CSC7066/CSC4066
Media Security

Tutorial Two

A Multiresolution Watermark for Digital Images

by Xia et al.

Presentation

- What are the differences from Cox's paper?

    - Very short
    - Not much Details
    - Directly presents the idea

- Why?
    - Conference Paper

- Conference, Why?
    - Timely, state-of-the-art works
    - Oral presentation : 20 – 30 min.
    - Poster presentation

Key Points

- Transform Domain

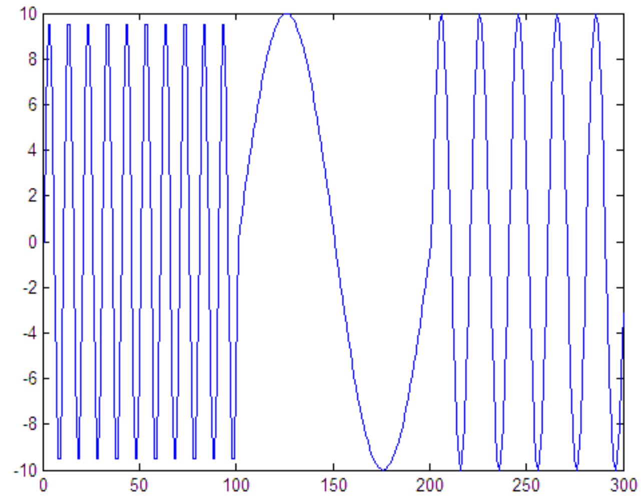
- Wavelet Transform, Why?
  - Multiresolution analysis
  - HVS
  - Emerging Coding standards
    - » 1997
    - » EZW ; obsolete
    - » SPIHT
    - » JPEG2000

