

Image Security achieved through Watermarking- Survey based on Spatial and Transform Domain Techniques

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Abstract—Human beings experience a non avoidable situation of sharing and posting their pictures, documents, videos etc on the internet almost every week. Intruders are often the ones who do not want to work hard and they claim on somebody's original work. Digital Watermarking has been an extraordinary rescue to the humiliating plight. There are broadly two most popular ways of embedding the watermark in the digital content ie spatial domain and transform domain. We present here the survey on both the kinds of methodologies in practice worldwide for authenticating images, in recent years.

Keywords— Watermarking, Transform Domain, Spatial, Neural Network

I INTRODUCTION

This world has experienced several phenomenal techniques of overcoming the sincere problems related to counterfeiting and illegal infringement of digital media. There are mainly four ways of authenticating the digital media namely fingerprinting, steganography, cryptography and watermarking. The information to be embedded in an image, audio, video signal is called a digital watermark. Digital watermark also means the difference between the watermarked signal and the cover signal. It acts as a digital signature, giving the image a sense of ownership or authenticity. Digital watermarking technology makes use of the fact that the human eye has only a limited ability to observe differences. Minor modifications in the color values of an image are subconsciously corrected by the eye, so that the observer does not notice any difference. A digital watermark should be statistically invisible, robust in terms of passive, forgery and collusion attacks such as JPEG compression, scaling, aspect ratio changes, rotation, cropping, row and column removal, addition of noise, filtering, cryptographic and statistical attacks, as well as insertion of other watermarks also the watermark must be extractable without much trouble. Here we discuss the work done in the field of watermarking in spatial and transform domain in recent years.

II METHODOLOGIES

A. Spatial Domain Watermarking

Spatial domain method refers to the image plane itself and methods in this category are based on direct manipulation of the pixels an image. Simple watermarks could be embedded in the images by modifying the pixel values or the Least Significant Bit (LSB) values. Even though spatial domain based techniques cannot sustain most of the common attacks like compression, high pass or low pass filtering etc., researchers suggest spatial domain based schemes for the sake of time saving and simplicity.

1. Prediction Error Expansion (PEE) Based Embedding

Prediction Error Expansion works on the principle of Tian's difference expansion technique through the insertion of confidential data into the prediction error histogram.

Thodi and Rodriguez (2004) coined a method for distortion free grey level image watermarking that embeds the crucial information into the prediction errors.

Huang et al.,(2008) proposed a prediction error method of hiding information in color palette images.

Zhijua and jiping(2008) came out with color image digital watermarking method based on value-value surface. The value value of curve surface of the original image is found to get the outline information of the original image; then embedding watermarks into the edge of the outline. This method has strong resistance to attacks like filtering and zooming.

Dinu Coltuc(2011) reduced the distortions due to watermarking by embedding the expanded difference into the current pixel and its prediction context.

Luo et al.,(2011) innovated the combination of PEE and compensation for enhanced reversible image watermarking.

2. LSB Based Embedding

Kao et al., (2002) came out with the watermark technique based on spatial domain in color image by embedding watermark in saturation on the HSI space.

Chang et al., (2005) succeeded in hiding the watermark into DC components of the color image directly in the spatial domain, followed by a saturation adjustment technique performed in RGB space

Krishna V.V et al., (2009) presented a novel fact , that by inserting the watermark using Least Significant Bit (LSB), the grey value of the image pixel either remains same or increases or decreases to one. Ambiguity of grey level values by LSB method comes between successive even and odd grey level values only. This approach allows high robustness, embedding capacity and enhanced security.

Zeki A.M, Manaf A. A,(2009) aimed at replacing the watermarked image pixels by new pixels that can protect the watermark data against attacks and at the same time keeping the new pixels very close to the original pixels in order to protect the quality of watermarked image. The technique is based on testing the value of the watermark pixel according to the range of each bit-plane.

Ganeshan and Gupta (2010) gave a scheme in which 12 binary images can be embedded in the spatial domain using LSB substitution technique in a single RGB image. The proposed scheme also provides an extra level of security to the watermark image by scrambling the image before embedding it into the host image.

Megalingam et al.,(2010) watermarked image in the spatial domain at different intensity subsections.

