ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An UGC Approved Journal)

Website: www.ijareeie.com

Vol. 6, Issue 9, September 2017

A Hybrid Method for Image Watermarking in YCbCr Color Space

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ABSTRACT: The exponential growth in digital data over internet have increased the requirement of a robust and high quality watermarking techniques. In general, the existing digital image watermarking techniques embed the binary or gray scale watermark into the host image although most multimedia images. In this paper, a hybrid method for image watermarking YCbCr Color Space for digital image is proposed. In this technique a gray image watermark is embedded into the mid frequency sub-band of a cover image by using variable visibility factor. The insertion and extraction of the watermark in the cover image is found to be simpler than other transform techniques. The experimental results demonstrate that the watermarks generated with the proposed algorithm are invisible and the quality of watermarked image and the recovered image are improved.Performance is evaluated in term of different fidelity parameter like as peak signal to noise ratio, normalize cross-correlation.

KEYWORDS: Digital Watermarking,YCbCr, Wavelet Transform, singular value decomposition (SVD), PSNR,NCC.

I.INTRODUCTION

With the rapid development of multimedia and the widespread distribution of digital data over the internet networks, it has become easy to obtain the intellectual properties. Consequently, the multimedia owners need more than ever before to protect their data and to prevent their unauthorized use. Digital watermarking has been proposed as an effective method for copyright protection and an unauthorized manipulation of the multimedia [1].The digital watermark is then introduced to solve this problem. Digital watermarking is a branch of information hiding which is used to hide proprietary information in digital media like photographs, digital music, or digital video [2-4]. The ease with which digital content can be exchanged over the Internet has created copyright Infringement issues. Copyrighted material can be easily exchanged over peer-to-peer networks, and this has caused major concerns to those content providers who produce these digital contents.

Generally, the image watermarking can be done in spatial domain or in transform domain [5]

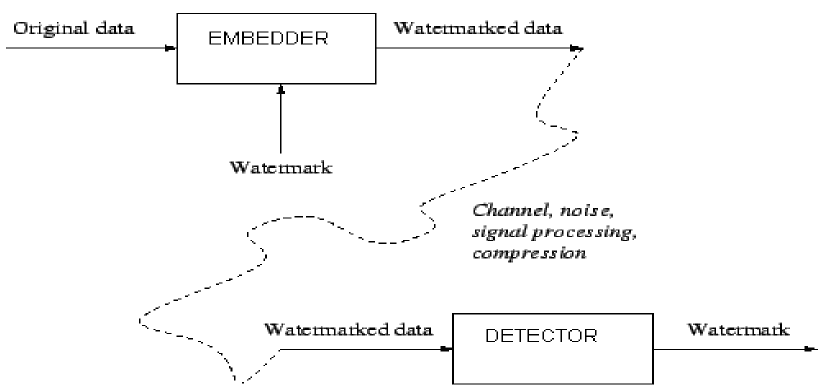

Figure 1. A generic diagram of digital watermarking

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Compared to spatial domain techniques frequency-domain watermarking techniques proved to be more effective with respect to achieving the imperceptibility and robustness requirements of digital watermarking algorithms [6-8].Commonly used frequency-domain transforms include the Discrete Wavelet Transform (DWT), the Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT).

II.METHODOLOGY

a. Overview of Discrete Wavelet transform (DWT)

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image.The transform of a signal is just another form of representing the signal. It does not change the information content present in the signal. It is useful for processing of non-stationary signals. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process. Wavelets are created by translations and dilations of a fixed function called mother wavelet. Wavelet can represent a signal in time-frequency domain. Analyzing a signal with this kinds, wavelet transform not only transforms the time domain representation of a signal to the frequency domain representation, but also preserves spatial information in the transform. This feature enhances the image quality especially for the low bit rate representation. This section analyses suitability of DWT for image watermarking and gives advantages of using DWT as against other transforms. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four no overlapping multi-resolution sub-bands LL1, LH1, HL1 and HH1. The sub-band LL1 represents the coarse-scale DWT coefficients while the sub-bands LH1, HL1 and HH1 represent the fine-scale of DWT coefficients. Due to its excellent spatial-frequency localization properties, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. In general most of the image energy is concentrated at the lower frequency sub-bands LLx and therefore embedding watermarks in these sub-bands may degrade the image significantly. Embedding in the low frequency sub-bands, however, could increase robustness significantly. On the other hand, the high frequency sub bands HHx include the edges and textures of the image and the human eye is not generally sensitive to changes in such sub-bands. This allows the watermark to be embedded without being perceived by the human eye.

