A Watermarking Algorithm based on Chirp Z-Transform, Discrete Wavelet Transform, and Singular Value Decomposition a Review

Gurlaganbir Kaur[1] Anu Sheetal[2] Tarun Arora[3]
[1]M.Tech. Student [2,3]Assistant Professor
[1,2,3]Department of Electronics and Communication Engineering
[1,2,3]Guru Nanak Dev University, Regional Campus Gurdaspur, India

Abstract— Watermarking scheme based on the discrete wavelet transform (DWT) in conjunction with the chirp z-transform (CZT) and the singular value decomposition (SVD). Firstly, the image is decomposed into its frequency sub bands by using 1-level DWT. Then, the high-frequency sub band is transformed into z-domain by using CZT. Afterward by SVD, the watermark is included with the singular matrix of the transformed image. Finally, the watermarked image is obtained by using inverse of CZT and inverse of DWT. This algorithm combines the advantages of most three algorithms.

Key words: Chirp Z-Transform, Discrete Cosine Transform (DCT) Wavelet Transforms (WT) And Singular Value Decomposition (SVD)

I. Introduction

In this we make a short overview of most popular watermarking methods. But we mainly focus on the functional aspects of the methods.

[Zebbiche et al., 2014] has discussed a robust wavelet-based fingerprint image watermarking scheme using an efficient just perceptual weighting (JPW) model. In this, JPW model three human visual system characteristics has been defined, namely: spatial frequency sensitivity, local brightness masking and texture masking, to compute a weight for each wavelet coefficient, which is then used to control the amplitude of the inserted watermark [Saini et al., 2014] has introduced a hybrid watermark embedding and extracting technique. SVD and DWT methods are used for watermark embedding because DWT method is more flexible and provides a wide range of functionalities for still image processing. Further a significant image attacks are carried out on the watermarked image and the watermark is extracted by the help of proposed watermark extraction algorithm based on Back Propagation Neural Network (BPNN).[Sharma and Jain, 2014] has discussed that Watermarking is the technique to solve the issue of copyright degradation, but this has to be resolved by keeping a steady check on the imperceptibility and robustness which incur to be its main objectives. In order to accomplish these objectives the usage of a hybrid transform is adopted in this paper, the idea behind using a hybrid transform is that the cover image is modified in its singular values rather than on the DWT sub band.[Varghese et al., 2014] has analyzed an image adaptive Singular Value Decomposition based Watermarking scheme. The algorithm repurposed by author incorporates standard deviation method to identify high / low frequency blocks of the carrier image to decide where the blocks of the watermark image are to be embedded so that perception quality is not affected.. [Zhao and Xu, 2013] has presented a new semi-blind watermarking scheme based on discrete wavelet transform (DWT) and subsuming. Finally, the encrypted watermark is embedded into the singular values by watermark middle matrix. During the watermark extraction, the algorithm relies on the reference sub graph, achieving a semi-blind extraction. Experimental results demonstrate that the proposed scheme not only improve the Peak Signal-to-Noise Ratio(PSNR) value significantly, but also raise the robustness to JPEG compression, Gaussian noise and geometric attack etc.

The advancing world of digital multimedia communication is faces problems linked to security and authenticity of digital data. The data security term is described as protecting information or digital data against any attack that may be performed by utilizing different attacking technologies, methods and techniques. A watermark system is reported to be secure, if the hacker cannot take away the watermark without full knowledge of embedding algorithm, detector and composition of watermark. A watermark should only be accessible by authorized parties.

Digital Communication has increasing now. In the context of multimedia communication, digital images and videos have numerous applications in entertainment world like TV channel broadcasting. The rapid evolution of digital technology makes the development of reliable and robust schemes for protecting digital images, audio, text and video from piracy. On communication channel watermarked may be corrupted by noise. An effective encoding and decoding techniques should remove random noise occur over a communication channel. By Error Correcting codes help to eliminate noise in communication. So, watermarking systems are systems in which the hidden message is related to the host signal. A watermark is just a recognizable image or pattern in paper that appears as various shades of lightness. Adding an obvious watermark is just a common means of identifying images and protecting them from unauthorized use online.