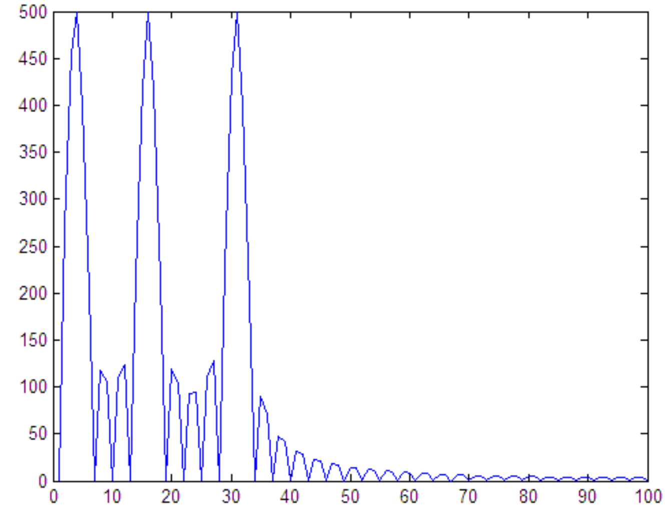
DISCRETE WAVELET TRANSFORM - I

- Basic problem in DFT and DCT

    - Spatial localization of the particular frequency

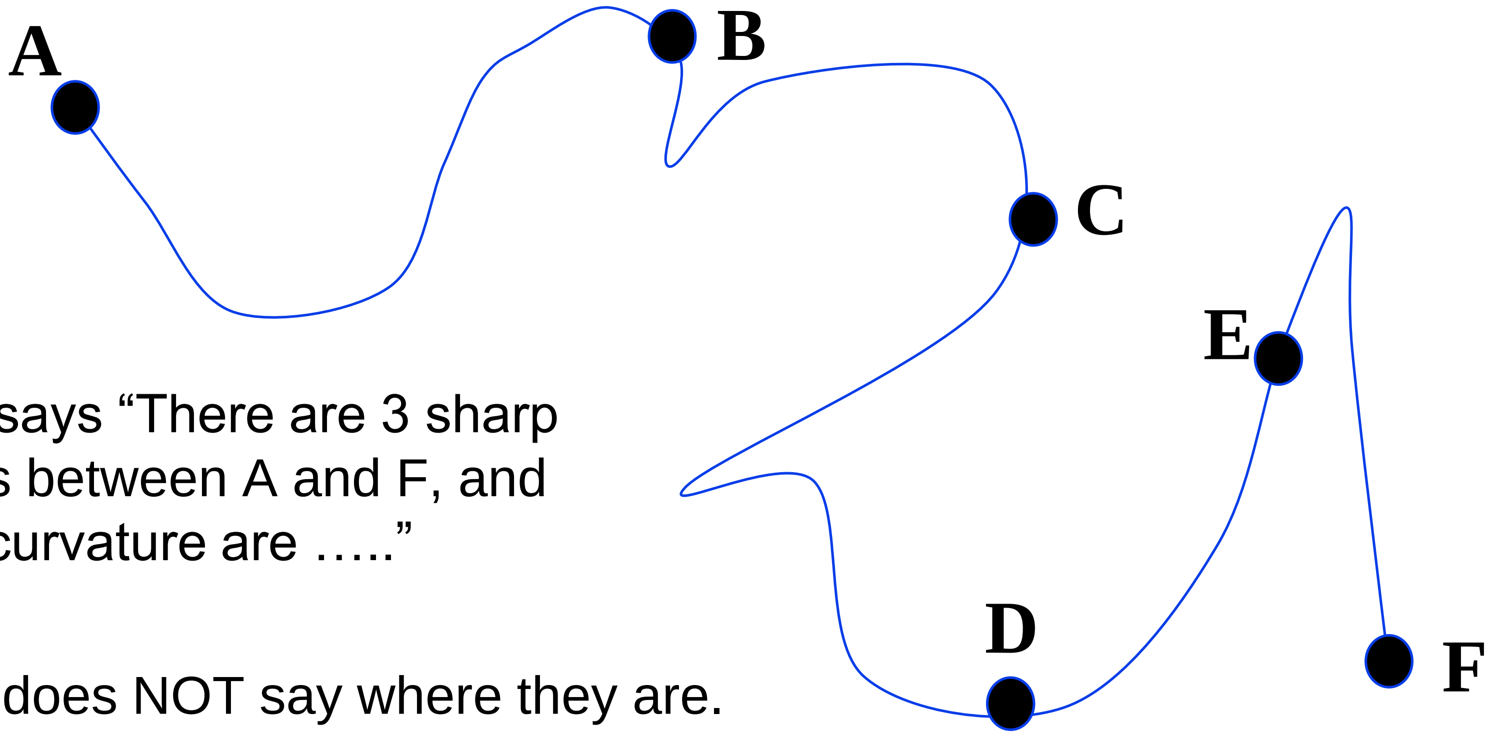
    - FFT gives only the frequency, not the location





DISCRETE WAVELET TRANSFORM - II

- Why is spatial information important?



- FFT says “There are 3 sharp bends between A and F, and their curvature are …..”
- But it does NOT say where they are.

