QIM watermarking in the JPEG2000 coding pipeline

Peter Meerwald,

pmeerw@cosy.sbg.ac.at

blind watermarking & self–noise suppression

quantization index modulation (QIM) watermarking

dither modulation (DM)

JPEG2000 pipeline & watermarking

results

Blind watermarking

➔original image not available for watermark detection

additive embedding $f(m,n)' = f(m,n) + a \cdot |f(m,n)| \cdot w_i$

detection $d = \frac{1}{M} \cdot \sum^{M} f(m,n)' \cdot w_i$

threshold $t = \frac{a}{3 \cdot M} \cdot \sum^{M} |f(m,n)|$

➔ host image is noise for blind additive detector (mutual correlation)

Communication model

received signal = host image (self noise)

+ embedded watermark

+ processing noise

➔ extraction possible?

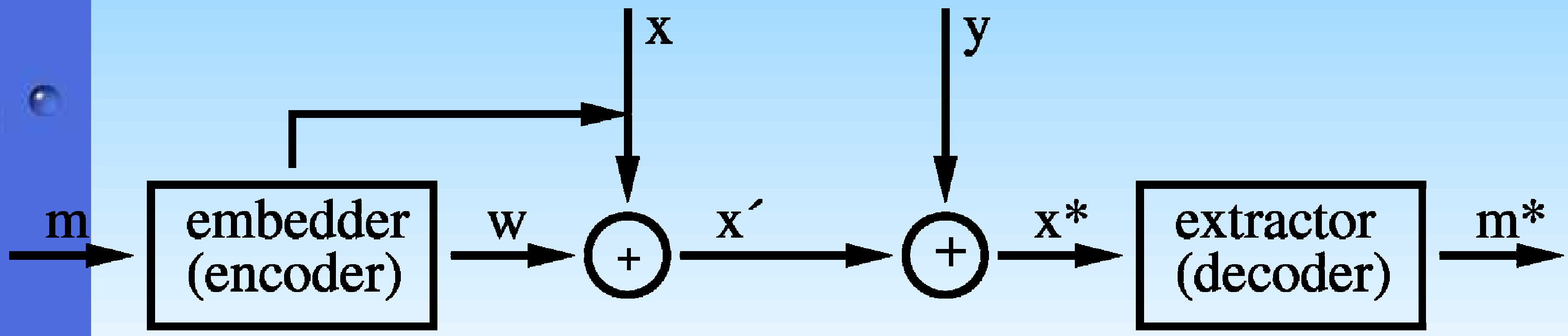


Image components

image transformed to frequency representation (DCT, DWT, ...) – energy compaction – transform coding gain

low frequency component = image noise, most energy

mid– and high frequency component = processing or attack noise

Where to place watermark?

- blind additive (linear) watermarking: tradeoff between low– and high–frequency components
- blind quantization (non–linear) watermarking: theoretically same performance as non–blind scheme (Costa’s proof)

➔ can suppress self noise

work by Chen & Wornell, Eggers, Ramakumar

Quantization index modulation (QIM)

