A Survey of Wavelet–domain Watermarking Algorithms

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motivation & classification

approximation image and detail subband characteristics

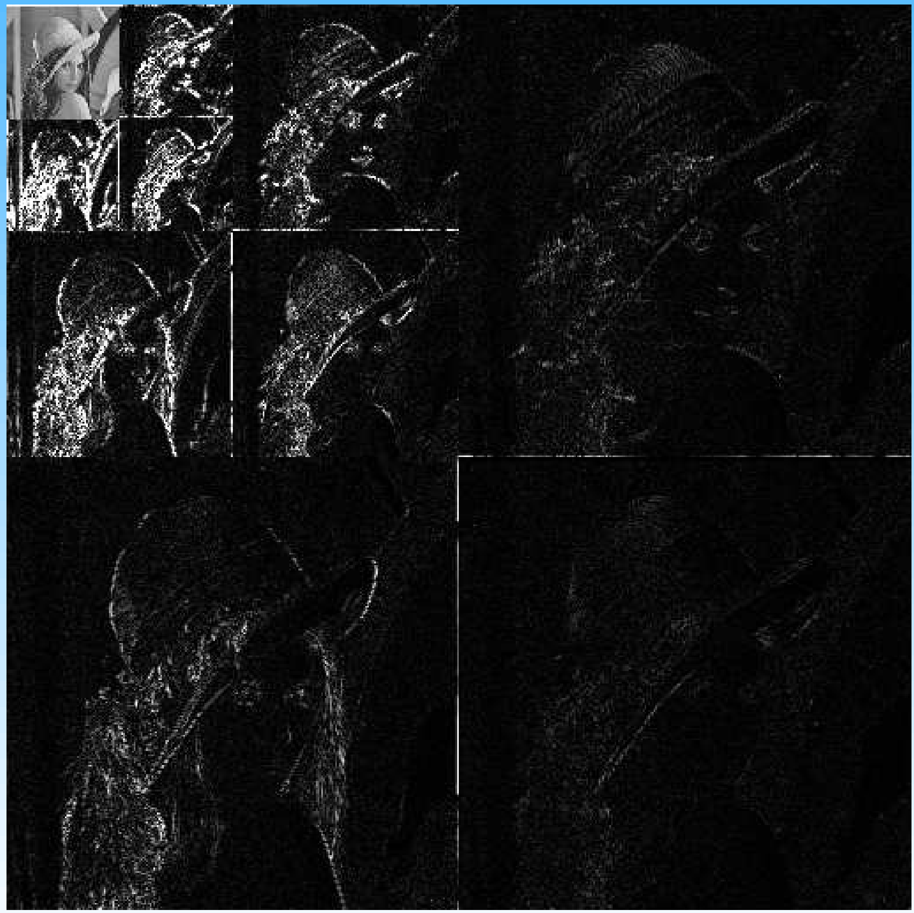
relationship to compression and JPEG2000

Why wavelet–domain watermarking?

- robustness
  - allows to mark significant image components
- advantages due to transform structure
  - space–frequency localization
  - multi–resolution representation
  - adaptivity
- compatibility with JPEG2000 standard