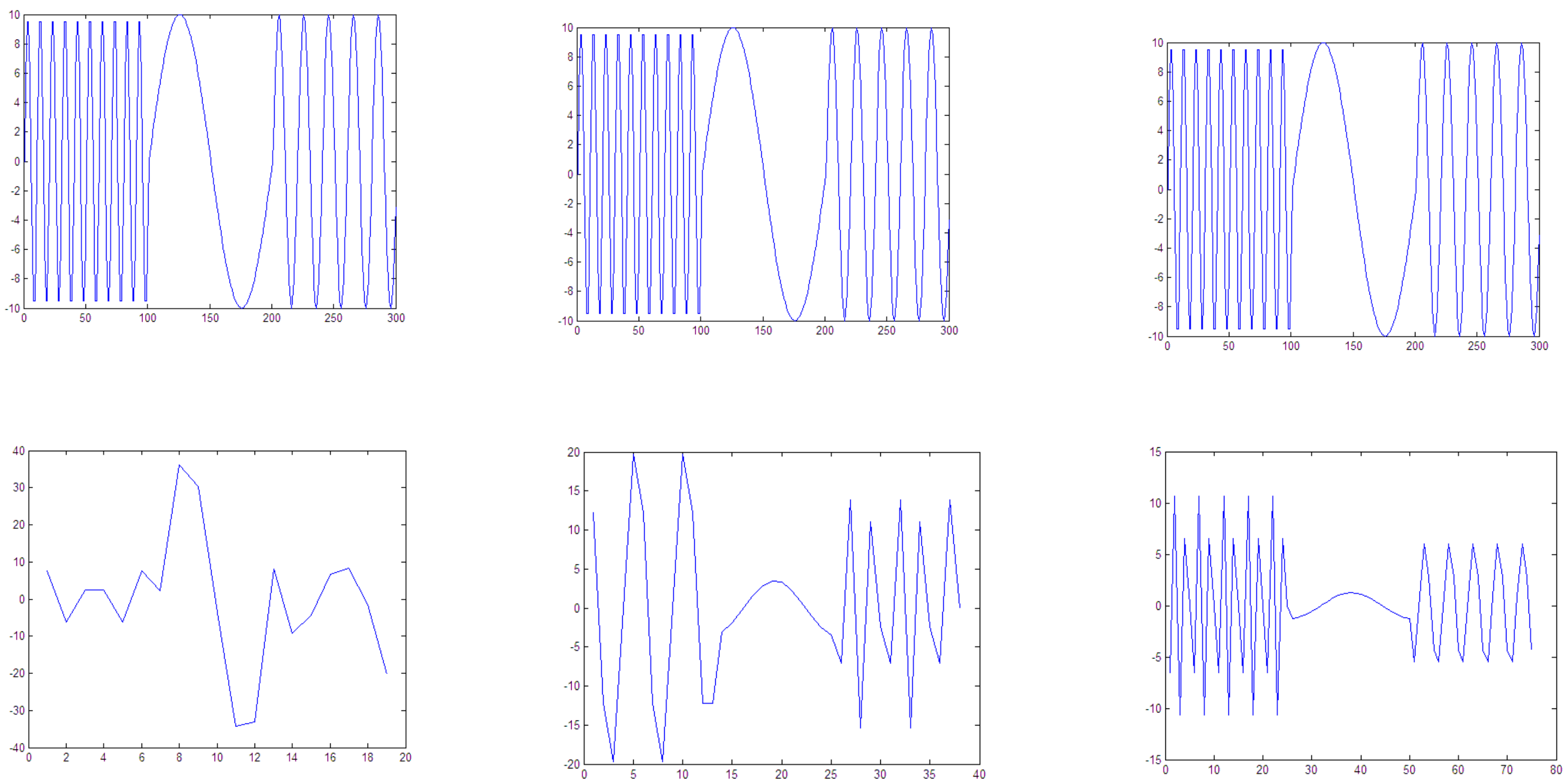
DISCRETE WAVELET TRANSFORM - III

- Discrete Wavelet Transform (DWT) answers this question by providing spatial information along with the frequency information.

  - Provides multiresolution representation of the signal

  - The DWT theory involves filtering and high volume maths.
    - “Digital Image Processing”, 2^{nd} edition, Gonzales and Woods, Prentice Hall
    - TA1632/GONZ

