Digital Watermarking of Images using Modified hybrid Approach in Dual Domain

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***Abstract*-With the expansion of the World Wide Web an increased amount of digital information becomes available to a large number of people. Information hiding has become very challenging with the advancement of technology. In Telemedicine the integrity of received images are very critical. The spatial domain watermarking is simple and less complex in nature. Regardless of the subsequent processing, it can be applied to any image. On the other hand, it is very sensitive to even simple attacks such as jitter attack, stir mark attack etc. These types of watermarking are sensitive even to rotation, transformation or print and scan, as the location of the watermark in this situation may be lost. The frequency domain watermarking is more secure and robust compared to spatial domain watermarking. Frequency domain watermarking is more complex and relatively difficult to implement. An image once watermarked in frequency domain, subsequent processing is not possible. The size of the watermark image to be embedded in the host image in frequency domain is less when compared to spatial domain. We have proposed a new modified hybrid approach using variance, which uses dual domains-spatial and frequency. By this approach, the proposed algorithm enables greater control over the cryptic part of the watermark. It is embedded in the host image and the embedded watermark size is greatly enhanced. In our approach, we have taken care of information hiding as well as the clarity of the image.**

Keywords: Watermarking, Spatial domain, Frequency domain, Variance

I. INTRODUCTION

The success of the Internet, cost effective and popular digital recording and storage devices and the promise of higher bandwidth and Quality Of Service (QOS) for both wired and wireless networks has made it possible to create, replicate, transmit and distribute digital content in an effortless way [1]. Various techniques have been developed to protect the numerical media content. These techniques are popular under the terms of Ciphering, Stegnography and Watermarking. Ciphering means to transform a message into a non-accessible one and to read the ciphered message we need a key using the corresponding program. Stegnography means dissimulating a message into another. The message is extracted using addresses of different parts of the supporting message. Watermarking means dissimulating a mark by using a key in public data and the mark needs to be undetectable and robust to techniques of information processing.

A. *Digital Watermarks*

Digital watermarking is the numerical combination of a hidden signature, or digital watermark, with an original image. The watermark, which exclusively identifies the owner of the picture, has to be perceptually invisible. In addition, the watermark must not be separated from the image, and flexible for possible changes brought by filtering, color manipulations, rescanning, cropping, compression etc. The watermark should also resist cryptographic attacks from colluding parties. Classical watermarking schemes include two main steps a) Embedding b) Detection of mark. Embedding is the process of inserting a mark in the initial image. The insertion may be done in any representation domain such as the DCT coefficients and wavelets coefficients [2]. The Human Visual System (HVS) can be exploited to improve the invisibility of the mark. There are two families of watermarking schemes. The substitutive schemes replace some attributes of the image by the mark. The detection step is performed on the marked image or on a transformation version. The detection step can be developed in two different ways: Using the original image or not using it. As for the embedding scheme, two categories of detection are developed. For the additive scheme the detection of the mark is

based on the correlation between the signature and the marked signal. For the substitutive scheme the detection of the mark is based on the examination of the extracted coefficients. Though, in general, the requirements to be fulfilled are application-dependent, some of them like security, invisibility, no of bits to be hidden, low error probability, robustness, and Watermark reversibility are common to most practical applications.

In this paper, literature survey is discussed in section II. Proposed system of modified hybrid algorithm for digital image watermarking in dual domain is explained in section III and the conclusion in section IV.

II. LITERATURE SURVEY

An image is made up of pixels, which have a value (gray value or RGB values) at each location in the 2-D space of it. By inserting the mark in these values the quality of the image is not degraded. This technique is spatial domain approach. In the spatial domain, we can simply insert watermark into a host image by changing the gray levels of some pixels in the host image. Adaptive watermarking techniques are a bit more difficult in the spatial domain compared to frequency domain.

