SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECE301 – IMAGE PROCESSING AND COMPUTER VISION

III B.E. ECE / V SEMESTER

UNIT 3 – IMAGE COMPRESSION AND IMAGE SEGMENTATION

TOPIC – WAVELET CODING

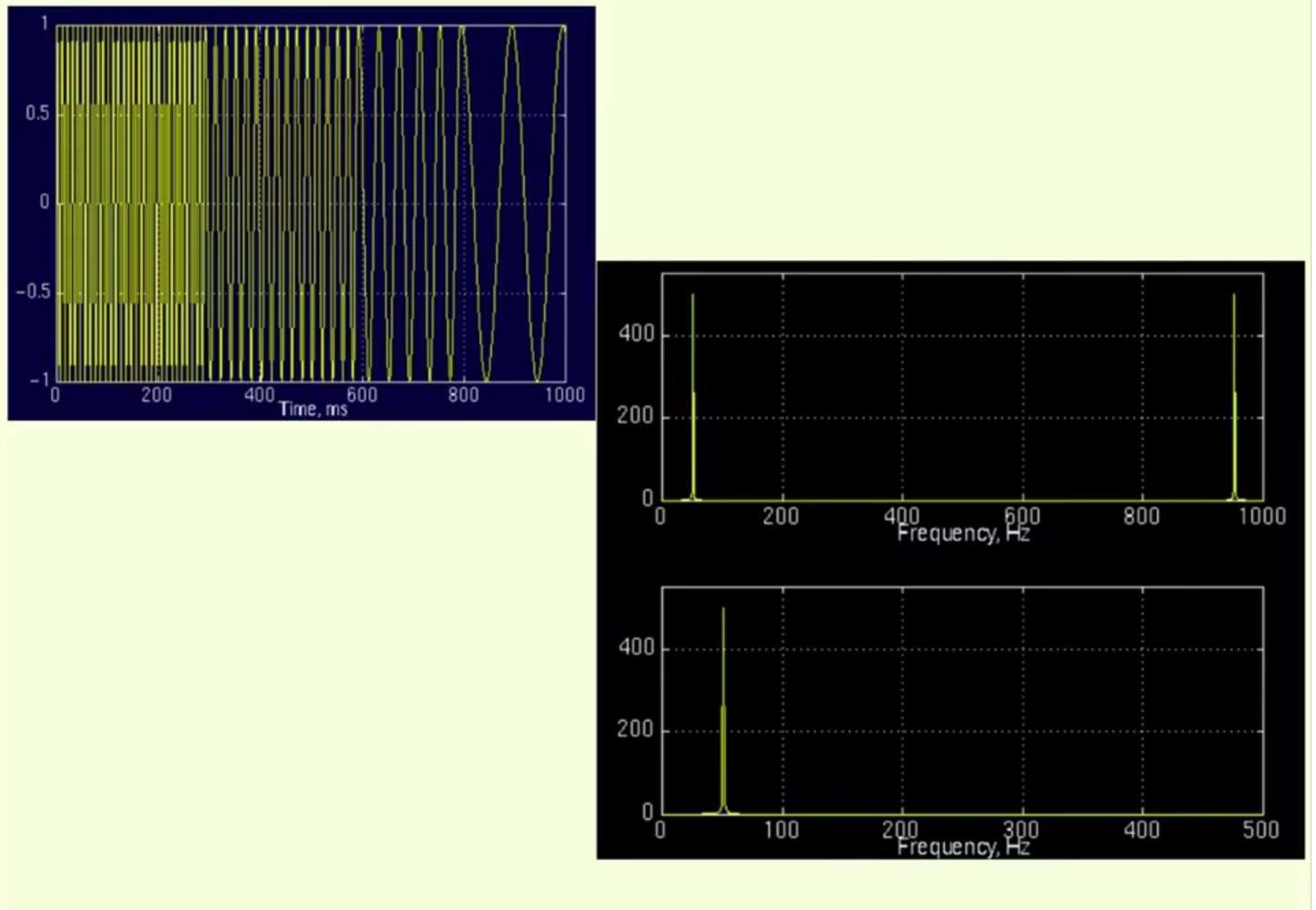
WAVELET CODING

First of all, why do we need a transform, or what is a transform anyway?

