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Evaluation of Digital Image Watermarking Techniques

Gyan Singh Ahirwar
Assistant Professor Department of IT,
Rajkiya Engineering College Banda, *India*
E-mail- gyan98@gmail.com
Ankur Tandon
PG Scoler,
Department of CSE & IT,
KIT, Kanpur, *India*
E-mail- ankur.tandon26@gmail.com

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Abstract

In the recent few years, it has become a daily need to distribute digital images as a part of widespread multimedia technology by means of the World Wide Web. Digital Image Watermarking techniques have been developed to protect digital images from illegal modifications and illegal reproductions. So these techniques has developed widely to maintain the broadcasting media and content authentication, broadcast monitoring, tamper detection, copyright protection, and many other applications. Due to the emergence of the online applications user data along the network is not very secure. Also in surveillance applications data security is essential. In this paper, a two folded security is considered; where first using Least Significant Bits (LSB) stenography data decryption keys send in advance to the receiver. Later actual information is send using digital watermarking as an encrypted image. This twofold security makes the information more secure. In the watermarked technique Discrete Cosine Transform (DCT) is considered. The performance measure is done in terms of Peak Signal to Noise Ratio (PSNR) and Structural Similarity (SSIM).

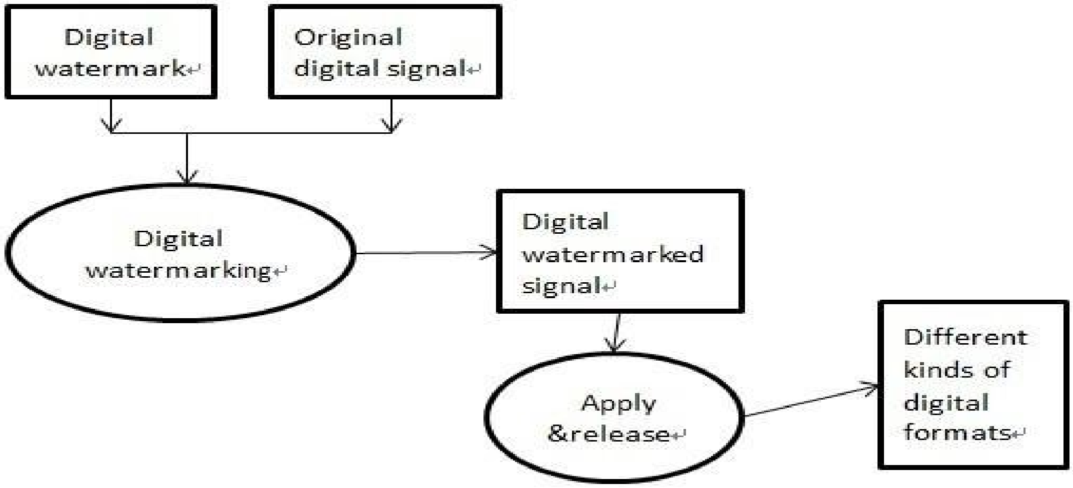
Keywords**—** LSB, PSNR, watermarking, SSIM

I. INTRODUCTION

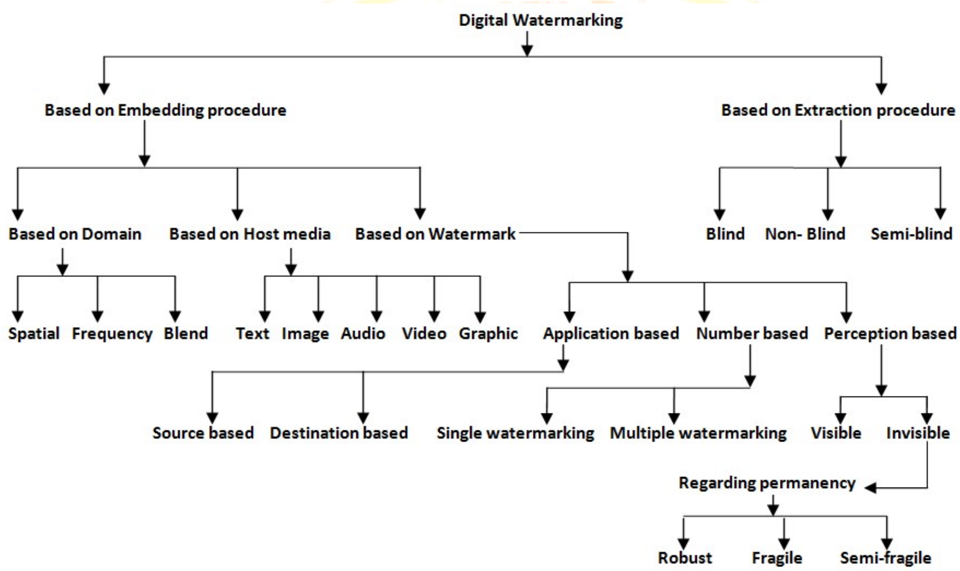
The digital watermarking is latest and most popular technique for copyright protection. Digital watermarking hides the copyright information into the digital data through certain algorithm. To trace illegal copies, a unique watermark is required based on the location or identity of the recipient in the multimedia network. The sort of information hidden in the item when using watermarking is usually a signature to signify origin or ownership for the purpose of copyright protection. The application of watermarking is copyright control, in which an image owner seeks to avoid illegal copying of the image. Robust watermarks are well matched for copyright protection, because they reside intact with the image under various manipulations. A watermarking system is divided into three distinct steps, embedding, attack and detection. In embedding an algorithm accepts the host and the data to be embedded, and produces a watermarked signal. The output of the watermarking scheme is the watermarked image. A VLSI architecture is also used that can put in noticeable watermarks in images.