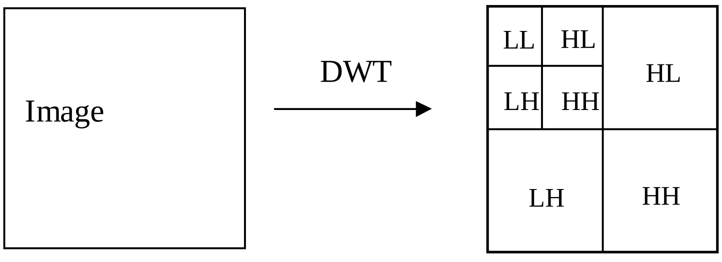

Fig.1 show DWT decomposition of image at level-2

Fig. 2(a) illustrates the DWT decomposition structure for Image, & filter bank representation for image analysis is done through first row wise decomposition and the column wise, its produce the four different band of image such as LL, HL, LH and HH known as approximation information, horizontal detail information, vertical detail information and diagonal detail information; and Fig. 2.2(b) represents the two-level DWT decomposition and sub-band of image in two dimensional structure. In wavelet analysis, maximum energy of function or image is centered at LL band means as approximation coefficient.

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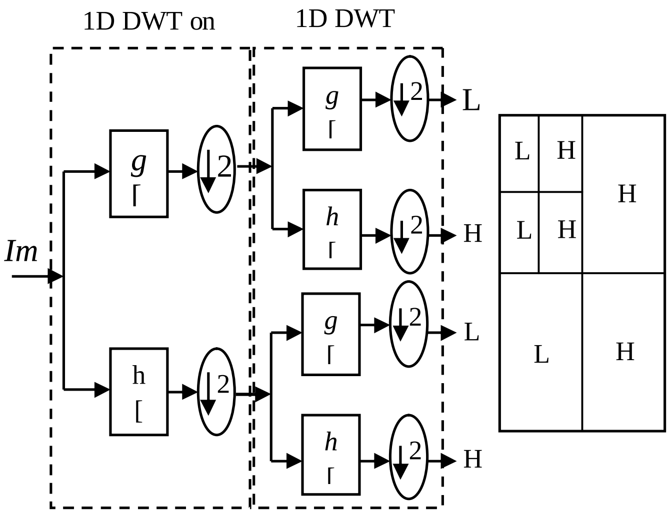

Fig2(a) Fig2(b)

As pointed out, wavelet-based watermarking methods exploit the frequency information and spatial information of the transformed data in multiple resolutions to gain robustness.
Wavelet transforms use wavelet filters to transform the image. There are many available filters, although the most commonly used filters for watermarking are:- Haar Wavelet Filter, Daubechies Orthogonal Filters, Daubechies Bi-Orthogonal Filters, Symlet wavelets. Each of the filters decomposes the image into several frequencies. Single level decomposition gives four frequency representations of the images

DWT has a few benefits over DCT which makes it a better choice of transformation than DCT. Wavelet transformed (WT) picture being multi resolution may be shown at extra one tiers of decision and can be sequentially processed from low decision to excessive decision. Further WT provides both frequency and spatial description for an image unlike DCT. DWT avoids blocking artefacts and has higher flexibility. In addition DWT transform is closely related to HVS and has high PSNR (measure of image quality) valve.

b. Overview of singular value decomposition (SVD)

The singular value decomposition of a matrix is a factorization of the matrix into a product of three matrices. Given an $m \times n$ matrix A, where m ≥ n, the SVD of A is defined as eq. (1)

$A = U\Sigma V^T$ (1)

Where, U is an $m \times n$ column-orthogonal matrix whose columns are referred to as left singular vectors; $\Sigma = \mathrm{diag}(\sigma_1, \sigma_2, \ldots, \sigma_n)$ is an $n \times n$ diagonal matrix whose diagonal elements are nonnegative singular values arranged in descending order; V is an $n \times n$ orthogonal matrix whose columns are referred to as right singular vectors.
If rank (A) = r, then Σ satisfies $\sigma_1 \geq \sigma_2 \geq \ldots \geq \sigma_r \geq \sigma_{r+1} = \sigma_{r+2} = \ldots \sigma_n = 0$.
Here, SVD efficiently represents intrinsic algebraic properties of an image, where singular values correspond to brightness of the image and singular vectors reflect geometry characteristics of the image. Since slight variations of singular values of an image may not affect the visual perception, watermark embedding through slight variations of singular values in the segmented image has been introduced as a choice for robust watermarking [12].

c. YCbCr color space

YCbCr represents color area as brightness and color change signals whilst RGB represents color as RGB add-ons. In YCbCr, Y is luminance, Cb is the difference of blue component and luminance (B−Y) and Cr is the difference of red component and luminance (R − Y) Cb or Cr are Preferred chrominance technique.

