A Survey on DWT and LWT based Digital Image Watermarking

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ABSTRACT

A watermark is a pattern of bits inserted into a digital image, audio, video or text file that uniquely identifies the owner of the particular image. The main steps in the watermarking technique are embedding and extraction. A watermark is embedded into the host image and we obtain the watermarked image. Later for proving the ownership, this watermark is extracted from the watermarked image and thereby the host image and watermark is obtained. This survey is based on the Discrete Wavelet Transform (DWT) and Lifting Wavelet Transform (LWT) techniques which are used for implementing digital image watermarking.

Keywords: *DWT, Embedding, Extraction, LWT, Watermark.*

I. INTRODUCTION

The increasing digital image piracies are a threat in this IT world nowadays. Even we are forced to prove the ownership of our own images, videos or audios. The person who received our image/audio/video may claim the ownership of that image. So for getting rid of these type of attacks, unauthorized uses and to enhance the security of our images, digital image watermarking technique is adopted. This technique involves watermark embedding as well as extraction.

Watermarking techniques may be visible or invisible in nature. In visible watermarking, the watermark that we have embedded into the image is visible in nature whereas in later case, the watermark is not at all perceptible in nature. Also watermarking techniques can be blind, semi-blind or non-blind in nature [1]. This classification is based on the requirements for watermark detection or extraction . The blind schemes needonly the secret keys for extraction. Non-blind watermarking schemes requires the original image along with secret keys for watermark detection sequence for extraction.

1.1. Types, Properties and Classification

According to the type of document to be watermarked, watermarking techniques can be divided into four types. They can be text, image, audio and video based watermarking [2]. Various properties of watermarking can be listed as effectiveness, imperceptibility, image fidelity, security, capacity and robustness [3] [4]. Classification of watermarking can be done according to several characteristics. According to characteristics or robustness, watermarking can be classified as robust, fragile and semi fragile[4], according to attachedmedia/host signal they can be image, video, audio, text or graphics watermarking, according to perceptivity, it can be visible or invisible, according to purpose, watermarking can be copyright protection, tampering tip, anti-counterfeiting or anonymous watermarking. According to domain, watermarking can be either spatial or frequency domain watermarking.

1.2. Purpose of the Survey

This survey is a comparative study of the frequency domain watermarking techniques DWT and LWT. Watermarking techniques are classified into two categories generally which are spatial domain techniques and frequency-domain techniques[5].

In spatial domain watermarking techniques, the secret messages are directly embedded into cover image. Here the pixels in randomly selected regions of the image are modified according to the watermark chosen. There are three factors that determine the parameters of the algorithm applied in this technique[6]. The three factors are the information associated with signature, the secret random key, the masking property of image. The advantages of spatial domain methods are easy and simple implementation, high payload and provide easy way to control. LSB watermarking is an example of this kind of technique. The limitation of this approach is that it is vulnerable to every slight steganalysis methods.

In frequency domain techniques such as DWT, LWT, DCT, FFT etc. , the cover image converted into frequency domain coefficients before embedding the secret message into it[7]. Advantages of frequency domain techniques over spatial domain is the ability for high resistance against steganalysis methods and signal processing manipulations. But transformations into frequency domain are basically computationally complex.

II. LITERATURE SURVEY

2.1. DWT Based Watermarking

Wavelet transform is a time domain localized analysis method. It decompose the image into different spatial do- main and independent frequencies.When the image is DWT transformed, it is decomposed into four districts namely LL which is a low frequency district and three high frequency districts namely LH(Level detail), HL(Upright detail) and HH(Diagonal detail). Figure 1 shows the one level DWT decomposition process.

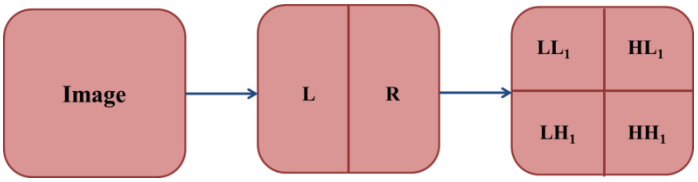

Fig. 1. One Level DWT Decomposition Process

Bhupendra Ram mentioned in his paper ' Digital Image Watermarking Technique Using Discrete Wavelet Transform And Discrete Cosine Transform '[8] that wavelet Transformis a modern technique frequently used in digital image processing, watermarking, compression, etc. The transforms are based on small waves which are called wavelet, of varying frequency and it is with limited duration. The wavelet transform decompose original signal into wavelet transform coefficients which contains the position information. The original signal can be fully reconstructed by performing Inverse Wavelet Transformation on above coefficients.