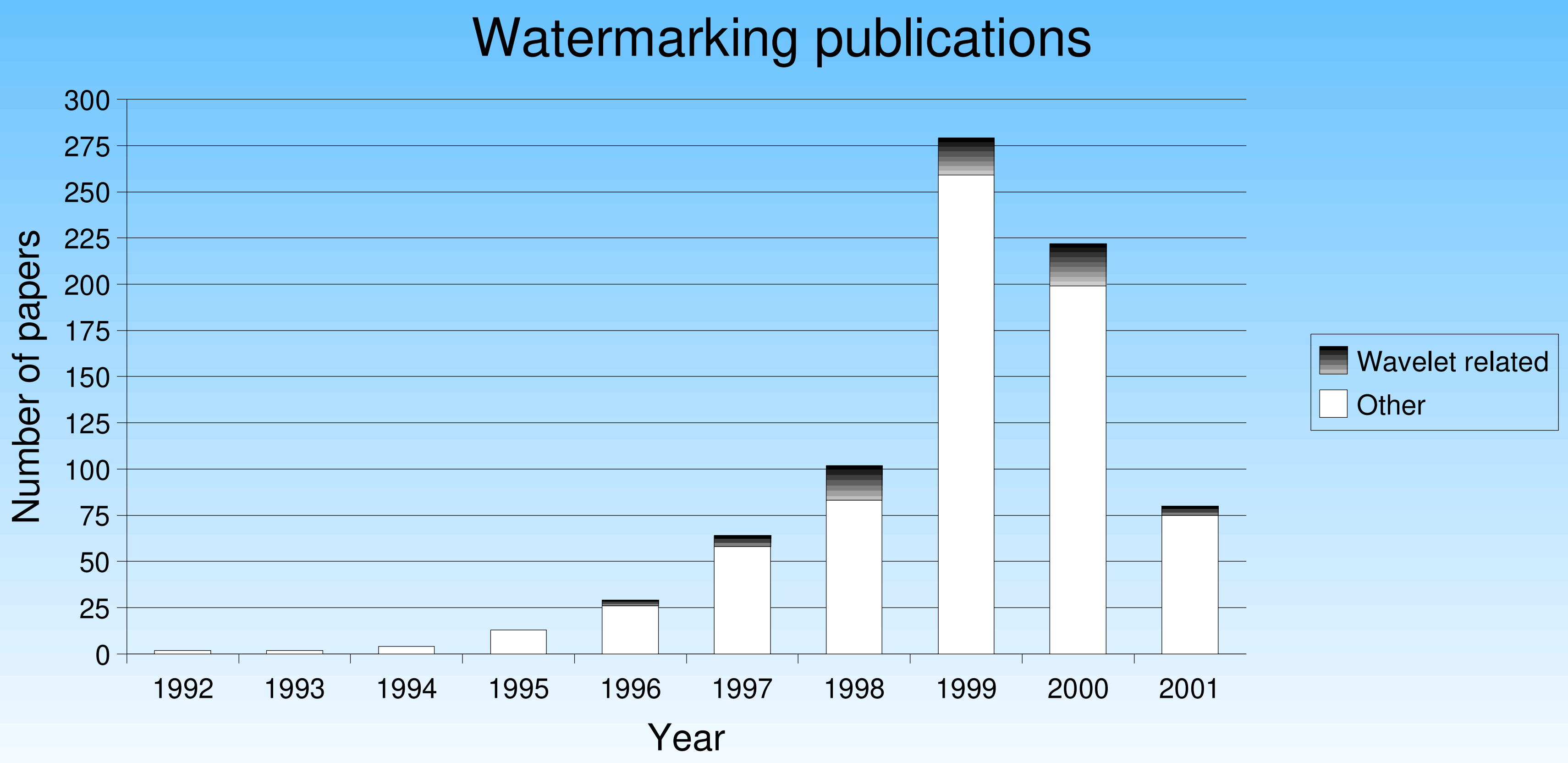
The wavelet transform domain

- successive low–pass / high–pass filtering steps
- approximation image
- detail subbands
- multi–resolution representation



Wavelet–domain watermarking

- extensive research [Dugelay]

