A ROBUST COLOR IMAGE WATERMARKING TECHNIQUES WITH CONTRAST ENHANCEMENT

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ABSTRACT: In recent years, many works on digital image watermarking have been proposed all aiming at protection of the copyright of an image document or authentication of data. With the help of my proposed Modified LSB watermarking embedding with Color Histogram Equalization -Contrast Adjustment (CHE-CA) algorithm, the high contrast watermarked image is obtained & watermark can easily be extracted in both clean and noisy environments. Experiments are performed to verify the robustness of the proposed algorithm. The results show that the proposed algorithm is superior to other algorithm in terms of providing a high PSNR. It is also shown that the proposed algorithm is highly robust against various kinds of attacks such as compression, noise, filtering, cropping & rotation.

KEYWORDS: Watermarked, PSNR, MSE, DWT, IDWT, RGB, HE.

1. INTRODUCTION:

Image watermark is one of the most active and challenging subjects in the information hiding research because it is an efficient solution to protect the copyright of the digital media. Wavelets have been widely applied in image watermark owning to their perfect performance for piecewise smooth signals in one dimension [4].

Watermarking techniques can be categorized in different ways. They can be classified according to the type of watermark being used, i.e., the watermark may be a visually recognizable logo or a sequence of random numbers. Another classification is based on domain which the watermark is applied i.e., the spatial domain or the transform domain. The earlier watermarking techniques were almost in spatial domain. Spatial domain techniques are not resistant enough to image compression and other image processing. Transform domain watermarking schemes like those based on the discrete cosine transform (DCT), the discrete wavelet transform (DWT) typically provide higher image imperceptibility and are much more robust to image manipulations [2].

Histogram equalization is one the most well-known methods for contrast enhancement. Such an approach is generally useful for images with poor intensity distribution. Since edges play a fundamental role in image understanding, one good way to enhance the contrast is to enhance the edges [3].

2. LITERATURE REVIEW:

Hamidreza Sadreazami et.al: Author's proposes "Multiplicative Watermark Decoder in Contourlet Domain Using the Normal Inverse Gaussian Distribution" A novel watermark decoder in the contourlet domain. It is known that the contourlet coefficients of an image are highly non-Gaussian and a proper distribution to model the statistics of the contourlet coefficients is a heavy-tailed PDF. The proposed watermark extraction approach is developed using the maximum likelihood method based on the NIG distribution. Closed-form expressions are obtained for extracting the watermark bits in both clean and noisy environments. Experiments are performed to verify the robustness of the proposed decoder. The results show that the proposed decoder is superior to other decoders in terms of providing a lower bit error rate. It is also shown that the proposed decoder is highly robust against various kinds of attacks such as noise, rotation, cropping, filtering, and compression [1].

M. Abdullah-Al-Wadud et.al: has proposed Dynamic Histogram Equalization (DHE) technique takes control over the effect of traditional HE so that it performs the enhancement of an image without making any loss of details in it. DHE partitions the image histogram based on local minima and assigns specific gray level ranges for each partition before equalizing them separately. These partitions further go through a repartitioning test to ensure the absence of any dominating portions. This method outperforms other present approaches by enhancing the contrast well without introducing severe side effects, such as washed out appearance, checkerboard effects etc., or undesirable artifacts [6].

H. Sadreazami et.al has proposed: "A Robust Multiplicative Watermark Detector for Color Images in Sparse Domain": A blind multichannel multiplicative color image watermarking scheme in the sparse domain is proposed. In order to take into account the cross correlation between the coefficients of the color bands in the sparse domain, a statistical model based on the multivariate Cauchy distribution is used. The statistical model is then used to derive an efficient closed-form decision rule for the watermark detector. Experimental results and theoretical analysis are presented to validate the proposed watermark detector. The performance of the proposed detector is compared with that of the other detectors. The results demonstrate the improved detection rate and high robustness against the commonly used attacks such as JPEG compression, salt and pepper noise, median filtering, and Gaussian noise [7].

