The Wavelet transform

Review of applications to Music Information Retrieval

Contents

- History

- Wavelet vs. Fourier

- Applications

- MIR Applications

History

- First mention in appendix of the thesis of A. Haar (1909)

- Cochlear transform, Zweig (1975)

- Continuous Wavelet Transform (CWT), Grossman and Morlet (1982) – Geophysics

- Discrete Wavelet Transform (DWT), Strömberg (1983)

- Daubechies' orthogonal wavelets with compact support (1988)

- Mallat's multiresolution framework (1989)

Wavelet

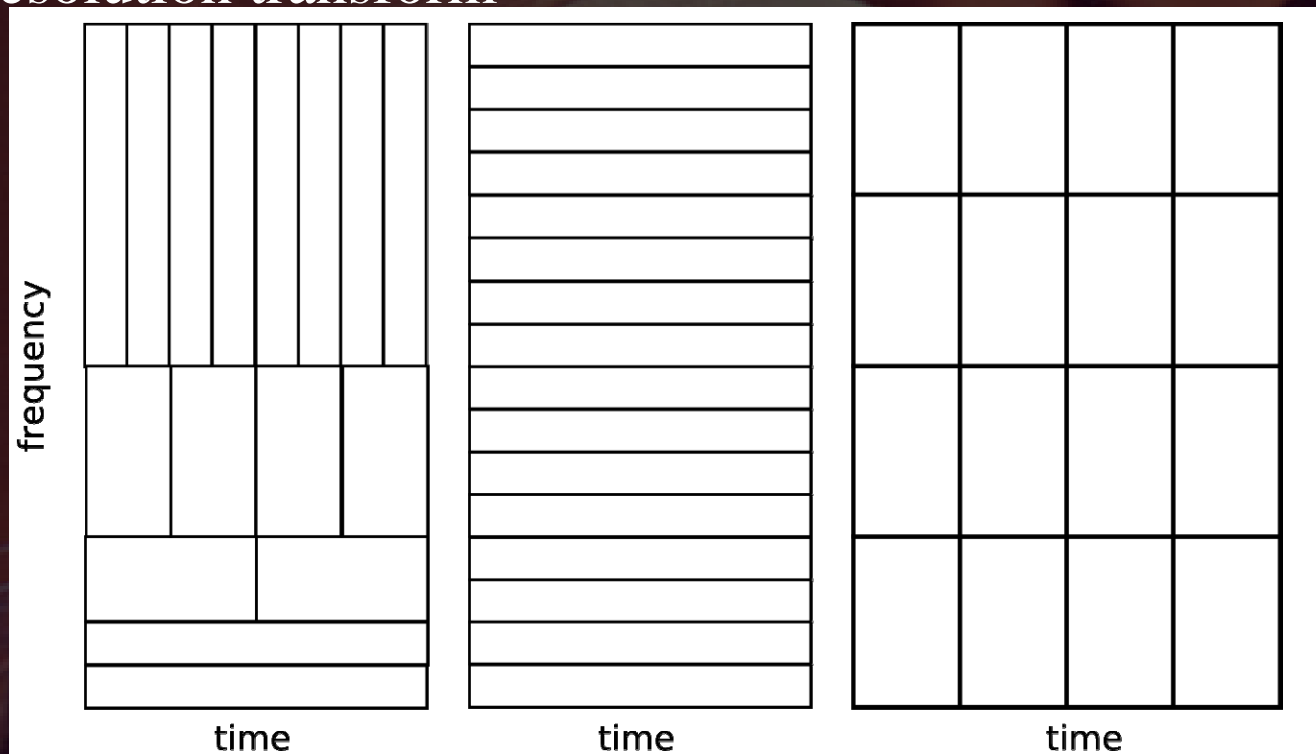- Wavelet: a wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero
- Wavelet-theory: wavelet with zero-integral and finite energy
- Wavelet transform: projection on the sub-spaces associated with each wavelet
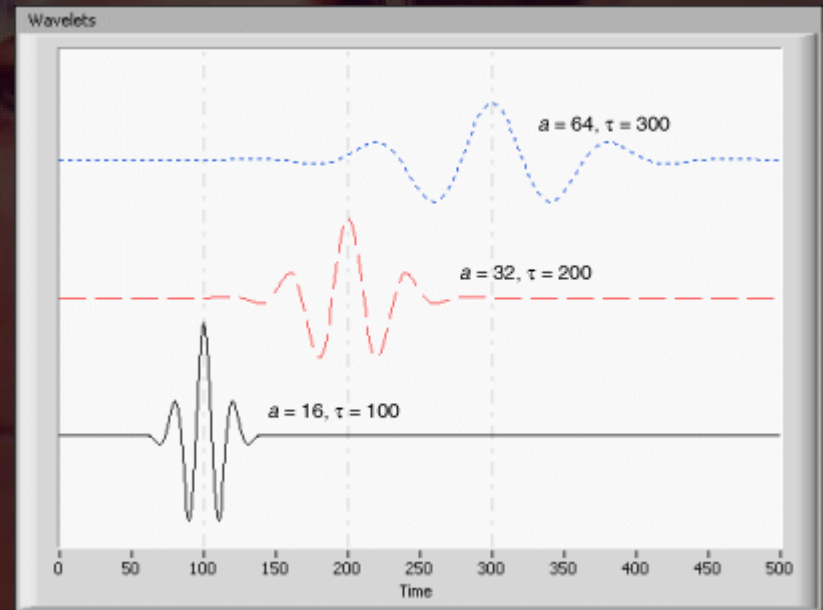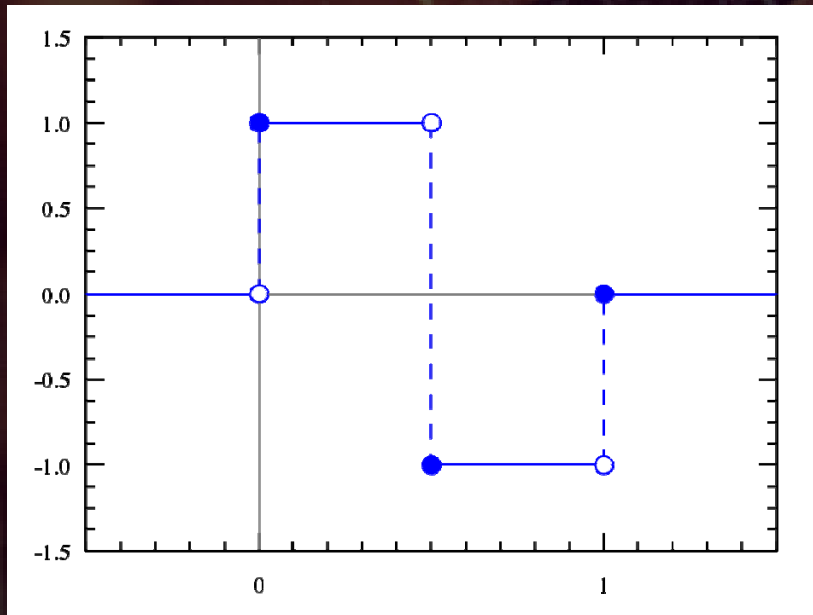
DWT vs. DFT and STFT