Hussein Jamal A. (2010) gave the idea of selecting 16 blocks of 8X8 from the center of colored RGB image converted to $YCbCr$ color space , to embed the monochrome image. The selected blocks are chosen spirally among the blocks that have log-average luminance higher than or equal the log-average luminance of the entire image. Each byte of the monochrome watermark is added by updating a luminance value of a pixel of the image. If the byte of the watermark image represented white color (255) a value α is added to the image pixel luminance value, if it is black (0) the α is subtracted from the luminance value.

Bamatraf et al.,(2011) also emphasised the manipulation of least significant bit for watermarking because of the least possible effect on the quality of cover image. They inversed the binary values of the watermark text and shifting the watermark according to the odd or even number of pixel coordinates of image before embedding the watermark. There is a flexibility depending upon the length of the watermark text. If the length of the watermark text is more than $((M \times N)/8)-2$,there is a way to embed the extra of the watermark text in the second LSB.

Surekha and Swamy (2011) in their paper explored the possibility of embedding multiple binary images simultaneously in the host image also they gave the way to iteratively embed the watermark in different locations of cover image for enhancing robustness.

B. Transform Domain Watermarking

1. Discrete Cosine Transform (DCT) Based Embedding

Hernandez et al.,(2000) utilized the usefulness of a spread-spectrum-like discrete cosine transform domain (DCT domain) watermarking technique for copyright protection of still digital images .Generalized Gaussian distributions were applied to statistically model the DCT coefficients of the original image and show how the resulting detector structures lead to considerable improvements in performance with respect to the correlation receiver.

Barni M et al.,(2002) expressed the idea of hiding the watermark within the color image by modifying a subset of full frame DCT coefficients of each color channel .The extraction was only possible by comparing the correlation with a threshold.

Ahmadi and Safabaksh (2004) converted the original image into the NTSC color space for separating the grayscale information from color data followed by dividing the luminance component Y into 8X8 blocks and transforming it to DCT. To prevent tampering or unauthorized access, watermark permutation function was present.

Li and Xue (2004) modified a subset of block DCT coefficients of each color channel and extracted the watermark by information conveyed by every channel.

Du and Zhang (2009) suggested the use of scrambled R ,G and B components of image as watermarking sequences. They gave an algorithm which understands the human visual system for implanting watermarks with different strengths into DCT coefficients of host image's luminance, contrast and textures blocks.

Saxena and Tiwari (2010) gave a scheme of inserting the watermark into the DCT coefficients for higher capacity embedding .

Manimaran et al., (2010) devised a unique way of encrypting the watermark by DES method after compressing it and the cover image is DCT transformed , followed by embedding.

Xie Bin (2011) extended the idea of DCT transform of blocks of Y component of image but here its converted into Y C_b C_r color space.

2. Discrete Wavelet Transform (DWT) based Embedding

Wavelet based image watermarking is gaining more popularity because of its resemblance with the human visual system.

He Hong Jie, et al .,(2006) generated the embedded watermark using the discrete wavelet transform (DWT), and elaborated security watermark by scrambling encryption is embedded into the least significant bit (LSB) of the host image.

Zude et al.,(2006) provided a novel digital watermarking scheme for color image, watermarking image was embedded into the corresponding wavelet coefficients of the original image's R, G, B sub images via discrete wavelet transform.

Yang and Jin (2008) took the advantage of DCT and DWT coefficients for color image watermarking. Firstly, the green components of an original image are divided into blocks, for each of which DCT is calculated and from each of which DC components are chosen to make up a new image, and new images are transformed with Haar wavelets. Then, a binary image of scrambling chaotic encryption is embedded into a low frequency sub-band.

Guofu and Lingge (2008) secured the color images with the scheme relying on DWT and HVS properties. The mean quantization approach was utilized to insert the watermark into the wavelet coefficients of the luminance component and color components of the colorful host image respectively. Extraction was also possible without the cover image.

Chang Gao (2009) utilized the phenomenal process of embedding the authentication information into the low frequency coefficients of DWT transformed JPEG format host image.

3. Discrete Fourier Transform (DFT) Based Embedding

DFT domain has been explored in case of watermark extraction algorithms from image that underwent affine transformations.

Hernandez, et al.,(2005) analysed DFT-based watermarking algorithm, which inherently provides invariant property of some geometrical transform. In this watermarking scheme, the original image is not required during the detection process. The developed method is resistant not only to geometrical transformation, but also to JPEG compression, filtering, corruption by noise.

