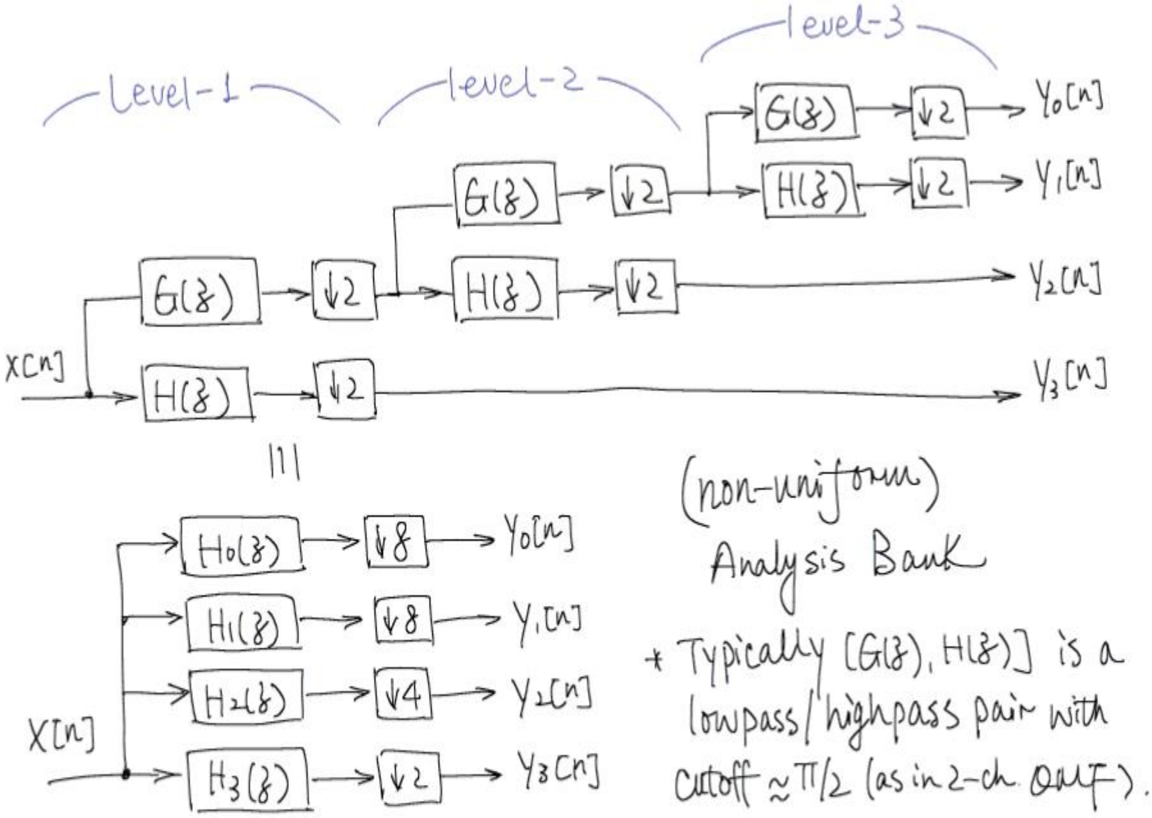
▲ *2. Original image used for demonstrating the 2-D wavelet transform.*



▲ *3. A one-level ($K = 1$), 2-D wavelet transform using the symmetric wavelet transform with the 9/7 Daubechies coefficients (the*



