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ROBUST WATERMARKING OF RELATIONAL DATABASES WITH ONTOLOGY-GUIDED DISTORTION CONTROL

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Abstract:
A robust and secure technique is required to protect multimedia data as it can be easily produced as illegal copies. Digital watermarking is used for Intellectual Property Rights protection and authentication. In this paper, a lossless watermarking scheme based on Integer wavelet transform (IWT) and singular value decomposition (SVD) is implemented. The watermark image is embedded on the elements of singular values of the low-low (LL) Sub band of original image. The Integer Wavelet Transform is implemented based on lifting scheme which is computationally efficient than Discrete Wavelet Transform. The watermark image is extracted which is highly correlated with the original watermark image. The proposed algorithm is robust and authenticated under different attacks.

Keywords : IWT, Lifting Scheme, SVD

1. INTRODUCTION

Digital watermarking is a technique for inserting data (the watermark image) into an image, which can be extracted later for identification and authentication purposes. Digital watermarking technology is a method of protecting copyrights in digital images. It is realized by embedding data into an host image that is invisible to the human visual system. An effective watermarking scheme should satisfy the following basic requirements.

Imperceptibility: The difference between the original image and the watermarked image should be unknown to the human observer.

Trustworthiness: A watermarking scheme should guarantee that it is impossible to generate counterfeit watermarks and should provide trustworthy evidence to protect the rightful ownership.

Robustness: Watermarks should be robust to common signal processing and intentional attacks. The watermarks should still be extracted from the attacked watermarked image.

A. Motivation

Liu et al, proposed the scheme which performs two times of SVD transformation during embedding phase and hides the watermark in the S component of the SVD-domain image. This method performs well on transparency and robustness. It needs highly computational complexity due to two times of SVD during the watermark-embedding phase [6]. Chang et al, proposed an image watermarking scheme based on SVD. Non- fixed orthogonal bases and one-way non-symmetrical decomposition are employed in SVD. These properties provide the advantages of various sizes of transformation and more security. The robust performance of SVD- based methods is not always better than that of frequency based methods for most of attacks. SVD-based methods involve several attacks such as median, average, Gaussian filtering and noising [2]. Chin Chin Lai et al, proposed hybrid watermarking scheme based on Discrete Wavelet Transform and Singular Value Decomposition. The watermark is embedded on the elements of singular values of host image. This approach is able to withstand a variety of image processing attacks [4]. Li- bao et al, proposed watermarking based on DWT. DWT (Discrete Wavelet Transform) has been successfully used for encoding of still images. However, the filter coefficients of DWT often have floating point coefficients. When the input images consist of sequences of integers, the outputs no longer consist of integers. Lot of multiplications of floating point coefficients also increase the computational complexity [5].

2. THEORY

Integer Wavelet Transform is used for lossless compression. The transform coefficients are represented by finite precision numbers, and this allows for truly lossless coding. Integer Wavelet Transform is much faster than the Discrete Wavelet Transform because the floating point wavelet transform demands for longer data length than the integer wavelet transform. Reversibility is another benefit of Integer Transform. That is, the image can be reconstructed without any loss because all the coefficients are integers and can be stored without rounding off errors.