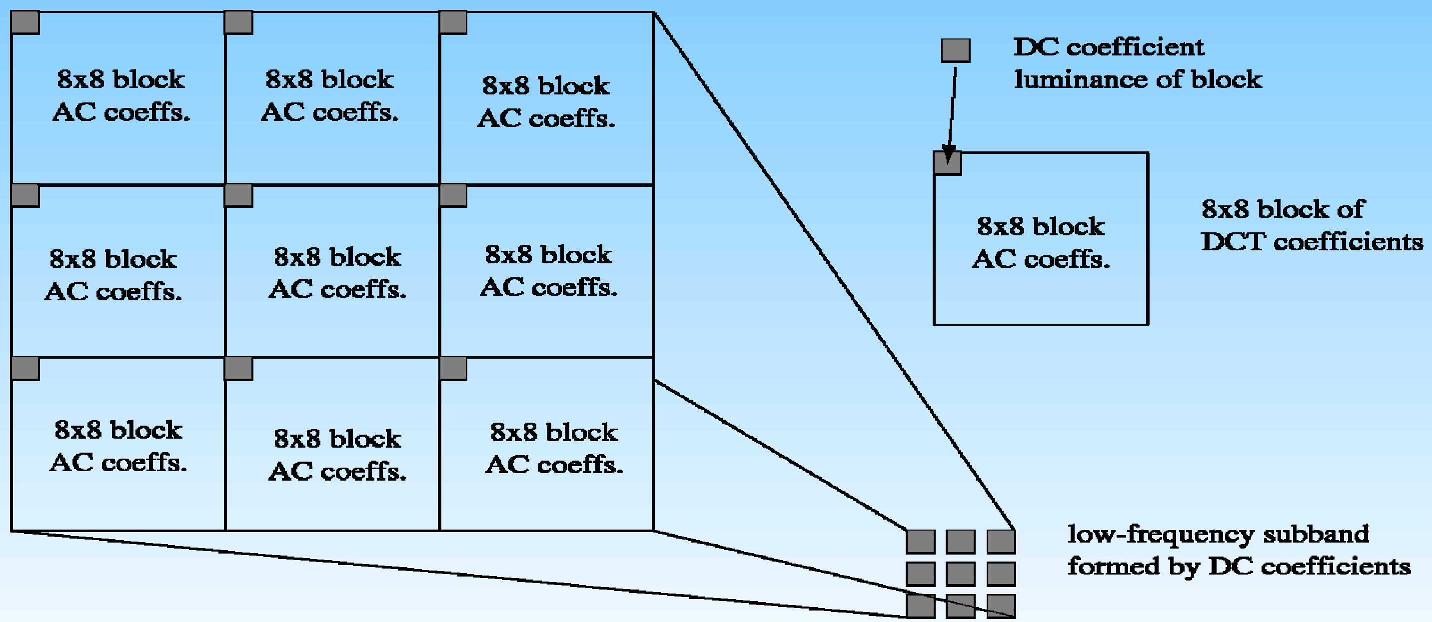


Classification of schemes

- decomposition strategy
  - number of levels, adaptivity, packet basis
- coefficient selection
  - approximation image or detail subbands?
- embedding and extraction method
  - additive or quantization strategy
- HVS modelling
  - implicit or explicit

