Multimedia Copyright Protection

LANCASTER UNIVERSITY

Hiding Information in Media Data

Embed or hide information without noticeably altering the host image/video

Applications
Owner identification, copyright control
Requirements
Imperceptibility, robustness, and security
Aim
Embed as many information bits as possible while satisfying the above requirements
Informed data hiding with blind detection
The original (host) data only known at the encoder

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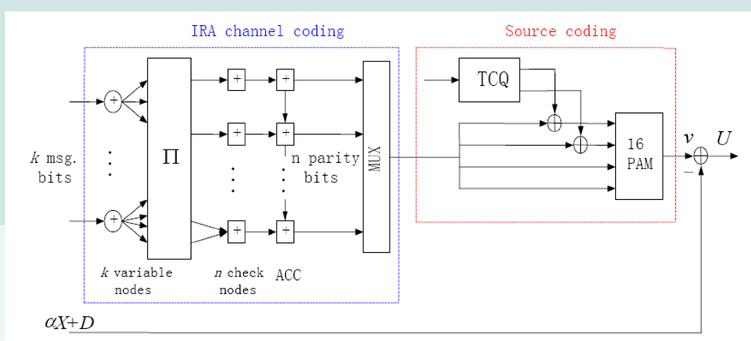
Dirty-Paper Coding (DPC)

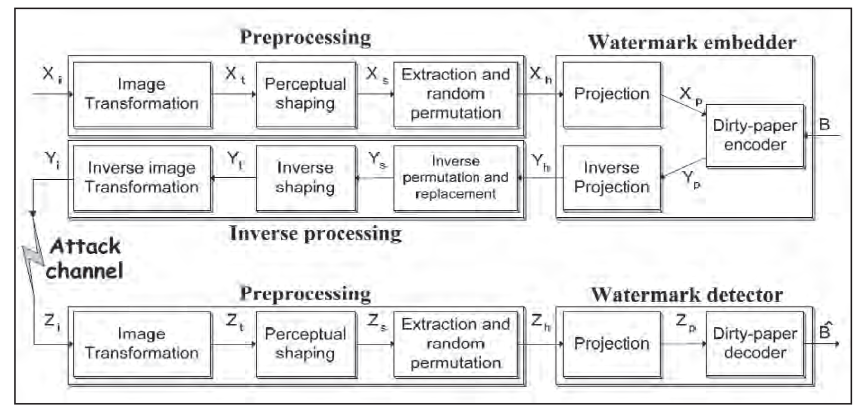
- Informed data hiding can be modeled as channel coding with encoder side information
  · The host image is treated as encoder side information
- When the attach channel is modeled as Gaussian channel, we have the DPC problem
  · Capacity of a DPC channel is the same as the Gaussian channel (without encoder side information)
- The connection between data hiding and DPC first pointed out by Chen and Wornell '99
  · Scalar DPC scheme based on quantization index modulation (QIM)
  · But QIM is not efficient

Our Dirty-paper Code Designs
Based on separate TCQ and IRA coding

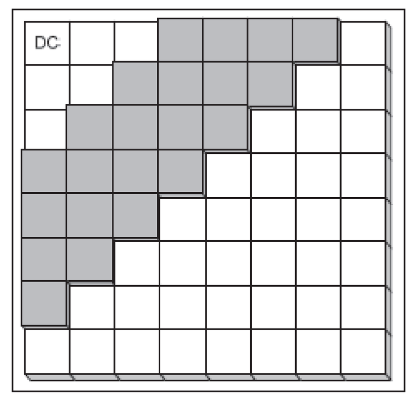


· Best result: 0.83 dB away from the capacity at 0.25 b/s
· Lower complexity than other designs at the same performance

Data Hiding With Near-Capacity DPC



- DCT image transform
- Perceptual shaping
  · Based on Watson's model (for visually optimal quantization)
  · Each 8x8 DCT block scaled by a frequency sensitivity table
- Only 22 mid-frequency DCT coefficients involved
  · Synchronized random permutation

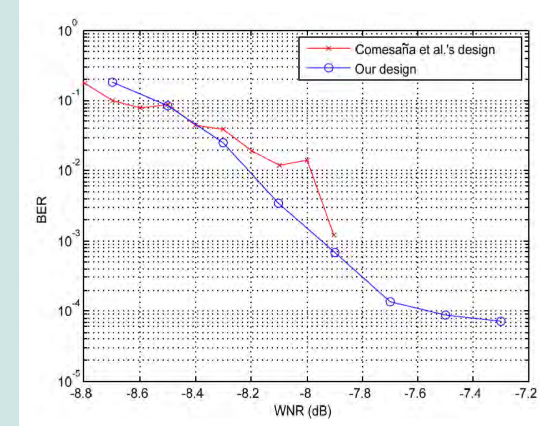


Results

Original 256x256 Lena

After embedding 1500 bits

Performance Against AWGN Attacks



Our design
1.83dB from capacity

Comesaña et al.'s
3.64dB from capacity

· Turbo cliff at watermark-to-noise ratio (WNR) -7.9 dB (with BER<10-3): same as in Comesaña et al.'s work
· 33% more bits embedded (1500 bits vs 1122 bits)