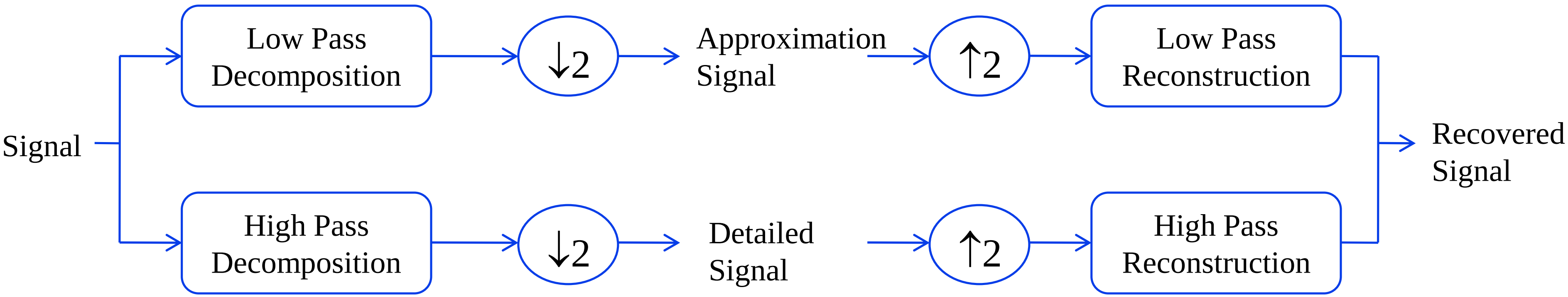
DISCRETE WAVELET TRANSFORM - IV



Low Frequency High Frequency

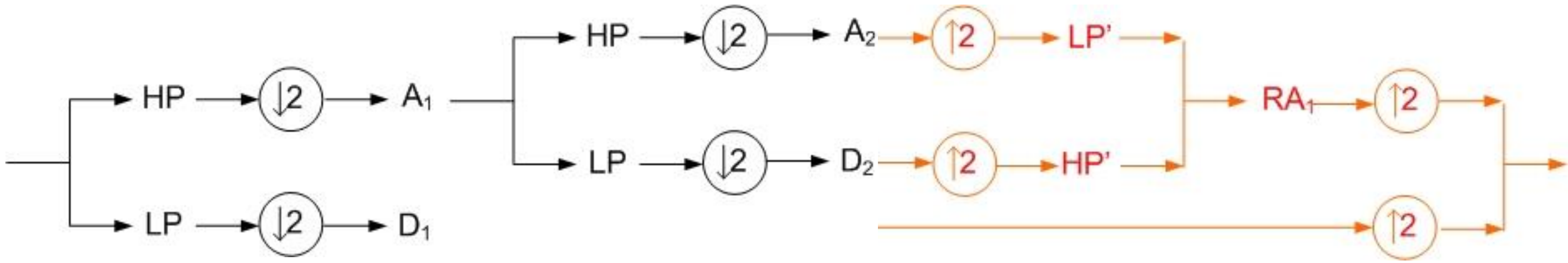
DISCRETE WAVELET TRANSFORM - V

- **How does it work ?**
- **1D signal**
- 1 level decomposition



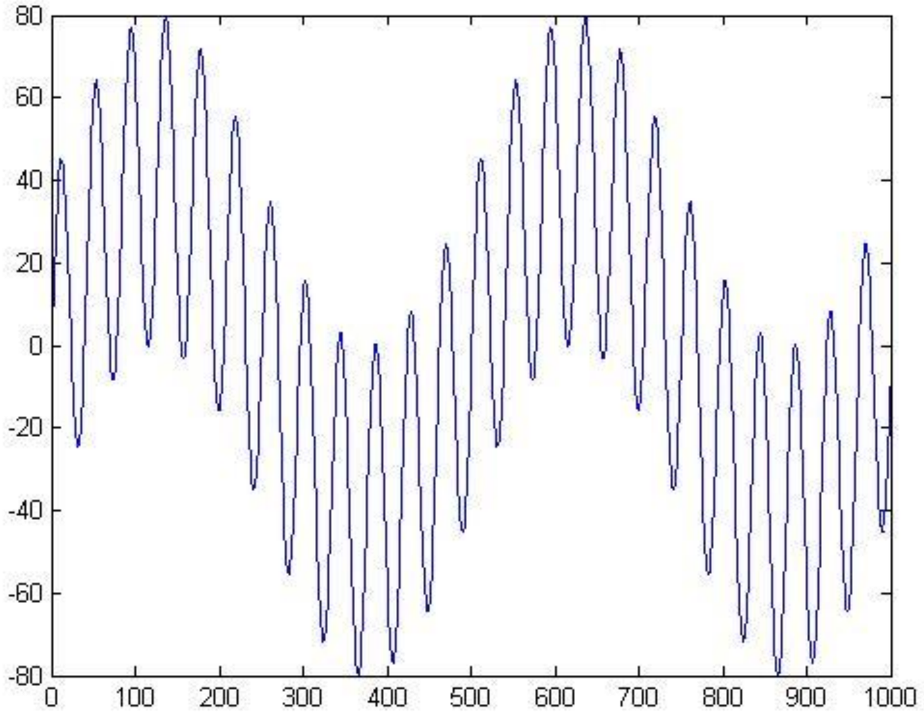