Chin man-Pun (2006) protected the image copyrights by DFT coefficients based watermarking. First, the original image was decomposed into DFT coefficients using a fast Fourier transform. For minimal loss in image fidelity, the watermark was embedded in those DFT coefficients with highest magnitudes except for those in the lowest one. Extraction did not require the cover image.

Yan , et al.,(2006) said that a chirp signal and a template could be embedded in the discrete fractional Fourier transform (FRFT) domain and discrete Fourier transform (DFT) domain respectively, and used the watermark position and the transform order as the encryption keys.

Poljicak, et al.,(2011) used the magnitudes of the fourier transform for embedding. The PSNR values were chosen the means for evaluating the quality degradation. The method was robust enough to handle the print scan , print cam and the attacks from Stir Mark benchmark software.

4. Neural Network Based Embedding

Nikolaidis and Pitas (2001) proposed the use of salient spatial features resulting from image segmentation. The use of a certain chaotic system that produces trajectories of controlled low pass properties was suggested in order to preserve the robustness of the method to manipulations such as filtering, noise addition and compression.

Davis et al.,(2001) proposed a method based on neural networks to find maximum-strength watermarks for DWT coefficients.

Mei et al.,(2002) put forward a three-layer neural networks to determine the strength of watermarking for image DCT coefficients.

Zhang et al., (2003) proposed a RBF neural network to achieve maximum-strength watermark according to the frequency component of the cover image.

Chang and Su (2005) suggested the use of FCNN for watermarking differently, they trained the network to memorize multiple cover images and single watermark.

Sang Jun, Mohd Alam (2005) A lossless digital image watermarking algorithm based on neural network is proposed. The algorithm uses the neural network technique and the exclusive-or (XOR) operation to model the relationships

among some randomly selected pixels with their neighborhoods, and to extract the features of the cover image instead of embedding watermark into it. It does not degrade the visual quality of the cover image, i.e., lossless watermarking. The algorithm may be used for automatic piracy detection as well as copyright demonstration by cooperating with a copyright authentication center.

C.-R. Piao et al.(2006) proposed a new blind watermarking scheme in which a watermark was embedded into the DWT (Discrete Wavelet Transform) domain. It also utilized RBF Neural network to learn the characteristic of the image, using which the watermark would be embedded and extracted. The embedding scheme resulted in a good quality watermarked image.

Zhang and Yang (2008) studied the HVS characteristics and back propagation network to hide a scrambled watermark into the host image .

Yi et al.,(2009) proposed a novel digital watermarking scheme based on improved Back-propagation neural network for color images. The watermark was embedded into the discrete wavelet domain of the original image and extracted by training the BPN which learnt the characteristics of the image. To improve the rate of learning and reduce the error, a momentum coefficient is added to the traditional BPN network.

Chen, et al.,(2009) discovered the algorithm of combining the features of Genetic Algorithm and Synergetic Neural Network. GA was used to select the fit wavelet coefficients to embed watermarking bits into the host gray image. After some kinds of attack, the extracted watermark could be identified expediently through the synergetic neural network (SNN). The scheme performed well enough on grounds of security, imperceptibility and robustness.

Bansal and Bhadauria (2010) solved the issues such as 'Proprietary Net' and 'Sure Win' by enhancing the security of images through DCT transform and encoding the secret bits in the high energy region ,thereafter presenting the encoded image to FCNN for embedding watermark.

Yang et al., (2010) adaptively embedded three identical watermarks with some differently expanded bit streams , into the low frequency sub-bands generated from three channels for a color image, respectively. Due to the adaptive learning capabilities of neural network, the expanded bit streams could be used to train back propagation (BP) neural networks to represent the relationship among the neighbour wavelet coefficients.

Xu He, Chang Shujuan (2011) proposed an adaptive image watermarking algorithm after studying the characteristics of Human Visual System and the association memory ability of neural network. The watermarking signal was embedded in

higher frequency, which is in the lower frequency of original image by DWT joined with DCT.

III CONCLUSION

Digital watermarks have been broadly and successfully deployed in billions of media objects across a wide range of applications such as forensics and piracy deterrence, content filtering (includes blocking and triggering of actions), communication of ownership and copyrights, document and image security, rich media enhancement for mobile phones. An exhaustive list of digital watermarking applications is of course impossible. Many challenges remain to meet user needs in some applications. However, it is interesting to note the increasing interest in fragile watermarking technologies. Especially promising are applications related to copy protection of printed media.. Various companies have projects in this direction and it is very likely that fully functioning solutions will soon be available.

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