Image Watermarking Using Contourlet Transform

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Abstract - A novel watermarking algorithm using contour let transform. The contour let transform is preferred for watermarking because of its ability to capture the directional edges and contours superior to other transforms such as cosine transform, wavelet transform, etc. Watermark is encrypted and embedded into high frequency directional sub and, which is obtained by performing contour let decomposition on the host image. The watermarked image has very good perceptual transparency. Watermark extraction algorithm is a non-blind process, which makes use of original image as reference for retrieving the watermark. This algorithm is robust against cropping attacks and geometric attacks and also has superior Peak Signal to Noise Ratio (PSNR) for the watermarked image.

Keywords: Watermarking, Encryption, Contour Let Transform.

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INTRODUCTION

Digital watermarking is considered as an efficient tool to prove the ownership of digital data. Watermark embedding is the process in which the secret image is hidden inside the cover image without modifying the visibility of the cover image. The hidden image is retrieved at the receiver by watermark extraction process. Watermarking can be classified depending on the data type that is being used. They are image watermarking, video watermarking, audio watermarking and text watermarking. According to human perception the digital watermarks are classified as visible watermark and Invisible watermark. Visible watermarking systems are those in which watermark embedded is visible to the human visual system (HVS) when image is viewed [10]. Visible watermarking is normally used to prevent unauthorized access to the data.

In invisible watermarking, watermark embedded is perceptually invisible to the HVS [6]. The major requirements of watermarking system are perceptual transparency, payload of the watermark, robustness, security and efficiency [12]. Robustness of the watermarking system is its ability to resist various signal processing attacks. Some of the common signals processing attacks are JPEG compression, filtering, cropping, geometric distortions and additive noise. The digital watermarking has been used in a wide variety of

LITERATURE REVIEW

Watermarking in the early stages were done using spatial domain techniques like LSB. In the spatial domain method, the watermark is added by just modifying pixel values of host images. The most common spatial domain method is the least significant bit (LSB) modification. This watermarking approach modifies least significant bits of images based on assumption that the LSB bits are insignificant [17]. Spatial domain but these techniques are vulnerable to attacks that can destroy the watermark. The other techniques work in the transform domain, where images are represented in terms of frequencies. Reversible transforms are used to transfer an image to its frequency representation. Watermark can be embedded by modifying values of transform domain coefficients. Inverse transforms are used to obtain the watermarked image. The discrete localization, multiresolution representation and superior HVS modeling. In the DWT domain watermarking [9], [15] image is decomposed into four subbands and embedding of the watermark is done in the finest scale wavelet coefficients to have better robustness and transparency. As human visual system is less sensitive to the changes made in the high frequency coefficients finest scale coefficients is chosen compared to coarse level coefficients. Wavelet transform has been accepted as right tool for one dimensional piecewise smooth images. Wavelets when extended to two dimensions are good at isolating discontinuities at edge points but failed to capture

smoothness along the contours. Moreover directionality property of wavelet is also limited.

As an improvement on wavelet transform Minh Do and Martin Vetterli proposed contourlet transform (CT) [8]. The contourlets possess multiscale and time frequency localization properties of wavelets in addition to directionality and anisotropy [21]. Hence contourlets are considered as an improvement over wavelets in terms of efficiency. Some algorithms of watermarking based on contourlet transform have also been proposed so far.

CONTOUR LET TRANSFORM

Contour let Transform proposed by Minh N. Do and Vetterli [8] is a true two dimensional image representation and decomposition scheme. Contourlet transform efficiently represent images containing contours and textures since it is a geometrical image based transform. The multiresolution, localization and critical sampling properties of wavelets are also possessed by contourlets, but the two properties that make contourlets superior than other transforms are directionality and anisotropy. The Contourlet expansion is composed of basis function oriented at various directions in multiple scales with flexible aspect ratios (anisotropy).The main feature of this transform is its potential to capture the geometric smoothness of the contours.

MATERIAL AND METHOD

Watermark Embedding

Public key is used for encryption purpose, while private key is used for decryption purpose. The encrypted watermark is embedded into the directional subbands of the host image. Contourlet decomposition is performed on the host image to obtain the subbands. The steps involved in watermark embedding are as follows.

Step 1: The host image of size MxN is decomposed into number of subbands using contourlet transform. At each level of decomposition, there are 2n directional subbands, where n=1, 2, 3, 4. Four level of contourlet decomposition is performed on the host image to produce 16 directional subbands. N. Mahesh

Step 2: Watermark Image is encrypted using Knapsack Algorithm. For every bit position the weight is taken in the super increasing order in combination, denoted as private key. Public key is extracted from this private key. Watermark is encrypted with the public key.

Step 3: The coefficients of selected directional subband i.e. 15th subband is modified as per the following equation

The multiplication factor is selected such that the watermarked image looks similar to the original image and *Ak* represents the encrypted watermark bit.

Step 4: Inverse contourlet transform (ICT) is performed to obtain the watermarked image. Then Peak Signal to Noise Ratio (PSNR) is calculated to measure the watermarked image quality with that of the original image.

Where MSE is the mean square error, M and N is the rows and columns of host image, *I* (*i*, *j*) represent the original image and *k*(*i*, *j*) represents the watermarked image.

Watermark Detection

In the extraction process a copy of the original image is used as reference. The watermarked image and the original image undergo contourlet decomposition to produce directional subbands. The subband coefficients of the original image are subtracted from the modified subband coefficients of the watermarked image to obtain the encrypted watermark, which is given by the following equation.

$$f'(i, j) - f(i, j)\, Ak$$

The obtained encrypted watermark is decrypted using knapsack algorithm which makes use of private key for the decryption process.

CONCLUSION

In this paper, we proposed an algorithm for watermark embedding and watermark extraction using contourlet transform. Embedding encrypted watermark to high frequency subbands allows high performance watermark extraction. The proposed method outplays the existing transform domain techniques such as Watershed, DWT Transform etc., in terms of performance and PSNR. By increasing the levels of decomposition for the watermarked image, the resistance against the attacks & the quality of extracted watermark can be improved.

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