A watermarking system is divided in to three distinct steps, embedding, attack and detection. In embedding an algorithm accepts the host and the information to be embedded, and produces a watermarked signal. The output of the watermarking scheme may be the watermarked image. A VLSI architecture is also used that may insert visible watermarks in images. A visible watermark typically consists of a conspicuously visible message or a company logo indicating the ownership of the image.

On the other hand, an invisibly watermarked image appears very similar to the original. The existence of an invisible watermark can only be determined using an appropriate watermark extraction or detection algorithm. In this research we restrict our attention to invisible watermarks. An invisible watermarking technique, in general, consists of an encoding process and a decoding process.

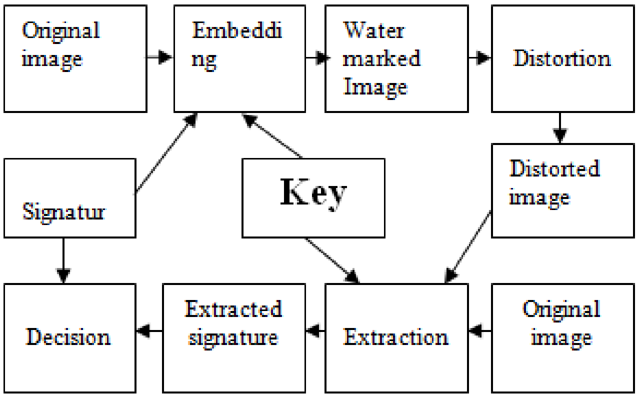

Fig. 1.1: Typical Watermarking block diagram

II. IMAGE WATERMARKING ARCHITECTURE

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 major 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 digital watermark can be *visible* or *invisible*. A visible watermark typically consists of a conspicuously visible message or a company logo indicating the ownership of the image. On the other hand, an invisibly watermarked image appears very similar to the original. The existence of an invisible watermark can only be determined using an appropriate watermark extraction or detection algorithm. In this report we restrict our attention to invisible watermarks.

A watermarking system is divided into three distinct steps, embedding, attack and detection [5]. In embedding an algorithm accepts the host and the data to be embedded, and produces a watermarked signal.The watermark insertion step is represented as:

$$X0 = EK(X; W)$$

where X is the original image, W is the watermark information being embedded, K is the user's insertion key, and E represents the watermark insertion function and the watermarked variant is represented as $X0$.

Depending on the way the watermark is inserted, and depending on the nature of the watermarking algorithm, the detection or extraction method can take on very distinct approaches. Watermark extraction works as follows:

$$W = DK0\ (\hat{}X\ 0)$$

where $\hat{}X\ 0$ is a possibly corrupted watermarked image, $K0$ is the extraction key, D represents the watermark extraction/detection function, and $\hat{}W$ is the extracted watermark information.