2.WATERMARKING TECHNIQUES

Numerous watermarking techniques are available. But, the following techniques are frequently used in image watermarking. 2.1 Discrete Cosine Transform Discrete Cosine Transformation (DCT) transforms a signal from the spatial into the frequency domain by using the cosine waveform. DCT divide the information energy in the bands with low frequency and DCT popularity in data compression techniques such as JPEG and MPEG. The DCT allows an image to be broken up into different frequency bands, making it much easier to insert watermarking information into the middle frequency bands of the image. DCT represents data in terms of frequency space. DCT based watermarking techniques are robust as compared to spatial domain techniques. DCT domain watermarking can be classified into Global DCT watermarking and Block based DCT watermarking.



BASIC MODEL OF DIGITAL IMAGE WATERMARKING



Classification of digital watermarking.

II. PRELIMINARY CONCEPTS

2.1 Image composition & Transformation coefficient importance in watermarking: Mostly the realistic image is a composition of sharp variant & smooth variant where sharp variant (fine detail such as texture, edges etc) lies in between the smooth variant (image base such as flat regions, slow varying regions, color etc). Technically, low frequency components (LL) are represented by smooth variations & high frequency components (HH) are indicated by sharp variations. Any image processing operation is performed after the separation of these components. Sin ce, the low frequency components of image at the edges do not describe the signal fairly, so some energy from low frequency part leaks into high frequency parts which give rise to middle frequency components (HL, LH).The low frequency components constitute with most important image information and any alterations (adding of watermark) will degrades the quality of host image but imparts robustness. The high frequency components consists of least important image information (such as edges, texture), imperceptibility will be achieved if this region is used for watermarking but watermark will be eliminated when the image is exposed to image processing operations (say compression). The best portion for watermarking is Mid frequency components (horizontal, vertical details) because it offers tradeoff between imperceptibility & robustness. According to characteristics of HVS model, the vertical components are more sensitive to human eyes than horizontal components. Hence the watermark will be more imperceptible when embedded in the horizontal detail of middle frequency component.

2.2 Discrete Cosine Transform (DCT): Transformation using DCT tends to minimize the information by removing the redundant data of the media. DCT is a widely used scheme for image transformation which imparts various advantages such as good information packing ability and low calculation complexity, high resistive to image processing attacks, compression attack etc. It also provides suitable tradeoff between HVS model and the image deformation degree. Global DCT watermarking and Block-based DCT watermarking are the two variants of DCT watermarking. DCT computation is performed on the entire image or on the non-overlapping blocks to obtains lowest frequency (FL), middle frequency (FM) and highest frequency (FH) components. According to, for a image of size N*N DCT is defined in equation 1, 2, 3 & 4.

$$F_{(u,v)} = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} C_u C_v f_{(i,j)} \cos\left[\frac{\pi(2i+1)u}{2N}\right]\left[\frac{\pi(2j+1)v}{2N}\right] \quad \ldots\ldots 1. \qquad C_u = \sqrt{\frac{1}{N}} \ for\ u,v = 0 \ldots\ldots 3.$$

$$f_{(i,j)} = \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} C_u C_v F_{(u,v)} \cos\left[\frac{\pi(2i+1)u}{2N}\right]\left[\frac{\pi(2j+1)v}{2N}\right] \quad \ldots\ldots 2. \qquad C_v = \sqrt{\frac{2}{N}} \ for\ u,v = 1,2,\ldots\ldots 4.$$

Where: F(u, v) represents 2D-DCT, f(i, j) represents 2DIDCT& N is number of pixels in u rows & vcolumns i.e. N =4,8,16 etc.