Chan and Cheng et al proposed an algorithm for digital image watermarking by changing the LSB of the original image according to the message to be embedded. In this paper an optimal pixel adjustment process to the stego-image obtained by the simple LSB substitution method were discussed. The image quality of the stego image can be greatly improved with low extra computational complexity [3]. Unlike spatial domain, frequency domain approaches use the transforms of the original image to insert the mark. The transforms of the image such as DCT (Discrete Cosine Transform), DWT (Discrete Wavelet Transform), DFT (Discrete Fourier Transform), FFT (Fast Fourier Transform) etc are used to insert the mark. Zhang and Bao [4] proposed a wavelet based edge detection scheme by scale multiplication. The dyadic wavelet transforms at two adjacent scales are multiplied as a product function to magnify the edge structures and suppress the noise. Unlike many multi scale techniques that first form the edge maps at several scales and then synthesize them together, the authors determined the edges as the local maxima after an efficient thresholding. The dislocation of neighboring edges is improved when the width of detection filter is set large to smooth noise. Allan M.Bruce [5] proposed that most of the methods are based on the Discrete Cosine Transform (DCT) or the Fast Fourier Transform (FFT). Athanasios Nikolaidis and Ionnis pitas [6] proposed a new detector scheme applied in the case of additive watermarking in the DCT (Discrete cosine Transform) or DWT (Discrete wavelet Transform) domain. Thus, an optimal detector is constructed based on well known results of the detection theory. The embedding model is an additive watermark inserted in a transform domain. Amit Kumar et al suggested a technique to implement watermark in spatial domain [7]. Rakesh et al has conducted a study on various approaches of watermarking [8]. Every technique has its own advantages and disadvantages. In the spatial domain, watermark can be inserted into a host image by changing the gray levels of some pixels in the host image. In the frequency domain, watermark can be inserted into the coefficients of a transformed image, for example, using the Discrete Fourier Transform (DFT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT). But too much of data cannot be embedded in the frequency domain because the quality of the host image will be distorted significantly. That is, the size of watermark should be smaller than the host image. Generally, the size of watermark is 1/16 of the host image [9]. In order to provide more watermark data and to minimize the distortion of the watermarked image, a novel technique using the combinational spatial and frequency domains is proposed by Frank et al. The hybrid algorithms relates only to the insertion of watermark partially in the frequency domain and the rest in the spatial domain. A.Memon et al had worked on hybrid watermarking approach for medical images [10]. The Combinational approaches are very simple but not robust as the cryptic part need not be in the central part of the image. We are proposing a new modified approach for watermarking where in the security of cryptic data is given more significance.

III. MODIFIED HYBRID ALGORITHM FOR DIGITAL IMAGE WATERMARKING IN DUAL DOMAIN

A. *Proposed Algorithm*

Let H be the host image and W be the image to be watermarked using this algorithm. W_m is one of the N x N blocks of the watermark image W. V_m is the variance vector which has variances of each N x N block. P_x and P_y are the vectors having the coordinate values of the selected blocks. W_{bin} is the binary

watermark constructed from the watermark image W. $W_{bin\ spa}$ is the part of the binary watermark to be inserted in the spatial domain; $W_{bin\ fre}$ is the part to be inserted in the frequency domain of the host image. H_s is the host image after inserting a part of the watermark in the spatial domain and H_F is the host image after inserting the watermark in both the domains. The steps of the algorithm are as follows.

The watermark of size M x M is divided into blocks of Size N x N.

$W = \{w(i, j), 0 \leq i, j < M\}$,

$W_m = \{w_m(i,j), 0 \leq i, j < N\}$, where $w_m(i,j) \in \{0,1,2,\ldots..,2L - 1\}$ and m is the total number of N x N blocks.