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Y = (zero.257 × R) + (0.504 × G) + (0.098 × B) + 16 Cb = (zero.439 × R) − (0.368 × G) − (0.071 × B) + 128 Cr = (zero.148 × R) − (0.291 × G) + (0.439 × B) + 128

III.PROPOSED WORK

Here, in this section we explain a hybrid image Watermarking Technique. The algorithm is divided into two parts, watermark embedding and watermark extraction.

A. Watermark Embedding

The watermark embedding process is described below as following:
Step.1: Read the cover image and watermark image.
Step.2: The Cover image and Watermark is converted intoYCbCr color space from RGB color space and Y channels is chosen for embedding.
Step.3: Perform 2-level-DWT on the Y channel on both the images.
Step.4: Compute new sigma matrix using scaling factor both sigma matrix obtained from SVD.
Step.5: Using new computed signal matrix Snew, New HL band is computed with inverse SVD.
Step.5: finally watermarked image is obtained by performing inverse DWT and SVD on sub band of cover image.

B. Watermark Extraction

Watermark extraction process is also very important process, it give the hidden information from watermarked image; which are embedded into cover image. The watermark embedding process is described below as following:
Step.1: Read watermarked image.
Step.2: The Watermarked image is converted into YCbCr color space from RGB color space and Y channels is chosen for extraction.
Step.3: perform 2-L DWT and decomposed the images into sub-bands respectively.

Step.4: Compute new sigma matrix using scaling factor work as key in watermark embedding process.

$$S_j = (S_m - S_i)/alpha$$

Step.5: Extract singular matrices with orthogonal matrices for final extracted watermark is calculated by formula:

$$W = U_m * S_j * V_m'$$

Step.5: Therefore, extracted watermark image obtained by performing inverse DWT on sub-bands

IV.RESULT ANALYSIS AND DISCUSSION

Evaluation Fidelity Parameteers

The visual performance of watermarked images is determined by using peak signal-to-noise ratio (PSNR) and Normalized Correlation which are historically adopted in image processing in order to evaluate the performance of the output results as shown in table I-II; these parameters use continues to be predominant in the performance evaluation of any image coding system.

$$MSE = \frac{1}{NM}\sum_{i=1}^{N}\sum_{j=1}^{M}(f(i,j)-g(i,j))$$

$$PSNR = 10\log_{10}\frac{L^2}{MSE}$$

From eq. L shows the values of pixel range. The quality of the image is measured using cross co-relation (CC) and is obtained by using eq.

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$$NCC = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M} g(i,j) * g'(i,j)}{\sqrt{\sum_{i=1}^{N}\sum_{j=1}^{M}(g(i,j))^2}\ \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{M}(g'(i,j))^2}}$$

Image Database

For analysis we use 512X512 image which is obtained from USC-SIPI image database as a standard evaluation database for watermarking algorithms. Here, results analysis of proposed technique illustrate the efficiency of proposed watermarking technique

Fig. 3(a). Lena & Mandrill (cover image)

Fig. 3(b). Cameraman & Dell logo (watermark image)

Fig. 3(a) shows the original image and Fig. 3(b) shows the watermark image for embedding of watermark in the original image.

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Table I shows the PSNR Value and NCC value for proposed image watermarking techniques using (Lena (as cover) & Cameraman (as watermark).

Scaling factor	Proposed method	
α	PSNR	NCC
0.01	52.07	0.9966
0.02	52.05	0.9987
0.025	52.00	0.9991
0.03	51.94	0.9999
0.05	*51.60*	*0.9998*
0.1	50.41	1.00
1	35.54	1.00
10	18.34	0.9999

