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IJIEMR Transactions, online available on 20 May 2017. Link :

http://www.ijiemr.org/downloads.php?vol=Volume-6&issue=ISSUE-3

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Volume o6, Issue 03, Pages: 212 – 219.

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ROBUST AND SECURE IMAGE WATERMARKING AND SINGULAR VALUE DECOMPOSITION

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ABSTRACT:

Two vulnerable attacks on the wavelet transform (WT) and Singular Value Decomposition (SVD) based image watermarking scheme are presented in this paper. The WT-SVD based watermarking is robust against various common image manipulations and geometrical attacks; however, it cannot resist against two security attacks, i.e. an attacker attack which successfully claims the real owner's watermarked image, and owner attack which correctly extracts watermark from any arbitrary image. As proved in this study, the SVD watermarking scheme cannot provide trustworthy evidence in rightful ownership protection. In addition, the robustness of the SVD watermarking scheme in is a result of improper algorithm design.

Keywords: False Positive Problem, Image Watermarking, Wavelet Transform, Singular Value Decomposition (SVD), Vulnerable Attack.

I INTRODUCTION

The good watermarking algorithm design should meet three criteria, i.e. the rightful ownership protection, robustness to image manipulations, and watermark imperceptibility. Numerous researches have been elaborated in order to improve the SVD watermarking performances. The watermark information is embedded into the singular value matrix of the host image. The host image is firstly transformed using wavelet transform or its family before performing the SVD operation. The discrete wavelet transform and its family are chosen to achieve the imperceptibility aspect in the watermarked image. The scaling factor plays an important role to control the robustness and imperceptibility of watermark.

The Redundant Discrete Wavelet Transform (RDWT)-SVD watermarking scheme directly embeds a grayscale watermark image of the same size with host image into the singular value matrix of the RDWT-transformed host image, then produces the left and right orthogonal matrices as side information which will later be used in the watermark extraction stage. The RDWT-SVD approach takes the advantage of the RDWT redundancy to achieve high embedding capacity and preserves the watermark imperceptibility by exploiting the SVD properties. As reported in, the RDWT-SVD watermarking scheme is not only robust against several image processing attacks and geometric distortions, but also at the same time it yields the high PSNR value for the watermarked image. It means that the RDWTSVD can successfully render the watermark image into the host image and achieve the robustness aspect. However, the RDWT-SVD is not vigorous against two vulnerable attacks presented in this paper.

II.LITERATURE SURVEY

Xueyi *et al.* proposed an image watermarking algorithm based on zernike moment. This algorithm resists geometric attacks like rotation and scaling and hence makes watermark more robust. Chittaranjan *et al.* used cross chaos and arnold map to encrypt watermark before embedding it in host image. The behavior of the chaos is unpredictable which makes attacker difficult to decrypt it. The possibility for self synchronization of chaotic oscillations has sparked an avalanche of works on application of chaos in cryptography.

Henry-Ker *et al.* proposed a private key encryption for two dimensional image data. Along with encryption, lossless compression is performed simultaneously. The testing results and analysis demonstrate the characteristics of the proposed scheme. This scheme can be applied for problems of data storage or transmission in a public network.

Chang-Mok et al. proposed image encryption using binary phase XOR operation [8]. Since pixels of the image are highly correlated to its neighboring pixels, hence there is need of any technique which can shuffle pixels so as to reduce the correlation among pixels so called transformation of image.

Tapas *et al.* suggested digital watermarking techniques along with encryption of watermark using bit xor with random values. These two technologies are complimenting each other, and the increased security of the digital artifacts can be achieved by using benefits of the both. The experimental results demonstrate the high robustness of the proposed algorithm to various image processing attacks like noise additions, rotations, cropping, filtering.

Tao *et al.* proposed an algorithm on image watermarking using integer to integer wavelet transforms. Watermark is embedded in the significant wavelet coefficients by a simple XOR operation. After the wavelet transform, the significant coefficients are selected and modified according to watermark. Simulation results suggests that watermark is robust to various operations such as JPEG compression, random and gaussian noise and mean filtering. Further the method avoids complicated computations and high computer memory requirement that are the main drawbacks of common frequency based watermarking algorithms. Mingli *et al.* proposed a novel robust image watermarking scheme based on discrete wavelet transform (DWT), singular value decomposition (SVD), and chaotic mixtures. In this method, the singular values of the encrypted watermark are embedded on the singular values of the inscribed circle domain of normalized cover image's DWT sub-bands. Experimental results illustrate that this approach is robust to a wide range of attacks, especially geometrical attacks.

Asia *et al* proposed selective image encryption using confusion and diffusion which distorts correlation among neighboring pixels. Confusion is the process in which pixels of the image is substituted by randomly generated values. Confusion is carried out using arnold cat map. Arnold cat map generates chaotic numbers which will accomplish encryption process. Diffusion is the process in which the pixels of image are shuffled within image. Henon and 2D Baker chaotic maps are used for

diffusion. Sunita *et al.* proposed key based encryption algorithm called Byte Rotation Encryption Algorithm (BREA) with parallel encryption model which enhances security as well as encryption.