- Multi-resolution transform

- Complexity: $O(N)$ vs $O(N \log N)$
- Perception-like approach?

FFT example
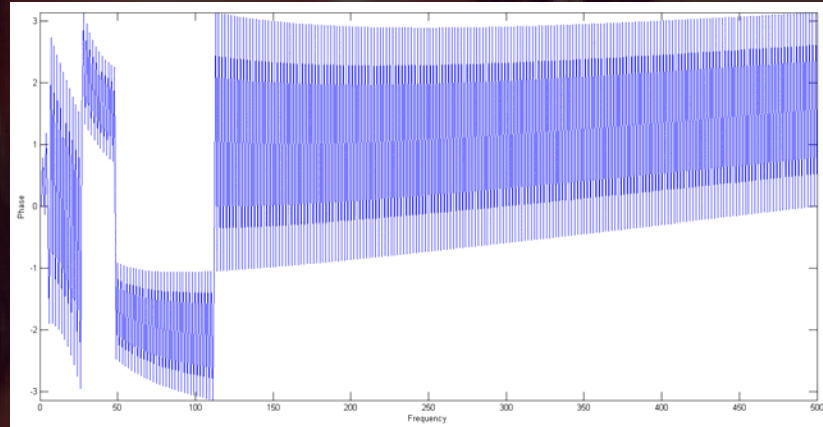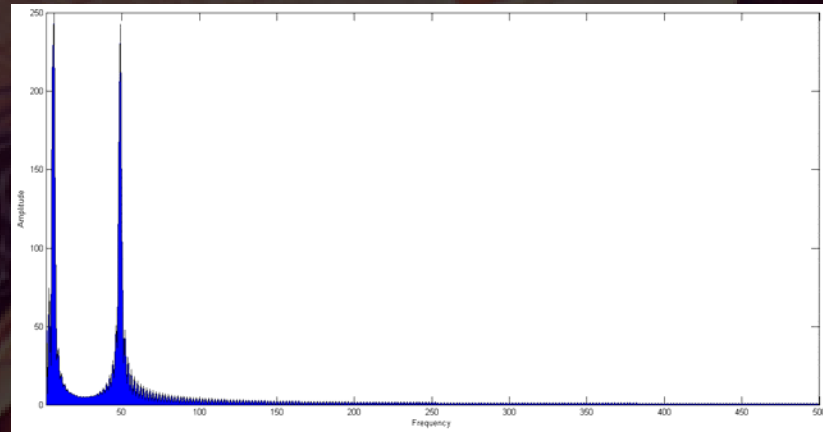