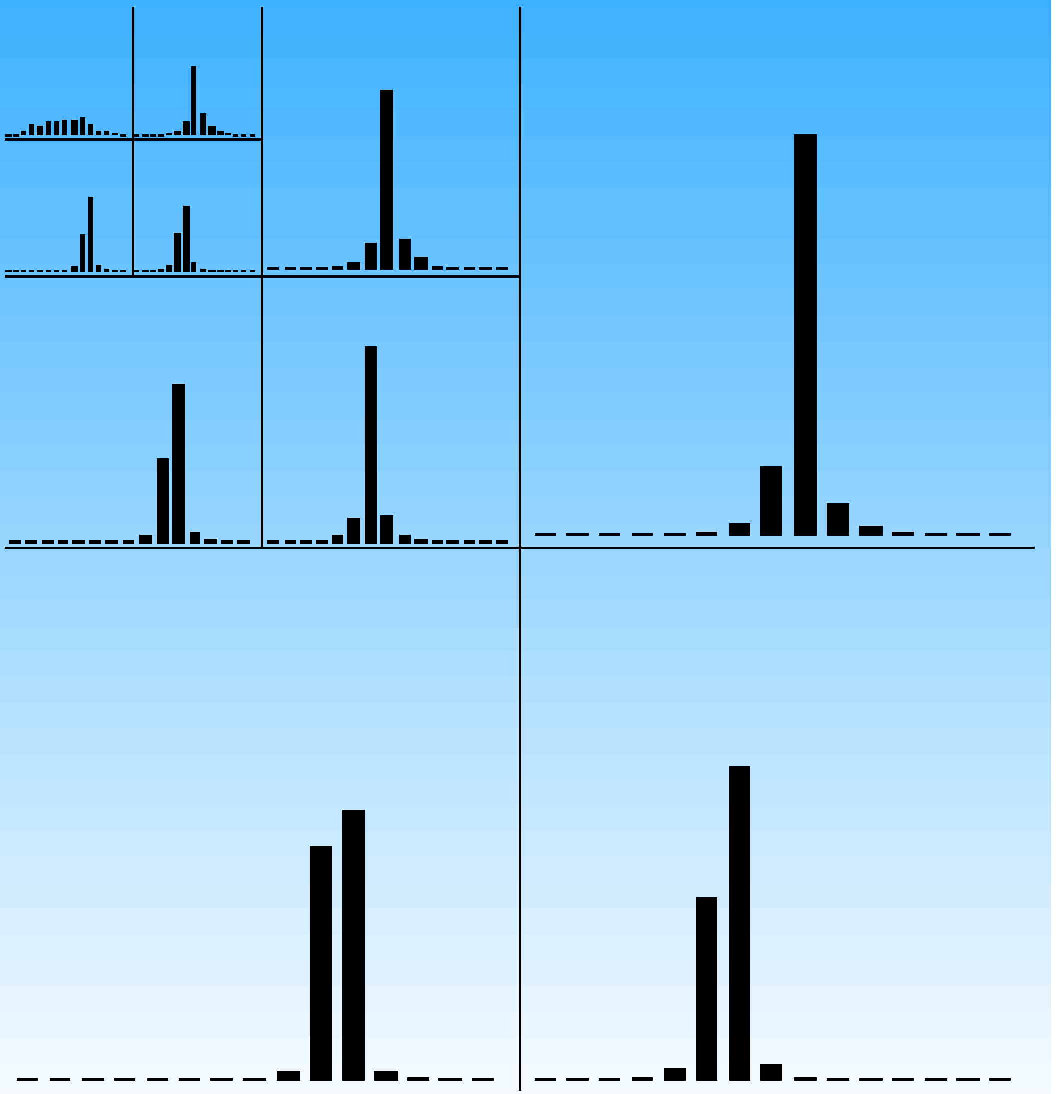
Approximation image watermarking

- first algorithm [ORuanaidh96] and early schemes, e.g. [Corvi97]
- general low–frequency marking, e.g. [Tzovaras98], [Liang]



