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ENTROPY BASED ADAPTIVE DIGITAL IMAGE WATERMARKING TECHNIQUE

[1]Mr. Shailesh Sakpal , [2]Prof. B. G. Hogade

Research Scholar Terna Engineering College, Navi Mumbai. Mumbai University
shails016@gmail.com
Professor, Terna Engineering College, Navi Mumbai. Mumbai University

Abstract:- In this digital world, Internet use has become prevalent. For all web users, information or data is a primary tool. Today it has become popular for accessing and exchanging media files such as images, audio, videos and copyrighted documents on public networks such as the Internet through Facebook, Twitter, email, forums, blogs, etc. The Internet paves the way for a wide range of multimedia content, such as text, images, audio, and video to be distributed. With the use of sophisticated signal/image processing algorithms, manipulations and duplication of audio, images, videos and documents are much easier. Therefore, content authentication has become an imminent and significant issue through encryption and resistance to general attacks such as noise, compression, and geometry. Data protection has become a big problem. Even the means through which the data is transmitted are not reliable. Therefore, some methods are required to protect media content. Digital watermark is one of the techniques that plays a key role in data protection. In this article, we proposed an adaptive digital watermark technique through the color and texture characteristics of an image through Arnold transform using DWT. In this research, we took entropy as one of the statistical parameters to decide the watermark based on color or texture. The two most popular attributes of the watermark, which are imperceptibility and robustness, decide the success of watermark algorithms. Experimental results in different cover images and under bindings such as mean attack, salt and pepper noise and geometric attack using PSNR and NCC, clearly demonstrate the robustness of the proposed algorithm.

Keywords: *Entropy, DWT, Attack, Adaptive Watermarking*

I INTRODUCTION

In the mid-1990s, the digital watermarking field became popular as a research topic. The watermark is defined as pasting a message, text, image, or logo into an image or audio or video file. In recent years, the rapid advancement of digital multimedia technology and Internet technology has made the transmission of images, video and audio convenient and widely used. The transmission of digital information over the Internet is faster and more convenient. However, duplicating, editing content, and modifying data is easier if you access that information in any way. In addition, it is not easy to distinguish between the original copy and the duplicate copy of the digital data. As a result, copyright protection and data authentication are becoming increasingly difficult tasks for digital content. Encryption/decryption can be used to protect this information. But if one has access to shared keys for this process, he/she can easily play with the data, thus changing its quality and semantics. Digital image watermarking techniques are widely used for copyright protection and content authentication. Digital watermark technology is a specific process that is an easy mean to extract the information embedded in the original signal. Digital watermark plays a key role in protecting digital content, copyright management and tamper detection. In this article, we propose an adaptive digital watermark algorithm based on wavelet transformation, which can perform blind detection.

II. RELATED WORK

This section describes the research done in the field of proposed system.

C. Ananth, et al. proposed DWT based multiple image watermarking technique for images using “Back Propagation

Neural Network (BPNN)" [1]. The PSNR value achieved was 45.01dB claiming the system to be imperceptible.

Subhrajit Sinha Roy, et al. developed spatial domain based digital watermarking system for copyright protection of digital images. "Adaptive LSB replacement technique" was used to embed the copyright information into the cover image [2]. The PSNR value obtained was 49.74 dB, NC for rotation attack 0.979 and for salt-and-pepper noise 0.995.

Di Fan, et al. proposed a blind watermarking algorithm in "Contourlet domain based on adaptive quantization" [3]. The NC value obtained for salt-and-pepper noise was 0.997 and for mean filtering it was 1 which proved that system was highly resistive to noise.

Palak Garg, et al. presented an optimized color image watermarking technique to protect an image data from any unauthorized access [4]. The technique presented in the paper used a combination of Discrete Stationary Wavelet Transform (DSWT), Singular Value Decomposition(SVD), Discrete Cosine Transform(DCT) and Arnold Transform. The PSNR value for salt-and-pepper noise was 65.08dB with NC value 0.94.

Sachin Gaur, et al. presented secure hybrid digital image watermarking scheme based on Redundant Discrete wavelet transform (RDWT), Discrete Cosine Transform (DCT) and Singular value decomposition (SVD) in zigzag order with Arnold transform [5]. The maximum PSNR obtained was 56.37dB for girl image and maximum NC value of 0.9938 for compression attack.

