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A DWT-SVD Hybrid Approach for Robust Digital Image Watermarking

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***Abstract*—Digital media can be copied and modified easily nowadays leading to security issues. There is a need for protection of digital media against unauthorized access. Digital Watermarking is a technique for protecting the copyrights and unauthorized manipulation of the digital content. In this some ownership data is embedded into the digital media that can be extracted later to prove the ownership. This paper focuses on DWT - SVD hybrid approach for improving the robustness of the watermark against various attacks**

Keywords—Digital watermarking, Discrete Wavelet Transform, Singular Value Decomposition.

I. INTRODUCTION

The distribution of multimedia across the internet has tremendously increased over a last few decades. This advancement has made copying and modification of digital media very easy and has thus lead to a challenge of copyright protection. Protection of digital content against unauthorized access is the motivating factor in developing new encryption technologies. Digital watermarking is one such technique. Digital media has the capability to embed additional data into the original media data in a way which is perceptually undetectable. Digital watermarking refers to the process of embedding an authentication code called watermark into digital multimedia without affecting the visual quality of the host multimedia. Watermarking can be divided into two categories: spatial domain and frequency domain. In Spatial domain the data is embedded directly by modifying pixel values of the host image, while transform domain schemes embed data by modifying transform domain coefficients. Studies show that hybrid of Discrete Wavelet Transform and Singular Value Decomposition technique is more robust against various attacks in comparison to other individual techniques.

In this paper we have used a DWT - SVD hybrid approach for achieving high robustness against various attacks.

The paper is organized as follows. Section II contains basic watermarking model. Section III and IV contains DWT watermarking scheme and SVD watermarking scheme respectively. Section V contains proposed DWT - SVD hybrid approach for watermarking.

II. BASIC WATERMARKING MODEL

A basic watermarking model comprises of two processes namely embedding and extraction.

In Embedding process the watermark is inserted into the cover image. An algorithm accepts the host and the data to be embedded, and produces a watermarked signal. Inputs to the process are the watermark, the cover data and an optional public or secret key. The key is used to enforce security. The outputs are watermarked image.

In extraction process an algorithm is applied to the attacked signal in order to extract the watermark from it. Inputs to the process are the watermarked data, the secret or public key and depending on the method, the original data and or the original watermark. The output of this process is the recovered watermark.

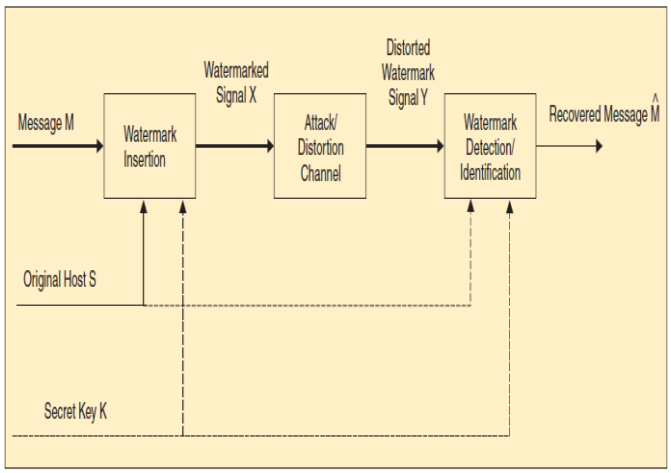

Fig. 1 Basic Watermarking Model

III. DISCRETE WAVELET TRANSFORM

Discrete Wavelet Transformation (DWT) a mathematical tool for hierarchically decomposing an image. This transform is based on small waves known as wavelets. Wavelet transform provides frequency as well as spatial description of an image and retains the temporal information. DWT splits the signal into high and low frequency parts. The high frequency part contains information about the edge components, while the low frequency part is split again into high and low frequency parts. Initially an image is decomposed into four sub bands: LL, LH, HL, and HH where LL denotes the coarse level coefficient which is the low frequency part of the image. LH, HL, and HH denote the finest scale wavelet coefficient. The LL sub band can be decomposed further to obtain higher level of decomposition. This decomposition can continues until the desired level of decomposition is achieved for the application. The watermark can also be embedded in the

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remaining three sub bands to maintain the quality of image as the LL sub band is more sensitive to human eye.

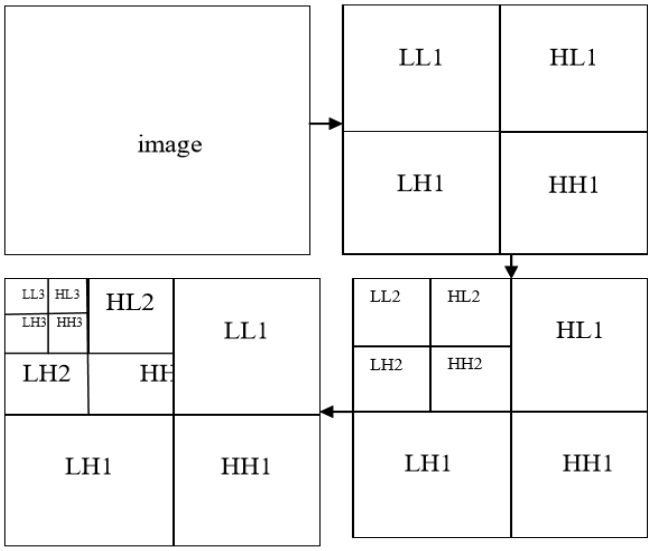

Fig. 2 Sub- bands formation at each decomposition levels of DWT

IV. Singular Value Decomposition

Singular Value Decomposition (SVD) is a numerical technique which is used in numerical analysis for diagonalizable matrices. It is a method for transforming correlated variables into a set of uncorrelated ones that better expose the various relationships among the original data items.

