An Adaptive DCT Domain Visible Watermarking Technique for Protection of Publicly Available Images

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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 in order to prevent its deletion by clipping.
- The watermark should be visible yet must not significantly obscure the image details beneath it.
- The watermark must be difficult to remove; removing a watermark should be more costly and labor intensive than purchasing the image from the owner.

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.

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:

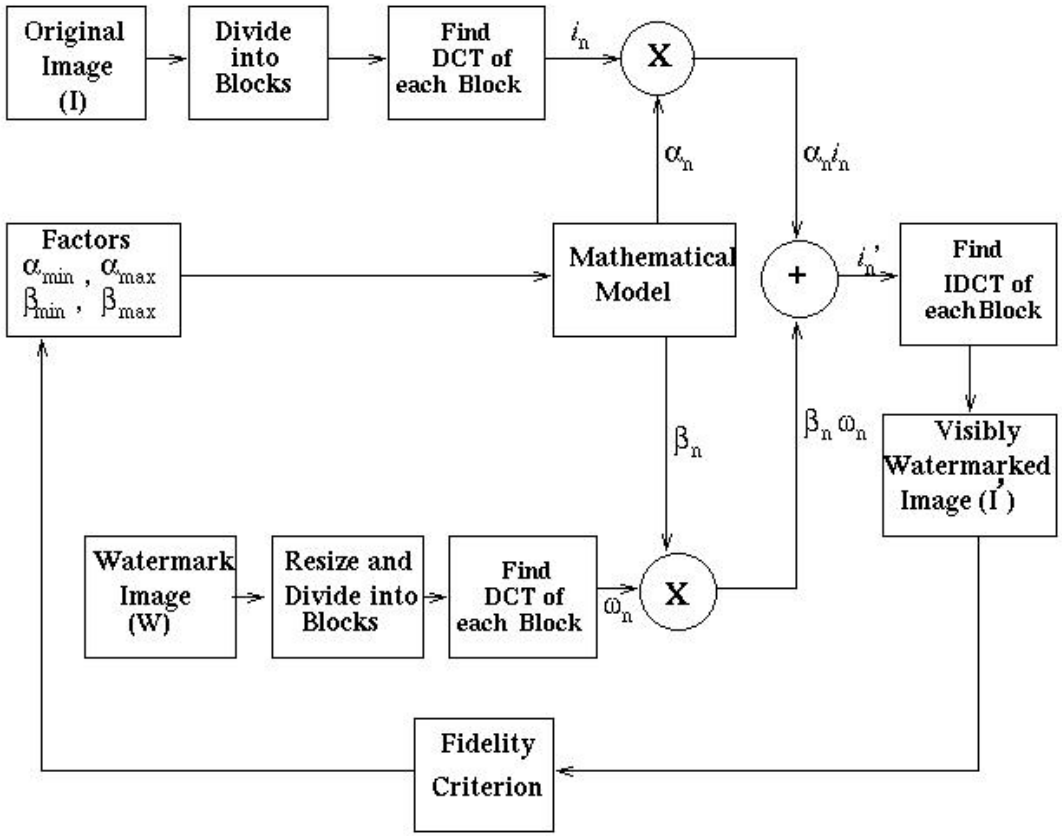
$$\alpha_n = \sigma'_n \exp.(- (\mu'_n - \mu')^2)$$

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

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 (α_{min} , α_{max}) and (β_{min} , β_{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

Conclusions

- 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.
- 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.