3. WATERMARKING TECHNIQUE

In general digital watermarking involves two major operations: (i) watermark embedding, and (ii) watermark extraction. For both operations a secret key is needed to secure the watermark. The keys in watermarking algorithms can apply the cryptographic mechanisms to provide more secure services. The secret message embedded as watermark can almost be anything, for example, a bit string, serial number, plain text, image, etc. The most important properties of any digital watermarking technique are: robustness, security, imperceptibility, complexity, and verification. Watermarking techniques can be classified according to the nature of data (text, image, audio or video), or according to the working domain (spatial or frequency), or classified according to the human perception (robust or fragile). In images, the watermarking techniques can broadly be classified into three types: (i) visible watermark, (ii) invisible fragile watermark and (iii) invisible robust watermark, which has wider currency and use [5].

4. HISTOGRAM EQUALIZATION

In this section, we review some of the existing HE approaches in brief. Here we discuss about GHE, LHE, DHS and some methods based on histogram partitioning.

A. Global Histogram Equalization (GHE):

Suppose input image f(x, y) composed of discrete gray levels in the dynamic range of [0, L-1]. The transformation function C(rk) is defined as where $0 \leq sk \leq 1$ and k = 0, 1, 2, …, L-1. In (1), ni represents the number of pixels having gray level ri, n is the total number of pixels in the input image, and P(ri) represents as the Probability Density Function (PDF) of the input gray level ri. Based on the PDF, the Cumulative Density Function (CDF) is defined as C(rk). This mapping in (1) is called Global Histogram Equalization (GHE) or Histogram Linearization.

B. Local Histogram Equalization (LHE) :

While GHE takes into account the global information and cannot adapt to local light condition, Local Histogram Equalization (LHE) performs block-overlapped histogram equalization. LHE defines a sub-block and retrieves its histogram information. Then, histogram equalization is applied for the center pixel using the CDF of that sub-block. Next, the sub-block is moved by one pixel and sub-block histogram equalization is repeated until the end of the input image is reached [6].