2.3 Discrete *Wavelet Transform (DWT):* Using this transform the coefficients to be watermarked can easily be identified because it is analogous to the HVS model & understands it more precisely. DWT based watermarking offers following advantages such as a large watermark embedding capacity, good robustness against noise, good energy compaction properties which leads to effective data compression. Wavelet transform implementation can be accomplished using various digital filters such as Haar, Symlets, Daubeschies etc .The basic idea behind wavelet transform for processing the image is its multi-resolution decomposition which decomposes the image into sub images of different frequencies (such as low frequency& high frequency) with different resolutions . As DWT analyze the signal in both spatial &frequency domain , this spatial frequency (time-frequency) representation locate the low frequency components in frequency domain & the high frequency components in spatial/time domain precisely. The first decomposition level is resulted after the horizontal & then vertical filter in (or vice versa)of image which decomposes the image into four sub bands i.e. one approximation (low frequency or coarse wavelet) coefficient and three detailed (high frequency or finest wavelet) coefficient i.e. LL (approximation) and high frequency coefficient is labeled with HL (Horizontal Detail), LH (Vertical Detail), HH (Diagonal Detail).

The multi-resolution capability of the transform offers scalability i.e. to obtain the next decomposition step to obtain LL sub band is further decomposed in to four sub bands and the process continues until the desired DWT decomposition level is reached. More decomposition level means lesser frequency sub band resolution with higher important coefficients while the other detailed bands can be classified of lesser importance. Generally for watermarking or compression application decomposition are done not more than up to four

Levels because watermark embedding capacity will decrease on the other hand more decomposition leads to ringing artifacts around the edges. According to, For image f (x,y) of size M*N the DWT is given in equation 5 & equation

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$$W_{\Phi}(j_0, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) \Phi_{j0,m,n}(x,y) \ldots\ldots\ldots\ldots 5.$$

$$W_{\varphi}^{i}(j, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) \varphi_{j,m,n}^{i}(x,y) \ldots\ldots\ldots\ldots 6.$$

where Wϕ(j0,m,n) is low frequency component &Wφi(j,m,n) is defined as horizontal, vertical ,diagonal details of f(x,y), i={Horizontal, vertical, diagonal}, j0 is arbitrary scaling factor where j>=j0.

PROPOSED METHODOLOGY:-

Step 1. Read the cover image.

Step 2. Interlace the image, proceed with 2-level interlacing

because its decomposition will result into square matrix and this will be required during DCT based embedding step. Step 3. On the selected sub-image apply 1-level DWT and select its HL component for watermarking. All three components say RGB of the above selected sub-image will be used during processing.

Step 4. Read the watermark text, convert it into binary sequence.

Step 5. On the above selected sub image, apply 8*8 DCT and select its mid frequency coefficient for embedding of

Watermark.

Step 6. Apply inverse DCT followed by inverse DWT in Order to obtain the watermarked image. The watermarked Image obtained in this step is the interlaced image which is processed for watermarking.

Step 7. Apply DWT followed by DCT on the watermarked image in order to the image and extract the watermark.

Watermark embedding & extraction operation.

Embedding: Iw(x,y) = I(x,y) + k * w

where k = {-k for w=1, +k for w=0}

Extraction: if (Iw(x,y) >=0)

w = 0; else

w=1;

Where: Iw(x,y) = watermarked image coefficient. I(x,y) = original image coefficient.

k = random number. w = watermarked bit.

RESULT:-

For simulation of the proposed algorithm MATLAB (R2013a) software is used. Using standard image database various test images have been taken. In our experiment the cover image is the color image of size 512*512 and Watermark is the text (maximum of 32 characters).

The performance of the proposed algorithm is evaluated using measure such as MSE, PSNR in order to find the degradation of the original image Vs embedded image &original image Vs attacked image. Also BER is used to determine the error received in bits of the extracted watermark. The above performance index is formulated as:

1) The Mean Square error (MSE) is defined as average squared difference between the original cover image and Watermarked image. If MSE increases watermarked image quality gets decrease. Ideally, for good algorithm should Reaches to zero. For NxN image it is calculated by the formula given below: Here X (i,j) is original pixel value and X'(i,j) is decoded pixel value.

2) The Peak Signal to Noise Ratio (PSNR) measures the degradation in the watermarked image with respect to the cover image. It is widely used metrics to measure imperceptibility. In ideal case when PSNR reaches to

Infinity, watermarked image thus produced is of the higher quality. Higher PSNR indicates less difference between the two corresponding images. It is calculated by the formula given below:

3) The Bit Error Ratio (BER) is the ratio which determines the number of received bits in error with respect to the total received bits when transmitted over noisy channel. Here H is height & W is width of watermarked image. P is a counter set to 0 & is incremented by 1, if there exist bit difference between cover image & watermarked image

VI. CONCLUSION & FUTURE SCOPE

In this paper we proposed the hybrid "Interlacing-DWTDCT" watermarking scheme with the aim of keeping the Cover image in reduced sized format which will be required during ownership authentication. The results of the proposed watermarking technique do not seem to be robust against attacks and results in higher manipulation of the Watermark text after extraction. So in near future we will tryto enhance the performance of the proposed hybrid Algorithm using different strategy for embedding &extraction of watermark in order to impart better robustness

To the scheme.