ensemble of embedding functions

indexed by message $m \in \{1 \ldots M\}$

approximate–identity function $s(x;m) \approx x$

➔ can be realized with dither modulation and quantization

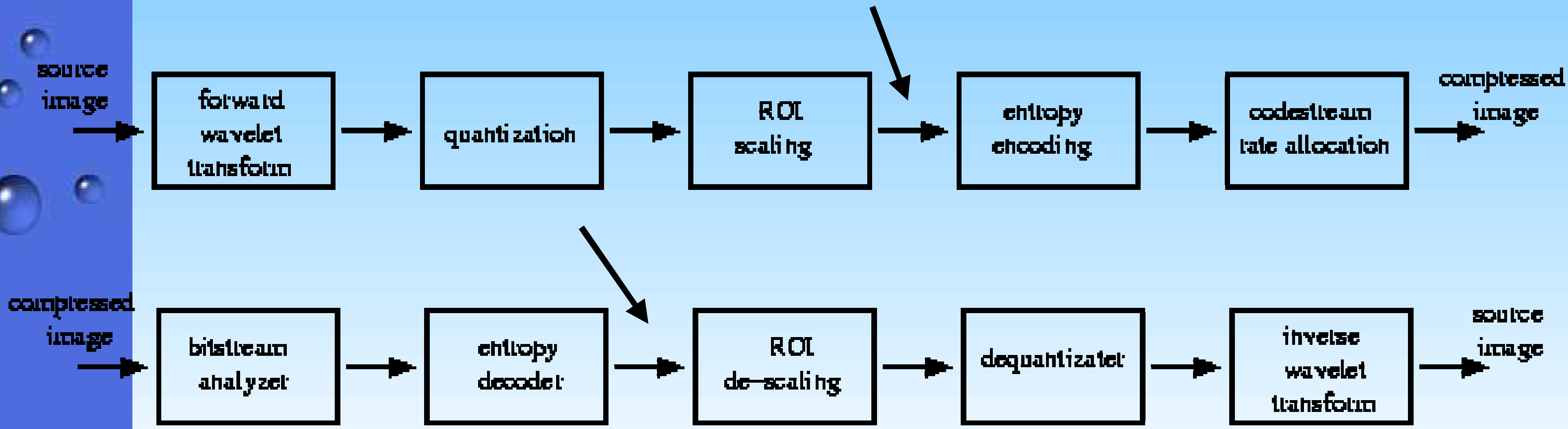
$$s(x;m) = Q(x + d(m), \Delta) - d(m)$$

JPEG2000 coding pipeline

independent processing of 64x64 code block

➔ embedding before entropy coding

➔ detection after entropy decoder



Watermarking with JJ2000

➔ using JJ2000 3.2.2, http://jj2000.epfl.ch

modular implementation of JPEG2000 VM in Java

5 level wavelet decomposition (7/9–biorthogonal)

pipeline interface:

64x64 code–blocks of 32bit integers (normalized)