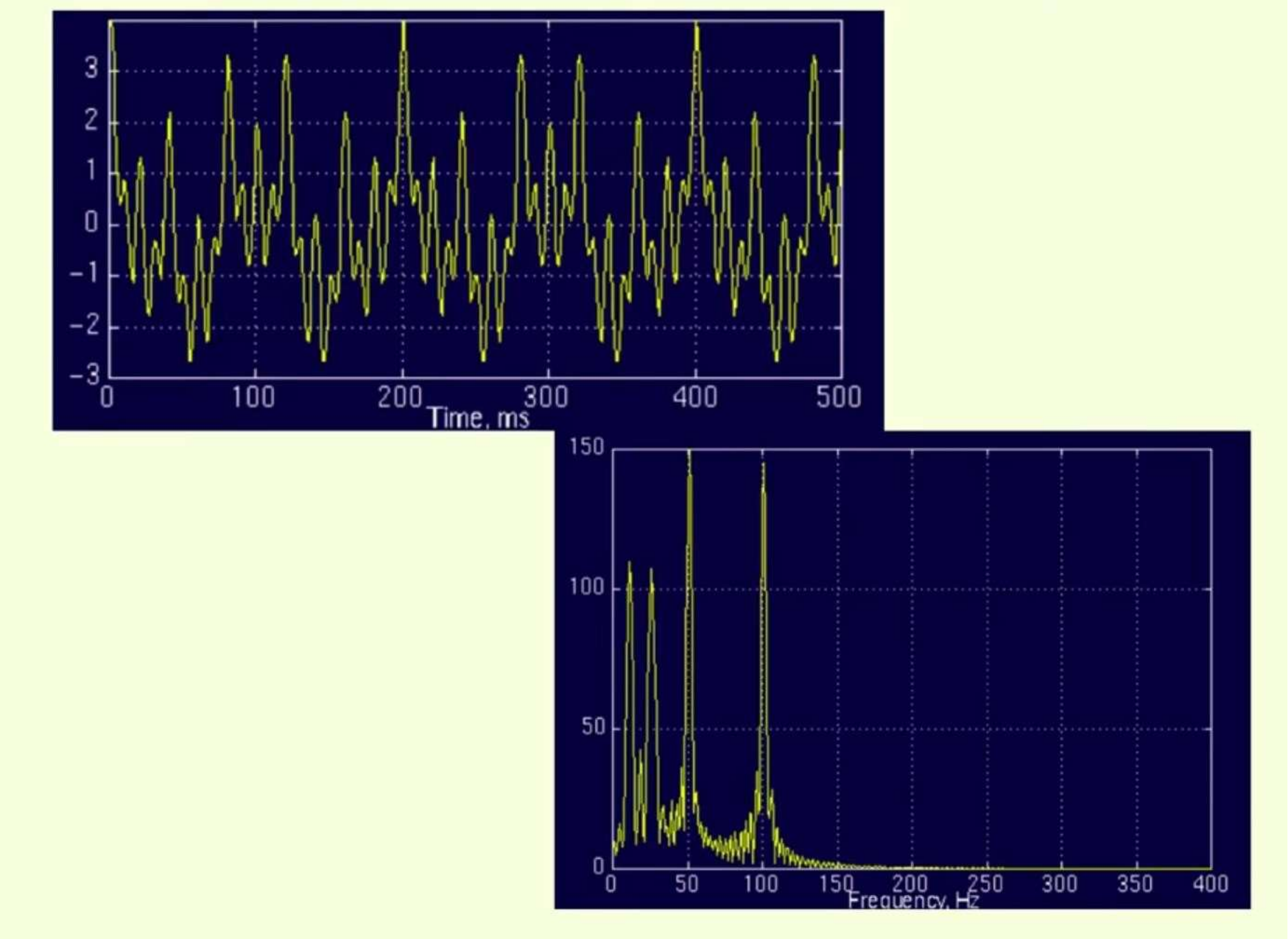
Mathematical transformations are applied to signals to obtain further information from that signal that is not readily available in the raw

Most of the signals in practice, are TIME-DOMAIN signals in their raw format. That is, whatever that signal is measuring, is a function of time. In other words, when we plot the signal one of the axes is time (independent variable), and the other (dependent variable) is usually the amplitude. When we plot time-domain signals, we obtain a time-amplitude representation of the signal. This representation is not always the best representation of the signal for most signal processing related applications. In many cases, the most distinguished information is hidden in the frequency content of the signal. The frequency SPECTRUM of a signal is basically the frequency components (spectral components) of that signal. The frequency spectrum of a signal shows what frequencies exist in the signal.