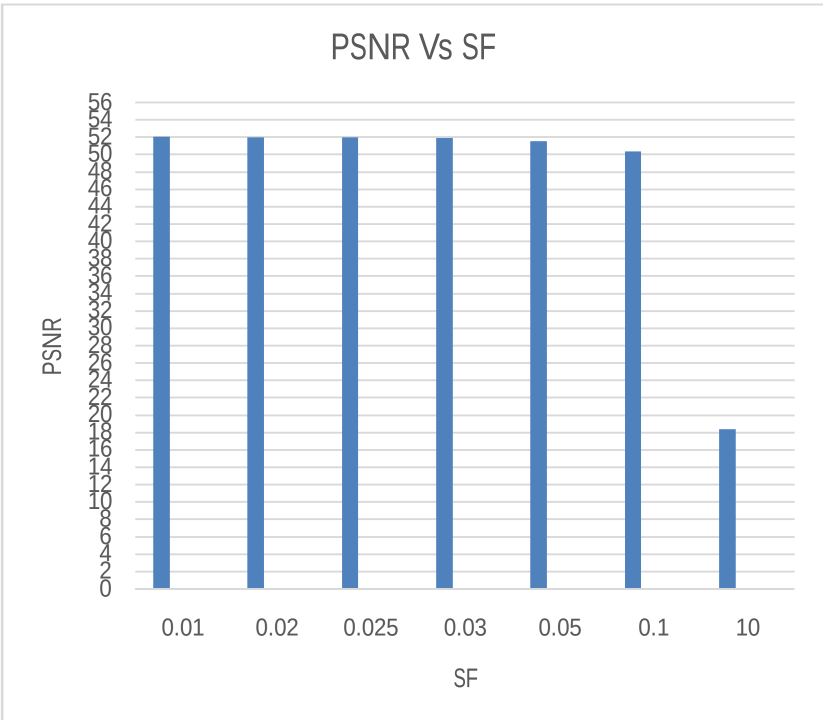

Fig.4 Bar chart for PSNR at different value of S.F

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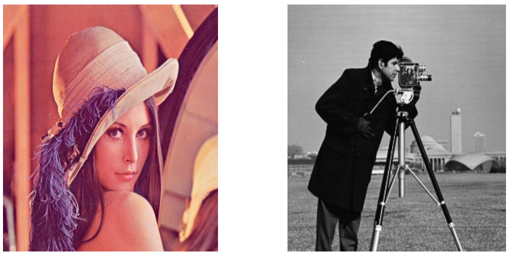
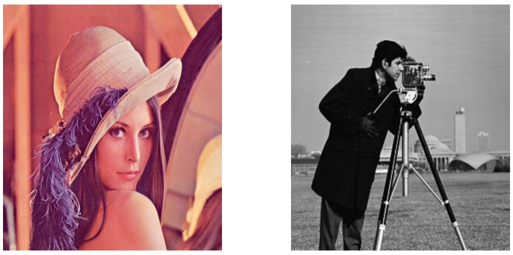
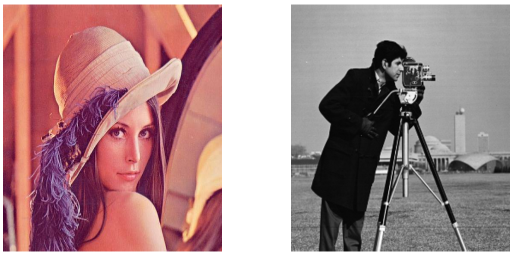
Fig: 4 show Bar chart of PSNR at different value of scaling factor for proposed method.



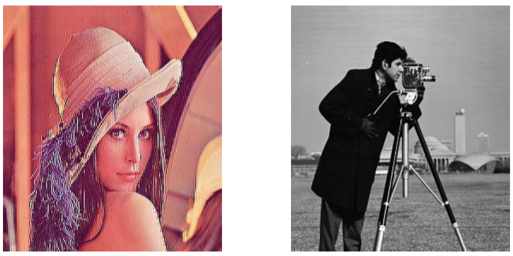
Watermarked image & recover water mark image at 0.01 using proposed method



Watermarked image & recover water mark image at 0.025 using proposed method



Watermarked image & recover water mark image at 0 .1 using proposed method



Watermarked image & recover water mark image at 10 using proposed method

As seen in simulated results, watermarking algorithm is efficient and generate good quality of watermarked image as well as recover highly correlated extracted watermark image.

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V.CONCLUSIONS

Digital watermarking based on transform domain is at the focus of current research because of their robustness and imperceptibility. In this paper, we proposed a hybrid method of image watermarking in YCbCr color space using 2 levels DWT approach. The proposed method shows colossal development in imperceptibility and the robustness. This algorithm could be extended to watermark the images using color images as the watermarks. The robustness and effectiveness of this watermarking technique tested both quantitatively and qualitatively.

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