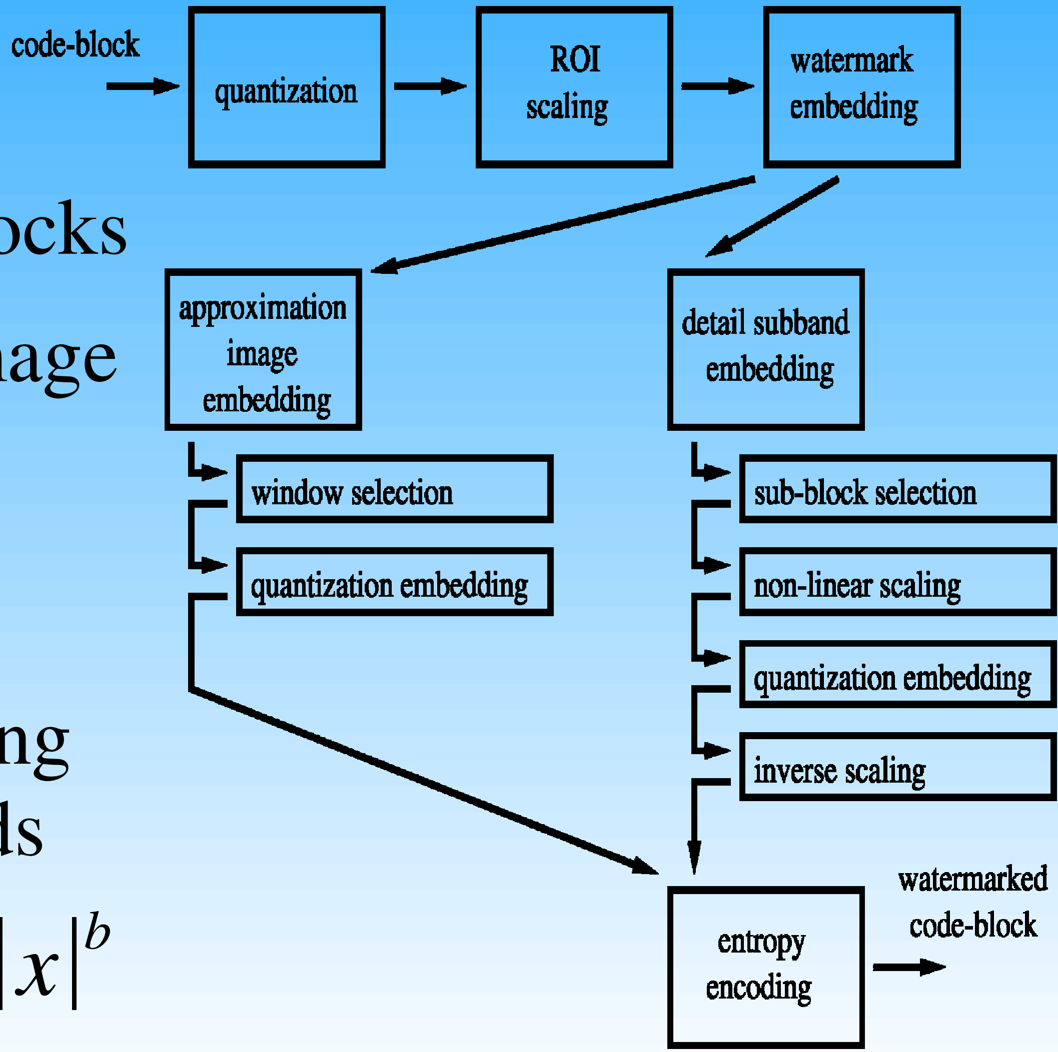
Watermark Embedder

distinguish code–blocks

- approximation image
- detail subbands

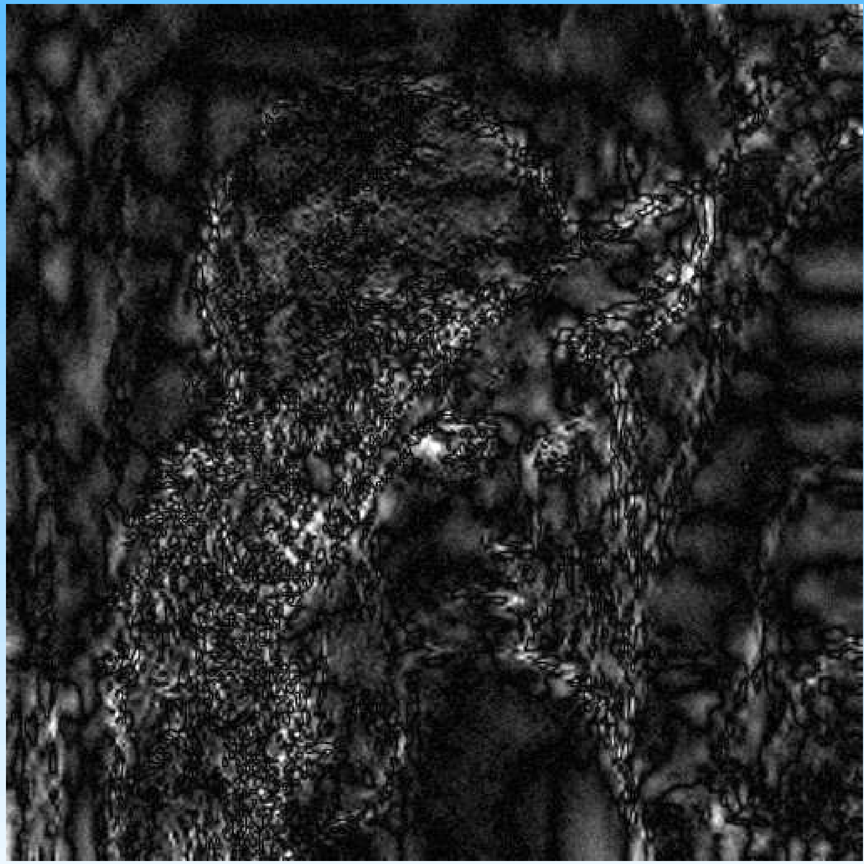
use non–linear scaling
for detail subbands

