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ROBUST DIGITAL IMAGE WATERMARKING FOR COPYRIGHT PROTECTION

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ABSTRACT - A new robust and secure digital image watermark scheme is used for copyright protection. This scheme uses the integer wavelet transform (IWT) and singular value decomposition (SVD). The grey image watermark pixels values are embedded directly into the singular values of the 2-level IWT decomposed sub-bands. Experimental results demonstrate the effectiveness of the proposed scheme in terms of robustness, imperceptibility and capacity due to the IWT and SVD properties. Digital signature is embedded into the watermarked image for authentication purpose and also to reduce the false positive problem. The digital signature mechanism is generate and embed a digital signature after embedding the watermarks; the ownership is then authenticated before extracting watermarks. Thus the proposed scheme achieved the security issue where the false positive problem is solved, in addition to that, the scheme is considered as a blind scheme .Thus the proposed scheme achieve the security and the false positive problem is solved. It is used in content identification, copyright protection, content filtering.

Keywords — Digital image watermarking, Integer wavelet transform, Singular value decomposition, Digital signature

IINTRODUCTION

A digital watermark is a kind of marker covertly embedded in a noise tolerant signal such as an audio, video or image data. It is typically used to identify ownership of the copyright of such signal. Watermarking is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal[1]. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. Traditional Watermarks may be applied to visible media (like images or video), whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models. A signal may carry several different watermarks at the same time. Digital watermarking is the process of concealing secret information in a digital medium. Since a digital copy of data is the same as the original, digital watermarking is a passive protection tool. It just marks data, but does not degrade it or control access to the data. A watermark is embedded into a digital signal at each point of distribution. Digital watermarking consists of two processes: the embedding process and the extraction process. There are two types of digital watermarking-visible and invisible. A visible watermark is a visible semi-transparent text or image overlaid on the original image. It allows the original image to be viewed, but it still provides copyright protection by marking the image as its owner's property. Thus they are preferable for strong copyright protection of intellectual property that's in digital format. An invisible watermark is an embedded image which cannot be perceived with human's eyes[4]. Only electronic devices (or specialized software) can extract the hidden information to identify the copyright owner. Invisible watermarks are used to mark a specialized digital content (text, images or even audio content) to prove its authenticity. The peak signal-to-noise ratio (PSNR) is a metric that is used to evaluate imperceptibility performance. The similarity between the original medium and its watermarked version is known as imperceptibility. Generally in the watermarking world, a minimum PSNR of 38dB is considered acceptable. The mean square error (MSE) is the difference between the host image and the watermarked image. Using this error value, the PSNR can be calculated. A trade-off always exists among the robustness, capacity and imperceptibility the researchers have increased their efforts to develop techniques for, while increasing the embedding capacity in an image may enhance its robustness while simultaneously degrading its imperceptibility. The security term is used to resists many hostile attacks, but it is not secured against malicious attacks[9]. The security aspect of the singular value decomposition (SVD)-based schemes should be monitored, specifically the problem of false positive, thus will serve the security requirements.

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SVD is a technique that can be used to mathematically extract the algebraic properties from an image. Considering an image as a matrix A, SVD of A can be represented as follows:

$$SVD\ (A) = U\ SV^T$$

U, S and V^T are matrices.

The paper is structured as follows. Section II analyzes of techniques used. Section III discusses the proposed system of our project and its module description. Section IV provides the results and discussions.

IITECHNIQUES USED

A. Singular value decomposition

The Singular value decomposition (SVD) is a factorization of a real or complex matrix [1]. It has many useful applications in signal processing and statistics. Formally, the singular value decomposition of an $m \times n$ real or complex matrix M is a factorization of the form M = UΣV, where U is an $m \times m$ equal or complex unitary matrix, Σ is an $m \times n$ rectangular diagonal matrix with nonnegative real numbers on the diagonal, and V (the conjugate transpose of V, or simply the transpose of V if V is real) is an $n \times n$ real or complex unitary matrix. The diagonal entries $\Sigma i,i$ of Σ are known as the singular values of M. The m columns of U and the n columns of V are called the left-singular vectors and right-singular vectors of M, respectively.[6]
The singular value decomposition and the Eigen decomposition are closely related. Namely:

- The left-singular vectors of M are eigenvectors of MM.
- The right-singular vectors of M are eigenvectors of MM.
- The non-zero singular values of M (found on the diagonal entries of Σ) are the square roots of the non-zero eigenvalues of both MM and MM.

