Digital Video Watermarking Using Discrete Cosine Transform And Perceptual Analaysis

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Abstract

Due to the extensive use of digital media applications, multimedia security and copyright protection has gained tremendous importance. Digital Watermarking is a technology used for the copyright protection of digital applications. In this paper, a comprehensive approach for watermarking digital video is introduced. We propose a hybrid digital video watermarking scheme based on Discrete Cosine Transform (DCT) The video frames are first decomposed using DCT and the binary watermark is embedded In this paper, we describe a visible watermarking scheme that is applied into the host video in the DCT domain. A mathematical model has been developed for that purpose. We have also proposed a modification of the algorithm to make the watermark more robust.

Introduction

The popularity of digital video based applications [1] is accompanied by the need for copyright protection to prevent illicit copying and distribution of digital video. Copyright protection inserts authentication data such as ownership information and logo in the digital media without affecting its perceptual quality. In case of any dispute, authentication data is extracted from the media and can be used as an authoritative proof to prove the ownership. As a method of copyright protection, digital video watermarking [2, 3] has recently emerged as a significant field of interest and a very active area of research. Watermarking is the process that embeds data called a watermark or digital signature into a multimedia object such that watermark can be detected or extracted later to make an assertion about the object. The object may be an image or audio or video. For the purpose of copyright protection digital watermarking techniques must meet the criteria of imperceptibility as well as robustness against all attacks [4-6] for removal of the watermark.

Many digital watermarking schemes have been proposed for still images and videos [7]. Most of them operate on Uncompressed videos, while others embeded watermarks directly into compressed videos. The work on video specific watermarking can be further found in [08-10].

Video watermarking introduces a number of issues not present in image watermarking. Due to inherent redundancy between video frames, video signals are highly susceptible to attacks such as frame averaging, frame dropping, frame swapping and statistical analysis. Video watermarking approaches can be classified into two main categories based on the method of hiding watermark bits in the host video. The two categories are: Spatial domain watermarking where embedding and detection of watermark are performed by directly manipulating the pixel intensity values of the video frame.Transform domain techniques, on the other hand, alter spatial pixel values of the host video according to a pre-determined transform and are more robust than spatial domain techniques since they disperse the watermark in the spatial domain of the video frame making it difficult to remove the watermark through malicious attacks like cropping, scaling, rotations and geometrical attacks. The commonly used transform domain techniques are Discrete Fourier Transform (DFT), the Discrete Cosine Transform (DCT), and the Discrete Wavelet Transform (DWT).

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. In visible watermarking of Video, a secondary image (the watermark) is embedded in a primary (host) video such that watermark is intentionally perceptible to a human observer whereas in the case of invisible watermarking the embedded data is not perceptible, but may be extracted/detected by a computer program.

Some of the desired characteristics of visible watermarks are listed below .

- A visible watermark should be obvious in both color and monochrome images.
- The watermark should spread in a large and 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, rather removing a watermark should be more costly and labor intensive than purchasing the image from the owner.
- The watermark should be applied automatically with little human interventionand labor.

There are very few visible watermarking techniques available in current literature.
The IBM Digital Library Organization has used a visible watermarking technique to mark digitized pages of manuscript form the Vatican archive. Rajmohan proposes a visible watermarking technique in DCT domain. He divides the image into different blocks, classifies these blocks by perceptual classification methods as proposed in [5] and modifies the DCT coefficients of host image as follows.

$$X'n = \alpha_n Xn + \beta_n Wn \qquad (1.1)$$

The α_n and β_n coefficients are different for different classes of blocks. Xn are the DCT coefficient of the host image blocks and Wn are the DCT co-efficients of the watermark image block. Here, we propose a visible watermarking scheme that modifies gray values of each pixel of the host image. The modification is based on the local as well as global statistics of the host image. The characteristics of the Human Visual System (HVS) are taken into consideration so that the perceptual quality of the frame is not very much affected.

1. Proposed Watermarking Technique

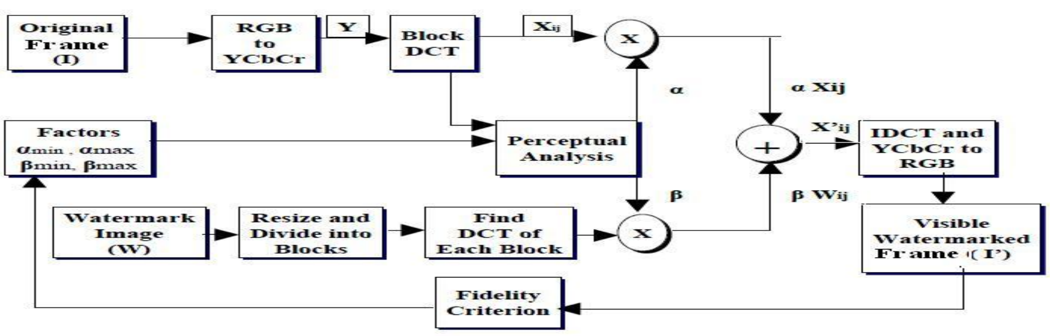

Figure 1.0 Schematic representation of visible watermarking

The steps for watermark insertion are discussed below.