Emanuele Maiorana and Patrizio Campisi applied watermarking technique on "high dynamic range (HDR) media to prevent the misappropriation of HDR images" [6]. The bit error rate obtained for Gaussian noise was 28.43%.

Deepti Shukla and Nirupama Tiwari presented a survey and comparison on various digital watermarking techniques on images. Authors explored different watermarking techniques present in spatial and frequency domain [7].

L. R. Roldan, et al. proposed a "watermarking-based color image authentication with detection and recovery capability" [8]. Authors also used multilayer perceptron (MLP) to improve the quality of recovered image. The PSNR value achieved for the experiment was 24.68dB.

Prashanth Vaidya S., et al. proposed "an adaptive invisible watermarking technique in wavelet domain". Authors used Bhattacharya distance and kurtosis for embedding parameters [9]. The PSNR obtained was 52.07dB for Barbara image and 47.79dB for Lena image.

Aniket Roy, et al. proposed an image "adaptive optimized DWT-SVD based color image watermarking scheme in YCbCr color space using Human Visual System (HVS) model" [10]. Authors obtained PSNR of 51.95dB.

Hai Tao, et al. reviewed the theoretical analysis and performance investigation of representative watermarking systems in transform domains and geometric invariant regions [11]. This was based on image processing in spatial and transform domain. Different techniques using singular value decomposition and discrete wavelet transform in transform domain have been reviewed.

Pushpa Mala. S., et al. explored different watermarking techniques and different types of watermarking attacks. Authors performed experiment of digital watermarking attacks using "Fractional Wave Packet Transform" [12] and obtained a PSNR value of 35.78 for salt-and-pepper noise.

III. ALGORITHM

1. Given the dataset of cover image and watermark image.
2. Compute the mean of entropy of all cover images in the dataset.
3. Select the cover image and compute its entropy.
4. If entropy(cover_image) < mean_entropy

   Then

   i. Perform watermarking in color channels.

   ii. User will be prompted to select the color channel of the cover image (i.e. Red Channel, Green Channel, Blue Channel).

   Else

   i. Perform watermarking considering texture features of the RGB cover image.

   ii. Texture features like mean, variance, standard deviation, skewness and kurtosis are considered.

   iii. User will be prompted to select Bhattacharya distance or K L Divergence distance.
5. Compute the performance parameters like MSE, PSNR and NCC without attack and attacks like mean attack and salt and pepper noise attack and geometric attack.

Watermarking in Color Channels:

1. Read the input cover image and watermark image of size m x n.
2. Separate the R, G, and B channels for both the cover image and the watermark image.
3. Decompose each color channel of both cover image and watermark image into four sub-bands LL, LH, HL and HH using Debauches two dimensional discrete wavelet transform.
4. Use alpha-blending technique with alpha = 0.01 (can be varied) to perform watermarking using the LL sub-band of the watermark image for all color

channels (R, G, and B). With this, watermark image is now embedded into the cover image.

5. 2D inverse DWT is applied on the resultant LL sub-band coefficients of the watermarked image along with LH, HL, and HH sub-band coefficients of the cover image.
6. Compute the performance parameters like MSE, PSNR and NCC for the extracted watermarked image.
7. After that, compute the performance parameters like MSE, PSNR and NCC for the image exposed to mean attack and salt and pepper noise and also geometric attack.

Texture Based Watermarking

1. Read the input cover image and watermark image of size m x n.
2. Convert both the cover image and the watermark image from RGB to gray scale.
3. Decompose each color channel of both cover image and watermark image into four sub-bands LL, LH, HL and HH using Debauches two dimensional discrete wavelet transform.
4. Compute the texture features like mean, variance, standard deviation, skewness and kurtosis for each sub-band of the cover image and the watermark image.
5. Compute Bhattacharya Distance or K L Divergence distance between the above feature vectors of sub-bands of both the cover image and the watermark image.
6. Embed the scrambled LL sub-band of the watermark image into their respective LL sub-band of host image using the equation:
   Z = (1- alpha)* X + alpha * Y
   Where alpha is visibility coefficient ranging from 0 to 1
   X is the LL coefficient of cover image
   Y is the LL coefficient of watermark image
7. 2D inverse DWT is applied on the resultant LL sub-band coefficients of the watermarked image along with LH, HL, and HH sub-band coefficients of the cover image.
8. Compute the performance parameters like MSE, PSNR and NCC for the extracted watermarked image.
9. After that, compute the performance parameters like MSE, PSNR and NCC for the image exposed to mean attack, salt and pepper noise and also geometric attack.