5. PROPOSED METHOD

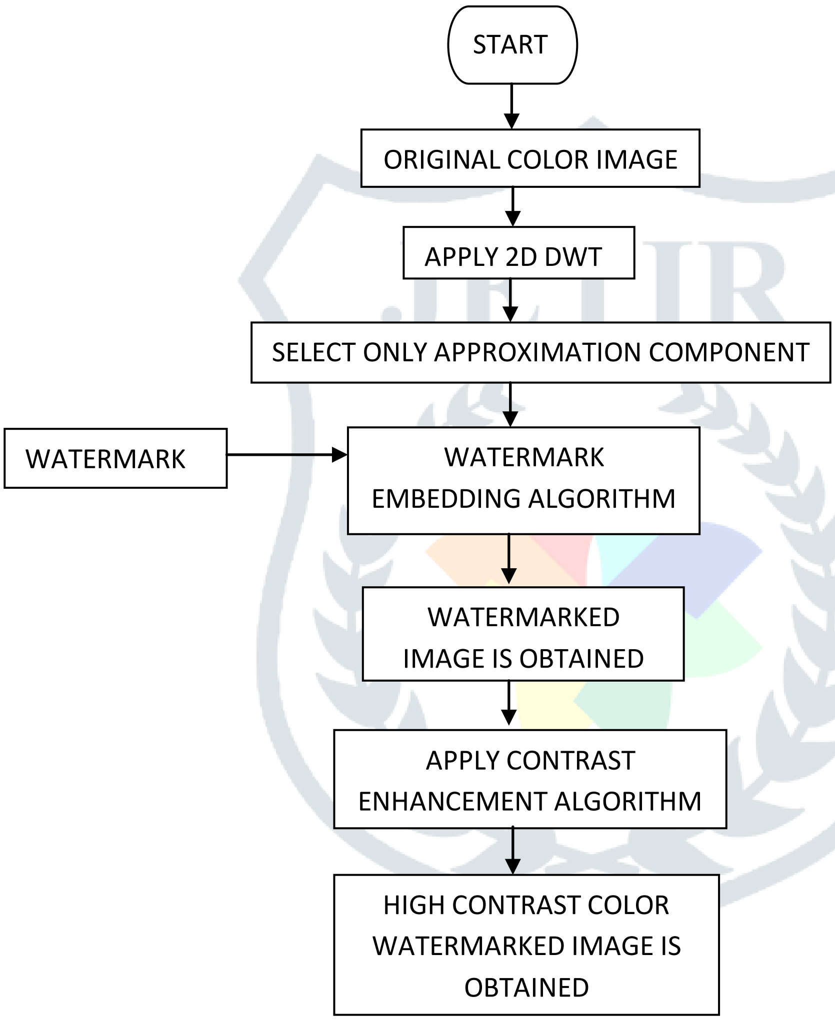


FIGURE 1. FLOW CHART OF WATERMARKING EMBEDDING ALGORITHM

An image is a two dimensional signal containing a multitude of frequencies both high and low and is also represented as a two dimensional matrix. Therefore the most appropriate portion to be taken into account for watermark embedding consists of high frequency components. So in order to identify the significant portion of the image data for consideration of watermark, the image I of size MXN is subjected to level 1 DWT thereby decomposed into four non overlapping multi-resolution sub-bands viz. LL (Approximation sub-band), HL (Horizontal sub-band), LH (vertical sub-band) and HH (diagonal sub-band), out of which LL is the low frequency component and rest are high frequency (detail) components. Apply watermarking embedding algorithm in Approximation sub-band so that watermarked image is obtained. But when we want to increase the contrast of image apply contrast enhancement technique. So that clear high contrast with watermarked image is obtained. When we want to extract the watermark apply IDWT on the watermarked image after than apply watermarking extraction algorithm so that watermark image is obtained.

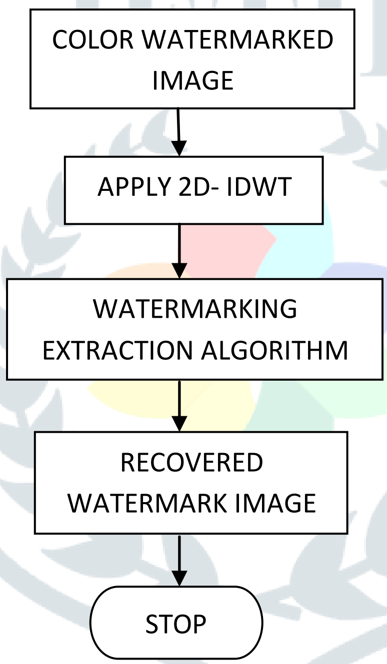


FIGURE 2. FLOW CHART OF WATERMARKING EXTRACTION ALGORITHM

6. EXPERIMENTAL RESULTS:

Experiments are performed to evaluate the imperceptibility of the embedded watermark as well as the robustness of the proposed watermarking scheme against various attacks. In our experiments, we use color images of size 512X512.

6.1. INVISIBILITY OF WATERMARK: Invisibility is an evaluative measure of perceptual quality of the watermarked image. In a satisfactory image watermark algorithm, watermark should not cause much degradation of perceptual quality of the watermarked image. In the proposed algorithm, a watermark image is embedded into different test images to test invisibility. As shown in figure 3 & 4, there are not much visual differences between original test images and their corresponding watermarked images. The extracted watermarks are all easily distinguishable. Furthermore, by analyzing the absolute difference between the test image and the watermarked image the images are indistinguishable, thus showing the effectiveness of the proposed watermarking scheme in terms of the invisibility of the watermark.

Figure 3 (a) Original and (b) proposed watermarked test images of *Lena* and (c) the difference between the original and proposed watermarked images.

Figure 4 (a) Original and (b) proposed watermarked test images of Chhaya, and (c) the difference between the original and proposed watermarked images.

TABLE 1: Performance of the Proposed Watermarking Scheme. The Best PSNR and MSE Values are Shown in Bold

IMAGES	**PSNR(db)**		**MSE**	
	Proposed Algorithm	REF[1]	Proposed Algorithm	REF [1]
Lena	**58.48**	55.58	**0.0923**	0.153
Chhaya	**58.14**	54.71	**0.0944**	0.2198

6.2. ROBUSTNESS OF THE PROPOSED ALGORITHM

Robustness is a default measure which is used to evaluate the performance of watermarking algorithm resistance against attacks such as compression, salt & pepper noise, filtering, cropping, and rotation. In a satisfactory algorithm for image watermark, the watermark would not be easily removed from the watermarked image after common and deliberate attacks.

TABLE 2: PSNR and MSE comparisons of LENA test image between the proposed scheme and the algorithm in [1].