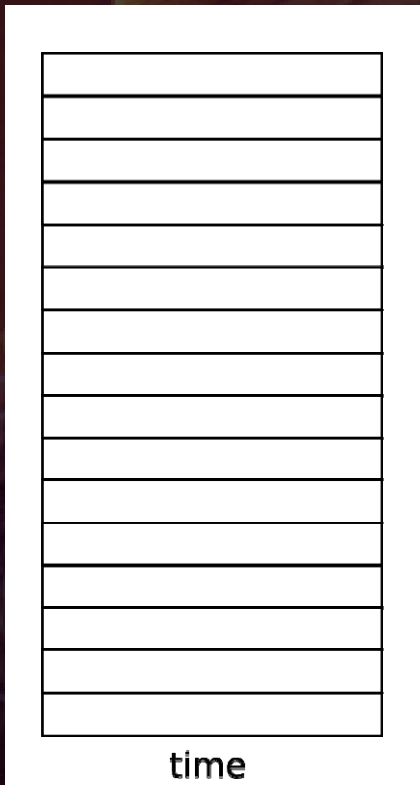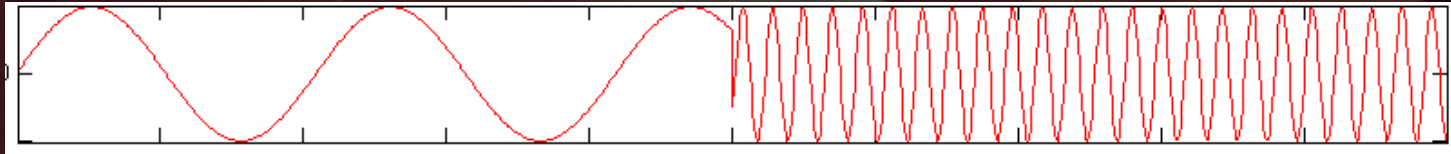
DWT Example
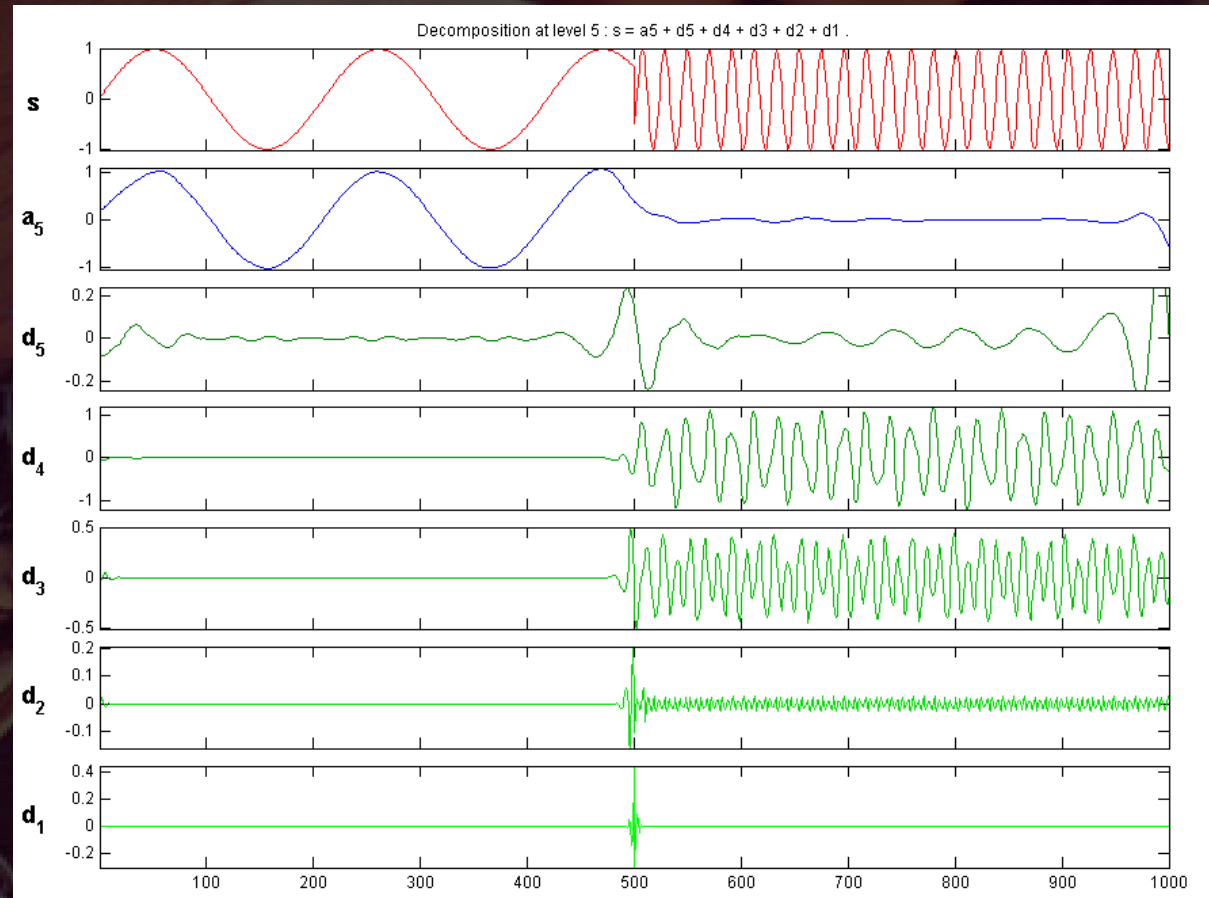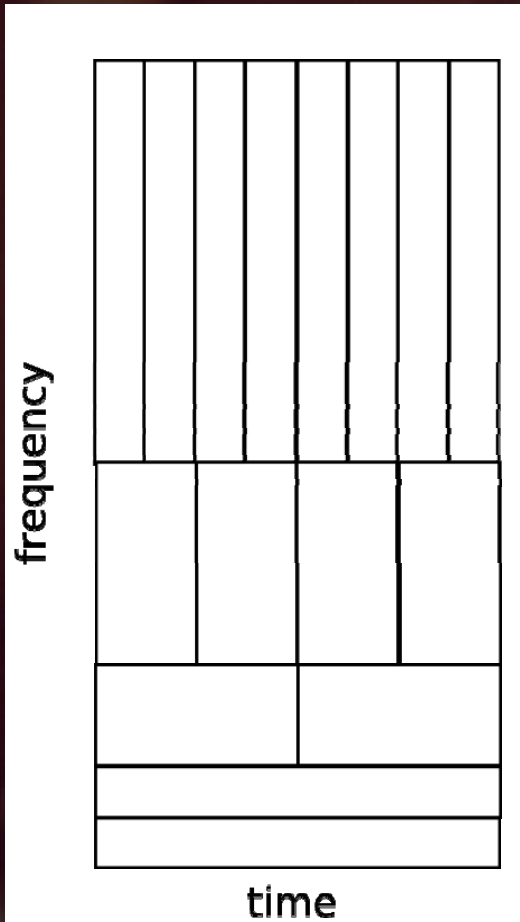
Wavelet applications