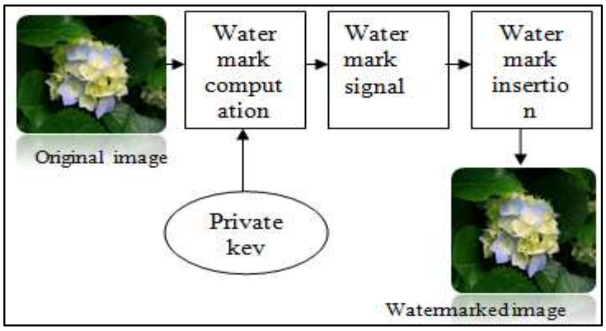

Fig. 2.1Watermark Embedding Process

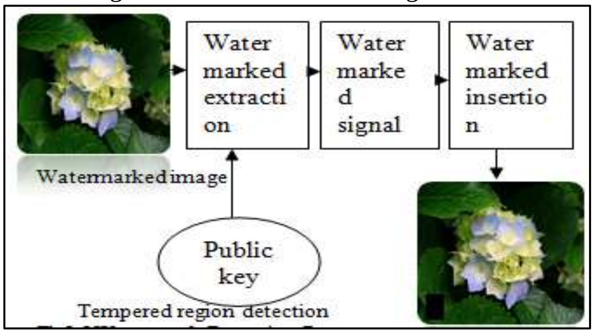

Fig 2.2: Watermark Detection Process

III. WATERMARKING TECHNIQUES

Many watermarking techniques are available. But, these techniques are mostly utilized in image watermarking. Watermarking techniques could be broadly classified into two categories in accordance with operation domain: Spatial and Transform domain methods. Early image watermarking schemes operated directly in spatial domain. The spatial domain methods modify the original image's pixel values directly. But poor robustness against various attacks which was mostly connected with poor robustness properties. On the other hand, in the transform domain such as for example, discrete cosine transform (DCT) wavelet transforms (WT) and singular value decomposition (SVD) provide more advantages and better performances is likely to be obtained in equate to those of spatial ones in nearly all of recent researches. Basically, a set of basic requirements is evaluated for a watermarking scheme to be effective. These requirements could be categorized as follows:

1) imperceptibility
2) robustness
3) capacity.

The next transform domain techniques are mostly utilized in image watermarking:

A. *Discrete Cosine Transform*

Discrete Cosine Transformation (DCT) transforms a sign from the spatial to the frequency domain by using the cosine waveform. DCT divide the info energy in the bands with low frequency and DCT popularity in data compression techniques such as for example JPEG and MPEG. The DCT allows a picture to be separated into different frequency bands, which makes it easier to embed watermarking information into the center frequency bands of the image. FL is use to denote the best frequency aspects of the block, while FH is used to denote the larger frequency components. FM is chosen while the embedding region as to supply additional resistance to lossy compression techniques [3]. DCT represents data with regards to frequency space. DCT based watermarking techniques are robust in comparison to spatial domain techniques. DCT domain watermarking could be classified into Global DCT watermarking and Block based DCT watermarking. The Discrete Cosine transform has been widely useful for source coding in context of JPEG and MPEG and was later also considered for the usage of embedding an email inside images and video.

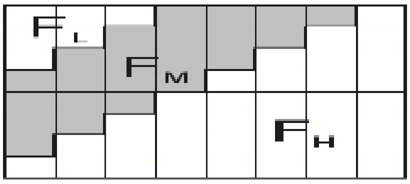

Fig. 3.1 Discrete Cosine Transform regions

Two-dimensional discrete cosine transformation and its inverse transform are defined as [13]:

$$C(u,v)=\alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos[\frac{\pi(2x+1)u}{2N}]\cos[\frac{\pi(2y+1)v}{2N}]$$

$$f(x,y)=\sum_{u=0}^{N-1}\sum_{v=0}^{N-1} \alpha(u)\alpha(v)c(u,v)\cos[\frac{\pi(2x+1)u}{2N}]\cos[\frac{\pi(2y+1)v}{2N}]$$

where, u,v = 0,1,2……… N-1

x,y = 0,1,2………N-1

α(u) is defined as follows:

$\alpha(u) = \sqrt{1/N}$ u=0;

$\alpha(u) = \sqrt{2/N}$ u=1,2……N-1

The major advantages of DCT include its high energy compaction properties and availability of fast algorithms for the computation of transform. The power compaction property of the DCT results in transform coefficients with only few coefficients having values, thus which makes it perfect for watermarking. Embedding rules in DCT domain are more robust to JPEG/MPEG.