In 'Comparison of Digital Image watermarking Methods DWT and DWT-DCT on the Basis of PSNR' [9] by Dr.S.J. Basha and Navnidhi Chaturvedi, it is mentioned that Discrete Wavelet transform (DWT) is a mathematical tool for decomposing an image hierarchically. It is useful for processing non-stationary signals. The transform is based on small waves of varying frequency and limited duration, called wavelets. Wavelet transform provides both spatial and frequency description of an image. Despite of conventional Fourier transform, in this transformation process, temporal information is retained.

In the paper 'A Dwt, Dct And Svd Based Watermarking Technique To Protect The Image Piracy' by Md. Maklachur Rahman [7], it is mentioned that in DWT technique, one dimensional signal is divided in two part, high frequency part and low frequency part. Then low frequency part is split up into two parts and the process continues. The high frequency part of the signal is occupied by edge nearby components. In each level of the DWT (Discrete Wavelet Transform) decomposition, an image separated into four parts.

Pallavi Patil and D.S. Bormane in their paper 'DWT Based Invisible Watermarking Technique for Digital Images' [10] describes that a secret message is embedded into DWT coefficients in medium high frequency components and after the secret messages have been extracted, it restores the original image coefficients . Wavelet transform is mainly used to convert an image from spatial or time domain to frequency domain. Decomposition of digital image is in a way like low frequency refers to smooth parts of image and high frequency corresponds to detailed parts of an image. The digital message will be embedded in medium-high frequency components and then the image will be reconstructed to get cover image which contain the hidden digital message. Embedded image decomposed into inverse discrete wavelet transform. To convert frequency domain into spatial domain, Inverse wavelet transform is used. Hence it is basically frequency- time representation. Embedded image will then extracted to sub-band frequencies using the DWTmethod. The digital data will be taken from medium high frequency components and extracted digital data will be compared with original message.

According to a technique as per mentioned in the paper 'Digital Image Watermarking via Adaptive Logo Texturization' by Mehran Andalibi and Damon M. Chandler [11], the process involves three steps. Stage 1 is basic texture segmentation which separate the host image into poorly textured and sufficiently textured regions. Stage 2 is texturization of the logo to match each host blocks which involves Arnold transform and lossless rotation. Stage 3 is the embedding of the texturized logos via the DWT. The update step calculates the scaling function, which results in a smoother version of the data.

2.2. LWT Based Watermarking

The lifting scheme is a technique for both designing wavelets and performing the discrete wavelet transform. It factorizes various wavelet transforms into elementary spatial operators called lifting. One main application is that it accelerates the fast wavelet transform algorithm. It has three operation split, predict and update. Split operation separate original data set to odd and even sequences. The predict step calculates the wavelet function in the wavelet transform. Here odd series is predicted according to even series by predict operator. Errors are called wavelet coefficients. The update step calculates the scaling function, which results in a smoother version of the data. Update operators are applied on wavelet coefficients and added with even series to obtain the scale coefficients. Figure 2 shows these three phases in LWT.