1. For each of the N x N block the variance (σ) is calculated and stored in V_m.
   $V_m = \{v_m(i, j), 0 \leq i, j < N\}$, $v_m(i,j) = var(W_m)$
2. The variances calculated are arranged in descending order. x blocks having the highest variances are selected and the top left corner pixel value of each selected block is stored in P_x and P_y.
   $P_x = \{p_x(i), 0 \leq i<x\}$, and $P_y = \{p_y(i), 0 \leq i<x\}$ where $p_x(i)$ and $p_y(i)$ are the x and f the i^{th} highest variance block respectively and x is the number of blocks selected to be inserted in the frequency domain of the host image.
3. The watermark image is then transformed into a binary watermark image W_{bin} by changing the pixel values into binary form.
4. The binary watermark image obtained is divided into two parts according to the selections made. The selected blocks are separated into W_{bin_fre} and the remaining part into W_{bin_spa}.
5. The pixel coordinates of the selected blocks P_x and P_y are converted into binary values and inserted in $W_{bin\_spa.}$
6. W_{bin_spa} is inserted in the spatial domain of H.
   $H_s = \{h_s(i,j) = h(i,j)\ \Theta\ w_{bin\_spa}(i,j), 0 \leq i,j < S\}$, where $h(i,j), h_s(i,j) \in \{0,1,2,\ldots..,2L - 1\}$ and L is the number of bits used as in the grey level of pixels.
7. W_{bin_fre} is inserted into the coefficients of H_{DCT} to obtain H_F.
   as $H_F = \{h_F(i,j) = h_{DCT}(i,j)\ \Theta\ w_{fre}(i,j), 0 \leq i,j < S\}$, where $h_F(i,j)$ is one of the DCT coefficients of the N x N block taken.
8. Inverse DCT transforms the embedded host image. The steps of the algorithm are justified as follows.

The watermark image W of size M x M is divided into blocks of size N x N. N may be any value less than M. N may generally be taken to be 8. The variance (σ) is calculated for each of the N x N block and is stored in the variable called V_m. The variances of all the blocks are evaluated. These are finally sorted in descending order. Hence higher the variance higher is the preference. The first grey level values of each of these blocks are stored in P_x and P_y. The selected blocks having higher variance are considered in $W_{bin\ fre}$ and the rest in $W_{bin\ spa}$. The binary converted pixel coordinates of the selected blocks are inserted in $W_{bin\ spa}$. W_{bin_spa} is embedded in spatial domain of H. H_F is obtained by inserting W_{bin_fre} into the coefficients of H_{DCT}. The embedded host image is transformed by using inverse DCT. The experimental result of modified hybrid algorithm is discussed in subsection B and C. The performance of the hybrid algorithm and modified hybrid algorithm are compared using Peak Signal to Noise Ratio (PSNR).The following section uncovers the experimental results of the modified hybrid algorithm for various host and watermark images.

B. *Experimental Results*

The experiments were carried out with 50 combinations of images. The results of the experiment of inserting a part of the cameraman image into Lena image, one part in spatial domain and the other part in complementary part of frequency domain are shown in Figure 1 as follows.