Applications that employ the SVD include computing the pseudo inverse, least squares fitting of data, multivariable control, matrix approximation, and determining the rank, range and null space of a matrix, general pseudo-inverse, full SVD ,image of unit ball under linear transformation, SVD in estimation/inversion ,sensitivity of linear equations to data error, low rank approximation via SVD.

B.Wavelet transform

A wavelet is a mathematical function used to divide a given function or continuous time signal into different scale components[2]. Usually one can assign a frequency range to each scale component. Each scale component can then be studied with a resolution that matches its scale. A wavelet transform is the representation of a function by wavelets. The wavelets are scaled and translated copies (known as "daughter wavelets") of a finite length or fast decaying oscillating waveform (known as the "mother wavelet"). Wavelet transforms have advantages over traditional Fourier transforms for representing functions that have discontinuities and sharp peaks, and for accurately deconstructing and reconstructing finite, non-periodic and/or non-stationary signals.

Wavelet transforms are classified into discrete wavelet transforms (DWTs) and continuous wavelet transforms (CWTs). DWTs use a specific subset of scale and translation values or representation grid. Applications of wavelet transform are transform data, and then encode the transformed data, resulting in effective compression and for communication applications.[5]

C. Discrete wavelet transform

In numerical analysis and functional analysis, a discrete wavelet transform (DWT) is any wavelet transform for which the wavelets are discretely sampled[3]. As with other wavelet transforms, a key advantage it has over Fourier transforms is temporal resolution: it captures both frequency and location information (location in time). Applications for discrete wavelet transform are signal coding, to represent a discrete signal in a more redundant form, often as a preconditioning for data compression, Practical applications can also be found in signal processing of accelerations for gait analysis, in digital communications.

D. Integer wavelet transform

The integer wavelet transform is a flexible technique and construction tool for adapting wavelets to general settings [10]. One of the significant features of lifting schemes is that they can be altered into a transform which maps integers to integers without rounding errors. The IWT is reversible and thus can ensure a perfect reconstruction property.

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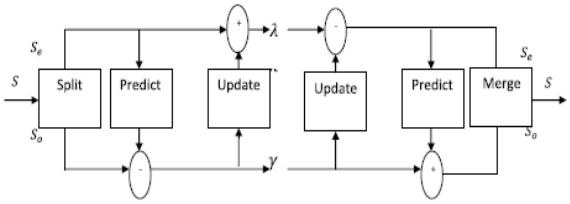


Figure1. Lifting and inverse lifting process

Split: The original signal is divided into two samples sets: even and odd sets.

Predict: This step is also called dual lifting. In this phase, the odd samples are predicted from the even samples.

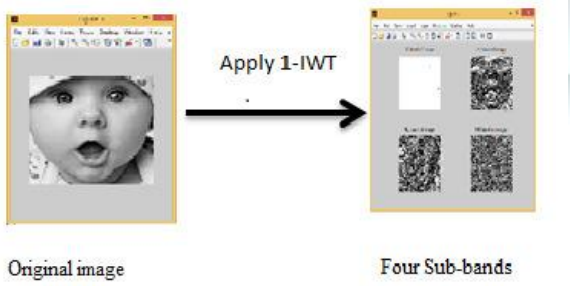
Update: This step is also called primal lifting. In this step new even samples are produced by adding the original even samples to the predicted odd samples after update them using the updating operator.

III PROPOSED SYSTEM

Several techniques were used for watermark. We have used Integer Wavelet Transform(IWT) which is flexible and it has features of lifting schemes that can be altered and Singular Value Decomposition(SVD) which is a numerical analysis technique and converts into a real or complex matrix. So IWT-SVD is preferred. The proposed IWT–SVD scheme has two procedures: watermark embedding and extracting. The tool used is MATLAB R2013a.