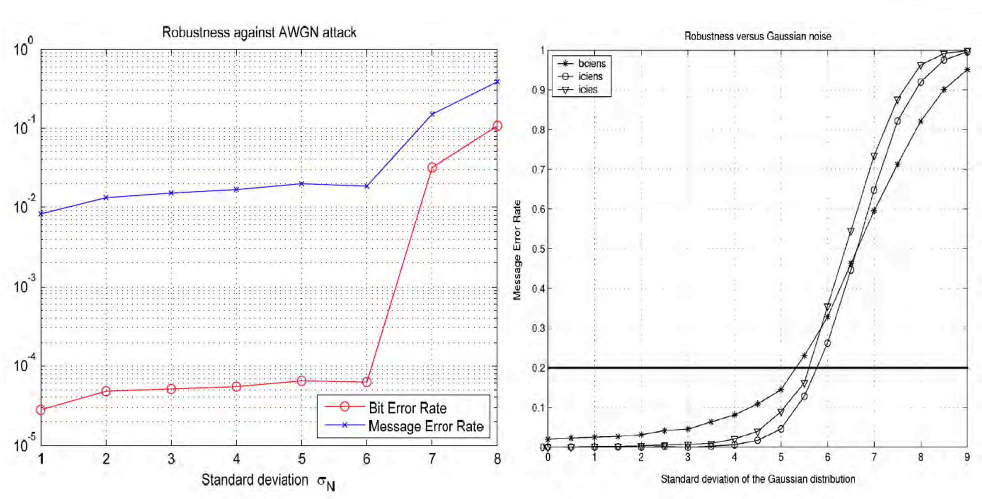
Better performance comes from better DPC

- More powerful source code
  -256-state TCQ vs 4-state TCVQ
- Better IRA code design
  · Carefully designed IRA degree profile
- Better code construction algorithm
  -Short cycles and small-weight error events removed by progressive edge growth algorithm

Conclusions

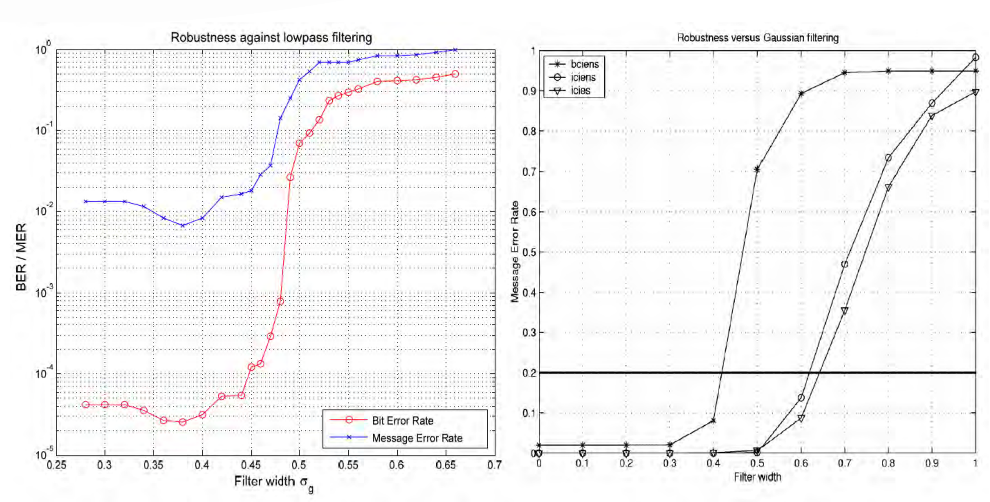
- A high-rate data hiding scheme based on near-capacity DPC
  · 33% more payload than Comesana et al. '05 (using Erez and ten Brink's dirty-paper code)
  · Result of better dirty-paper code designs
- Our scheme shows comparable robustness against different attacks to the one in Miller, Doerr, and Cox '04
- Good candidate for high-rate image data-hiding applications

Robustness Test: AWGN



Results better than those in Miller, Doerr, and Cox '04

Robustness Test: Low-pass Filtering



Results slightly worse than those in Miller, Doerr, and Cox '04

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