- Image processing (Medicine, Astronomy,…):
  - Compression (JPEG2000), pattern recognition, denoising, edge extraction…
- Speech processing
  - Recognition, classification, transient detection
- Geophysics (Earthquake detection)

- Medecine
  - blood-pressure, heart-rate and ECG analyses, DNA analysis, protein analysis, patient watching
- Physics
  - Molecular dynamics

…

Example: Edge Detection
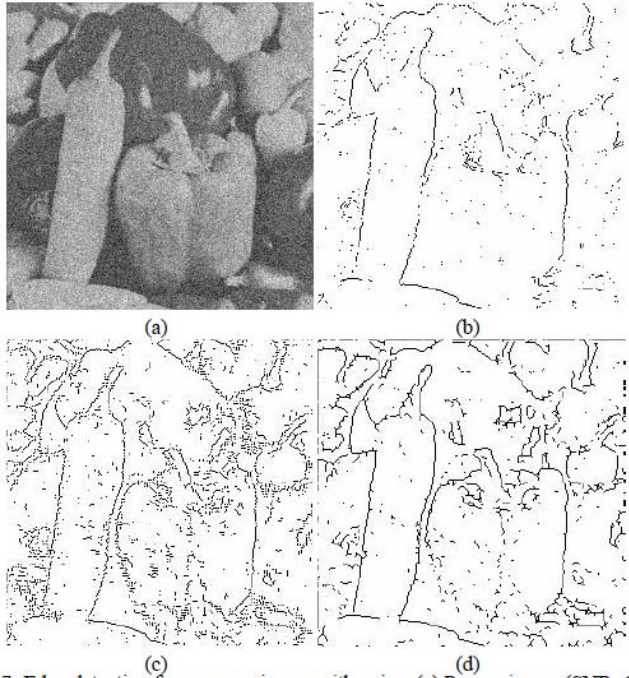
Fig. 6.7: Edge detection for a pepper image with noise: (a) Pepper image (SNR=10db); (b) Edges by the Sobel edge detector; (c) Edges by Canny edge detection with adjusted variance; (d) Edges by multi-level edge detection using wavelet
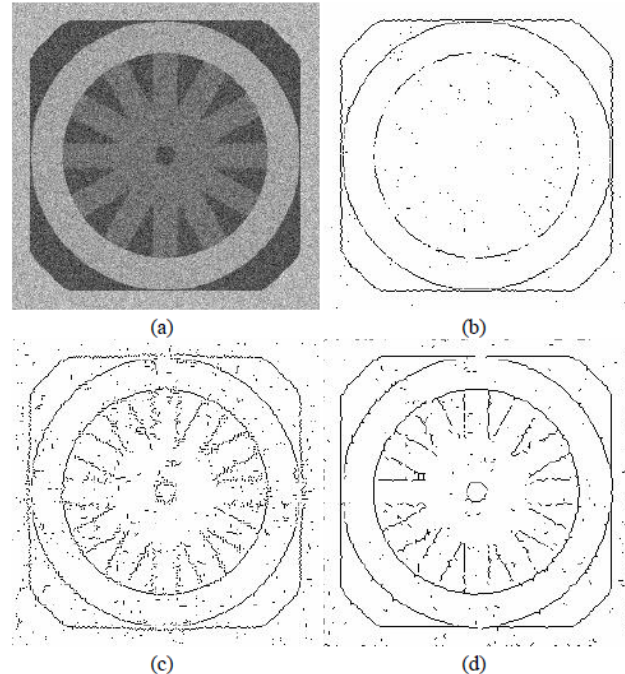
Fig. 6.8: Edge detection for a wheel image with noise: (a) Wheel image (SNR=10db); (b) Edges by the Sobel edge detector; (c) Edges by Canny edge detection with adjusted variance; (d) Edges by multi-level edge detection using wavelet