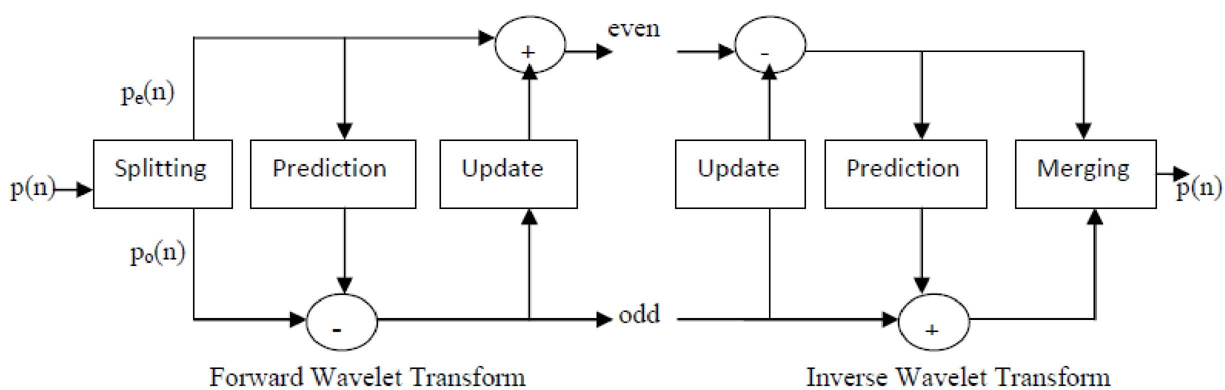

Fig.1. Lifting Scheme

IWT is implemented using the lifting scheme (LS). Its main advantage with respect to filter bank structure lies in its better computational efficiency and in fact it enables a new method for filter design. The lifting scheme is a simple method for designing customized Biorthogonal wavelets and offers several advantages: 1)Allows a faster implementation of the wavelet transform, 2) Saves storage by providing an in- place calculation of the wavelet Transform, 3) Simplifies determining the inverse wavelet transform, 4) Provides a natural way to introduce and think about wavelets. The Forward wavelet transform of lifting scheme divides the data set into an even half and odd half. The Predict step calculates the wavelet function in the wavelet transform. This is a high Pass filter. The update step calculates the scaling function, which results in a smoother version of the data. This operation consists of three steps.

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3. PROPOSED METHOD

The watermarking scheme based on IWT and SVD is implemented. The proposed method for embedding watermark and extracting watermark are presented.

