

A Survey of Substantial Digital Image Watermarking Techniques

Neha Sharma¹, Rasmiranjan Samantray²

¹Central College of Engineering and Management, Kabir Nagar, Raipur.
Chhattisgarh Swami Vivekananda Technical University, Bhilai

²Central College of Engineering and Management, Kabir Nagar, Raipur
Chhattisgarh Swami Vivekananda Technical University, Bhilai

Abstract: *In this paper, we have discussed about the various technique of watermarking. In which watermark is embedded inside the original data to provide copyright protection. Watermarking or digital signature belongs to the information hiding field. It has a lot of research interest in digital image watermarking scheme because of illegal access of data and unauthorized manipulation of multimedia data. Here we have discussed about detail survey of newly and existing watermarking techniques. The different techniques of watermarking are classified on the basis of their different domains.*

Keywords: Digital image watermarking, discrete wavelet transform, singular value decomposition, encryption, PSNR (Peak signal to noise ratio), MSE (Mean square error), RDH (Reversible data hiding)

1. Introduction

Recently there is a serious problem of an illegal and unauthorized access of multimedia files over the internet. Especially for image and video content privacy the case is more critical. Therefore in order to protect the copyright media there is a need of robust method. During the communication of secure images and videos over open communication channel, image and video privacy has become an essential constraint. Invisible image watermarking provides copyright protection of image by hiding secure image inside the cover image. Copyright protection is also obtained by embedding some additional information which is called watermark or digital signature. This paper is a survey of the different techniques that are used for embedding watermark image. This paper gives the brief description of different watermarking techniques which are used for embedding watermark on any host image or a cover image. There are different scheme proposed by authors to made watermarking more robust and imperceptible. Here we have discussed about various watermarking techniques which are recently used.

2. Digital Image Watermarking

Digital image watermarking is a technique of embedding watermark image inside the cover image or data. Watermarking is a technique which shows the proof of ownership of the data or a multimedia object. Digital image watermarking provides copyright protection and authentication of data. Many authors are using various techniques for embedding watermark image inside the cover image. The embedding process is used to decide the location where the watermark is embedded inside the cover image, which is robust against various attacks like cropping, Gaussian noise and other image processing attacks. On the basis of detection of watermarking, digital image watermarking is divided into following categories.

- **Non-blind image watermarking:** In this technique the original image is used to compare and find the watermark to authenticate the existence of watermark.
- **Blind image watermarking:** in this technique the correlation measure is used to detect the strength of watermark signal from the extracted watermark. Hence we can say that the original watermark image is directly compared with the extracted watermark technique.

3. Necessity of Digital Image Watermarking

The main requirements of the digital image watermarking are as follows.

- **Imperceptibility:** Imperceptibility means that the watermark image should be completely transparent or invisible and does not affect the quality of original cover image.
- **Robustness:** Robustness means the watermark is not easily extracted by the various image processing attacks and it is highly substantial in various Gaussian noise.
- **Quantitative transparency:** Quantitative transparency means that after watermarking the effect of watermark image on the cover image should be as low as possible. PSNR is used to calculate the effect of watermark image on cover image.



(a)

(b)



(c)

Figure 1: (a) Cover image (512x512 Lena); (b) Watermark image (512x512 Peppers); (c) Watermarked Cover (Lena) image

4. Digital Image Watermarking Techniques

For digital image watermarking the technique are categorised into one of the two following domains, which are spatial domain and transform domain.

1) Spatial domain

In spatial domain technique the watermark is embedded directly by modifying its pixels value of the host image. The advantage of spatial domain technique is that it is a simple process and its computation complexity is less hence the time consumption for extraction and embedding is very less. Spatial domain techniques are less robust to various attacks because the watermark is embedded by modifying its pixel value. Hence the watermark can easily detect or remove by simple image processing attacks.

2) Transform Domain

In this technique of watermarking transform coefficients are modified and to detect the watermark inverse transform are used. The various transform techniques are as follows

- **Discrete Cosine Transform (DCT):** This technique is the faster technique and it can survive in various attacks like compression, sharpening, filtering and noising. This is a very popular transform domain technique. In this technique image is divided into three frequency components like low frequency band (F_L), medium frequency band (F_M) and high frequency band (F_H). DCT allows the selection of band to embed data or watermark into image as shown in figure().The main drawback of this technique is that it cannot detect the edge of the signal.