(Li 2003)

MIR Applications

- Optical music recognition

- Watermarking

- Feature extraction – Recognition, Classification, Fingerprinting

- Music/Voice discrimination, Source separation

- Segmentation, Transcription

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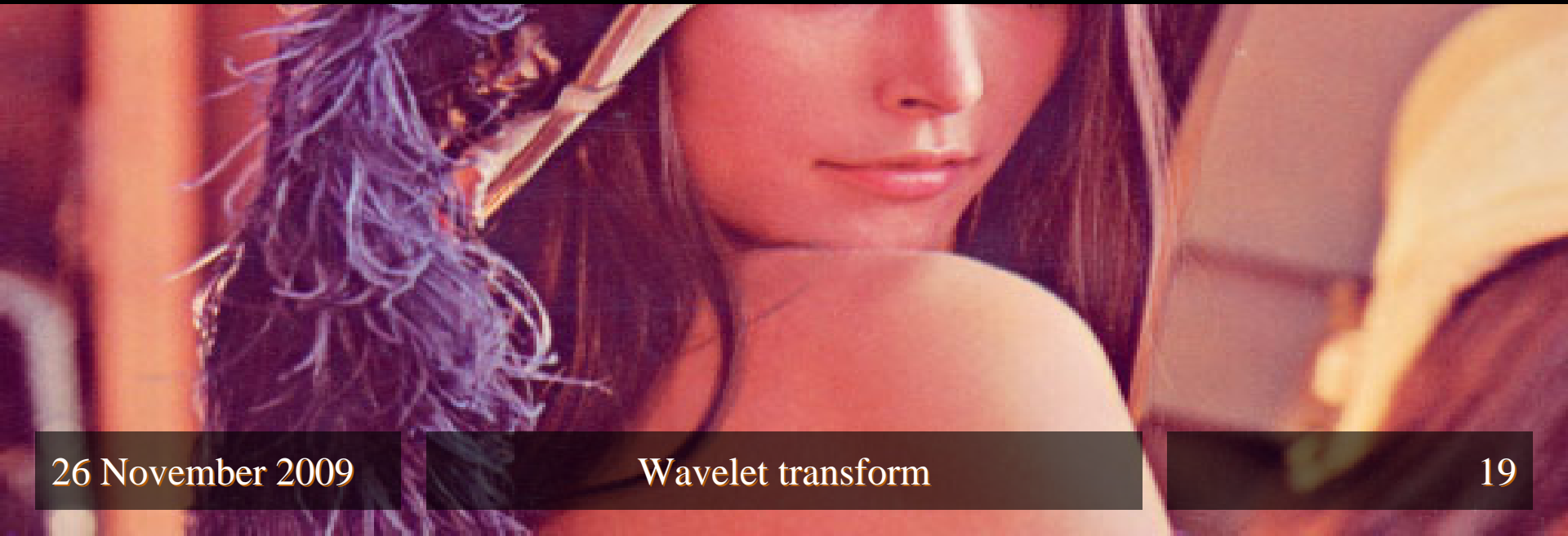
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Conclusion

Thank you

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