IV EXPERIMENT RESULTS

In this section, the performance of the adaptive digital watermarking technique using color and texture features and Arnold transform is presented. Arnold transform scatters the pixels in an image. Algorithm was provided with five cover images and two watermark images with varying color content and textures. Entropy of each cover image was calculated and the average entropy for the five images was 6.97. The entropy of each cover image was compared with this mean entropy and accordingly the digital watermarking technique was carried using either color channel or texture based. The results shown in table 1 and 2 below for different watermark image was performed using Bhattacharya distance metric and in red channel of the RGB image. Image Lena has uniform distribution of colors within the image. Image Flower and Fruits are rich in color with non-uniform distribution or highly concentrated in small areas. Image Baboon has only black and white color. These four images also have varying texture pattern. Image Brochure has very low visibility and also less textures in it. Peak signal-to-noise ratio (PSNR) and normalized cross correlation coefficients (NCC) are used to measure the imperceptibility and robustness of the algorithm. To evaluate the robustness of the algorithm, we had employed noise attack like mean noise and salt-and-pepper noise and geometric attack such as rotation and cropping. Table 1 and 2 depicts the measured parameters PSNR and NCC for the watermark image 1(a) and 1(b) respectively. The simulation was done using MATLAB software.

(a) (b)

Figure 1. Watermark Images

Table 1. Parameters with respect to figure 1(a)

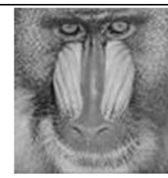
Attacks	**Parameters**	**Lena**	**Flower**	**Fruits**	**Baboon**	**Brochure**
						
	Entropy	**7.66**	**7.09**	**7.28**	**6.99**	**5.86**
Without Attack	PSNR (dB)	113.14	112.31	114.03	110.45	99.99
	NCC	0.98	0.97	0.97	0.98	1.00
Salt and Pepper Noise	PSNR (dB)	41.59	41.90	41.97	41.63	41.48
	NCC	0.85	0.86	0.89	0.80	1.00
Mean Noise	PSNR (dB)	88.88	91.68	87.37	92.28	83.89
	NCC	0.99	0.99	0.98	0.99	0.0039
Geometric	PSNR (dB)	34.61	33.14	32.60	34.09	33.32
	NCC	0.85	0.86	0.89	0.81	0.37

Table 2. Parameters with respect to figure 1(b)

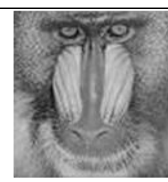
Attacks	**Parameters**	**Lena**	**Flower**	**Fruits**	**Baboon**	**Brochure**
						
	Entropy	**7.66**	**7.09**	**7.28**	**6.99**	**5.86**
Without Attack	PSNR (dB)	114.13	113.20	114.87	111.29	99.99
	NCC	0.9838	0.96	0.97	0.98	1.00
Salt and Pepper Noise	PSNR (dB)	41.56	41.80	41.91	41.70	41.43
	NCC	0.84	0.85	0.89	0.81	1.00
Mean Noise	PSNR (dB)	88.88	91.68	87.37	92.29	83.89
	NCC	0.99	0.99	0.98	0.99	0.0039
Geometric	PSNR (dB)	34.61	33.14	32.60	34.09	33.32
	NCC	0.85	0.86	0.89	0.82	0.37

Figure 2 shows the respective extracted watermark from Lena, Flower, Fruits, Baboon and Brochure images without attack. Figure 3 shows the respective extracted watermark from host images attacked by mean noise. Figure 4 shows the respective extracted watermark from host images attacked by salt-and-pepper noise. Figure 5 shows the respective extracted watermark from host images attacked by geometric attack.