DWT - VI

- Multiresolution



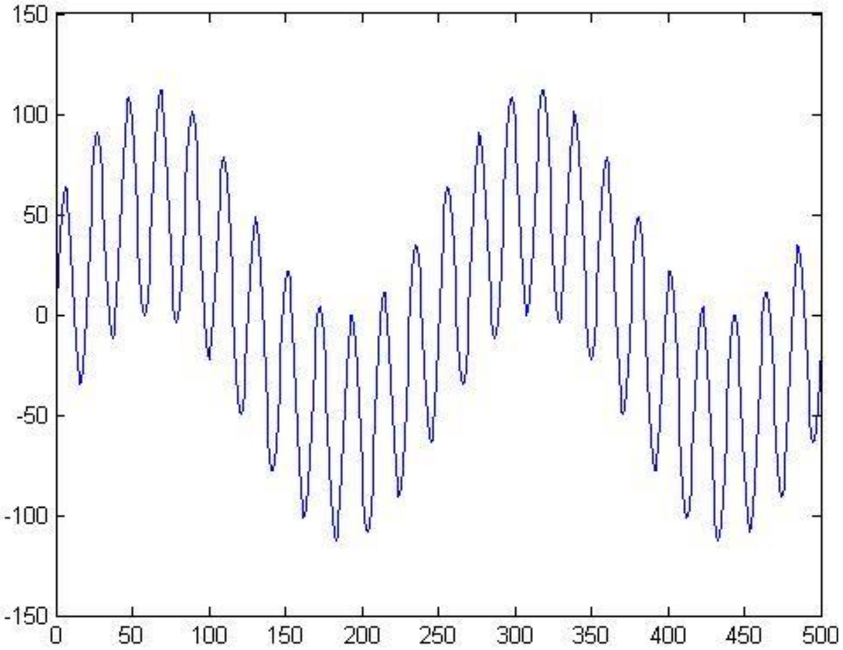
DWT- VII

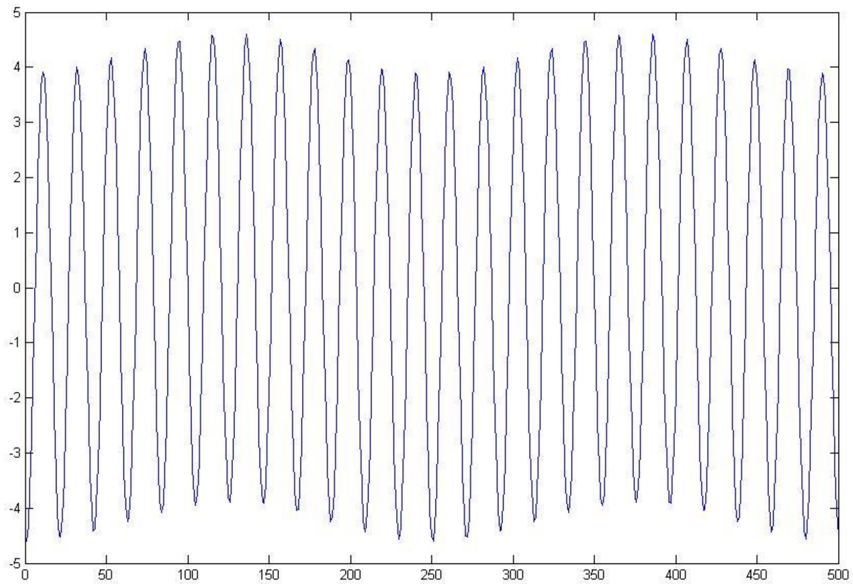
- Example
  - s : signal



DWT- VIII

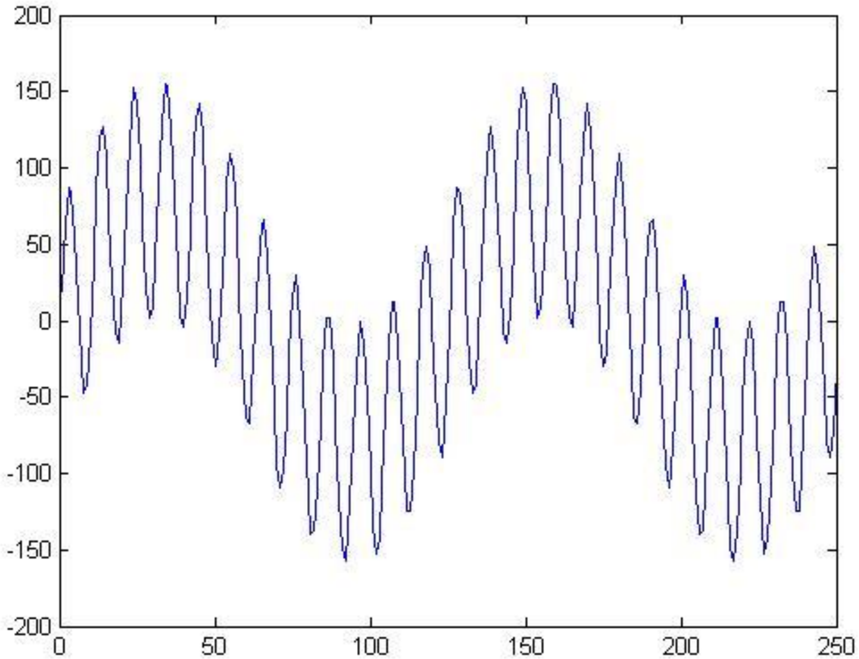
- First decomposition
- [a1, d1] = dwt(s,'db1','mode','per');