$$f(x) = sign(x) \cdot |x|^b$$



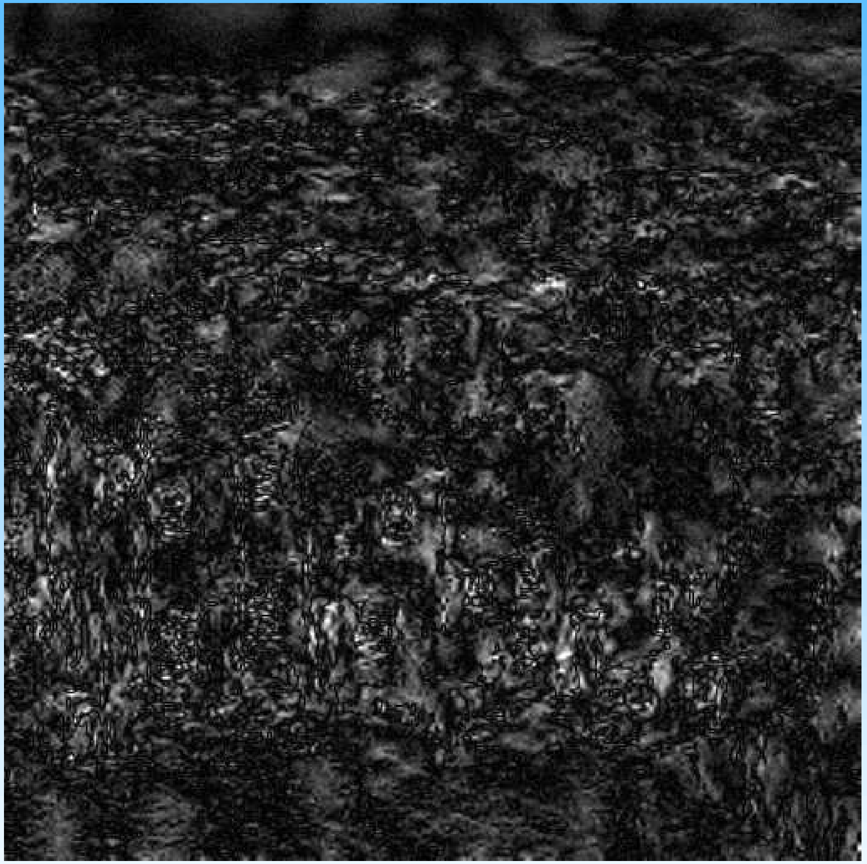
Results: Watermarked Lena

capacity 85 bits, PSNR 32.05 dB

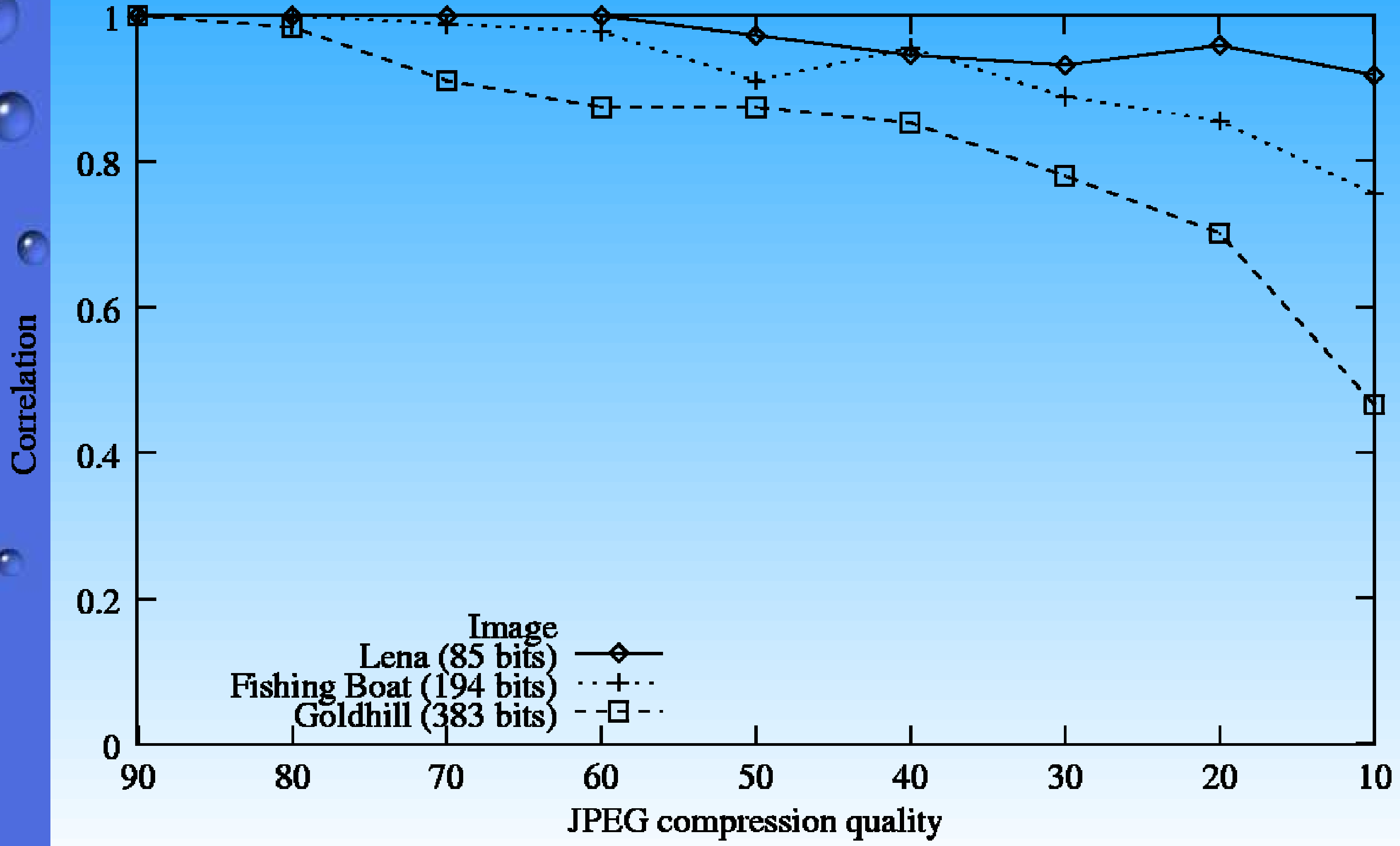