❖ Explained in the previous lecture ☺

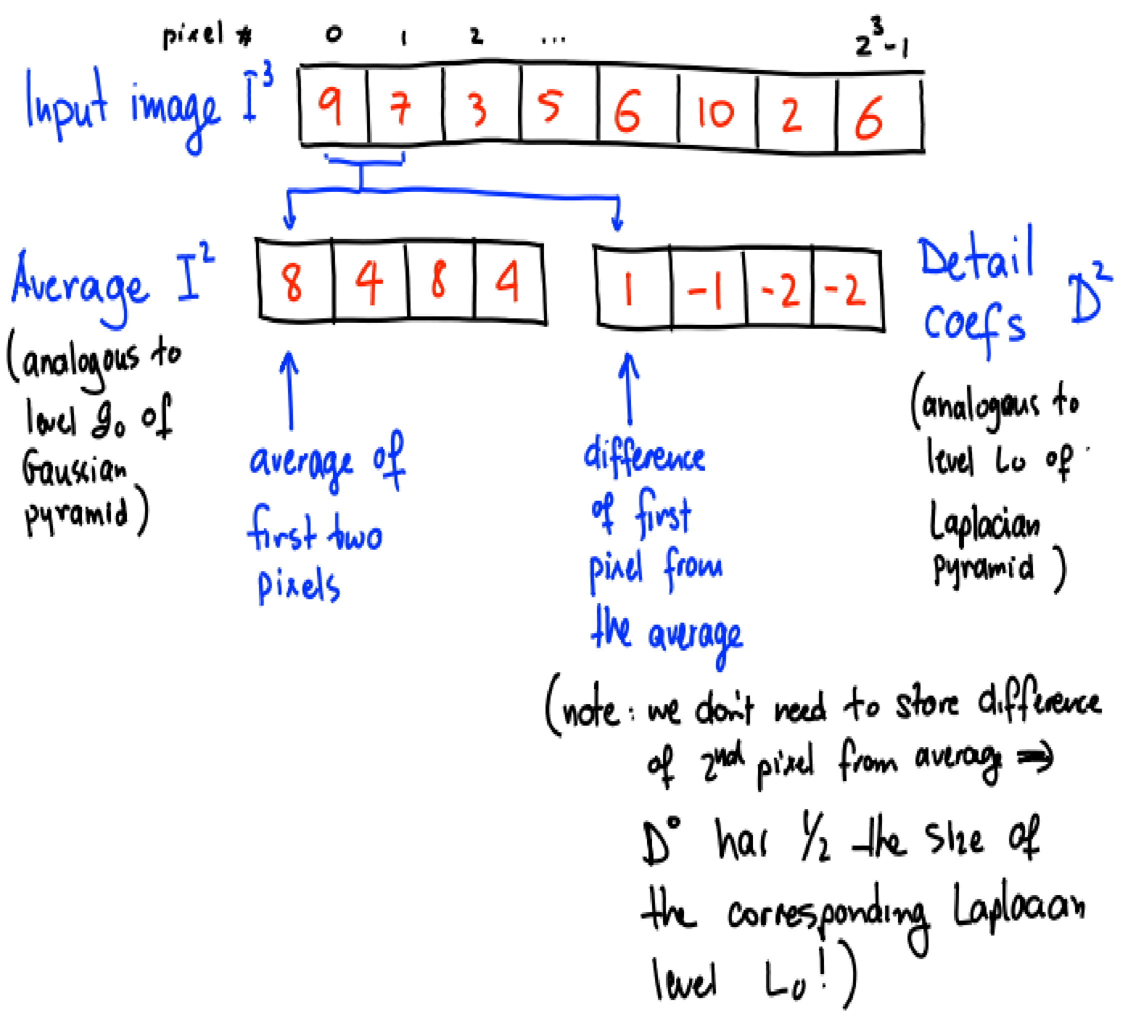


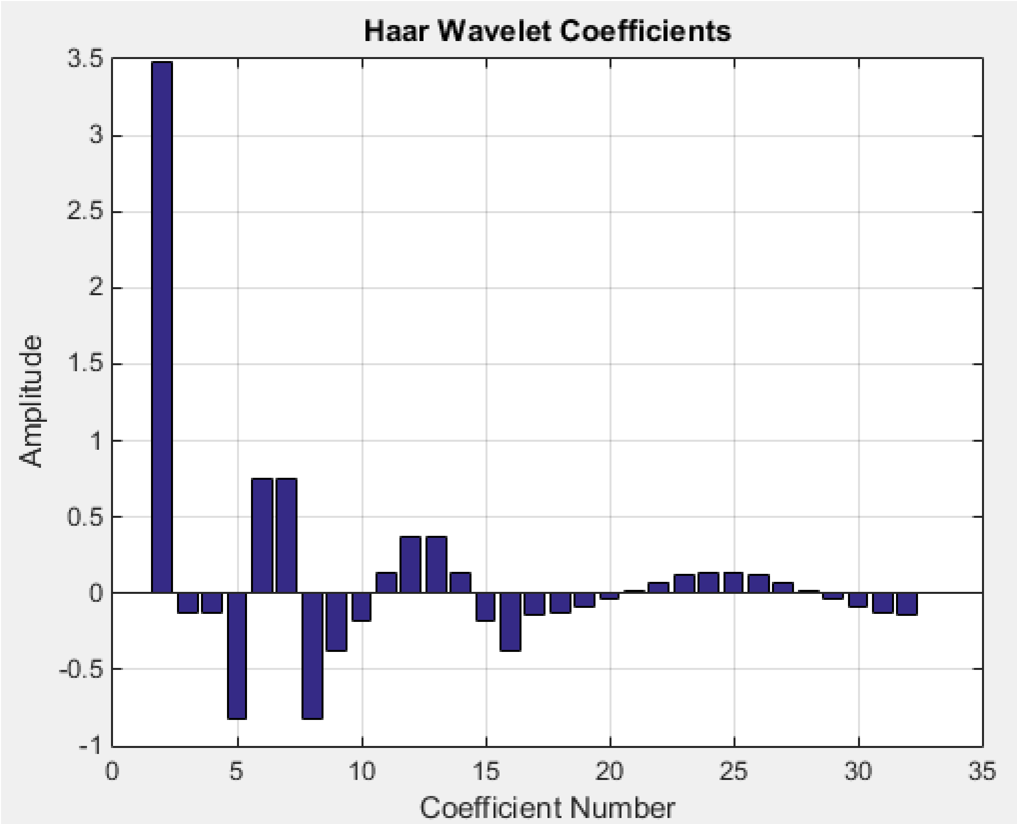
The Haar Wavelet Transform

The Haar wavelet is a nonlinear sequence of discontinuous rescaled "square-shaped" functions which together form a wavelet family or basis. Wavelet analysis is similar to Fourier analysis in that it allows a signal over an interval to be represented in terms of an orthonormal function basis.

An advantage of wavelets over Fourier transforms is temporal resolution. The wavelet captures both frequency and location in time. (But a waterfall FFT can also achieve some measure of temporal resolution.)