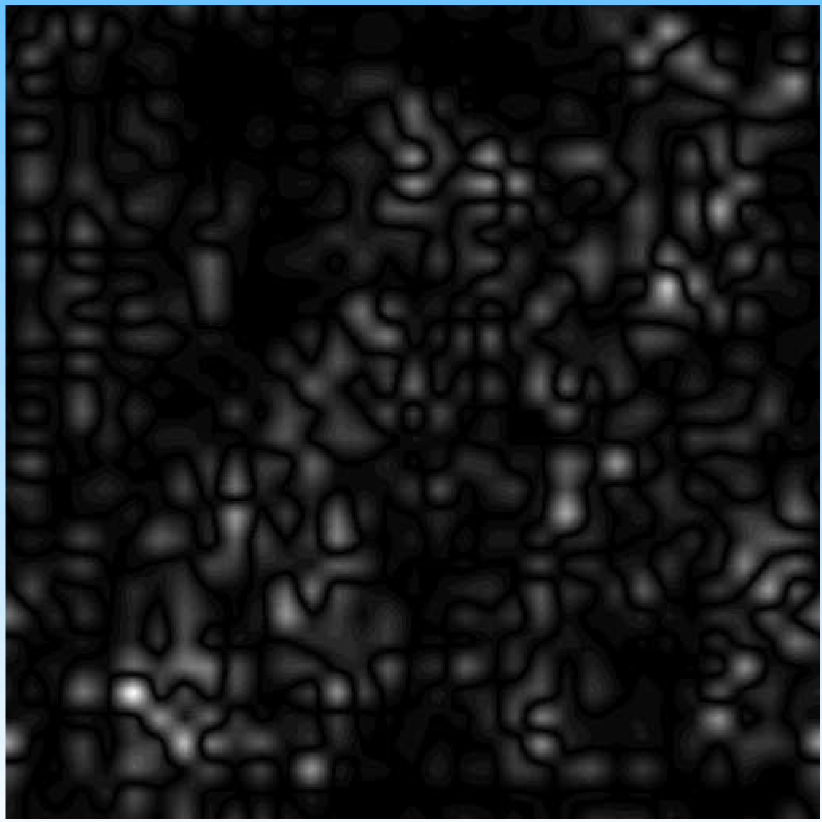
Detail subband embedding

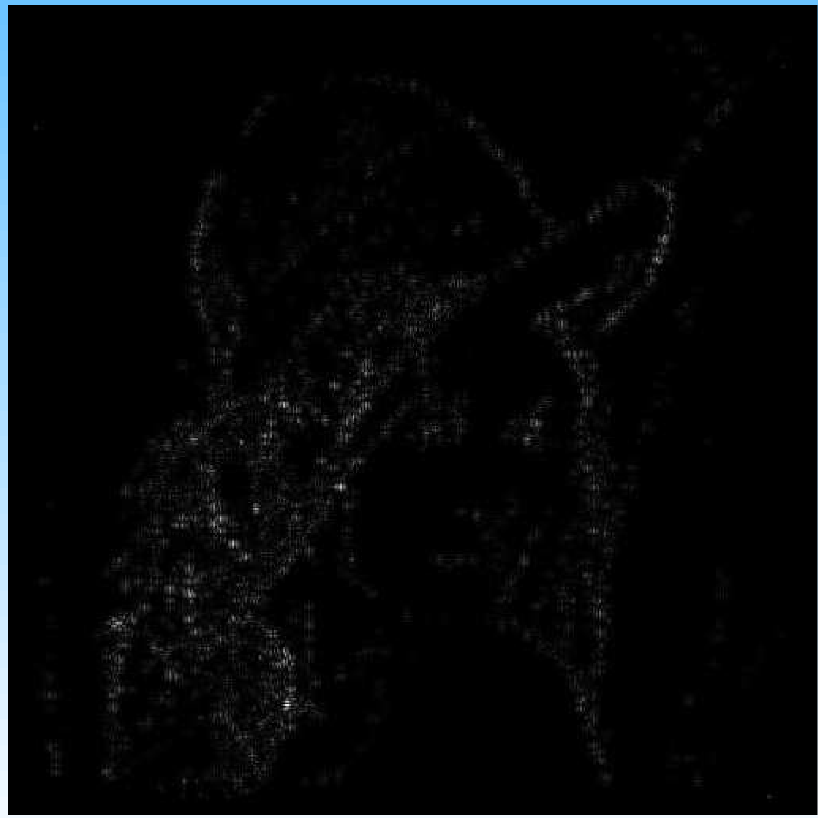
- Laplacian coefficient distribution
- large coefficients correspond to edges, texture



Difference images

created with algorithms by [Corvi97] and [Xia98]