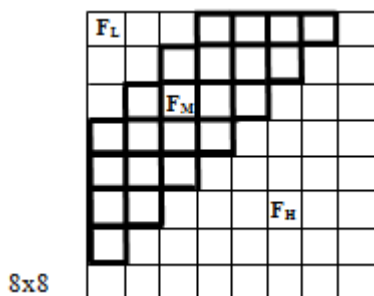


Figure 2: Discrete cosine transforms frequency 8x8 block.

- **Discrete Fourier Transform (DFT):** Discrete Fourier transform domain technique offer robustness to various geometric attacks like translation, scaling, rotation and cropping. The output of the DFT is always a complex

value and it require more frequency rate hence its computational efficiency is very poor.

- **Discrete Wavelet Transform (DWT):** Discrete wavelet transform is widely used in image processing because of its spatial frequency localization property. DWT divides the image into four bands LL, LH, HL and HH which is used to get the exact location where we want to embed watermark image. DWT is either 1 level, 2 lever or 3 level used for embedding watermark. The DWT is scalable in nature. Due to down sampling process the DWT does not provide the shift invariance. This leads to the inaccurate extraction of watermark image.

LL	LH
HL	HH

Figure 3: 1 level discrete wavelet transforms.

- **Redundant Discrete Wavelet Transform (RDWT):** Redundant discrete wavelet transform is established to overcome the problem occurs due to DWT. RDWT removes the down sampling from each filter bank, which increase the robustness of watermarking. After removing down sampler it provides shift invariance hence any change in the input image due noise can be easily detected at the output image. A hybrid method of RDWT with the SVD is also used for digital image watermarking. Hence after removing down sampling from each filter bank it provides high robustness to the image watermarking.

5. Literature Survey

Guangyong Gao; Yun-Qing Shi [1], In this paper there is a proposed method for data hiding, which is a conventional RDH process. This scheme provides high peak-signal-to-noise-ratio (PSNR) at undeniable amount of embedded bits. Recently, **Wu Et Al.** esteems that the enhancement of image quality is more important than sustaining high PSNR. Based on this point of view, they represented a scheme novel RDH. In which they were utilizing the contrast enhancement to replace the PSNR. However, when the large amount of bits is embedded, the contrast of the image is over-enhanced. Due to over-enhancement it introduces a clear distortion for human visual perception. To overcome this issue, a new RDH scheme is proposed by authors using two methods, which is the Haar integer wavelet transform (IWT) and controlled contrast enhancement (CCE). In this proposed scheme provides large embedding capacity of data and also maintaining satisfactory human visual perception.

Patel, Palak; Patel, Yask [2], they have presented a combined strategy of digital watermarking, steganography and cryptography to hide watermark logo of secure image inside the cover image. For hiding image they have used RSA, DWT, DCT and SVD approach. Using DCT, encrypted watermark logo, which is encrypted by using RSA technique, is hiding inside secure image. This combine method results in stego image. Stego image is hidden inside the cover image using DWT and SVD approach. There

proposed approach can be used for transmit secure information like thumb impression or finger print of specific person, copyright information of any company and movie with their respective image. The use of this method is for security purpose. Hence this method would be beneficial for all security.

Hao-Tian Wu; Jean-Luc Dugelay; Yun-Qing Shi [3], in this paper, a novel reversible data hiding (RDH) was proposed for digital image. The proposed technique enhanced the contrast of the image instead of trying to keep high PSNR value for betterment of its image quality. Histogram equalization can be performed by repeating the process because for data embedding, the highest two bins in the histogram were selected. The side information embedded into the host image along with the message bits. So the original image can be completely recoverable. To demonstrate the efficiency of proposed method, it was implemented on the two sets of the image. They claimed that, this technique is the first which achieves the image enhancement by reversible data hiding (RDH). The evaluation result of this proposed method shows that the visual quality of image can be preserved after a considerable amount of message bits have been embedded into the contrast enhancement images. The contrast enhancement of this technique is better than three specific MATLAB function used for image contrast enhancement purpose.

