An Image Watermarking Using hybridization of DWT, CZT and modified SVD

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***Abstract*— This paper has presented an evaluation of some well-known Digital image watermarking techniques. The Digital Watermarking includes three distinct steps; embedding, attack and detection to be explained later. The main objective of this study is to explore various algorithms of digital watermarking. The shortcomings of earlier work on digital images have also been evaluated. The main focus of this paper is to enhance watermarking technique using chirp z-transformation and artificial neural network.**

***Index Terms*—Watermarking; Digital Watermarking; DCT; SVD; DWT; Chirp Z Transformation.**

I. INTRODUCTION

Digital watermarking technique has been used for the protection of digital images from unlawful copying and manipulation. Digital watermarking can be defined as the process of embedding data into a multimedia element such as image, audio or video[12].

The digital watermarking is most widely used technique for copyright protection. Digital watermarking hides the copyright information in to the digital data through certain algorithm. The kind of information hidden in the thing when utilizing watermarking is generally a signature to signify origin or ownership for the goal of copyright protection.

The application form of watermarking is copyright control, by which an image owner seeks to avoid illegal copying of the image. Robust watermarks are perfect for copyright protection, because they stay intact with the image under various manipulations.

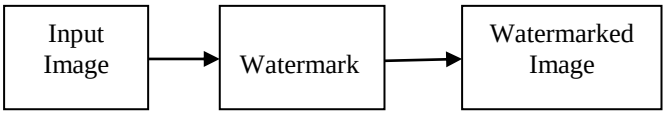

Fig. 1 Process of Digital Watermarking

II. WATERMARKING SYSTEM AND VARIOUS TECHNIQUES

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.

Watermarking algorithms can be classified on several criteria as, according to domain of watermark insertion like Watermarks can be embedded in the pixel/spatial domain or a transform domain. Second is according to visibility of watermark (visible and invisible) and according to watermark detection and extraction which contain blind and non blind techniques[4].

Watermarking techniques could be broadly classified into two categories in accordance with operation domain: Spatial and Transform domain methods. 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. Basically, a set of basic requirements is evaluated for a watermarking scheme to be effective. These requirements could be categorized as imperceptibility, robustness, capacity.

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.

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].

If we look at a signal with a large "window", we would notice gross features. Similarly, if we look at a signal with a small "window", we would notice small features. The result in wavelet analysis is to see both the forest and the trees. Wavelet transform uses wavelets as basis and is a tool that cuts up data or functions or operation into different frequency components, and then studies each component with a resolution matched to its scale. The original image is decomposed by the lowpass (LP) and highpass (HP) filters followed by downs amp ling first of rows and then of columns. The result of wavelet decomposition is approximation of original image and three detail signals (horizontal, vertical and diagonal)[6].

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

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. In SVD, every real (or complex) matrix A can be decomposed into two orthogonal matrices *U* and *V* and a diagonal matrix $S=diag(\sigma 1, \sigma 2, \ldots, \sigma r, 0, \ldots 0)$. The entries in this diagonal matrix are called the singular values of *A*. This decomposition is called Singular Value Decomposition of *A* and can be expressed as

$$A = USV^{T} \quad (1)$$

where *r* is the rank of *A* and hence *r=min(m,n)*. The first *r* columns of *V* are the right singular vectors and the first *r* columns of *U* are the left singular vectors[7].

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

- How big the matrices from SVD transformation should definitely not square and can be a rectangle.
- 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.
- Singular values contain intrinsic algebraic image properties, where singular values correspond to the brightness of the mage 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.

D. Chirp Z Transformation

CZT is an algorithm for evaluating the z-transform of a signal. Z-domain transfer functions can be factored into polynomials with poles and zeros as its roots, where poles model the peak energy concentration of the frequency spectrum and zeros model the troughs of the frequency spectrum. The CZT helps in approximating the transfer function of a system by giving a more accurate picture of zeros and poles of that system (representing the transfer function as ratios of polynomials in z), resulting to a sharper function at an effectively reduced bandwidth. Effective reduced bandwidths and a sharpen transfer function are possible due to the following reasons[13].

The sharpness of the resonance peak can be enhanced by computing the z-transform along a contour that lies closer to the pole(s). CZT has the ability of evaluating the z-transform at points both inside and outside the unit circle. Also, the bandwidths that are related to the energy loss (the lower the bandwidths the less the energy loss) can be determined by the radius of the poles. So, by evaluating the transform off the unit circle, the contour can be adjusted to pass closer to the poles of the system being study, leading to its transfer function being sharpened and its bandwidths effectively reduced. Chirp-z also has the advantage of detecting the fundamental frequency, as it can zoom the analyzed frequency spectrum with a very high resolution. It's usage in watermarking will help to achieve a highly imperceptible and a robust watermarked image, since the spectrum is sharpened and the frequency resolution is appreciably improved [13].

Chirp-z Transformation algorithm is based on the fact the values of z transform on a circular or spiral can be expressed as a discrete convolution. Chirp-z can simultaneously implement the FFT and the discrete *sinc* interpolation to get values at grid points that are not exactly on the original space grid.