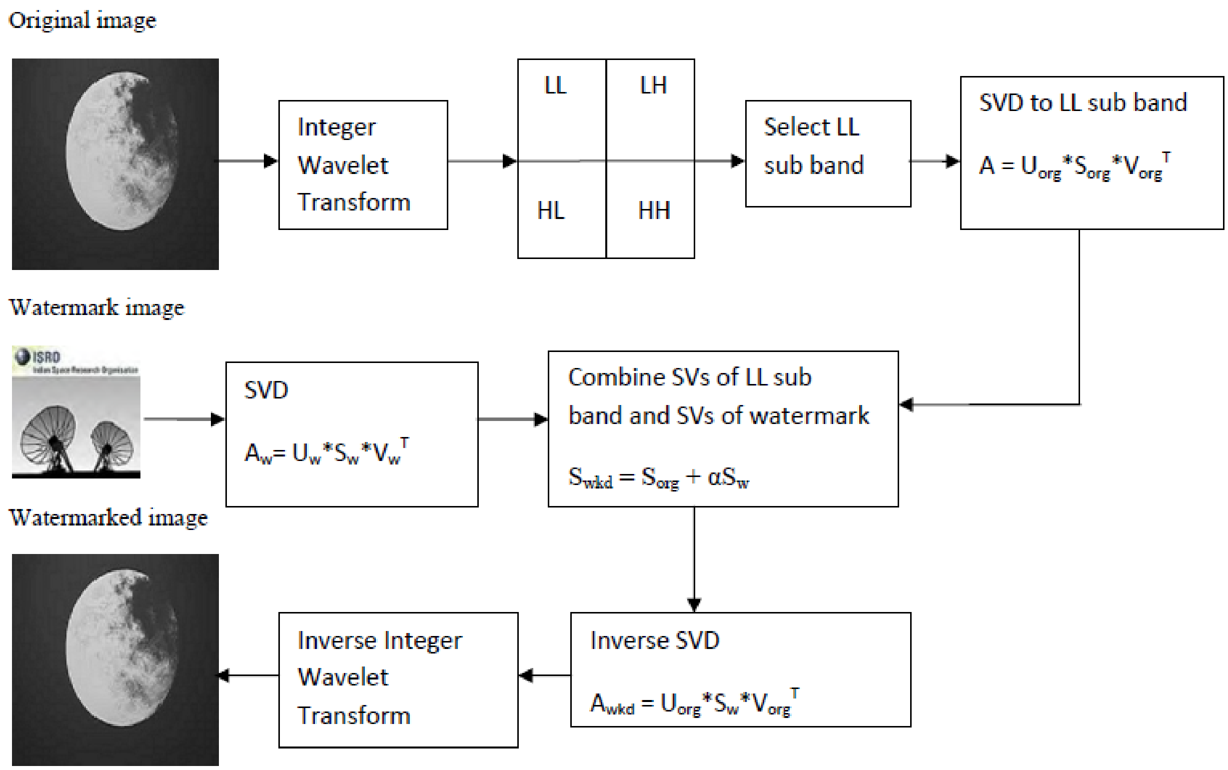

Fig.2. Watermark Embedding

Watermark was embedded into host image by using the following steps.

- Perform the 1-level IWT for a host image I with size L × K.
- Get the LL subband of the IWT image I.
- Apply SVD to LLorg subband of decomposed original image to get three components Uorg, Sorg, and Vorg.
- Apply SVD to watermark image to get three components Uw, Sw, and Vw.
- Combine SVs of the watermark with the SVs of the selected LL sub-band using appropriate scaling factor α, as illustrated in Equation (2) o Swkd = Sorg + αSw
- where α is the scale factor which controls the strength of each watermark bit to be embedded.
- Perform inverse SVD to Uorg, Swkd and Vorg to get LLwkd .
- Using inverse Integer Wavelet Transform, the watermarked image will be constructed.

In order to deploy this test, we implemented the scheme developed in [4], the advantage of which is that it introduces a constant distortion. More clearly, this one embeds a sequence of bits into the values of an integer attribute At of dynamic range [0, L] by adding the quantity to approximately a half of its values and - to the others. The length of the message and its robustness to database modifications (i.e., the capability to retrieve the message) depend on . The greater , the more robust or the longer the message can be (for more details see [4]). The test database contains about 5000 records with attributes (e.g., patient ID, age, stay duration, main diagnosis, associated diagnoses, etc.) referring to inpatient stays in the cardiology service of the hospital of Rouen. Attributes age and stay duration were considered for watermarking with different values of = [1, 2, 3, 4]. Thus, eight watermarked databases represented by a couple (watermarked attribute,) were obtained and from which sets/extracts of 30 records were extracted so as to build a sequence of extracts (see sections 1.1 and 1.2). Sequence and extract sizes were chosen so as to ensure low test duration. The evaluation tests have been carried out by one physician of the CISMeF team: the evaluator (PM). His expertise is based on more than 20 years of clinical practice and of medical information coding in cardiology and intensive care.

4. RESULT ANALYSIS

This section represents the experimental results for the lossless image watermarking scheme. The watermarking scheme was developed in JAVA with NetBeans environment. SVD of this scheme was developed using Java Matrix (JAMA) package. Singularvaluedecomposition class of JAMA package is used to get three matrices from single input matrix.

a) Host Image (PSNR = 37 dB) b) Watermark Image c) Watermarked Image

Fig.3. Result analysis

Fig.3 shows the host image, watermark image and watermarked images. The images used in experiments are of size 512 × 512 for host image and of size 256 × 256 for the watermark image.

$$NC(w,w') = \frac{\sum_{i=1}^{L}\sum_{j=1}^{K} w_{ij} \oplus w'_{ij}}{L \times K}$$

Normalized correlation (NC) is used to evaluate the similarity between the original watermark W and the extracted watermark W' which is retrieved from an attacked watermarked image.

CONCLUSION

A non-blind watermarking scheme based on IWT and SVD was implemented. Modifying Singular Values of the host image in IWT domain provides high robustness against the common attacks. High PSNR of watermarked image is another benefit of the algorithm as the result of IWT implementation. Making trade off between PSNR of the watermarked image and correlation between extracted watermark and the original data lead to selecting the best value of the scaling factor. The proposed algorithm takes the advantages of the Wavelet Transform and SVD methods. The extracted watermarks are more robust against all mentioned attacks. IWT is useful for medical imaging and remote sensing applications because it produces lossless image. In future, this watermarking scheme can be extended to blind watermarking.

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