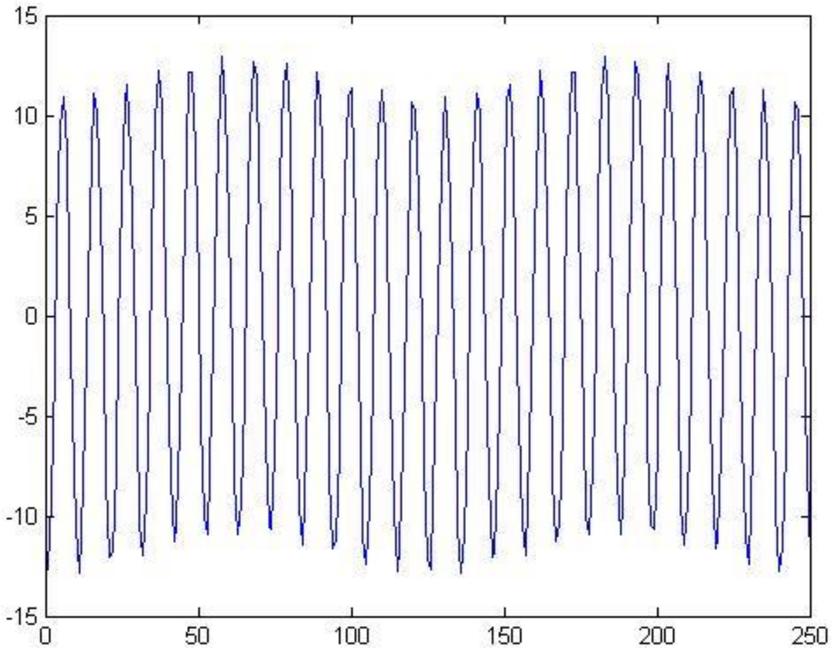




DWT- IX

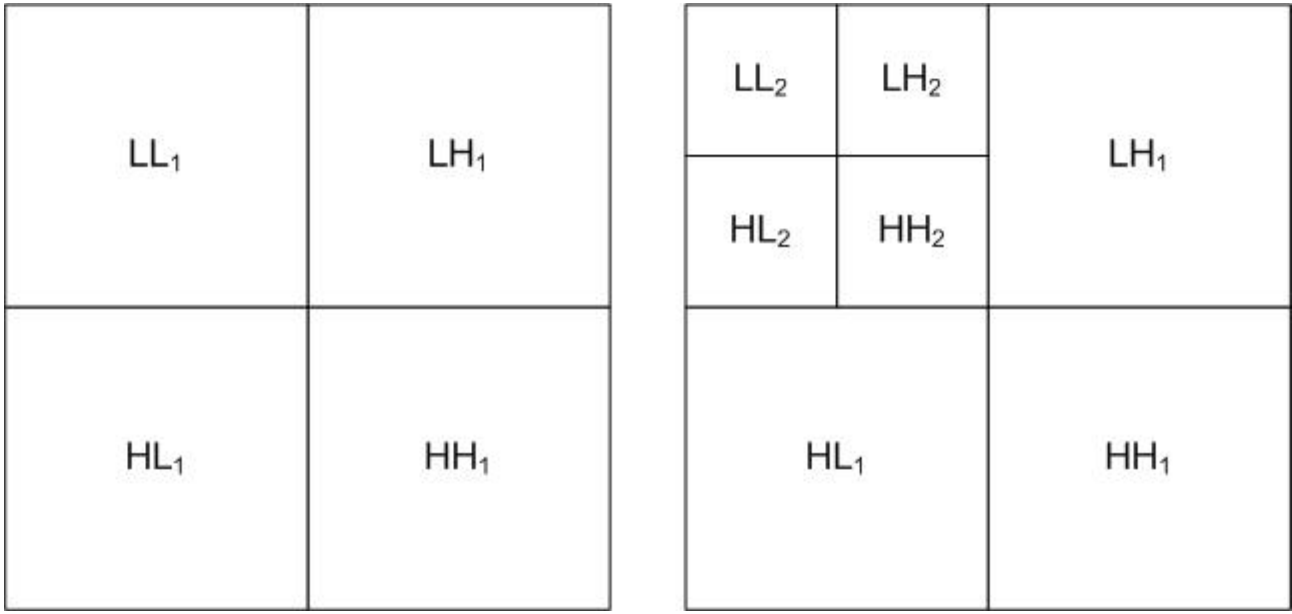
- Second decomposition
- [a2, d2] = dwt(a1,'db1','mode','per');