S.No.		PROPOSED WATERMARKED IMAGE		PROPOSED EXTRACTED WATERMARK		REF [1] WATERMARKED IMAGE		REF [1] EXTRACTED WATERMARK	
	ATTACK TYPE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE
1	NO ATTACK								

									
		58.48	0.0923	55.89	0.676	55.58	0.153	50.22	0.6176
2.	JPEG COMPRESSION								
		55.92	0.154	51.56	0.765	50.67	0.673	50.22	0.617
3.	SALT & PEPPER NOISE								
		52.79	0.341	50.82	0.789	49.14	0.793	48.19	0.886
4.	MEDIAN FILTER								
		55.89	0.167	51.98	0.799	50.12	0.781	49.81	0.994
5.	CROPPING								

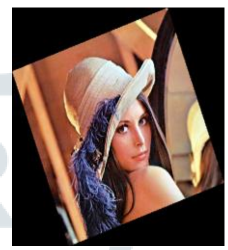
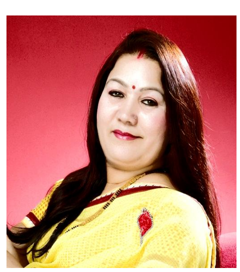
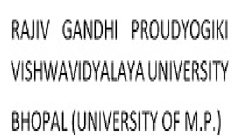
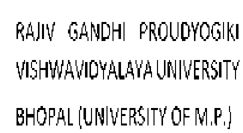
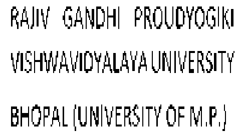
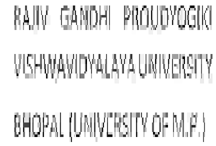
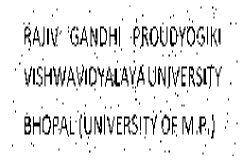
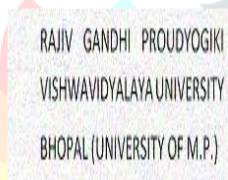
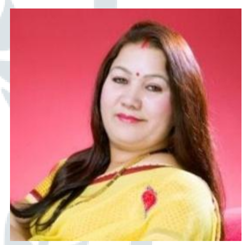
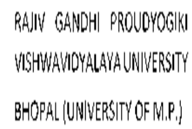
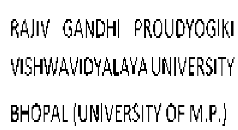
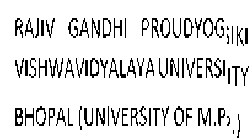
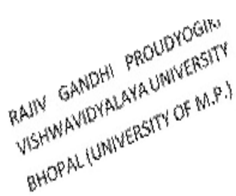
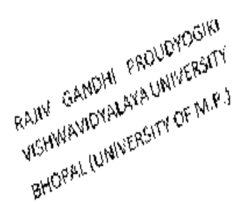
									
		51.22	0.7167	52.54	0.652	48.78	0.983	46.21	1.081
6.	ROTATION 20^0								
		51.79	0.541	49.82	0.999	49.67	0.811	48.99	0.986

TABLE 3: TEST IMAGE 2 PSNR and MSE comparisons of CHHAYA test image between the proposed scheme and the algorithm in [1].

S.No.		PROPOSED WATERMARKED IMAGE		PROPOSED EXTRACTED WATERMARK		REF [1] WATERMARKED IMAGE		REF [1] EXTRACTED WATERMARK	
	ATTACK TYPE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE
1	NO ATTACK								
		58.14	0.094	59.8	0.061	54.71	0.2198	55.89	0.1676
2.	JPEG								

	COMPRESSION								
		54.92	0.214	51.36	0.735	50.97	0.694	50.22	0.617
3.	SALT & PEPPER NOISE								
		52.79	0.341	49.42	0.812	48.94	0.713	48.09	0.826
4.	MEDIAN FILTER								
		55.95	0.165	50.28	0.531	50.82	0.681	49.81	0.994
5.	CROPPING								
		52.12	0.823	48.12	0.789	44.23	2.567	47.56	0.7967
6.	ROTATION 20^0								

		52.79	0.641	49.12	0.489	48.67	0.711	48.19	0.838

7. CONCLUSION

In this paper, a new proposed watermark detector with contrast enhancement has been proposed. Experiments have been carried out using standard color images to evaluate the performance of the proposed watermark algorithm. It has been shown that the performance of the proposed watermark algorithm for color images is substantially superior to that of the other conventional algorithm. It has been also shown that the performance of proposed algorithm is highly robust against common attacks such as JPEG compression, salt & pepper noise, median filtering, cropping & rotation.

8. REFERENCES

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