III. METHODOLOGY

Wavelet Transform

In mathematics, a wavelet series is a representation of a square-integrable (real- or complex-valued) function by a certain orthonormal series generated by

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a wavelet. Nowadays, wavelet transformation is one of the most popular candidates of the time-frequency-transformations. This article provides a formal, mathematical definition of an ortho normal wavelet and of the integral wavelet transform.

Formal definition

A function $\psi \in L^2(\mathbb{R})$ is called an **orthonormal wavelet** if it can be used to define a Hilbert basis, that is a complete orthonormal system, for the Hilbert space $L^2(\mathbb{R})$ of square integrable functions.

The Hilbert basis is constructed as the family of functions $\{\psi_{jk} : j, k \in \mathbb{Z}\}$ by means of dyadic translations and dilations of ψ,

$$\psi_{jk}(x) = 2^{\frac{j}{2}}\psi(2^j x - k)$$

for integers $j, k \in \mathbb{Z}$.

This family is an orthonormal system if it is orthonormal under the standard inner product $\langle f, g \rangle = \int_{-\infty}^{\infty} f(x)\overline{g(x)}dx$ on $L^2(\mathbb{R})$.

$$\langle \psi_{jk}, \psi_{lm} \rangle = \delta_{jl}\delta_{km}$$

where δ_{jl} is the Kronecker delta.

Completeness is satisfied if every function $h \in L^2(\mathbb{R})$ may be expanded in the basis as

$$h(x) = \sum_{j,k=-\infty}^{\infty} c_{jk}\psi_{jk}(x)$$

with convergence of the series understood to be convergence in norm. Such a representation of a function f is known as a **wavelet series**. This implies that an orthonormal wavelet is self-dual.

Wavelet transform

The integral wavelet transform is the integral transform defined as

$$[W_\psi f](a,b) = \frac{1}{\sqrt{|a|}}\int_{-\infty}^{\infty} \overline{\psi\left(\frac{x-b}{a}\right)} f(x)dx$$

The wavelet coefficients c_{jk} are then given by

$$c_{jk} = [W_\psi f]\left(2^{-j}, k2^{-j}\right)$$

Here, $a = 2^{-j}$ is called the binary dilation or dyadic dilation, and $b = k2^{-j}$ is the binary or dyadic position.

The fundamental idea of wavelet transforms is that the transformation should allow only changes in time extension, but not shape. This is effected by choosing suitable basis functions

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that allow for this.[how?] Changes in the time extension are expected to be conform to the corresponding analysis frequency of the basis function. Based on the uncertainty principle of signal processing,

$$\Delta t * \Delta\omega \geqq \frac{1}{2}$$

where t represents time and ω angular velocity (ω = 2*Pi*frequency).

The higher the resolution in time is required, the lower resolution in frequency has to be. The larger the extension of the analysis windows is chosen, the larger is the value of Δt.

When Δt is large,

1. Bad time resolution
2. Good frequency resolution
3. Low frequency, large scaling factor

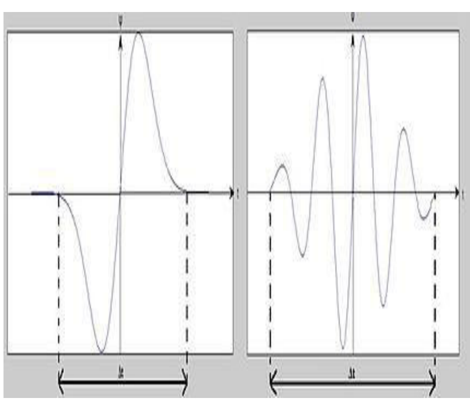

Fig 1: Larger, small value of Δt.

When Δt is small

1. Good time resolution
2. Bad frequency resolution
3. High frequency, small scaling factor

In other words, the basis function Ψ can be regarded as an impulse response of a system with which the function x(t) has been filtered. The transformed signal provides information about the time and the frequency. Therefore, wavelet-transformation contains information similar to the short-time-Fourier-transformation, but with additional special properties of the wavelets, which show up at the resolution in time at higher analysis frequencies of the basis function. The difference in time resolution at ascending frequencies for the Fourier transform and the wavelet transform is shown below.

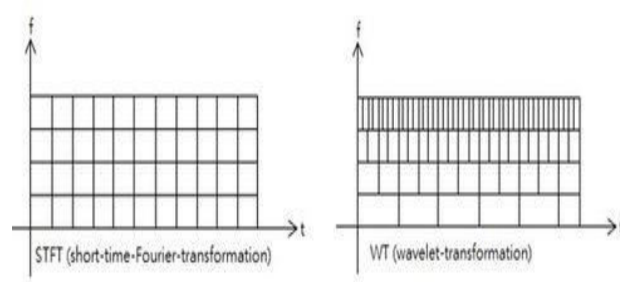

Fig 2: Wavelet Transformation Is Good In Time Resolution Of High Frequencies.