Haar Wavelet Transform example:-

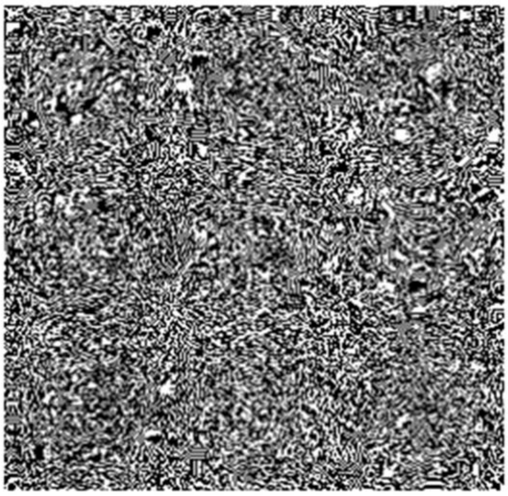


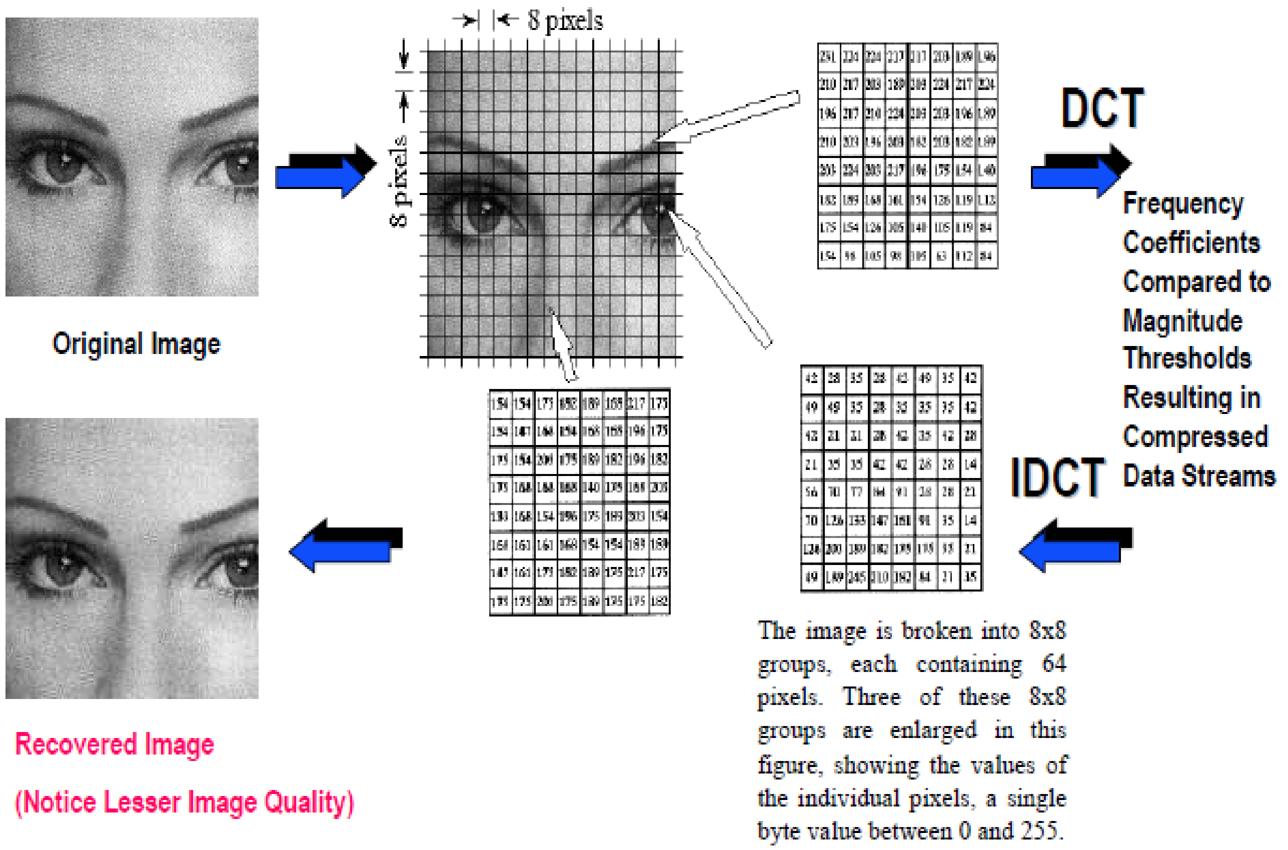


2. DCT (Discrete Cosine Transform)

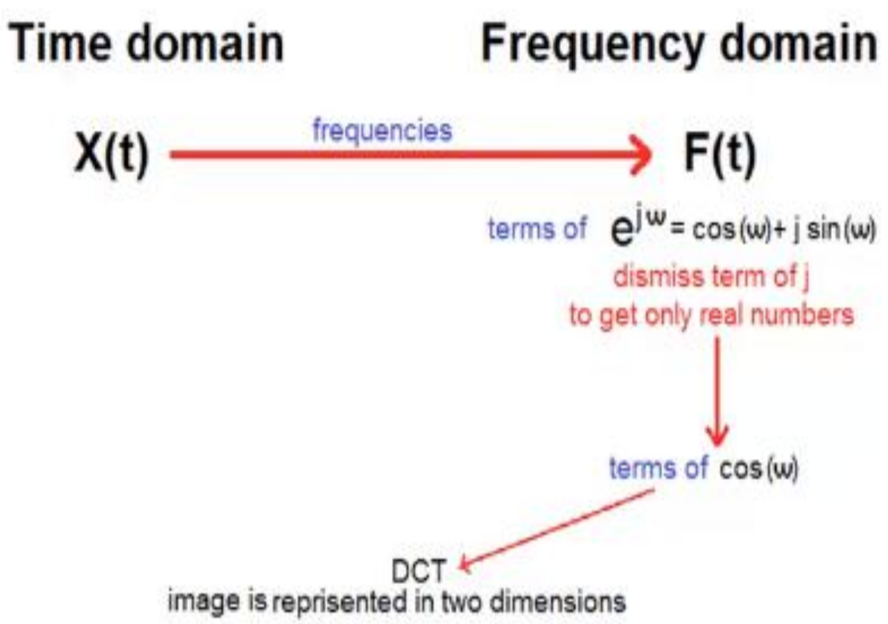
The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality). The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain.

DCT of pepper





The image is broken into 8x8 groups, each containing 64 pixels. Three of these 8x8 groups are enlarged in this figure, showing the values of the individual pixels, a single byte value between 0 and 255.



- $D(u,v) = \frac{2}{M*N} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} P(x,y) * \cos\left(\frac{(2x+1)u\pi}{2M}\right) * \cos\left(\frac{(2y+1)v\pi}{2N}\right)$

DCT

Example

Get the DCT for points (0,0) , (0,1)

1	3
2	0

2*2 image
M=2
N=2
The result is 2*2 image