The three main application of chirp z-transform are as follows:

- Enhancement of poles
- High resolution, narrow-band frequency analysis
- Time interpolation or sample rate changing

The major advantages of using the CZT are that the sharpness of the resonance peak can be enhanced by computing the z-transform along a contour that lies closer to the pole(s).

Since CZT has the ability of evaluating the z-transform at points both inside and outside the unit circle, by evaluating the transform off the unit circle, the contour can be adjusted to pass closer to the poles of the signal making the spectrum to sharpen. Chirp-z can also help to zoom the analyzed frequency spectrum with a very high resolution leading to its frequency resolution being greatly improved [13]. Its usage in watermarking will help to achieve a highly imperceptible and a robust watermarked image, since the spectrum is sharpened and the frequency resolution is appreciably improved.

III. RELATED WORK

An advantage of the spatial techniques is that they can be applied easily to any image. A disadvantage of spatial techniques is they do not allow for the subsequent processing in order to increase the robustness of watermark. Watermarking algorithm by using transform domain techniques embedding information into the frequency domain .The most popular transforms where the frequency domain watermarking algorithms work are Discrete Fourier Transform (FT), Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT). DFT decompose an image into sine and cosine form. DFT gives output in complex value and it requires more frequency rate. DFT is not used now days due to above disadvantages[3]. Discrete Cosine Transform (DCT) transforms real data into real spectrum and therefore avoids the problem of redundancy[2]. The two-dimensional DCT is usually used in digital image processing. Image scrambling refers to transformation of the image, which rearranges the spatial position of the pixels according to some rules, and makes image distortion for the purpose of security. If the transformation rules and keys were not given, we cannot reconstruct the original image. Common ways of scrambling include Arnold transform[2].Digital image watermarking is really a technology that has been developed to secure digital content from illegal use. The implementation and performance analysis of two different watermarking schemes predicated on DCT-DWT-SVD. These techniques have now been used to test the effectiveness for imperceptibility and robustness where peak signal noise ratio and normalized cross-correlation parameters are used[4]. SVD is a powerful numerical analysis tool for matrices which give minimum least truncation error. The main properties of SVD from the viewpoint of image processing applications includes the singular values of an image have very good stability, i.e., when a small perturbation is added to an image, its singular values do not change significantly[7].The watermark is just a RGB colour image where each pixel is represented by 24 bits. Then, the RGB colour watermark is preprocessed by converting it into binary sequence. The preprocessed colour watermark is embedded multi-times to the green channel of the RGB host image by modifying the low frequency coefficients of the DCT transformation. This new technique can resist classical attacks such as JPEG compression, low pass filtering, median filtering, cropping, and scaling attacks[9]. Spread spectrum modulation based method which includes greater robustness. As watermarking applications, demand development of low priced watermark algorithms in order to implement in real-time environment. With this, a block based multiple bit spatial domain spread spectrum image watermarking scheme has been represented the place where a gray scale watermark image is shown by less number of binary digits using novel channel coding and spatial biphase modulation principle. This algorithm may also be sent applications for authentication along with secured communication in real-time environment[11].

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[3]. Chirp-Z-Transformation is an algorithm for evaluating the z-transform of a signal. Z-domain transfer functions can be factored into polynomials with poles and zeros as its roots, where poles model the peak energy concentration of the frequency spectrum and zeros model the troughs of the frequency spectrum. The Chirp Z-Transformation helps in approximating the transfer function of a system by giving a more accurate picture of zeros and poles of that system (representing the transfer function as ratios of polynomials in z), resulting to a sharper function at an effectively reduced bandwidth. Effective reduced bandwidths and a sharpen transfer function are possible due to the following reasons[13]. The sharpness of the resonance peak can be enhanced by computing the z-transform along a contour that lies closer to the pole(s). CZT has the ability of evaluating the z-transform at points both inside and outside the unit circle. Also, the bandwidths that are related to the energy loss (the lower the bandwidths the less the energy loss) can be determined by the radius of the poles. So, by evaluating the transform off the unit circle, the contour can be adjusted to pass closer to the poles of the system being study, leading to its transfer function being sharpened and its bandwidths effectively reduced[13].

IV. GAPS IN STUDY

The survey has shown that the watermarking techniques have certain shortcomings and limitations as follows.

- The effect of the multiple attacks on a given Watermarked image has been neglected by the most of the existing researchers.
- Most of the researchers has used Standard SVD, the use of improved or modification SVD has been ignored in the most of existing research.
- The use of the other watermark scrambling has also been ignored in the majority of the existing research.

V. CONCLUSION AND FUTURE WORK

A new watermarking technique based on the DWT in combination with the CZT and modified SVD will be proposed. This algorithm combines the advantages of these three transforms, therefore have more robust results. The algorithm can help satisfy the robustness and imperceptibility characteristics of a good watermarking algorithm by greatly improving the visual quality of the watermarked image and being robust against common signal processing operations and attacks. Also the watermark scrambling by using the

Arnold transform will also be used to protect watermark further. Arnold transform will change the watermark in such a way that it become meaningless for the hackers or crackers. Various kind of multiple attacks will be considered to evaluate the effectiveness of the proposed technique.

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