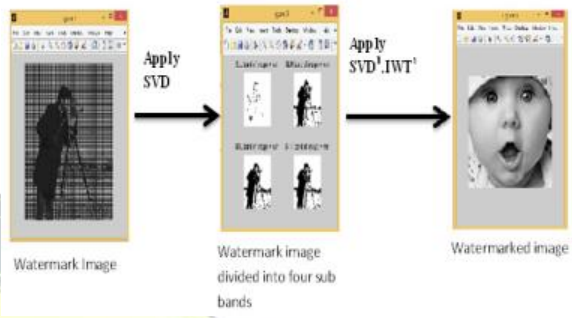
A. Segmentation

The original image is first segmented into four sub bands of (LL, LH, HL, HH) by applying integer wavelet transform



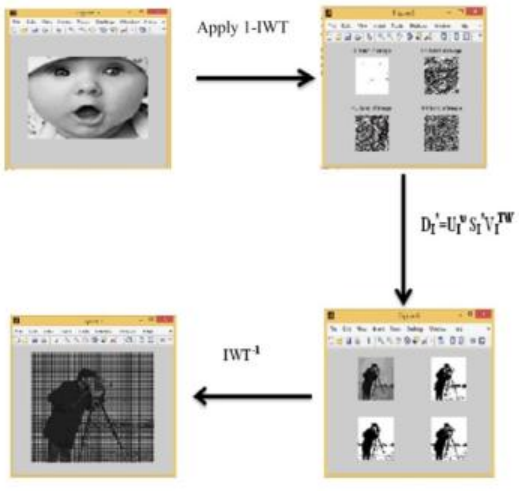
B. Watermark image embedding

After segmenting SVD is applied to all sub bands and $U_iS_iV_i^T$ is obtained. The singular values are taken and added with watermark image using the scaling factor (α). Then the SVD is applied to resultant values. After applying SVD to the resultant values the singular values of watermark image and the singular vectors of original image is taken and SVD^{-1} is applied. Then IWT^{-1} is applied and the watermarked image is obtained.



C. The watermark extraction process

The watermarked image is taken and the 1-IWT is applied to it and we get four sub bands. Further SVD is applied to all sub bands and we get $U_iS_iV_i^T$ .Then we have to compute the following for extraction process $D_i^*=U_i^WS_i^*V_i^{TW}$. Then the watermark is extracted using $W_i^*=(D_i^*-S_i)/\alpha$ where W_i^* is the watermark extracted from each sub-band.



D. Signature generation and extraction:

The Watermark image is embedded with the original image. Then the signature is generated for all sub

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bands and XOR operation is applied to all sub bands.[7]After generating the signature it is embedded into the original image for authentication purpose. The signature is mainly used for authentication purpose. Hence the output is analyzed and for authentication we have used SHA1 algorithm[9]. Christo Ananth et al. [8] discussed about a model, a new model is designed for boundary detection and applied it to object segmentation problem in medical images. Our edge following technique incorporates a vector image model and the edge map information. The proposed technique was applied to detect the object boundaries in several types of noisy images where the ill-defined edges were encountered. The proposed techniques performances on object segmentation and computation time were evaluated by comparing with the popular methods, i.e., the ACM, GVF snake models. Several synthetic noisy images were created and tested.

IV RESULTS AND DISCUSSIONS

The original image is segmented into four sub bands of (LL, LH, HL, HH) by applying integer wavelet transform. After segmenting SVD is applied to all sub bands and $U_iS_iV_i^T$ is obtained. The singular values are taken and added with watermark image using the scaling factor (α). Then the SVD is applied to resultant values. After applying SVD to the resultant values the singular values of watermark image and the singular vectors of original image is taken and SVD^{-1} is applied. Then IWT^{-1} is applied and the watermarked image is obtained.

A.PSNR (peak signal-to-noise ratio)

PSNR is a metric that is used to evaluate imperceptibility performance. The similarity between the original medium and its watermarked version is known as imperceptibility. Generally in the watermarking world, a minimum PSNR of 38dB is considered acceptable. According to our project the PSNR value obtained is 50.1608 but in our existing system the PSNR value obtained is 43.6769. The higher PSNR value indicates a higher imperceptibility. The PSNR value can be calculated by

$$\text{PSNR}=10\log_{10}\frac{[max(x(i,j))2]}{MSE}$$

B.MSE (mean square error)

It is the difference between the host image and the watermarked image. Using this error value, the PSNR can be calculated. The MSE value obtained is 2.5262. The MSE value can be calculated by

$$\text{MSE}=\frac{1}{m*n}\sum_{i=1}^{m}\sum_{j=1}^{n}[x(i,j)-y(i,j)]^2$$

V CONCLUSION

A new hybrid, secure and robust image watermarking scheme based on the IWT and SVD is proposed. The good stability of the SVD and the ability of the IWT are obtained and hence the security is provided by embedding the signature. The digital signature authentication mechanism helps to solve the false positive problem which is one of the important problems in the watermarking area and provides copyright protection. Hence it gives good imperceptibility and security.

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