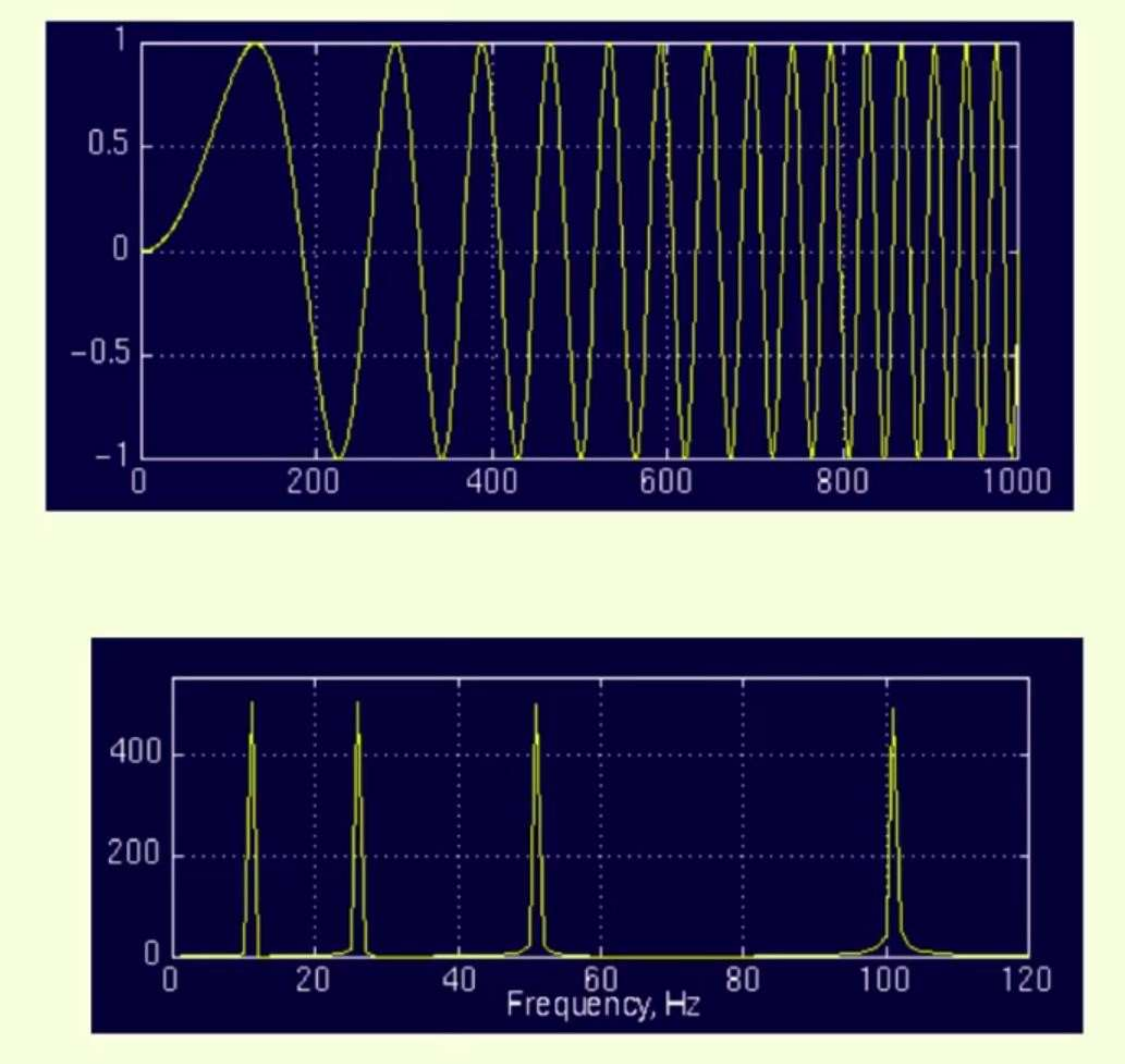
WAVELET CODING



WAVELET CODING



WAVELET CODING



WAVELET CODING

Fourier Transform gives what frequency components (spectral components) exist in the signal. No more, no less.