An image is an array of non- negative scalar entries that can be regarded as a matrix. Without loss of generality, if *A* is a square image, denoted as $A \in Rn \times n$, where *R* represents the real number domain, then SVD of *A* is defined as

$$A = USV^T$$

where $U \in R^{n \times n}$ and $V \in R^{n \times n}$ are orthogonal matrices, and $S \in R^{n \times n}$ is a diagonal matrix of singular values in decreasing order. The basic idea behind SVD technique of watermarking is to find SVD of image and the altering the singular value to embed the watermark. SVD is used because of the following properties:

1) 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 vary rapidly.
2) Singular Values represent algebraic image properties which are intrinsic and not visual.

V. Proposed DWT - SVD Technique

A. Watermark Embedding

In this process, the 3- level discrete wavelet transform is first applied to a cover image **A**, to decompose the cover image into four sub bands (LL_3, LH_3, HL_3, and HH_3). Then, the sub bands HL_3 is made to undergo an SVD operation individually to obtain

$$\mathbf{A_i = U_i S_i V_i^T \ (i = 1, 2)}$$

Similarly we apply SVD to the watermark image W. then we modify singular values of A_i by embedding singular values of watermark. SVD is then applied to the singular matrix. Next we obtain the modified DWT coefficients. Finally we get the watermarked image after applying inverse DWT.

The steps for inserting the watermark using this technique are shown in Fig. 3

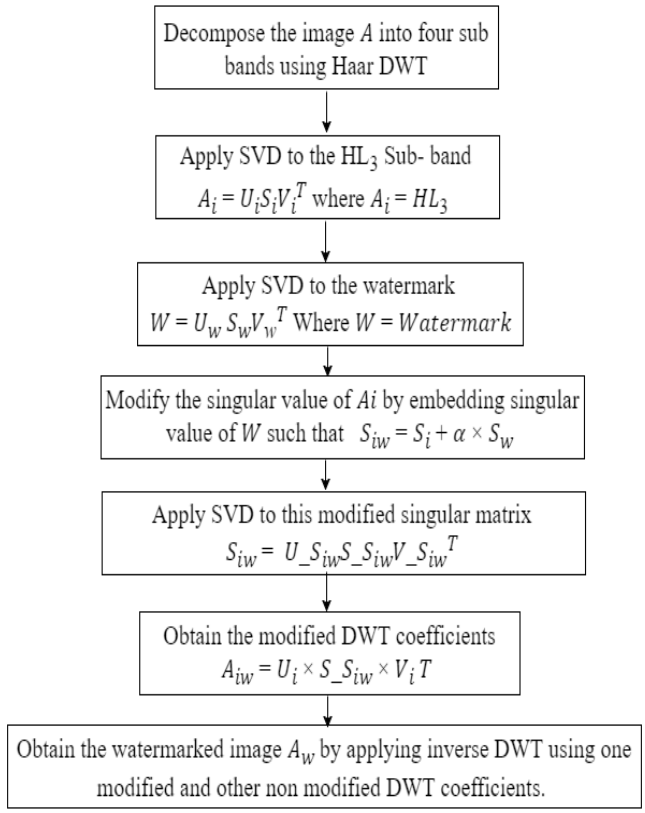

Fig. 3 Watermark Embedding Process

B. Watermark Extraction

In this process, the 3- level DWT is applied to the watermarked image A_w. Then SVD is applied to HL_3 sub band. Next singular matrix is computed and SVD is applied to the singular matrix. Finally we compute the extracted watermark by the given formula.

The steps for inserting the watermark using this technique are shown in Fig. 4

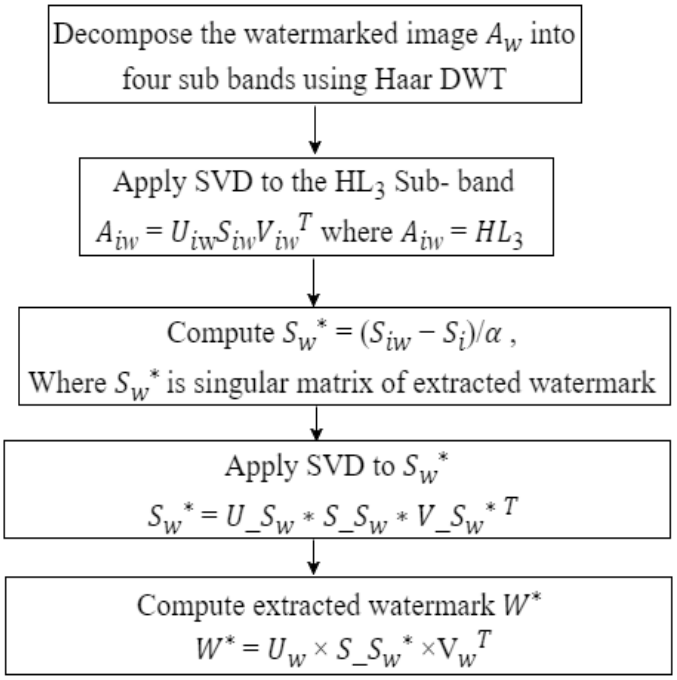

Fig. 4 Watermark Extraction Process

VI. CONCLUSION

In this paper a hybrid DWT - SVD digital image watermarking technique is discussed. This technique embeds watermark into the cover image which is more robust to various attacks. The combined properties of SVD and DWT make the watermark more robust without affecting the quality of the image.

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