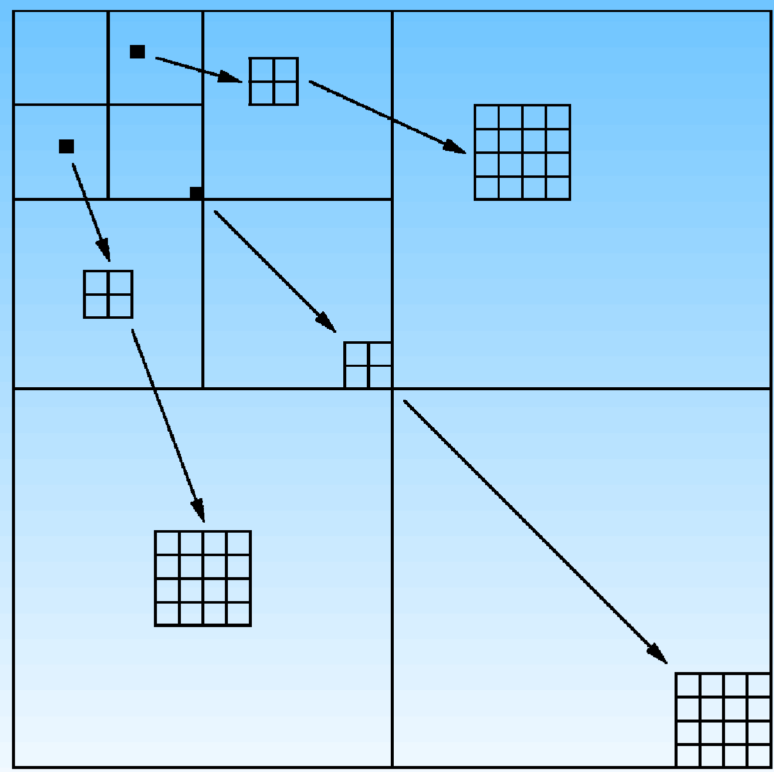


Relationship to image compression

- duality between compression and watermarking
- can use the same HVS model
- just–noticable difference (JND) paradigm
- quantization visibility [Watson97]
- watermarking can exploit visual masking

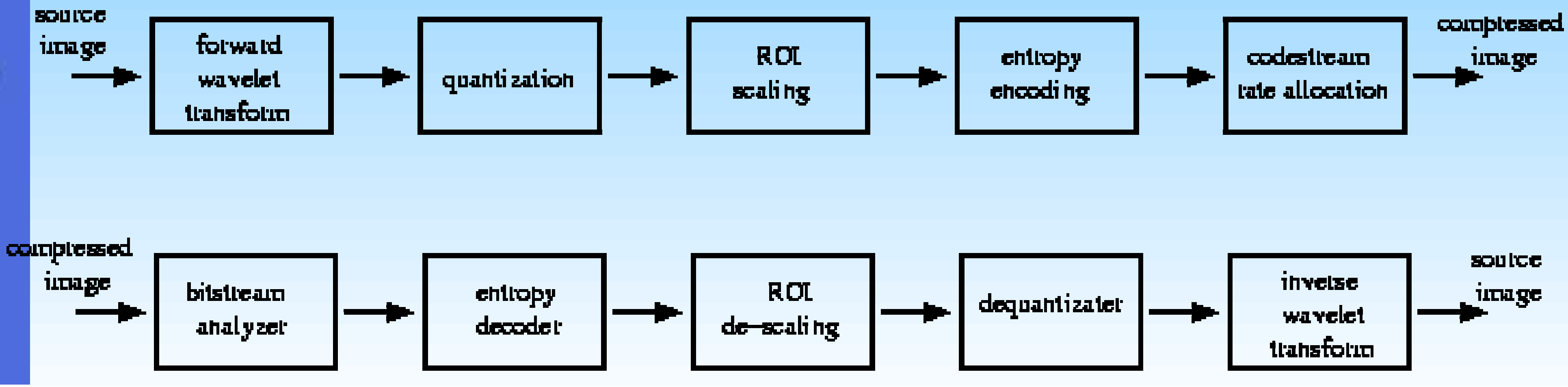
Relationship to image compression

- similar coding techniques
- MTWC [Wang98]
- zero−tree coding [Inoue98]
- EBCOT [Su99]