Bo Ou; Xiaolong Li; Weiming Zhang [4], In this paper they propose an effective and simple reversible data hiding (RDH) method for an encrypted image. They guarantee the exact original image recovery and data extraction from the marked encrypted image. In this technique the original image recovery and data extraction can be independently processed. However, first the cover image was encrypting by permutation in both pixel-wise and block-wise manners, by using a chaotic mapping. Then on each permuted block, they apply the pixel-value-ordering (PVO) embedding. By this method the reversibly data embedded into the encrypted image. The embedded data in this technique can be easily extracted by the inverse PVO whether the marked image is decrypted or not. Because the pixels value order is unchanged in each block after PVO embedding, experimental result shows that the proposed technique can provide better decrypted marked image fidelity.

Roshni, P.; Durvesh, A; Urvisha, P. [5], they represent a concept, by using an irreversible approach of data hiding, to embed data in an encrypted image. The aim of their proposed work is secretly a message into the data. There are various problems facing like data size capacity, data security, authentication, copyright control etc. during the message communication over the internet. A new proposed technique on encrypted image is applying reversible data hiding, by wishing to remove the embedded data before decryption of an image. To create a secure data hiding technology is the main aim of this paper. The two different keys are used for image encryption key and data hiding. For image encryption an encryption is used and for data hiding the data hiding key are used. So the receiver can retrieve the data embedded that has the data hidden key.

George, J.; Verma, S.; Chatterjee, M. [6], In this paper, for image watermarking they have proposed a novel technique by using SVD and DWT. In which SVD ensures its robustness from various attacks and DWT ensures imperceptibility of the watermark image. In their proposed technique they make use of Arnold transform to address the issue of watermark security. This watermark extraction is semi-blind hence we would not need original image for watermark extraction. Cover image and watermark image used are colour image. By using correlation coefficient value and PSNR values, the performance of the system was judged. Proposed system provides good robustness against various attacks like filtering, noise, JPEG compression and cropping.

Poonam, P.; Kundu, S.; Kumar, S.; Chander, K. [7], this paper proposed a new technique to improve the imperceptibility and the robustness of watermark from various attack. In this method the singular value of watermark image was embedded to the 3-level DWT of original image of approximation matrix. The watermark is embedded to the host image by a genetic technique, which was used to optimize the scaling factor. The technique takes two values, correlation and PSNR which makes use of fitness function. They also have found the imperceptibility and robustness of watermark data from various attacks.

Furqan, A.; Kumar, M. [8], In this paper to achieve copyright protection a robust and blind digital image watermarking technique was proposed. First they decomposed the original image or cover image into the four sub-bands by using 2-D DWT process, and then apply SVD on each sub-bands. After applying SVD they modified their singular value. Then the watermark image is subjected to various attack like adding noise, rotation, contrast adjustment, lossy compression, histogram equalization, sharpening, cropping, gamma correction, pixilation, rescaling, rotation etc, they extract the original watermark image from the all 4 sub-bands. After extraction compare them on the basis of their PSNR and MSE values. From the experimental results illustrated in this paper shows that we can recover the watermark from any of four sub-bands effectively, if we perform the modification in all sub-bands. Hence it will make watermarked image more robust to various image processing attacks (Including common geometry attacks).

Radouane, M.; Messoussi, R.; Touahni, R.; Boujiha, T. [9], In this paper author have proposed have proposed a study of digital image watermarking. The study of this paper is achieved by applying watermarking at different sub-bands of DWT (LL, HL, and HH) and using SVD transform by searching the optimal block which can be used to insert the watermark in original image that have maximum entropy. The experimental result shows for each coefficient of DWT there are different value of PSNR. The system is more robust against various attacks.