- The original Frame I (one to be watermarked) and the watermark image W are dividedinto blocks (both the images may not be of equal size, but blocks should be of equal size).
- μ and σ , the global mean and variance of the image I are computed.
- For each block the local statistics mean μn and variance σn are computed.
- Let **i**n denote the nth block of original image I ,and **wn** denote the nth block of watermark image W. Denoting the nth block of watermarked image by **in',**

we have,

$$i_{n'} = \alpha_n . i_n + \beta_n W_n \qquad n = 1,2, \ldots\ldots \qquad (1.2)$$

where α_n and β_n are scaling and embedding factors respectively for each bloc Computed as described below.

Fig.1.0 gives the schematic representation of the insertion process.

The choice of α_n's and β_n's are governed by certain characteristics of Human Visual System (HVS) which for watermark images can be translated into following requirements .

- The edge blocks should be least altered to avoid significant distortion of the image. So one can add only small amount of watermark gray value in the edge block of host image.
- This means that scaling factor α_n should be close to α_{max} , (the maximum value of the scaling factor) and embedding factor β_n should be close to β_{min} (the minimum value of the embedding factor).
- It s also pointed out that blocks with uniform intensity (having low variance) are more sensitive to noise than the blocks with non-uniform intensity (having high variance). So one can add less to the blocks with low variance and add more to the blocks with high variance. We assume the scaling factor α_n is inversely proportional to variance whereas β_n directly proportional to variance.
- Yet another characteristic of HVS is that the blocks with mid-intensity are more sensitive to noise than that of low intensity blocks as well as high intensity blocks. This means that the α_n should increase with local mean gray value up to mid gray value and again decrease with local mean gray value. The variation of α_n with mean block gray value is assumed to be gaussian in nature. The variation β_n with mean gray value is reverse to that of α_n .

Basing on the above discussion we propose the following mathematical model.

$$\alpha_n = \begin{cases} \alpha_{max} , & \text{for edge blocks} \\ \alpha_{min} + (\sigma_{min} (\alpha_{max} - \alpha_{min})/\sigma_n) \exp(- ((\mu_n - \mu)/\sigma)^2 / 2), & \text{for other blocks} \end{cases}$$

$$\beta_n = \begin{cases} \beta_{min} , & \text{for edge blocks} \\ \beta_{min} + (\sigma_n (\beta_{max} - \beta_{min}) / \sigma_{max}) [1 - \exp(- ((\mu_n - \mu)/\sigma)^2 / 2)], & \text{for other blocks} \end{cases}$$

For other blocks
Where,
α_{min} and α_{max} are respectively minimum and maximum values of scaling factor,
β_{min} and β_{max} are respectively minimum and maximum values of embedding factor,
σ_{min} and σ_{max} are respectively minimum and maximum values of block variances,
μ_n and σ_n are respectively normalized mean and variance of each block, and
μ and σ are respectively normalized mean & variances of the frame.

2. Results

Figure 2.1 original frame

Figure 2.2 watermarked image

Figure 2..3 watermarked at different positions

A video clip of size 176X144 is used in our experiments and the watermarked logo can be the variable size. The experiments are done on a desktop computer with Pentium 4 CPU 2.00GHz and 1GB RAM.

The proposed algorithm is applied to a sample video sequence "sea.avi" using a variable watermark logo. Fig 2.1 represents the original video frame is embedded with watermark logo of Fig 2.2 and the resultant watermarked frame obtained at Fig 2.3 respectively. In the Fig 2.3 represents the watermarked logo is embedded at different positions of the frame.

3. Conclusions

A visible watermarking technique has been proposed here in DCT domain. A mathematical model is developed for this purpose exploiting the texture sensitivity of the HVS. The typical values of $\boldsymbol{\alpha}_{min}$, $\boldsymbol{\alpha}_{max}$, $\boldsymbol{\beta}_{min}$, and $\boldsymbol{\beta}_{max}$ are 0.95, 0.98, 0.05 and 0.17 respectively. . For more robustness watermark should not be publicly available, the watermark should be used in different sizes and should be put in different portions for different frames. The watermark may find application in digital TV, digital libraries and e-commerce.

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