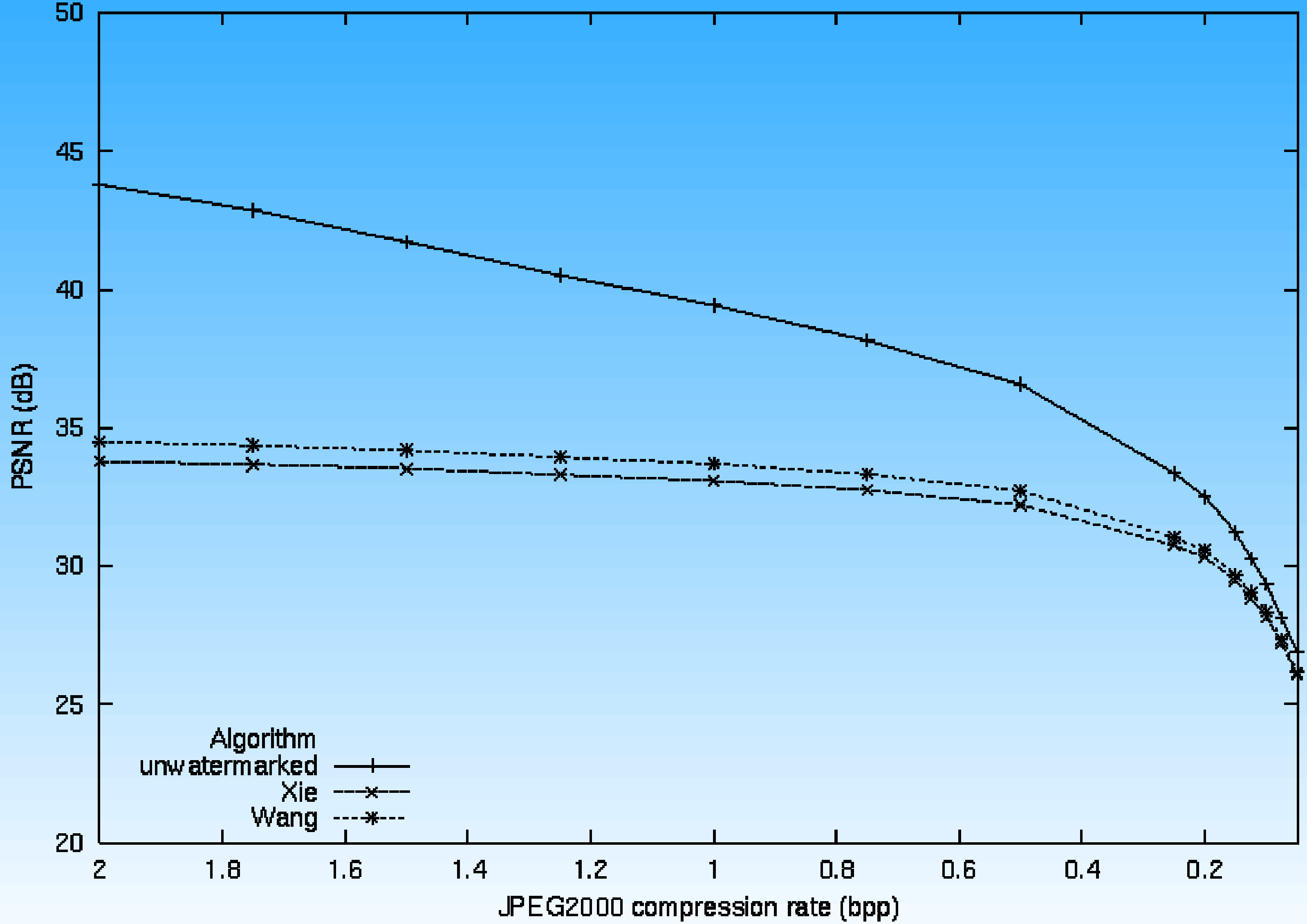


Compatibility with JPEG2000

- cheap devices require integrated coding and watermarking
- versatile wavelet–based image coder
- independent processing of image blocks, EBCOT [Taubman99]

