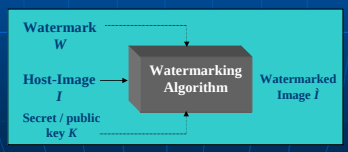
# Differential Evaluation Algorithm Based Fragile Image Watermarking

## Outline

- Introduction
- Review of digital watermarking
- Simple DCT based watermarking method
- DE-based watermarking method
- Experimental results
- Conclusion

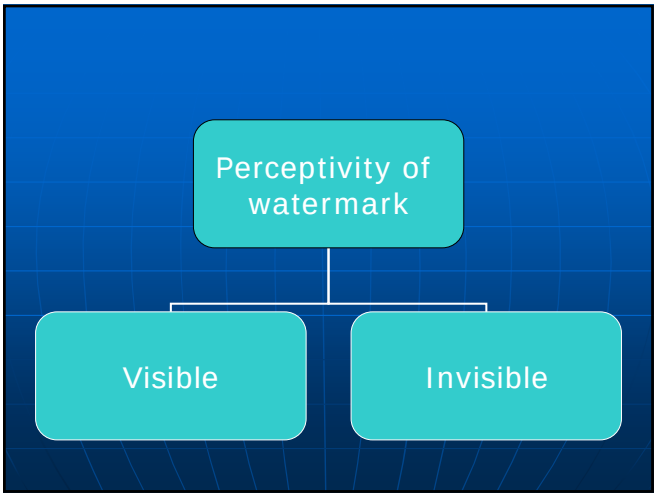
## Introduction

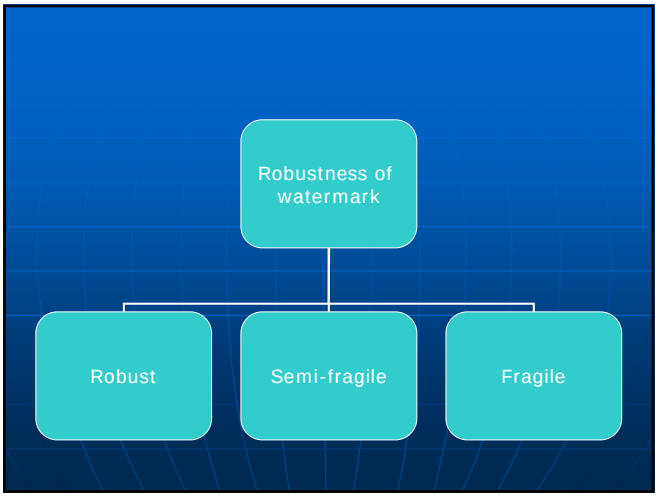
- Digital watermarking is to embed secret information, or the watermark into digital media.




## Watermarking Application Areas

- Copyright Protection
- Content Archiving
- Meta-data Insertion
- Broadcast Monitoring
- Tamper Detection
- Content Authentication
- Fingerprinting



# Basic Watermarking Principle

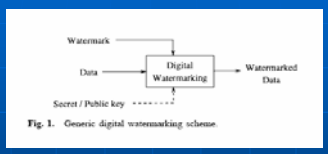


Fig. 1. Generic digital watermarking scheme.

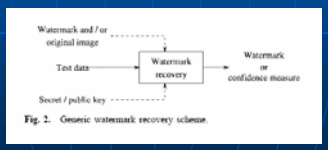
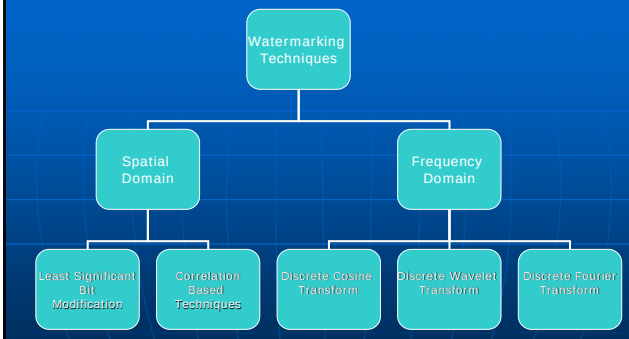


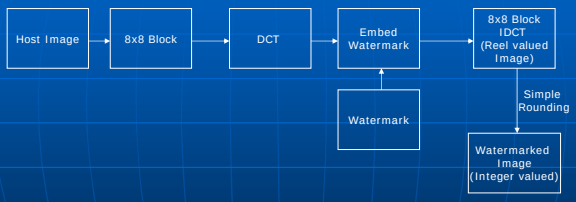
Fig. 2. Generic watermark recovery scheme.



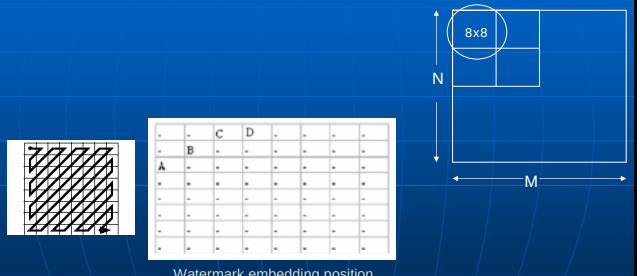

# Watermark Extracting Methods

| Required Data | Non-blind | Semi-blind | Blind |
|---|---|---|---|
| Host-Image ($I$) | O | X | X |
| Secret /public key ($K$) | (O) | O | O |
| Watermark ($W$) | O | O | X |