B. *Discrete Wavelet Transform*

DWT happens to be utilized in a wide variety of signal processing applications, such as for example in audio and video compression and removal of noise in audio. Wavelets have their energy concentrated over time and are perfect for the analysis of transient time varying signal. To understand the fundamental notion of the DWT we focus on a single dimensional signal. A signal splits into two parts, usually high frequencies and low frequencies. This technique is continuing until the signal has been entirely decomposed [3]. DWT is preferred, because it gives both a simultaneous spatial localization and a frequency spread of the watermark within the host image. The hierarchical property of the DWT offers the likelihood of analyzing a signal at different resolutions and orientations. To understand the fundamental notion of the DWT we focus on a single dimensional signal. A signal splits into two parts, usually high frequencies and low frequencies. This technique is continuing until the signal has been entirely decomposed. The Figure shows basics of DWT approach for image processing

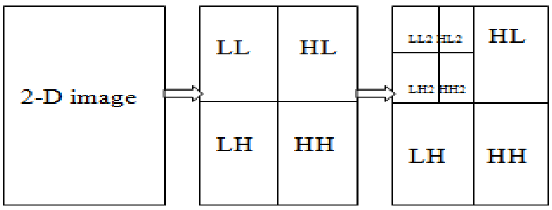

Fig 3.2: Wavelet Based Transform

The wavelet transform is given by equation 1.In the wavelet Domain where Wi denotes the coefficient of the transformed image. Xi denotes the bit of the watermark to be embedded. Here α is just a scaling factor. And (u, v) represents basic transformed functions [2].

I Wu,v = Wi + α|Wi| Xi where u, v € HL,LH (1)

C. *Singular Value Decomposition*

SVD is just a linear algebra technique used to resolve many mathematical problems. It is a strong watermarking scheme for audio signals. SVD has been employed for different image applications. Such as for instance compression, hash extraction and image watermarking. In image watermarking applications, the singular values of the host image are adapted to be able to embed the watermark. SVD has the capacity to efficiently represent the algebraic properties of an image. SVD techniques can be put on any type of images. If it's a dull scale image the matrix values are believed as intensity values and it could be modified directly or changes could be achieved after transforming images into frequency domain [5] [11] [12].

Let A be described as a general real (complex) matrix of order m×n. The singular value decomposition is these factorization [14]

A = U×S× (2)

Where, U and V are orthogonal (unitary) and S =diag (σ1, σ2, ..., σr), where σi, i = 1,…, r are the singular values of the matrix A with r = min (m, n) and satisfying:

≥ ≥ …… ≥ (3)

Use of SVD in digital image processing has some advantages which are listed as follows:

1) How big the matrices from SVD transformation should definitely not square and can be a rectangle.
2) Singular values in a digital image are less affected if general image processing is performed. This means that for a small perturbation added to an image, its SVs do not change fast.
3) Singular values contain intrinsic algebraic image properties, where singular values correspond to the brightness of the image and singular vectors reflect geometry characteristics of the image.

SVD can effectively reveal essential property of image matrices, so it has been used in a number of image processing applications such as for example noise estimation and digital watermarking.

IV. CONCLUSION AND FUTURE SCOPE

The various limitation found in the existing work:-Existing technique provide poor results in case of attacks.

The modification in CZT and SVD is neglected by many researchers to improve the robustness further. The use of standard CZT and SVD is easily crack-able by the hacker or cracker. This research work evaluates the performance of digital watermarking technique which will evaluate DCT, DWT, CZT and SVD. The CZT and SVD can be modified by Arnold transform. Proposed algorithm will combine the advantages of the well-known watermarking techniques DCT, DWT and modified CZT and SVD. Principal one level DWT will be applied to the input cover image. To accomplish inaudibility LL wave band will be selected for additional wave level decomposition and HH wave band will also be used. HH wave band will be divided into 484 blocks. DCT will be applied to every sub blocks and principal DC coefficient of every sub block will be selected and will be converted into a matrix. Modified- CZT and SVD will be then applied to the evaluated matrix and values will be adapted with the values of the image going to be watermarked.

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