The time localization of the spectral components are needed, a transform giving the TIME-FREQUENCY REPRESENTATION of the signal is needed.

WAVELET CODING

The wavelet transform is a transform of this type. It provides the time-frequency representation.

Wavelet transform is capable of providing the time and frequency information simultaneously, hence giving a time-frequency representation of the signal.

WAVELET CODING

Assuming that we have taken the lowpass portion, we now have 3 sets of data, each corresponding to the same signal at frequencies 0-250 Hz, 250-500 Hz, 500-1000 Hz.

Then we take the lowpass portion again and pass it through low and high pass filters; we now have 4 sets of signals corresponding to 0-125 Hz, 125-250 Hz,250-500 Hz, and 500-1000 Hz. We continue like this until we have decomposed the signal to a pre-defined certain level. Then we have a bunch of signals, which actually represent the same signal, but all corresponding to different frequency bands. We know which signal corresponds to which frequency band, and if we put all of them together and plot them on a 3-D graph, we will have time in one axis, frequency in the second and amplitude in the third axis. This will show us which frequencies exist at which time (there is an issue, called "uncertainty principle", which states that, we cannot exactly know what frequency exists at what time instance, but we can only know what frequency bands exist at what time intervals,

WAVELET CODING

Pre-1930

Joseph Fourier (1807) with his theories of frequency analysis

1930

Using scale-varying basis functions; computing the energy of a function

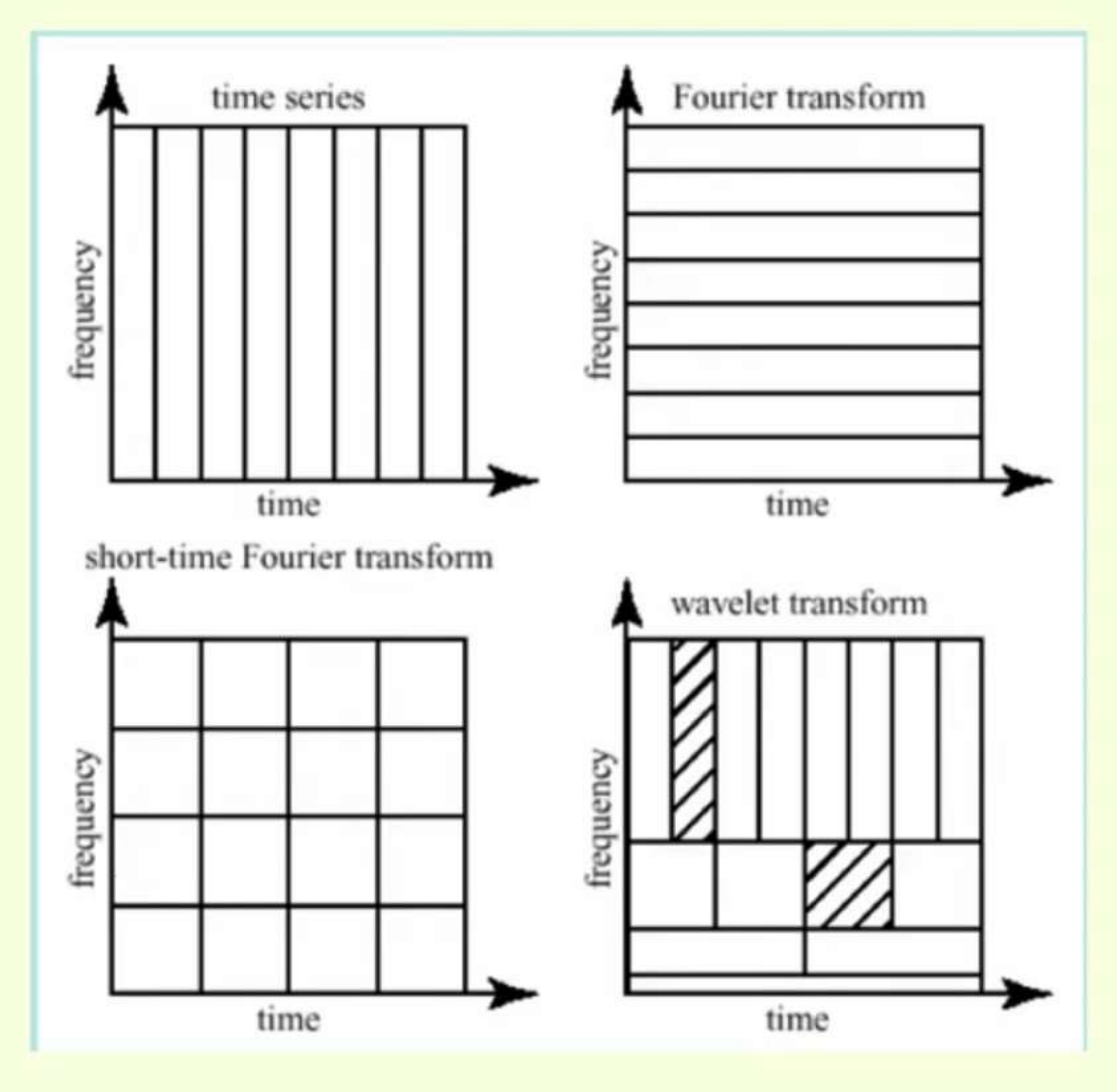
1960-1980

Guido Weiss and Ronald R. Coifman; Grossman and Morlet

Post-1980

Stephane Mallat; Y. Meyer; Ingrid Daubechies; wavelet applications today

WAVELET CODING



WAVELET CODING

Discrete Wavelet Transform

- Don't need to calculate wavelet coefficients at every possible scale
- Can choose scales based on powers of two, and get equivalent accuracy

$$\psi_{j,k}(x) = 2^{j/2}\psi(2^j x - k)$$

- We can represent a discrete function *f(n)* as a weighted summation of wavelets *ψ(n)*, plus a coarse approximation *φ(n)*

$$f(n) = \frac{1}{\sqrt{M}}\sum_k W_\varphi(j_0,k)\varphi_{j_0,k}(n) + \frac{1}{\sqrt{M}}\sum_{j=j_0}^{\infty}\sum_k W_\psi(j,k)\psi_{j,k}(n)$$

where j_0 is an arbitrary starting scale, and $n = 0,1,2, \ldots M$

"Approximation" coefficients

$$W_\Phi(j_0,k) = \frac{1}{\sqrt{M}}\sum_x f(x)\,\varphi_{j_0,k}(x)$$

"Detail" coefficients

$$W_\Psi(j,k) = \frac{1}{\sqrt{M}}\sum_x f(x)\,\psi_{j,k}(x)$$

WAVELET CODING

Wavelet Family Name
Haar wavelet
Daubechies wavelets
Symlets
Coiflets
Biorthogonal wavelets
Reverse biorthogonal wavelets
Meyer wavelet
Discrete approximation of Meyer wavelet
Gaussian wavelets
Mexican hat wavelet (also known as the Ricker wavelet)
Morlet wavelet
Complex Gaussian wavelets
Shannon wavelets
Frequency B-Spline wavelets
Complex Morlet wavelets
Fejer-Korovkin wavelets