DWT - X

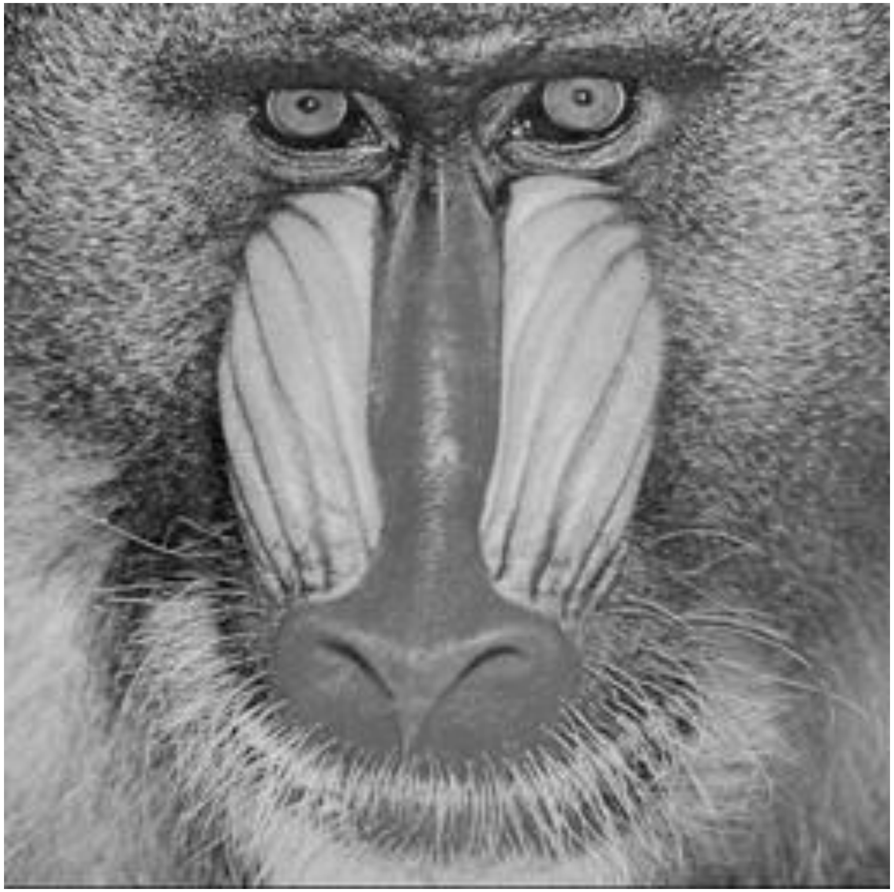
- Images
- Row / Column order
- 4 subbands
  - LL
  - LH
  - HL
  - HH

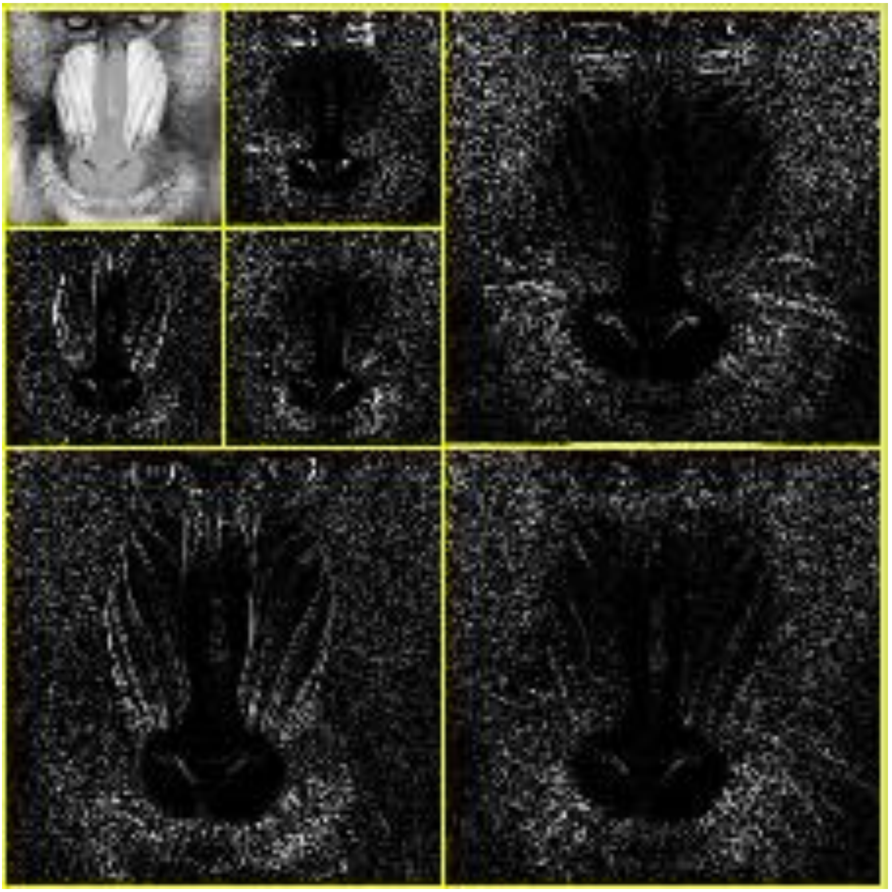


DWT-XI

- Example

```
[ll1,lh1,hl1,hh1] = dwt2(im,'db1','mode','per');
[ll2,lh2,hl2,hh2] = dwt2(ll1,'db1','mode','per');
```





Embedding (Encoding)

- Watermark
  - PRGS

- Embed all detail coefficients; exclude the approximation
  - WHY?