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This shows that wavelet transformation is good in time resolution of high frequencies, while for slowly varying functions, the frequency resolution is remarkable.

An other example: The analysis of three superposed sinusoidal signals $y(t) = \sin(2\pi f_0 t) + \sin(4\pi f_0 t) + \sin(8\pi f_0 t)$ with STFT and wavelet-transformation.

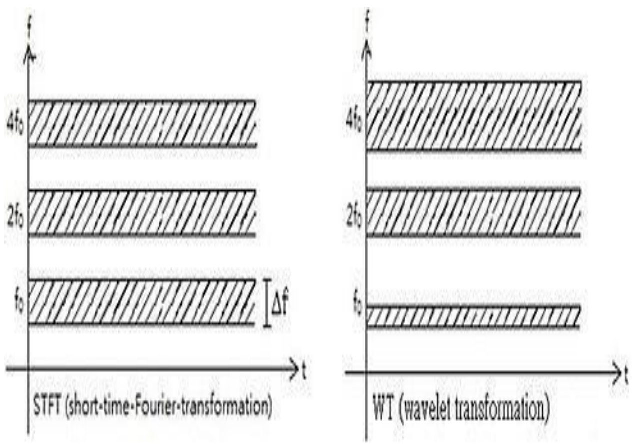

Fig 3: STFT and wavelet-transformation

Wavelet compression

Wavelet compression is a form of data compression well suited for image compression (sometimesalso videocompression and audio compression). Notable implementations are JPEG 2000, DjVu and ECW for still images, REDCODE, Cine Form, the BBC's Dirac, and Ogg Tarkin for video. The goal is to store image data in as little space as possible in a file. Wavelet compression can be either losslessor lossy.

Using a wavelet transform, the wavelet compression methods are adequate for representing transients, such as percussion sounds in audio, or high-frequency components in two-dimensional images, for example an image of stars on a night sky. This means that the transient elements of a data signal can be represented by a smaller amount of information than would be the case if some other transform, such as the more widespread discrete cosine transform, had been used.

Wavelet compression is not good for all kinds of data: transient signal characteristics mean good wavelet compression, while smooth, periodic signals are better compressed by other methods, particularly traditional harmonic compression (frequency domain, as by Fourier transforms and related).

See Diary Of An x264 Developer: The problems with wavelets (2010) for discussion of practical issues of current methods using wavelets for video compression.

Method

First a wavelet transform is applied. This produces as many coefficients as there

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are pixels in the image (i.e., there is no compression yet since it is only a transform). These coefficients can then be compressed more easily because the information is statistically concentrated in just a few coefficients. This principle is called transform coding. After that, the coefficients are quantized and the quantized values are entropy encoded and/or run length encoded. A few 1D and 2D applications of wavelet compression use a technique called "wavelet footprints"

V.RESULTS

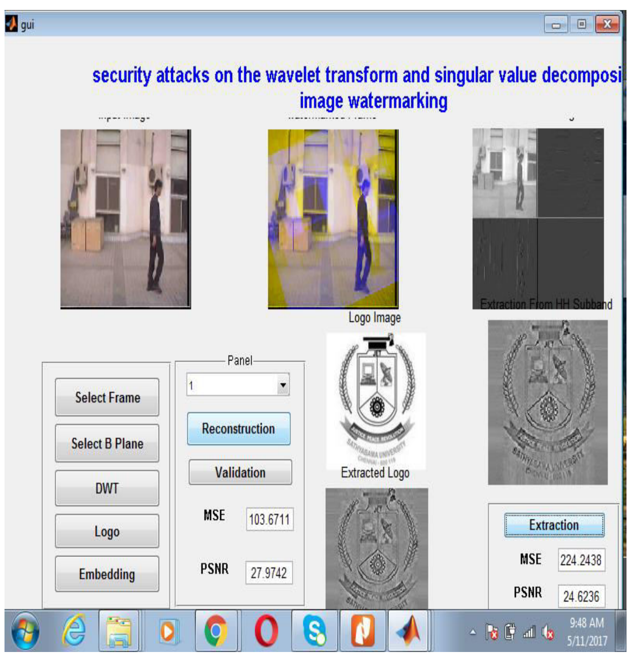

Fig 4: Screen Shot Of Security Attacks On Wavelet Transform And Singular Value Decopostion.

IV.CONCLUSION

Two vulnerable attacks have been presented in this study for wavelet transform and singular value decomposition watermarking scheme. The former RDWT-SVD scheme can embed the watermark information with high capacity while little degradation on the watermarked image quality. It meets the imperceptibility and robustness aspects, and thus meets the good watermarking design requirements. However, as proved in this study, in fact there is a fundamental flaw in the RDWTSVD scheme which leads to the serious false positive problem.

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