Results: Watermarked Goldhill

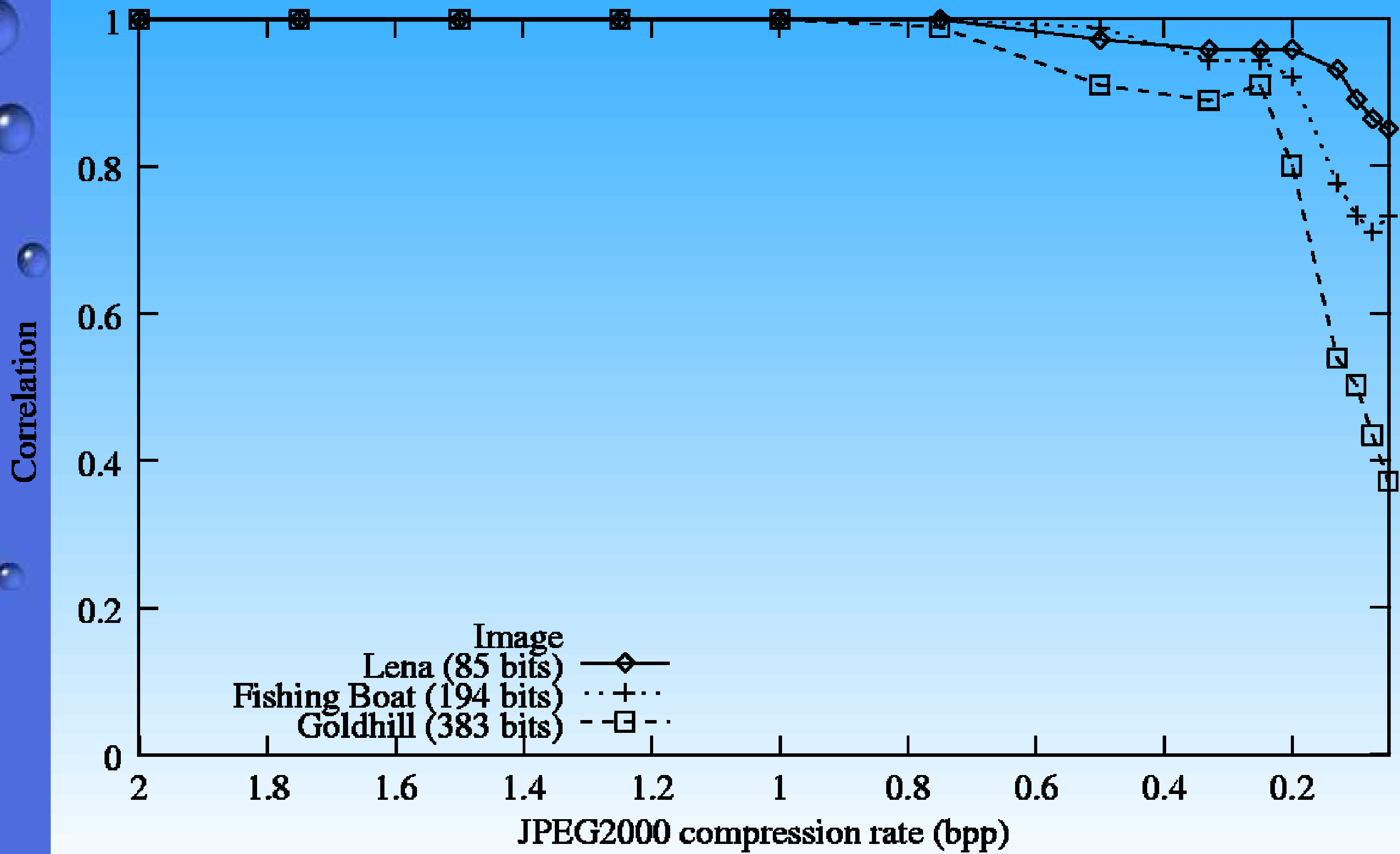
capacity 383 bits, PSNR 32.09 dB



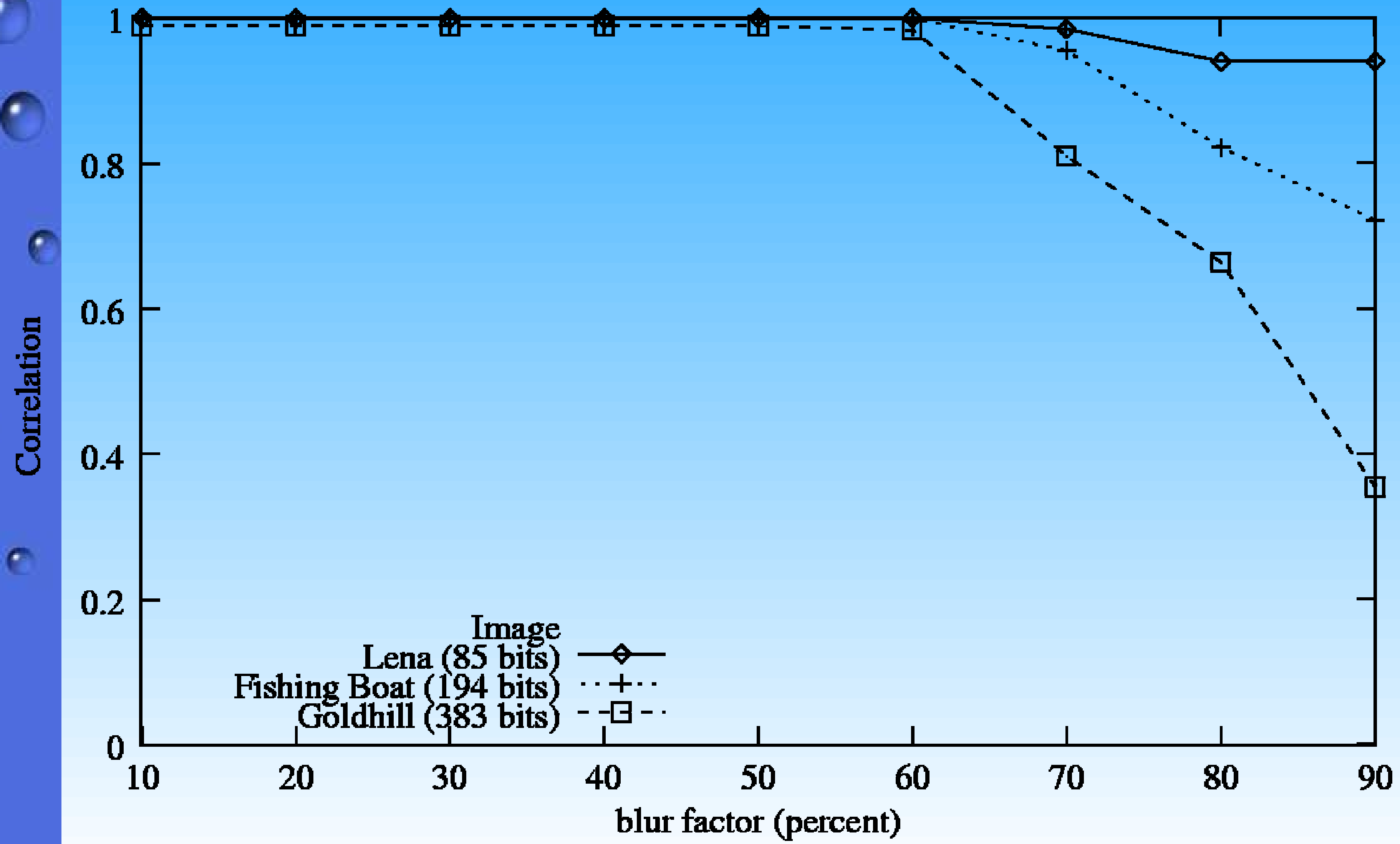