$$D(0,0) = \frac{1}{M*N} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} P(x,y)$$

$$= \frac{1}{4} \sum_{x=0}^{1} \sum_{y=0}^{1} P(x,y)$$

$$= \frac{1}{4} \left[1+3+2+0\right] = \frac{6}{4} = 1.5$$

$$D(u,v) = \frac{2}{M*N} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} P(x,y) * \cos\left(\frac{(2x+1)u\pi}{2M}\right) * \cos\left(\frac{(2y+1)v\pi}{2N}\right)$$

$$D(0,1) = \frac{2}{4} \sum_{x=0}^{1} \sum_{y=0}^{1} P(x,y) * \cos(0) * \cos\left(\frac{(2y+1)\pi}{4}\right)$$

$$= 1/2 \left[1*1*\cos\left(\frac{(2*0+1)\pi}{4}\right) + 3*1*\cos\left(\frac{(2*1+1)\pi}{4}\right)\right.$$

$$\left. + 2*1*\cos\left(\frac{(2*0+1)\pi}{4}\right) + 0*1*\cos\left(\frac{(2*1+1)\pi}{4}\right)\right]$$

$$= 1/2 * \left[\cos(\pi/4) + 3*\cos(3\pi/4) + 2*\cos(\pi/4)\right] = 1/2 * \left[\frac{\sqrt{2}}{2} - 3\frac{\sqrt{2}}{2} + 2\frac{\sqrt{2}}{2}\right] = 0$$