PSYCHOVISUAL ROTATION-BASED DPTC WATERMARKING SCHEME

Author : Marc CHAUMONT (LIRMM)

Speaker : Dalila GOUDIA (PhD Student - LIRMM)

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OUTLINE

- Few words about high rate watermarking schemes
- The Rotation-Based Dirty Paper Trellis Code Algorithm: RB-DPTC
- How to add a psycho-visual space?
- Experimental evaluations
- Conclusion
FEW WORDS ABOUT HIGH RATE WATERMARKING SCHEMES
HIGH RATE WATERMARKING SCHEMES

- Quantized-based:
  - DC-QIM, SCS, RDM, Perceptual-QIM...

- Trellis-based:
  - DPTC

- Mix of Quantized-based and Trellis-based:
  - T-TCQ

⇒ payload ≈ 1 bit embedded for 64 pixels
   (image 256×256 ⇒ 1024 bits embedded)
The Rotation-Based Dirty Paper Trellis Code Algorithm: RB-DPTC
RB-DPTC WATERMARKING SCHEME [1] - EMBEDDING SPACE -

- $x$ : host signal
- $w$ : watermark signal
- $y$ : watermarked signal
- $\{u_i\}_{i=1}^{N_{sec}}$ : carriers (normalized bipolar pseudorandom sequences)
- $v_x$ : host vector = secret space
- $v_w$ : watermark vector = (watermark in the secret space)


Author: M. CHAUMONT, Speaker: D. GOUDIA
HOW TO ADD A PSYCHO-VISUAL SPACE?
RB-DPTC
WATERMARKING SCHEME [1]


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PSYCHOVISUAL RB-DPTC WATERMARKING SCHEME
**PSYCHOVISUAL RB-DPTC WATERMARKING SCHEME**

- $x_{psy}$: psychovisual space
- **Shaping of the watermark:**
  \[ \forall i \in [1,N_{wlt}], w[i] = w_{psy}[i] \times \alpha[i] \]
EXAMPLE OF PSYCHOVISUAL MASKS

Rudimentary

Construction:
1. high pass filtering ($I_{filtered}$)
2. DWT and filling of vector $\beta$
3. $\alpha =$ absolute coefficients from $\beta$ scaled between $[1, \alpha_{\text{max}}]$

Pixel-Wise Mask (PW-M)

PW-M [3]:

$$\alpha_l^\theta (i, j) = \Theta(l, \theta).\Lambda(l, i, j).\Xi(l, i, j)^{0.2}$$

- $(i,j)$: position in subband
- $l$: resolution level
- $\theta \in \{a,h,v,d\}$: orientation

- $\Theta(l, \theta)$: noise sensitivity
- $\Lambda(l, i, j)$: local brightness
- $\Xi(l, i, j)$: local texture activity
- $\alpha$ scaled between $[1, \alpha_{\text{max}}]$

Barbara crop to $512 \times 512$

Wavelet decomposition

Rudimentary mask

Xie and Shen mask
CORRECTING CODE

- Add of a convolution correcting code
  2-memory, 1/2-rate
  - Encoding with the state machine
  - Decoding with Viterbi algorithm

The message is encoded before embedding

The use of a psychovisual mask may lead to a less robust scheme
Evaluation Protocol

- 100 images $256 \times 256$

- Payload = 1 bit (message) for 64 pixels
  - 1024 bits embedded for RB-DPTC.
  - 2048 bits embedded for new algorithms.

- Trellis: 128 states, 128 arcs by state

- Outputs arc labels: Gaussian distribution
  - number of labels by output arc: 12 (RB-DPTC) or 10.
ALGORITHMS

3 Algorithms are competing (fix SSIM = 98%):

- RB-DPTC (no psychovisual mask, no correcting code)
- PR-RB-DPTC (rudimentary mask + correcting code)
- PXS-RB-DPTC (Xie and Shen mask + correcting code)

4 attacks:
- Gaussian noise,
- Gaussian filtering,
- Valumetric scaling,
- Jpeg attack.
ATTACKS (1) – FIXED SSIM = 98%

Gaussian noise attack

Gaussian Filtering attack

Author: M. CHAUMONT, Speaker: D. GOUDIA
ATTACKS (2) – FIXED SSIM = 98%

Valumetric scaling attack

Jpeg attack
CONCLUSION & DISCUSSION
CONCLUSION & DISCUSSION

- Integration of a psychovisual mask inside RB-DPTC
- 10% BER saving (filtering & volumetric attack) for low power attacks

OPEN ISSUES:
- Sensitivity to Jpeg attack
- Relation between SSIM and penetration angle
- Construction of a robust psychovisual mask

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RB-DPTC WATERMARKING SCHEME
- EMBEDDING SPACE -

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RB-DPTC WATERMARKING SCHEME - INFORMED CODING & EMBEDDING -

- **Informed coding:**
  - identical to [2] (Trellis + Viterbi)
  - Input = \((v_x \text{ and message})\), Output = codeword \(c^*\)

- **Informed embedding:**
  - rotate \(v_x\) in the “Miller Cox Bloom plane”
  - and penetrate inside the Voronoï region
  - \(v_w = v_y - v_x\)