A DCT Domain Visible Watermarking Technique for Images

Saraju P. Mohanty
Dept. of Computer Sc. & Engg.
University of South Florida
Tampa, FL 33620, USA
smohanty@csee.usf.edu

K.R. Ramakrishnan
Dept. of Electrical Engg.
Indian Institute of Science
Bangalore 560 012, India
krr@ee.iisc.ernet.in

Mohan S Kankanhalli
School of Computing
National Univ. of Singapore
Kent Ridge, Singapore 119260
mohan@comp.nus.edu.sg

What is Digital Watermarking ?

Digital watermarking is defined as a process of embedding data (watermark) into a multimedia object to help to protect the owner's right to that object. The embedded data (watermark) may be either *visible* or *invisible*.

What is Visible Watermarking ?

In visible watermarking of images, a secondary image (the watermark) is embedded in a primary (host) image such that watermark is intentionally perceptible to a human observer.

Desired Characteristics of Visible Watermarks :

- A visible watermark should be obvious in both color and monochrome images.
- The watermark should be spread in a large or important area of the image.
- The watermark should be visible yet must not significantly obscure the image details.
- The watermark must be difficult to remove.

Visible Watermarking in DCT Domain

- Let $c_{ij}(n)$ are the DCT coefficients of the host image block and $w_{ij}(n)$ the DCT coefficients of the watermark image block.
- The DCT coefficients of the Watermarked image are then obtained as follows :

$$c'_{ij}(n) = \alpha_n \, c_{ij}(n) + \beta_n \, w_{ij}(n) \quad n = 1,2\ldots$$

- The α_n and β_n are scaling and embedding factors for block n respectively.

Previous Works

- In [4] the image is divided into different blocks and blocks are classified by perceptual methods to 6 different groups.
- 6 different values of $\mathfrak{Cn}_n$ and $\mathfrak{Ln}_n$ are used.
- No mathematical model is used.
- The algorithm does not work well when the image has very less number of objects.

Present algorithm

- This does not classify the blocks into different groups.
- Each block is assigned a different α_n and a different β_n basing on its texture. Thus the chances of image quality degradation is less.
- The algorithm can easily be automated.
- The algorithm is also works for images with less objects.

Factors considered to maintain Image Quality :

- The edge blocks should be least altered to avoid significant distortion of the image.
- The distortion visibility is low when the background has strong texture.
- The blocks with mid-intensity values ($\mu_n \approx \mu$) are more sensitive to noise than that of low intensity blocks ($\mu_n < \mu$) as well as high intensity blocks ($\mu_n > \mu$).

Finding Scaling and Embedding Factors :

- The α_n and β_n for edge blocks are taken to be α_{max} and β_{min} respectively.
- For non-edge blocks α_n and β_n are computed as:

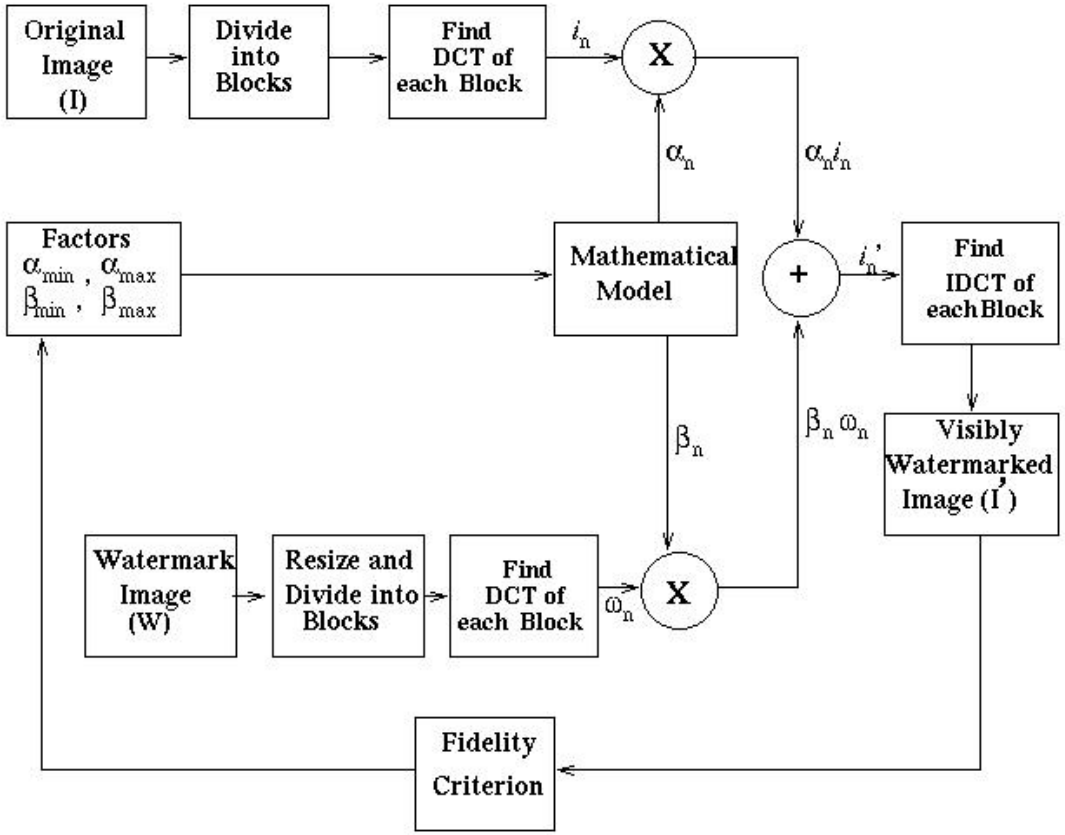
$$\alpha_n = \sigma'_n \exp.(- (\mu'_n - \mu')^2)$$