# Simple DCT based Watermarking Flowchart

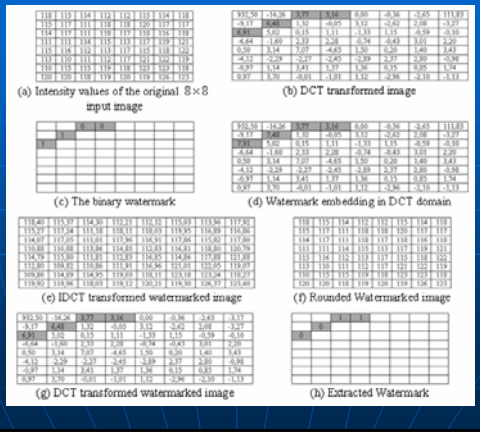



# Simple DCT based Watermarking Algorithm



Watermark embedding position

# An example of Simple Watermark Embedding and Extracting


(a) Intensity values of the original 8×8 input image

(b) DCT transformed image

(c) The binary watermark

(d) Watermark embedding in DCT domain

(e) IDCT transformed watermarked image

(f) Rounded Watermarked image

(g) DCT transformed watermarked image

(h) Extracted Watermark

## Block diagram of DE-based watermarking method


## The solution of DE

S1=[0 0 0 0 1 0 1 1 1 0 1 0 0 1 1 1 0 0 0 1 1 1 1 1 0 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 1 1 1 0 0 0 1 0 1 1 0 0 0 0 0 0]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

Translation Map

(1) If the signal is ‘‘1,’’ r* = Trunc(r) + 1,
(2) If the signal is ‘‘0,’’ r* = Trunc(r),

## An example of translation operation using DE, Extracting Watermark

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 118,40 | 115,37 | 114,30 | 112,21 | 112,12 | 115,03 | 113,96 | 117,92 |
| 115,27 | 117,24 | 111,18 | 118,11 | 118,03 | 119,95 | 116,89 | 116,86 |
| 114,07 | 117,05 | 111,01 | 117,96 | 116,91 | 117,86 | 115,82 | 117,80 |
| 110,88 | 110,88 | 113,86 | 114,85 | 112,83 | 116,81 | 118,80 | 120,79 |
| 114,79 | 115,80 | 111,81 | 112,83 | 116,85 | 114,86 | 117,88 | 121,88 |
| 112,80 | 109,82 | 110,86 | 111,93 | 116,96 | 121,01 | 122,05 | 119,07 |
| 109,86 | 114,89 | 114,95 | 119,03 | 118,11 | 123,18 | 123,24 | 118,27 |
| 119,92 | 119,96 | 118,03 | 119,12 | 120,21 | 119,30 | 126,37 | 123,40 |

IDCT transformed watermarked image

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 118 | 115 | 114 | 112 | 113 | 115 | 114 | 118 |
| 116 | 117 | 112 | 118 | 118 | 120 | 117 | 117 |
| 114 | 117 | 111 | 118 | 117 | 118 | 116 | 118 |
| 110 | 111 | 114 | 115 | 113 | 116 | 119 | 121 |
| 115 | 116 | 112 | 113 | 117 | 115 | 118 | 122 |
| 113 | 110 | 111 | 111 | 117 | 121 | 122 | 120 |
| 110 | 115 | 115 | 119 | 118 | 123 | 124 | 118 |
| 120 | 120 | 118 | 119 | 120 | 119 | 126 | 123 |

Watermarked image rounded by DE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | | | | |
| | 1 | | | | | | |
| 1 | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Extracted watermark

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 932,75 | -16,46 | 4,01 | 2,90 | 0,00 | -0,51 | -2,74 | -2,47 |
| -8,92 | 7,07 | 0,85 | -0,03 | 3,44 | -2,69 | 2,28 | -3,01 |
| 7,60 | 5,26 | -0,03 | 1,68 | -1,23 | 1,34 | -0,43 | 0,06 |
| -6,33 | -1,99 | 2,66 | 2,59 | -0,63 | -0,88 | 3,19 | 2,49 |
| 0,00 | 3,12 | 6,33 | -4,83 | 1,75 | -0,07 | 0,90 | 3,30 |
| -4,49 | -2,93 | -2,64 | -2,66 | -2,96 | 2,30 | 1,89 | -0,86 |
| -1,25 | 0,73 | 3,59 | 1,52 | 1,59 | -0,62 | 1,03 | 1,59 |
| 1,25 | 3,71 | -0,33 | -0,43 | 1,05 | -2,59 | -2,27 | -1,47 |

DCT transformed watermarked image

## Constraint and Fitness Functions used by DE

$$C = \sum_{i=1}^{t} \left| Watermark_i^{''} - Watermark_i^{'} \right| = 0$$

$$F(gen) = \sum_{i=1}^{64} \left| Watermarked\_image\_block_i - Original\_image\_block_i \right|$$

## Simulation Results

Host Image
256x256

Embedded Watermark
64x64

Watermarked Image
256x256

By simple rounding

By DE

$$PSNR = 10 \times \log_{10}\left(\frac{255^2}{\sum_{i=1}^{N}\sum_{j=1}^{N}\left[h(i,j) - h^{GA}(i,j)\right]^2}\right)$$

$$NC = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} W(i,j) \times W^{E}(i,j)}{\sum_{i=1}^{N}\sum_{j=1}^{N}\left[W(i,j)\right]^2},$$

| | By simple rounding | By novel DE |
|---|---|---|
| PSNR values of original and watermarked images | 63,4 | 57,51 |
| NC values of embedded and extracted watermark | 0,513 | 1 |

Thanks for your attention

- Questions? -