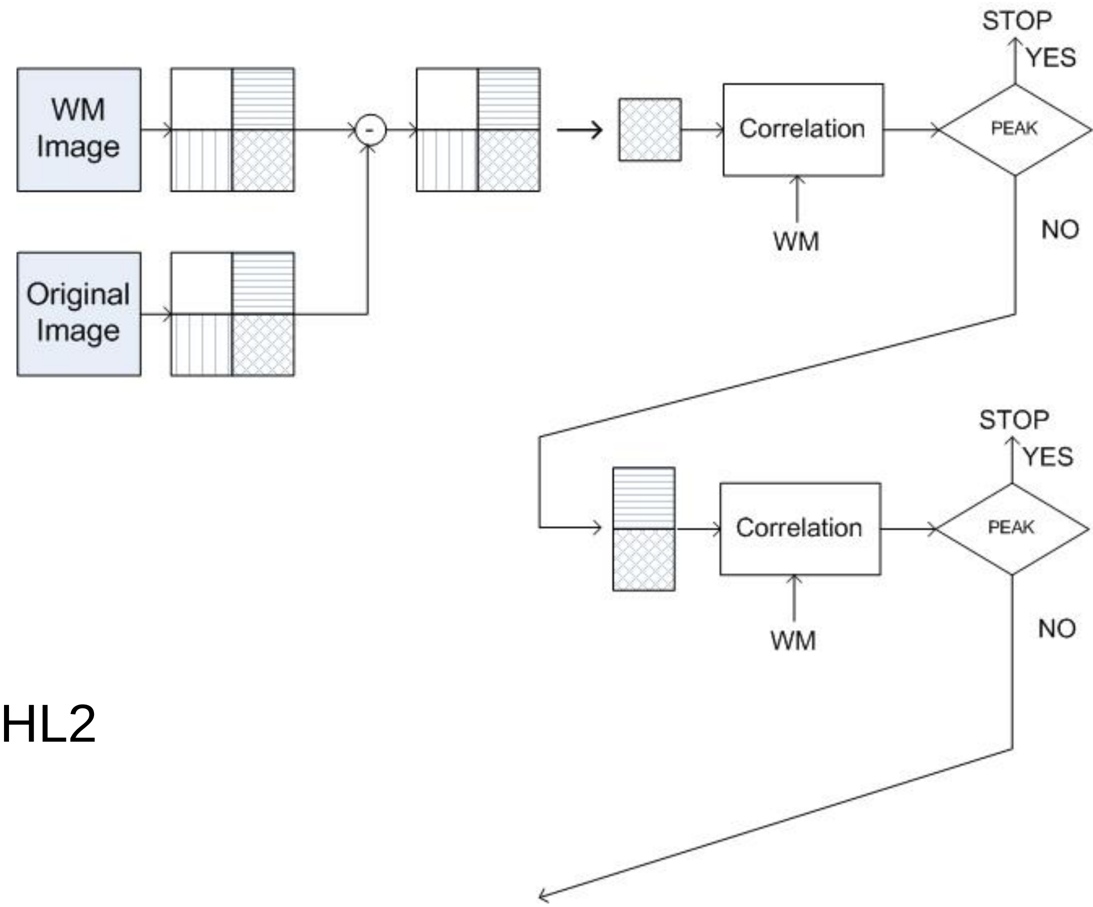
- Embedding Rule :

$$\hat{y} = y + \alpha \times (y)^2 \times wm$$

  - Why square?

Extraction (Decoding)

- Blind or Non-Blind
- Hierarchical search for the watermark
  - Cross correlation
    - » Same as the Cox et al.
  - HH1
    HH1,LH1
    HH1,LH1,HL1
    HH1,LH1,HL1,HH2
    HH1,LH1,HL1,HH2,LH2
    HH1,LH1,HL1,HH2,LH2,HL2



Implementation Details

- Image size
  - 512x512
  - Any other sizes?

- Wavelet Filter
  - Haar
    - » Daubechies
    - » Bi-orthogonal

- # of Level
  - 2 level
  - 7 subbands
    - » 6 of them are embedded

Weakness

- **Many details are missing**
  - What is the watermark length?
  - How can it be distributed to the bands?

- Haar wavelet
  - Most simple
  - Does not reflect HVS

- But earliest method for DWT based WM