WAVELET CODING

Application of Wavelet Transform in Digital Image Processing

Fingerprint Recognition

Image Compression

Image Denoising

Face Recognition

Image Fusion

WAVELET CODING

Original 512*512 Grayscale Lenna

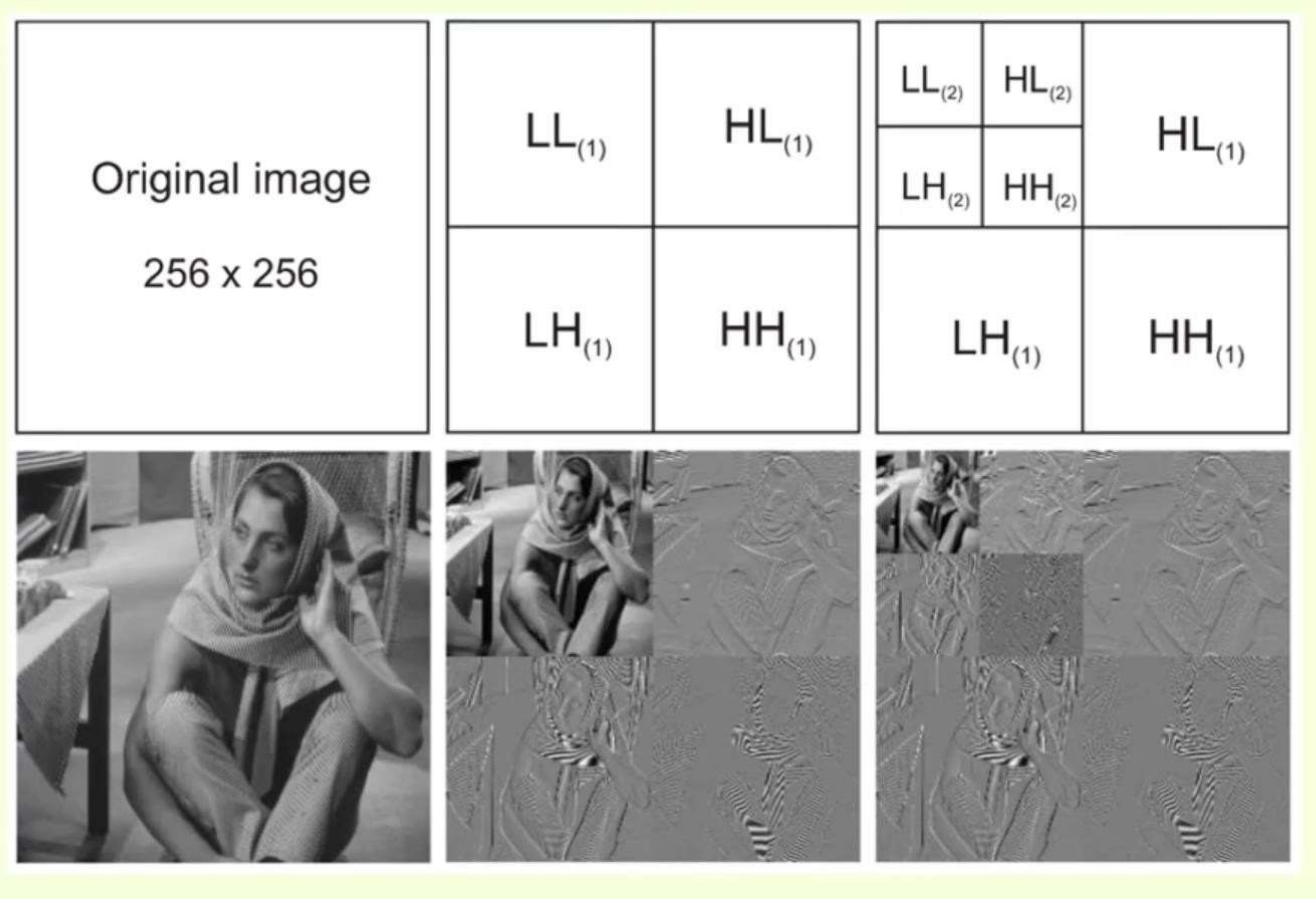
CJPEG
Compressed File Size: 4213 bytes
PSNR: 21.93 dB
(a)

LET
Compressed File Size: 3219 bytes
PSNR: 28.20 dB
(b)

CJPEG
Compressed File Size: 8078 bytes
PSNR: 30.40 dB
(c)

LET
Compressed File Size: 7812 bytes
PSNR: 32.05 dB
(d)

WAVELET CODING



Thank you!