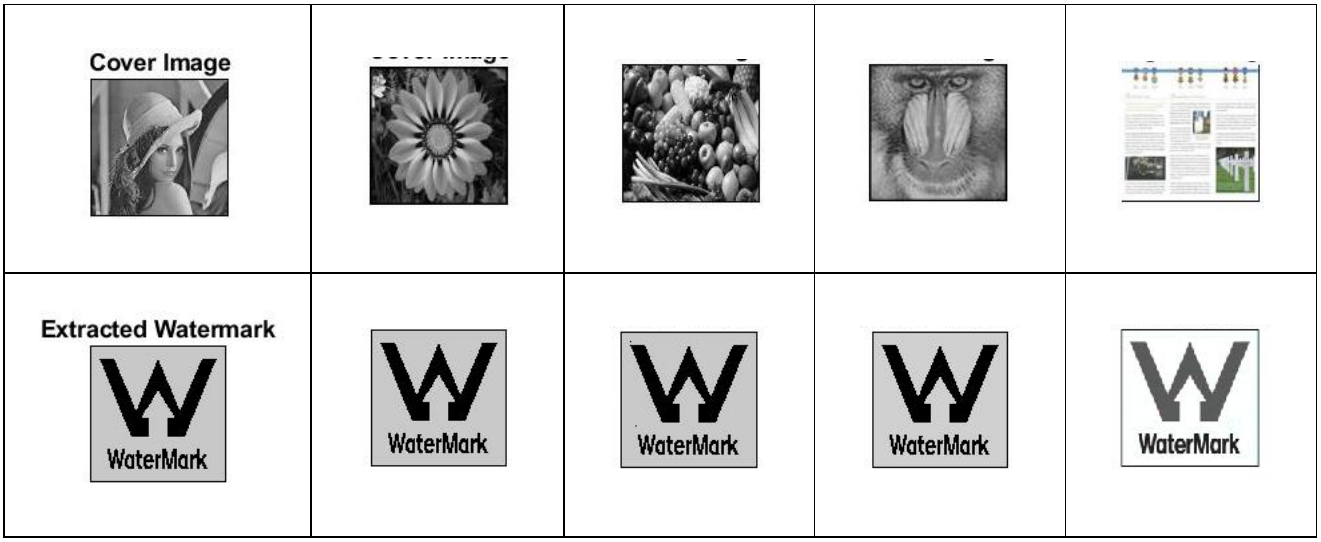


Figure 2. Extracted watermark image from respective host image without attack

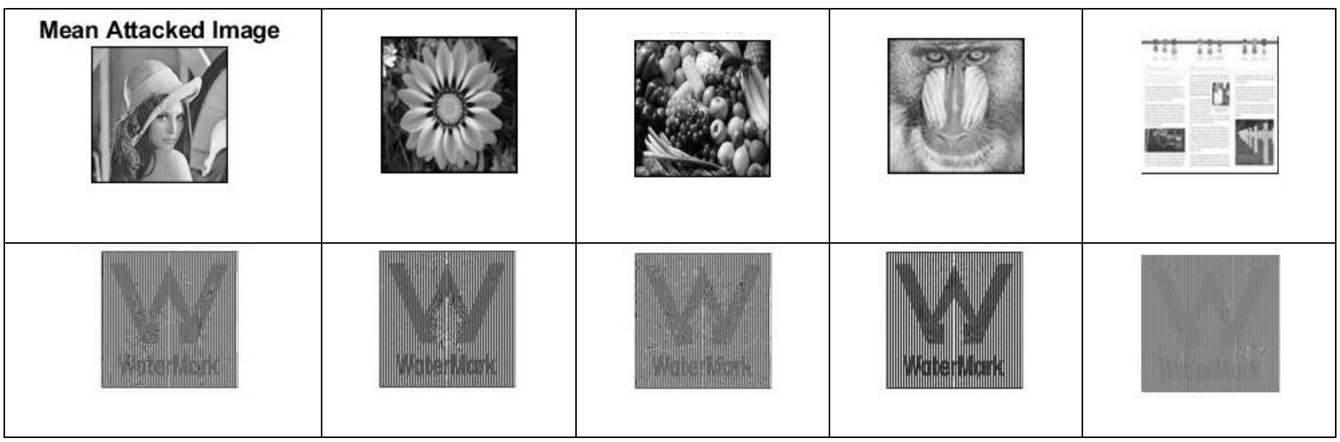


Figure 3. Extracted watermark image from respective host image Mean Attack

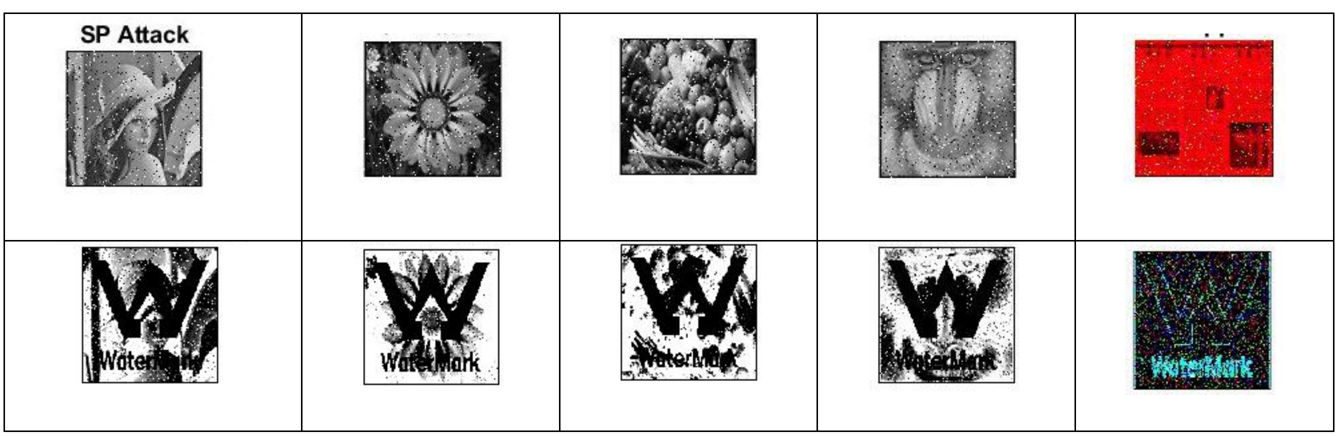


Figure 4. Extracted watermark image from respective host image Salt-and-Pepper Noise Attack

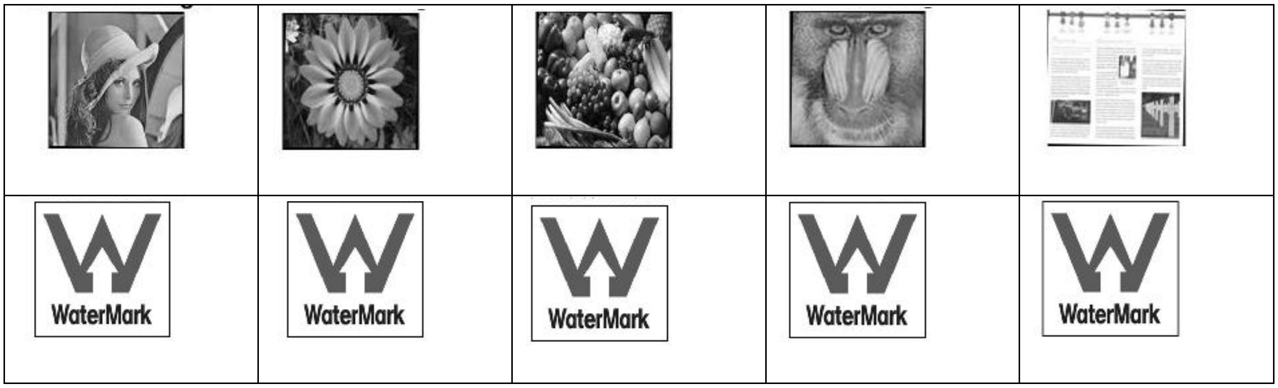


Figure 5. Extracted watermark image from respective host image with Geometric Attack

IV . CONCLUSION

In this research paper we have presented an imperceptible, robust and secure algorithm for Digital Image Watermarking of colored images. The novelty in this research is we have used entropy as the threshold parameter. This entropy decides whether the watermarking is to be done in color channel or texture based watermarking is to be carried out. Bhattacharya distance is used as one of the metric for texture based digital watermarking. The result show color based digital watermarking in red channel. Further, we can also show in green channel or blue channel of RGB image. The value of PSNR is more than 30dB, which indicates that the algorithm is robust to most common attacks like mean attack, salt-and-pepper noise attack and geometric attack. It also proves that the system is highly imperceptible. NCC values are less for image with less color distribution and texture when they are attacked by salt-and-pepper noise or geometric attack. In the experiment, we have considered only the LL sub-band coefficients to extract the watermark image during extraction process. To improve the values of NCC, it is required to consider all sub-band coefficients.

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