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COLOR IMAGE WATERMARKING TECHNIQUES AND ITS ALGORITHM IMPROVEMENT: REVIEW

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Abstract: **Image watermarking technique embeds copyright information (watermark) into host image so as to perform its protection and authentication. Schemes of embedding digital watermark into grayscale images have been researched and developed greatly. However color image is more common in our everyday life and it contains more information than grayscale image and provides information to against the attack of illegal copyright. So it is very important to embed the watermarking into color image for copyright protection. This paper presents a critical review of existing methods of Color Image Watermarking in recent years. This literature review concludes with the concept of betterment of algorithms and scope of its future direction of research.**

Keywords: **Color image watermarking, Spatial domain, Transform domain, Discrete wavelet transform (DWT), Singular value decomposition (SVD), Discrete cosine transform (DCT).**

I. INTRODUCTION

Watermarking has been studied for several years as one of the widely used copyright protection methods. Schemes of embedding digital watermark into grayscale images have been researched and developed greatly [2], [5]. However, color image is more common in our everyday life, and it contains more information than grayscale image and provides information to against the attack of illegal copyright. So it is very important to embed the watermarking into color image for copyright protection. This paper presents the literature review of existing color image watermark algorithms like Image averaging and tuned pixels prediction ,SVD,DWT,DCT based and combination of DWT-DCT,DWT-SVD based etc and discusses the scope of possible amendment in this regard.

II. IMAGE WATERMARKING

Image watermarking is a process of embedding watermark in to host image so that later it can be extracted for authentication and copyright protection. Image watermarking technique required to be robust and imperceptible. The image Watermarking schemes are classified into different types based on domain of processing; human perception and rigidity of scheme.

A. Image watermarking algorithm

A typical watermarking algorithm consists of three parts: watermark generation, watermark embedding and watermark detection or extraction. In the watermark generation preprocess, the embedded watermark information is generated by a series of pre-processing operations. Watermark embedding completes the choice of the embedding location, intensity and strategy. And the process of watermark detection or extraction is the inversion of watermark embedding, which extracts the watermark information from the embedded watermark image. There are two types of watermark detection techniques **a.** blind techniques where the original image is not required and **b.** non-blind technique where the original image is required to extract the watermark information. . Most of color image watermark systems are accomplished in the transform or frequency domains, not the spatial domain. Watermarking information embedding could be performed on different color space such as RGB, YIQ, YCbCr, HIS space [3], [7], [10], [11]. Next section discuss different spatial and transform domain based color image watermarking algorithm.

III. COLOR IMAGE WATERMARKING TECHNIQUES

For last 20 years watermarking is area of research in image, audio, video security. This paper presents critical review of some popular algorithms on color image watermarking. In [6], [1], [7] algorithms are based on spatial domain and in [3], [10], [11], [14] algorithm are based on transform domain. Peak signal to noise ratio (PSNR) and normalized correlation (NC) are the parameters used for performance comparison of watermarking techniques. The general definition of PSNR can be expressed as

$$PSNR(dB) = 20log\frac{255\sqrt{3MN}}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}(B'(i,j)-B(i,j))^2}} \quad (1)$$

Where M and N are the numbers of row and column of the images respectively. And, The NC can be determined by

$$NC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}w(i,j)w'(i,j)}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}w(i,j)^2}\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}w'(i,j)^2}} \quad (2)$$

Where $w(i,j)$ and $w'(i,j)$ are the original watermark bit and

the retrieved watermark bit at pixel (i, j) respectively. The maximum value of NC is 1. Also, higher the NC value more accurate the retrieved watermark will be.

B. Spatial Domain

In [6], [1], [7] spatial domain based color image watermarking algorithm is used. In the paper [6], a color image watermarking using mean based 2D color histogram that is resist to geometric attacks is proposed. The proposed algorithm is very robust to most invertible global attacks and cropping and also method has a good resistance to random bending attacks (RBAs). However, the proposed watermarking scheme is suffering from its limitation for histogram equalization since this operation will distort the histogram shape much. The NC value under histogram equalization is only 0.6872, and the extracted watermark is undistinguishable.
In [1], a color image watermarking using image averaging and tuned pixels prediction is proposed. Author compared the accuracy of the retrieved watermark to the methods in [8] and [9]. The results in term of average NC measured at different qualities of watermarked image from three watermarking methods is illustrated in Fig. 1. It can be clearly seen from the figure that this method outperformed the other two ([8] [9]).

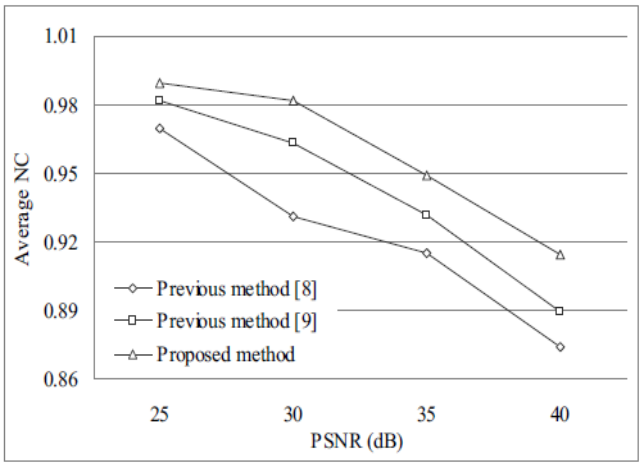

Fig.1. Performance comparison between three watermarking methods at different PSNR

The NC value of the retrieve watermark from the previous method [8], [9] and proposed method are 0.9562, 0.9663 and 0.9836 respectively.
In paper [7], a digital color image watermarking method using Singular Value Decomposition (SVD) is applied. Author used a 256×256 color pepper image as the original image and three 128×128 binary (monochrome) images as the watermarks. The SNR obtained from MATLAB program is 31.4249 dB. Therefore, we show embedding three binary images simultaneously into an original color image is feasible and demonstrate proposed watermarking scheme satisfies the property of imperceptibility. The results of the test have shown watermarking is very imperceptible and robust especially for JPEG and cropping attacks. But the rotation attack could change the features of image and the distribution of watermarks. The watermarks extracted from the rotated image are difficult to be recognized.