Dharwadkar, N.V.; Amberker, B.B.; Gorai, A. [10], In this paper proposed method is an effective imperceptible and robust colour image watermarking scheme. This method is used in colour image to resolve the copyright protection. In this scheme the watermark is embedded into the cover image

in RGB (Red, Green, and Blue) space. For embedding the watermarking the combination of discrete wavelet transform (DWT) and singular value decomposition (SVD) of blue channel is used. To embed the singular values of the watermark different scaling factors are used to modify the singular value of different sub-bands coefficients of blue channel. Watermark is very difficult to remove or destroy because the copy of the watermark is embedded into the coefficient of four sub-bands. The combination of proposed DWT and SVD provide high security, imperceptibility and robustness to the data.

Aslantas, V.; Dogan, A.L.; Ozturk, S. [11], In this paper author proposed a scheme of an optimal discrete wavelet transform and singular value decomposition (DWT-SVD) using particle swarm optimizer (PSO). The proposed watermarking scheme is based on DWT-SVD, in which initially the host image is decomposes into sub-bands, after this the singular value of each sub-bands of host image are modified by using different scaling factors to embed the watermark image into the host image. To obtain the high robustness without losing the transparency modification are optimized using particle swarm optimizer. Robustness and transparency under transparency under the certain attack is shown in the experimental results.

Qiang Li; Chun Yuan; Yu-Zhua Zhong [12], In this paper a hybrid DWT-SVD domain watermarking scheme considering human visual properties technique is proposed. In this scheme first the host image is decomposed into four sub-bands, and then they apply SVD to each sub-band and afterward embed singular value of the watermark into them. A human visual model is proposed in A. S. Lewis and G. Knowles, (1992) by which the embedding strength was determined. Their proposed scheme has advantage of large capacity for using SVD and robustness for its embedding data into all frequencies. It uses human visual model hence it also guarantees the imperceptibility of watermark.

Chih-Chin Lai; Cheng-Chih Tsai [13], In this paper author proposed a hybrid image watermarking scheme which is based on discrete wavelet transform and singular value decomposition. In this scheme the watermark is not directly embedded on the coefficient of wavelet but rather then this first cover image is decomposed into four sub-bands by using DWT. Afterward SVD is applied to both sub-bands of cover image and the watermark image, then modify the singular value of cover image with the singular value of watermark image by using different scaling factors. This proposed approach is able to withstand in various image processing attacks which we can observe in its experimental result.

Ramandeep Kaur; Sonika Jindal [14], In this paper they proposed a new robust technique of digital image watermark to protect the data from illegal access. This technique of digital watermarking is based on discrete wavelet transform and singular value decomposition using median filter. In this technique first image passes through the median filter, then apply first level discrete wavelet transform. This technique shows robustness from various image processing attacks. This technique is developed by embedding watermark in high frequency band. The median filter is used before

embedding to the original image. Use of median filter improves the result because filter makes image more smooth and remove the noise from image. In this technique the PSNR value is quite good. Because this technique is semi blind image watermarking hence to extract watermark there is only requirement of original watermark and its technique.

Anumol Joseph; K. Anusudha [15], In this paper authors proposed combined technique of DWT (Discrete Wavelet Transform) and Singular Value Decomposition. The watermark is embedding in the HL and LH bands of the host image. This paper deals with the new watermarking technique which is DWT SVD watermarking. Watermark is embed in HL and LH bands after two level decomposition of host image by using haar wavelet the afterward modified the singular value of cover image with the watermark image. The performance was evaluated by using correlation coefficient, PSNR and RMSE. A simulation result shows that the proposed technique withstands in various image processing attacks.

Deepika Sardana; Ajit Singh [16], In this paper instead of embedding in a simple time domain of cover image author proposed a new technology which embed the secret text in spatial domain by using 3 level discrete wavelet transform. To increase the security of secret message Huffman coding is used. Because 3 level discrete wavelet transform is used hence the technique cannot be easily detected by common attacks and provide imperceptibility to the image. In this technique PSNR value is improved for all image hence it provides high security and robustness to various image processing attacks.

6. Conclusion

In this paper we surveyed about the current literature of digital image watermarking techniques which is substantial to various image processing attacks. This paper shows different techniques which are recently used for watermarking. The techniques provide robustness and imperceptibility from various attacks.

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