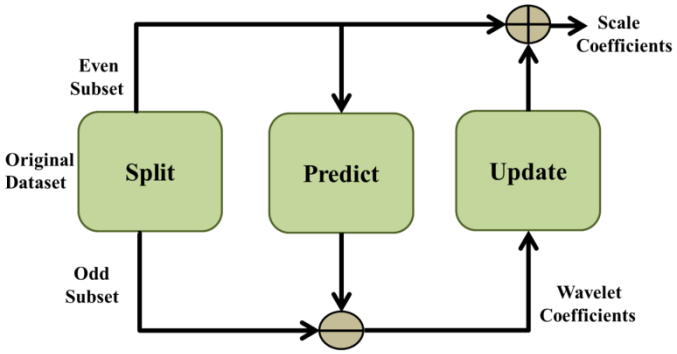

Fig. 2. Basic Lifting Wavelet Transform

The proposed method mentioned in the paper 'Lossless Image Watermarking using Lifting Wavelet Transform' [12] by S. Kurshid Jinna and L. Ganesan is about a LWT scheme which is a location free watermarking. Location map is required to indicate where data portion is embedded in the image. It reveals the pixel positions where data is embedded. But in this extraction can be done exactly and correctly from the watermarked image without using the location map. The space which was saved from location map can also be used to embed watermark data. Directly watermark data is embedded as bytes instead of bits. Then preprocessing of the original image is performed by integer Lifting Wavelet Transform of the image. Then Integer Wavelet Transform IWT is executed to decompose the image into its components like approximate coefficient, Horizontal coefficient, Vertical coefficient and Diagonal coefficient.

Sushma G. Kejgir and Manesh Kokare in their paper 'Lifting Wavelet Transform with Singular Value Decomposition for Robust Digital Image Watermarking'[13] mention about a robust LWT technique combined with SVD technique. Here the first step is decomposing the image into sub bands using LWT method. Intensities of subbands are compared to the computed Q value in next step. The subband which is having intensity more the Q value is used for singular value decomposition in later steps and watermark is embedded in it. Finally, the watermarked image reconstruction of watermarked image is done by inverse Lifting Wavelet Transform. The retrieval process is also mentioned in the paper.

C. Valens in his tutorial 'The Fast Lifting Wavelet Transform' [14] mentions about some properties of lifting wavelet transform. One property is that the inverse transform is immediately clear. It reverse the flow of data.i.e. change thesigns of all the scaling factors and replace split by merge and go from right to left. This invertibility is true for the lifting scheme always. Next property mentioned in the tutorial is that lifting can be done in-place. This means, it is never requiring samples other than the output of the previous lifting step and thus it is possible to replace the old stream by the new stream at every summation point. Third property is that lifting is not causal which is not really a problem. It is possible to delay the signal enough to make it causal, but it will never be real- time. Calculation complexity is another property i.e. for long filters the lifting scheme cuts computation complexity in half, compared to the standard iterated FIR filter bank algorithm.

In 'An Efficient Secure Image Watermarking Using Wavelet Transform'[15] by J.S. Leena Jasmine and L. Prabha, it is mentioned that LWT technique embeds ownership in- formation into the host image without degrading the visible quality of the host image contents. Here initially wavelet transform decomposes the signal into windows of different resolutions. Input image is selected and converted into grey scale image. Then on applying wavelet transform, binary images are constructed.

Three phases of the Lifting Wavelet Transform are mentioned in the paper 'Digital Image Watermarking Scheme Based on LWT and DCT'[16] by Amy Tun and Yadana Thein. They are split, predict and update. In split phase, the original data set is divided into two subsets with no elements in common and its length are the half of original data. Here actually the original signal is divided into odd subset and even subset. In predict phase, odd series is predicted according to even series by the predict operator , and the errors are called wavelet coefficients.

Mrs. Preet Kaur, Geetu Lalit in 'Comparative Analysis of DCT, DWT and LWT for Image Compression'[17] present the comparison of the performance of Discrete cosine transform , Discrete wavelet transform and Lifting wavelet transform. The basis of DCT is cosine functions while the basis

of DWT is wavelet function that satisfies multi resolution analysis. Here it describe that DWT Converts an input image coefficients into one high-pass wavelet coefficient series and one low- pass wavelet coefficient series. LWT is introduced for efficient computation of DWT. It is very necessary that the selection of transform should reduce the size of the resultant data in comparison to the original data.

III. CONCLUSION

This survey is a study about the frequency domain watermarking techniques Lifting Wavelet Transform and DiscreteWavelet Transform. It was very much useful to understand certain advantages and disadvantages of both transforms. Certain advantages of DWT are higher compression ratios avoid blocking artifacts, non-essentiality to divide the input coding into non-overlapping 2-D blocks and allow good localization both in spatial and time frequency domain. One disadvantage of DWT is that the use of larger DWT basis functions or wavelet filters produces blurring and also ringing noise near edges in images. This disadvantage of DWT is overcome in LWT. Other advantages of LWT are that it significantly reduces the computation time and speed up the computation process. Wavelet based compression is very much suitable for the applications in which the speed is critical. Thus the speed up mechanism can be more improved by using the lifting scheme.

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