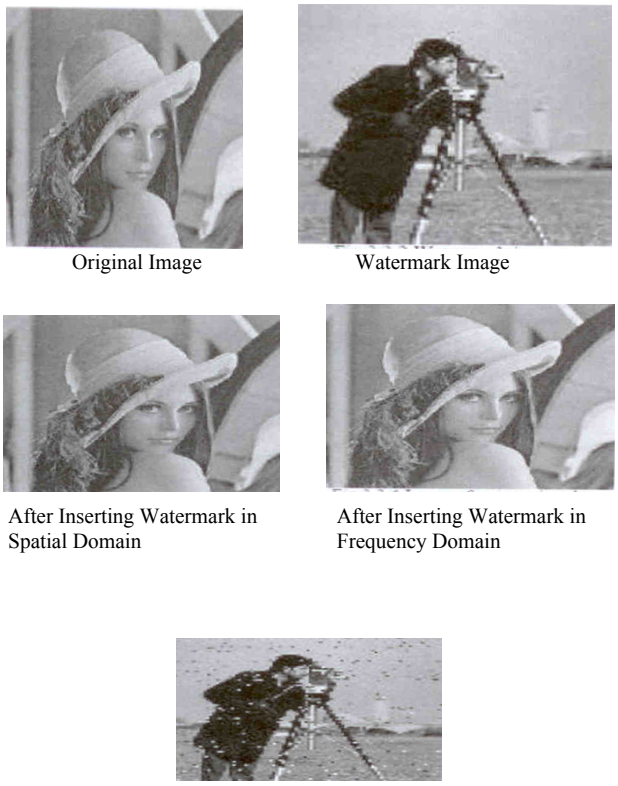

Figure 1 . Experimental Results of Lena and cameraman

C. *Comparisons*

The results of using the modified hybrid algorithm are compared to that obtained by using the hybrid algorithm. The parameters used are the Peak Signal to Noise Ratio (PSNR) and Normalized Correlation (NC). They are again defined for convenience as follows.

$$NC = \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} H(i,j)Hf(i,j)}{\sum_{i=1}^{N}\sum_{j=1}^{N} H(i,j)H(i,j)} \quad (1)$$

$$PSNR = 10\log 10 \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} H^*(i,j)^2}{\sum_{i=1}^{N}\sum_{j=1}^{N}[H(i,j) - H^*(i,j)]^2} \quad (2)$$

Where the symbol H denotes the host image, Hf denotes the watermark inserted host image and H* denotes the appropriate watermark inserted host image. The experiment used three pairs of images, Lena and cameraman, ships and baboon, house and trees. Sample results of Hybrid and Modified Hybrid approach for these three combinations are presented in the Table I. The first figure is an image of size 256 x 256 and the second one is the watermark to be inserted of size 90 x 90. This analysis uses N = 8.

TABLE I. PSNR AND NC FACTORS OBTAINED FOR DIFFERENT IMAGES USING DIFFERENT ALGORITHMS.

	Hybrid Algorithm			Modified Hybrid Algorithm		
	Lena And Cameraman	Ships And Baboon	House And Trees	Lena And Cameraman	Ships And baboon	House And Trees
PSNR in first step	45.3493	45.8274	47.3493	45.3782	45.8275	47.3530
PSNR in second step	45.2153	45.7073	47.2099	45.2541	45.7223	47.2153
NC	0.9991	0.9998	0.9991	0.9997	1.0000	0.9992

The results show that the modified hybrid algorithm is superior to hybrid algorithm as the PSNR and the NC values of the modified Hybrid algorithm are greater than that of hybrid algorithm in almost all cases. This clearly proves that the modified hybrid algorithm is more robust, secure and has clear improvement in the quality of the host image when compared to the hybrid algorithm. Peak Signal to Noise Ratio (PSNR) metric is widely used to measure the amount of difference between two images based on pixel differences. High value of PSNR shows the watermarked image has a better quality, the difference between the original image and the watermarked image are imperceptible.

Generally, the higher the absolute value of the coefficient, the stronger the linear relation between the two samples. Based on this fact, the absolute value of the normalized correlation coefficient is commonly employed for computing the matching score between the input and output.

IV. CONCLUSIONS

Earlier approaches do not ensure any security to the cryptic data. Hybrid algorithm assumes that the cryptic data is distributed randomly in the watermark. The hybrid algorithm primarily emphasizes on the combinational approach. It ignores the criterion by which the watermark is to be bifurcated among either of the domains. An innovative algorithm is proposed which overcomes the above drawback. Our modified hybrid algorithm analyses the complete watermark and selects the blocks, which have higher variances. Higher the variance, higher is the priority of the block to be assigned to the frequency domain. When the frequency domain is full to its capacity, the rest of the blocks are led to the spatial domain. This can be extended for medical images as well for Telemedicine. Our experimental results exemplify that modified hybrid algorithm is relatively more robust, secure and reliable.

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