C. Transform Domain

In the papers [3], [10], [11], [4] transform domain based color image watermarking algorithm is used. As mentioned in [3], a color image watermarking methods using Discrete Wavelet Transform (DWT) is proposed. Author performed experiments to clarify the difference of robustness of watermarks and the difference of image quality when decomposition level 1 and 2 of DWT is used. Result shows that Compared to decomposition level 1, PSNRs values are much lower in level 2. For the evaluation of the robustness, watermarks in 2LH and 2HL domains has higher robustness than those in LH and HL domain. As a result, watermark in decomposition level 1 has the higher quality of images, while it does not have higher robustness than that in level 2 domain.
In the paper [10], a digital watermarking algorithm based on the DCT domain is proposed. It is seen that the scrambled watermarking image can hide its original information well. And the watermarked image not lose its quality greatly (PSNR= 37.68dB), showing the good imperceptions of watermarking. NC of the extracted watermarking image is 1.0000, demonstrating that the original watermarking image and the extracted one are almost same. PSNR of the watermarked image and NC of extracted watermarking images after some attacks are displayed in Table 1.

Attack type	gaussian noises	salt-and-pepper noises	JPEG compression
PSNR (dB)	36.77	33.02	34.99
NC	0.9810	0.9545	0.7906

Table.1. PSNR of the watermarked image and NC of extracted watermarking images after three attacks [10].

It is seen that the extracted watermarking images attacked by the Gaussian noises and salt and-pepper noises don't lose their quality greatly.

Although the extracted watermarking image attacked by the JPEG compression has low quality, the NC value is relatively high, showing that the watermarking is still strong.

In the paper [11], a new blind watermarking algorithm for color images based on DWT-DCT is proposed. Experimental results (Tab1of [11]) show that watermarking algorithm is robust for various attacks such as noise adding, JPEG compression, cropping, rotating and image enhancement. The algorithm combines the advantages of DWT and DCT.

IV. COMPARISON BETWEEN VARIOUS WATERMARKING TECHNIQUES

Method	Color Space	Domain	Measuring Parameters (PSNR(dB), NC)	Detection	Features	Limitations
Geometrically Invariant Color Image Zero-Watermarking [6]	RGB	Spatial	NC = 0.6872 (under histogram equalization)	Blind	Resist to geometrical and random bending attacks(RBAs), Less complex	Histogram equalization distorts the histogram shape much. and the extracted watermark is undistinguishable
Image Averaging and Tuned Pixels Prediction [1]	RGB	Spatial	PSNR=34±0.01 NC=0.9538	Non Blind	Improved performance compare to previous work	Increase complexity compared to other spatial domain watermarking
(SVD) [7]	RGB	Spatial	PSNR= 31.4249	Blind	Good robustness , good imperceptibility and higher security	Rotation attack could change the features of image and the Distribution of watermarks.
(DWT) [3]	YCbCr	Transform	PSN==42.13 (α= ,LH	Blind	Higher Robustness compare to level 1 decomposition	Compared to decomposition level 1,PSNR values are Much lower so degrade image quality.
(DCT) [10]	RGB	Transform	PSNR= 37.68, NC=1.0000	Non Blind	Fully uses the characteristics of HVS (human visual system)	Under JPEG compression attack image quality poor.
DWT-DCT[11]	YCbCr	Transform	PSNR='40.3741 (JPEG Compression, quality=8)	Blind	High Robustness, Combines the advantages of DWT and DCT	Complexity Increases
DWT-SVD[4]	RGB	Transform	NC=0.9391 (LH)	Non Blind	Increases Security, Robustness and Imperceptibility.	Result show the NC value is more than 1 for some image processing attacks.

In the paper [4], Author proposed a non-blind watermarking scheme for color images in RGB space using DWT-SVD. Table 5 shows the extracted watermarks from four sub bands of attacked cover image which are highly similar to the original watermark

The combinations of DWT and SVD increase the security, robustness and imperceptibility of the scheme.

V. CONCLUSION

Although selection of watermarking algorithm is problem dependent but this review results that spatial domain is reliable under geometric and random bending attacks. But Transformed domain schemes are more robust and secure to general attacks as compared to spatial domain schemes. The combination of DWT & DCT watermarking algorithm improves the performance as compared to use of individual DWT and DCT algorithm. Also the combination of DWT & SVD watermarking algorithm performed better compared to the individual DWT and SVD algorithm. Finally this review concludes that a color image watermarking algorithm based on one algorithm using DWT and SVD in sequence with intelligence for all kind of attacks may be the future trend of research regarding improved color image watermarking

algorithms. Although it may create complexity in algorithm but efficiency will be certainly improved.

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