$$\beta_n = (1/\sigma'_n)(1 - \exp.(- (\mu'_n - \mu')^2))$$

where, μ'_n, μ' are the normalized values of μ_n and μ respectively, and σ'_n is normalized logarithm of σ_n (the variance of the AC DCT coefficients).

- α_n and β_n are then scaled to the ranges $(\alpha_{min}, \alpha_{max})$ and $(\beta_{min}, \beta_{max})$ respectively, where α_{min} and α_{max} are the minimum and maximum values of the scaling factor, and β_{min} and β_{max} are the minimum and maximum values of the embedding factor.

Insertion of Visible Watermark



Block Diagram showing Visible Watermark Insertion

Host and Watermark Images

Host Image

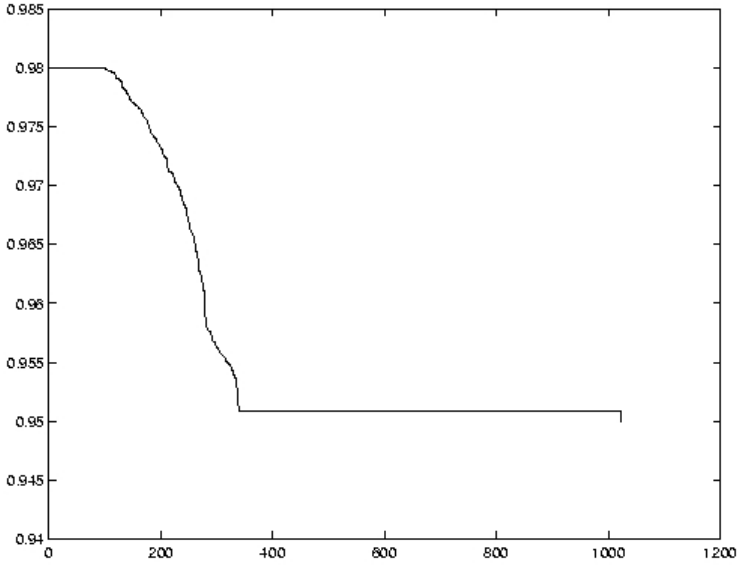
Watermark Image

Watermarked Images

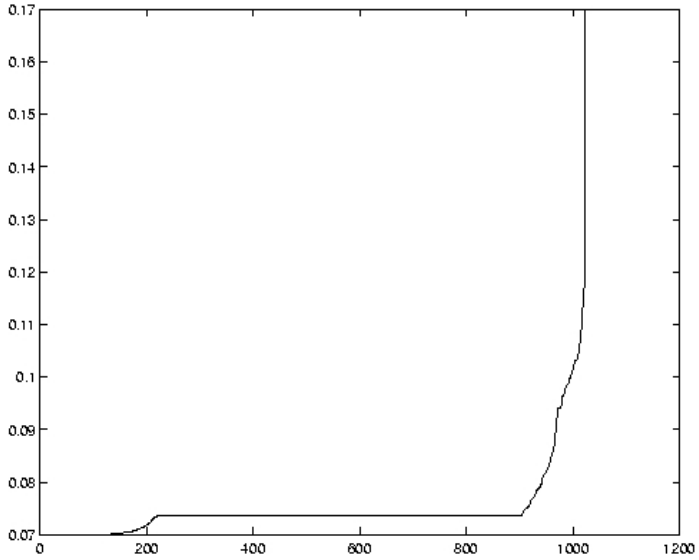
Watermark over the whole image

Small Watermark at a corner

Scaling and Embedding Factors for "Hardware" Image



Scaling Factors



Embedding Factors

Modifications to make Watermark Robust :

- After getting the β_n values we classify them two three different groups.
- If more than 1/3 of blocks have the same value then we generate Gaussian Random Number with mean same as image mean and varinace 1, and scale to the range 0 to $(\beta_{max}-\beta_{min})/2$.
- Then the numbers are added to (subtracted from) β_n of the largest group.
- The α_n values are not disturbed to preserve the quality of the image.

Watermarked “Hardware” Image

Hardware image

Watermarked ‘Hardware’ image

Conclusions and Future Work

- A visible watermarking technique has been proposed in DCT domain.
- A mathematical model is developed for this purpose exploiting the texture sensitivity of the HVS.
- A modification is proposed to increase the robustness of the watermark when used for images with very few objects.
- The typical values of α_{min}, α_{max}, β_{min} and β_{max} are 0.95, 0.98, 0.07 and 0.17 respectively.
- The visible watermark can be used in digital TV, digital library, e-commerce etc.