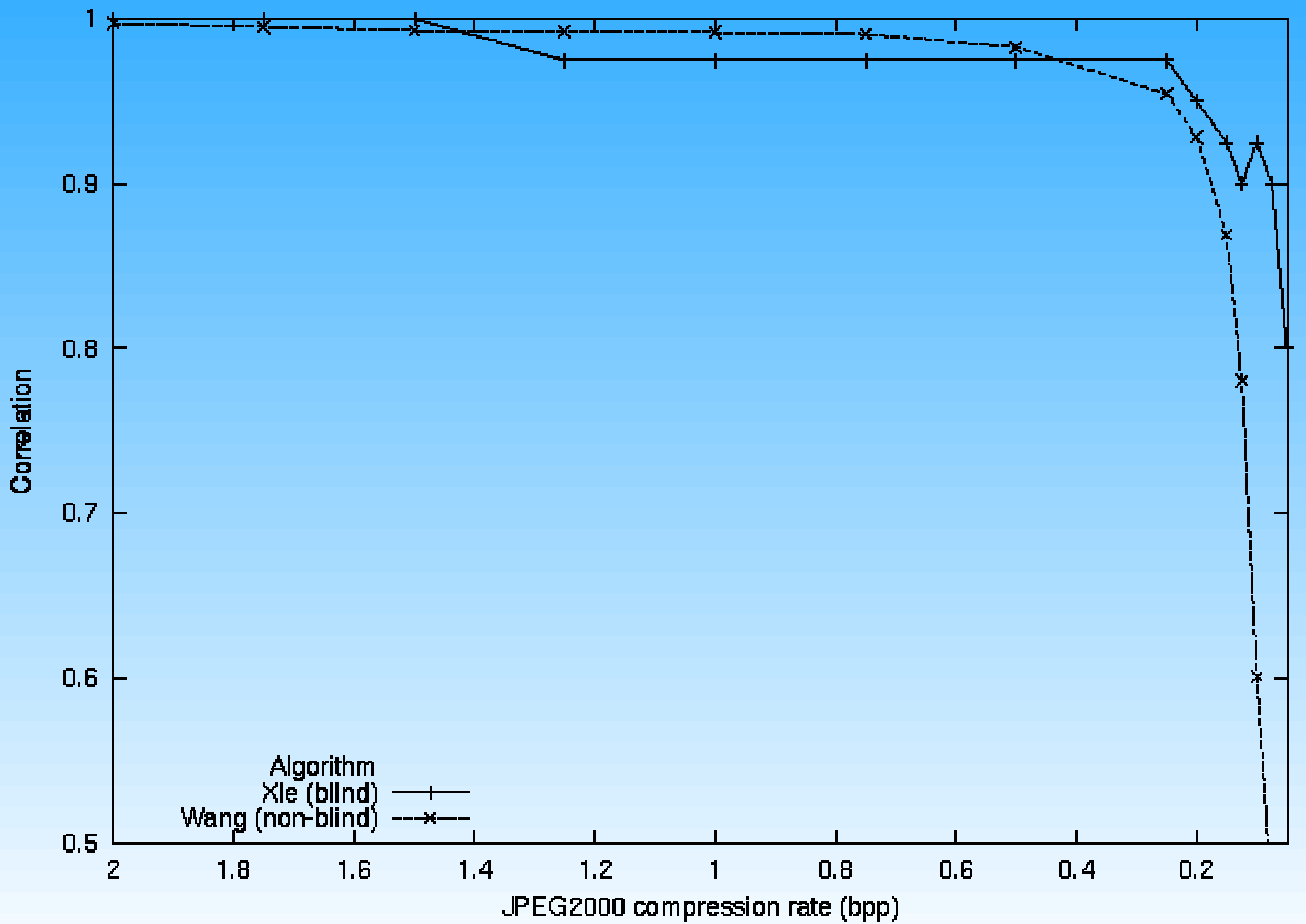


PSNR gap



50
45
40
35
30
25
20
PSNR (dB)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
JPEG2000 compression rate (bpp)
Algorithm
unwatermarked
Xie
Wang

Correlation



Conclusion

- investigate JPEG2000 coding process for watermarking
- look at color images and HVS model
- applications & security