Robustness to JPEG Compression



Robustness to JPEG2000 Compression



Robustness To Blurring



Robustness to Sharpening

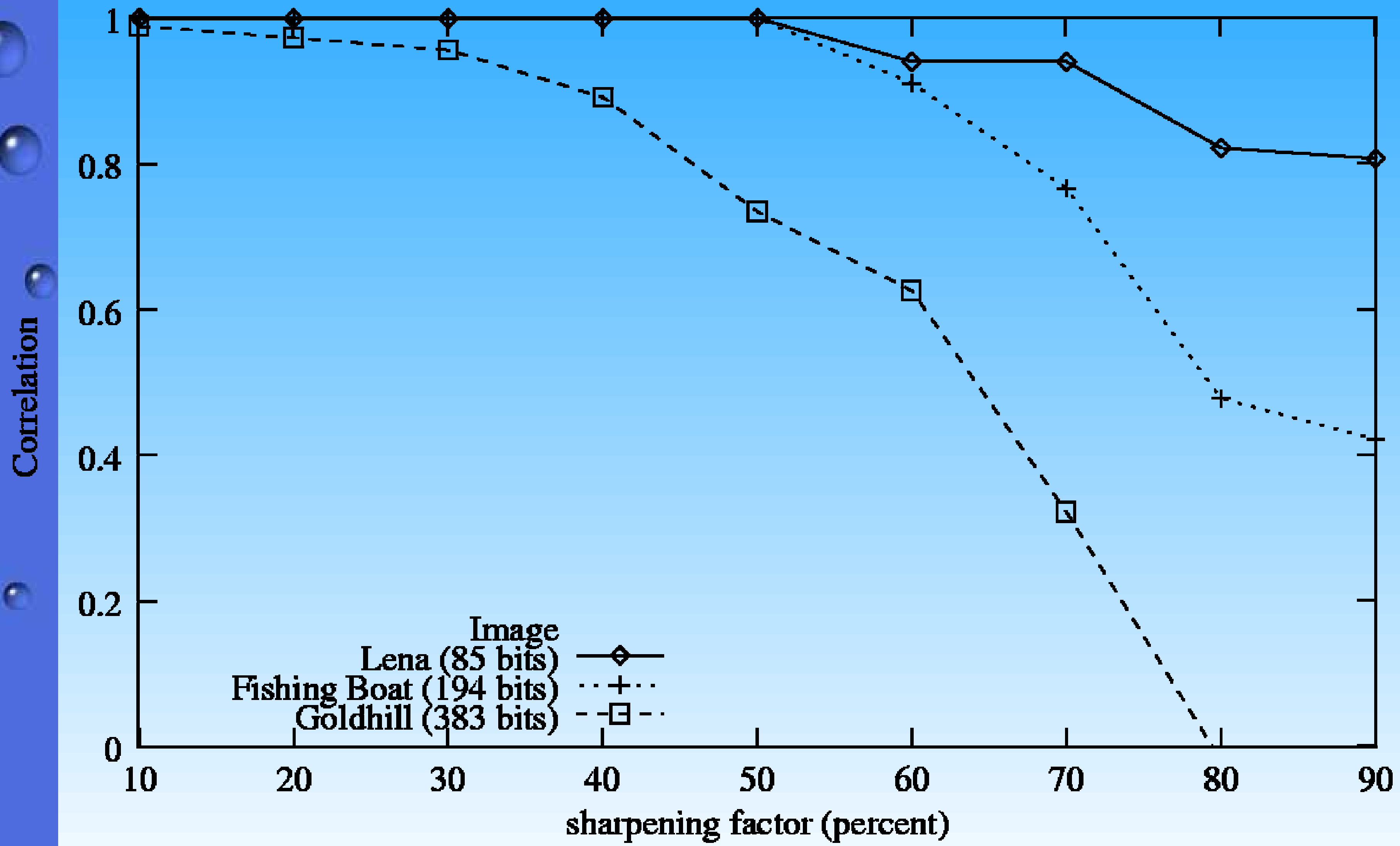
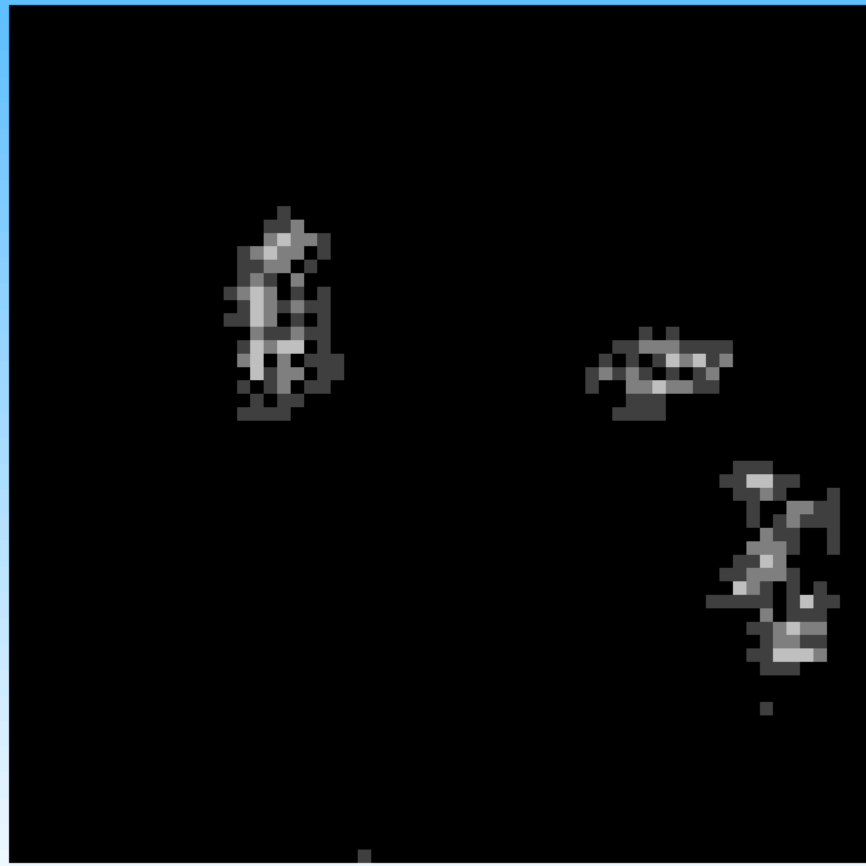


Image Authentication

watermarked and manipulated image

Tamper Detection

difference image and detected manipulation (after default JPEG compression)



Future Work

- better embedding method, results of Chen, Eggers and Ramkumar
- color images
- more human visual system (HVS) modelling
- region–of–interest coding (ROI)