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Design and Implementation of Image Watermarking Scheme based on Exponential Function

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Abstract— In this paper, exponential transformation based watermarking of multimedia images has been proposed. The principle behind the scheme is anticipated in frequency domain to elevate robustness and big data entrenching capacity. In the anticipated approach, the secrete image is first imperiled for compression using exponential function and then entrenched onto the cover data. Statistical analysis of resultant data proves better robustness in par with other existing methodologies.

Keywords— Robustness, Exponential transformation, Multimedia, Big data, Statistical analysis.

I. INTRODUCTION

Digital image watermarking (DIW) is an extensively used mutual technique to code multimedia data with an identifier for the purpose of authentication between source and destination [1-2]. Thumping the unique information by a deceptive (cipher) is the foremost feature of information security [3-7]. Digital watermarking can be a very effective tool for information hiding as it is a process of hiding information inside a digital signal [8]. By using watermarking, a secret information can be hidden into a digital signal whose authenticity has to be maintained. The secret information can be hidden by embedding it into the signal in such a way that it remains present in the signal no matter what happens throughout the transmission and reception process. The process by which watermarks are inserted into the host signal is known as embedding process [9].

Digital image entrenching is a practice of embedding multimedia data in an image in the form of logo or signatures for the persistence of identification and sanctuary [10]. The digital image watermarking techniques are broadly classified as major modules: frequency and spatial domain [11].

In spatial domain, pixel values are unswervingly reformed on the watermark. In frequency domain, the transformed co-efficient of secrete data is exposed for modification and then entrenched into the cover data.

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Discrete Wavelet Transform (DWT), Fourier Transform (DFT) and Cosine Transform (DCT) are the frequently used frequency domain transforms for the purpose of watermarking.

Robustness and imperceptibility are the major parameters of a secured watermarking technique [12-13]. Robustness involves the ability of a watermarked image to withstand differential attacks such as cropping of watermarked image, filtering the watermarked image to reduce noise interference and compression of watermarked image to reduce the space for storage. After watermarking process, the watermarked image is compared with host to define imperceptibility.

DIW is a process of hiding digital evidence in the carrier. Xiao-Long Liu & et. al. [14] described a new watermarking system based on DWT. The resultant watermark image withstands various security attacks. Thottempudi pardhu & et.al. [15] proposed a last line of defense against unauthorized distribution of digital media. They enhanced the watermarking properties including imperceptibility, robustness and security in the resultant image. S Gaur & et. al. [16] presented a hybrid digital watermarking method using Wavelets, DCT and Decomposition techniques. They adopted different optimization techniques for colour images and to make it adaptive with all sub bands getting best result. Decomposition based algorithms are resilient to geometrical transmutations, such as clipping, rotation and scaling. By the adoption of the above method, robust blind removal of the watermark and scrambling operation has been achieved, which enhances the robustness of the algorithm [17]. Prajwalasimha S N et. al. [18] introduced both Cosine (DCT) and Successive division based approaches to increase the reliability of watermarked images. Khalil et. al. [19] improved quality of obtained watermark image in terms of imperceptibility, robustness to gamma correction and histogram equalization. Noise interference in the watermarked domain has to be effectively examined to improve the level of security in the spatial domain [20].

The proposed algorithm deals with exponential maneuver on images in order to entrench watermark into base image using 128 bits of secrete key.

II. PROCEDURE

In the proposed scheme, the two phases include: entrenching the watermarking into the cover and de-watermarking from the same.

A. Implanting the Watermark

Step1: A cover image of size α X α is considered as base image for the entrenching process.

Step2: Comparing actual key with input.

Step3: By considering the anticipated secrete key combination, the watermark of size α/2 X α/2 is imperiled for 11^{th} root of exponential function.

$$\omega|(x,y) = \sqrt[11]{[\omega(x,y)]} \qquad 1 < a,b < \alpha/2 \qquad (1)$$

Where,

$\omega(a,b)$ - Input watermark

$\omega|(a,b)$ - Transformed watermark

Step4: A substance watermark of size α X α is poised by concatenating the exponentialzed watermarks to get complete bulk image.

$$\omega||(a,b) = \begin{bmatrix} \omega|(a,b) & \omega|(a,b) \\ \omega|(a,b) & \omega|(a,b) \end{bmatrix} \qquad (2)$$

Where,

$\omega|(a,b)$ –Transformed watermark

$\omega||(a,b)$ –Concatenated watermark

Step5: Bulk watermark is enriched into cover image by adding corresponding pixels of either image.

$$\omega,(a,b) = c(a,b) + \omega||(a,b) \quad 1 < a,b < \alpha \qquad (3)$$

Where,

$\omega,(a,b)$ -Watermark embedded image.

$c(a,b)$ - Cover image.

$\omega||(a,b)$ - Transformed watermark.

B. De-Embedding Processes

Step1: The obtained watermarked image is imperiled for de-noising processes to lessen the noise contents.

Step2: The filtered image is then separated from the cover image by subtraction process to get the watermark image in the malformed phase.

$$\omega'||(a,b) = \omega,(a,b) - c(a,b) \quad 1 < a,b < \alpha \qquad (4)$$

Where,

$\omega,(a,b)$ - Watermark embedded image.

$c(a,b)$ - Cover image.

$\omega'||(a,b)$ - Transformed watermark.

Step3: The obtained watermark of size α X α is composed by concatenated and transformed watermark.

$$\omega'||(a,b) = \begin{bmatrix} \omega'|(a,b) & \omega'|(a,b) \\ \omega'|(a,b) & \omega'|(a,b) \end{bmatrix} \qquad (5)$$

Where,

$\omega'|(a,b)$ - Transformed watermark

$\omega'||(a,b)$ - Concatenated watermark

Step4: Secrete key is considered to obtain watermark image α/2 X α/2 in exponential phase is imperiled for 11^{th} power of exponential function.

$$\omega(a,b) = [\omega|(a,b)]^{11} \qquad 1 < a,b < \alpha/2 \qquad (6)$$

Where,

$\omega||(a,b)$ - Transformed watermark

$\omega'|(a,b)$ - Resultant watermark

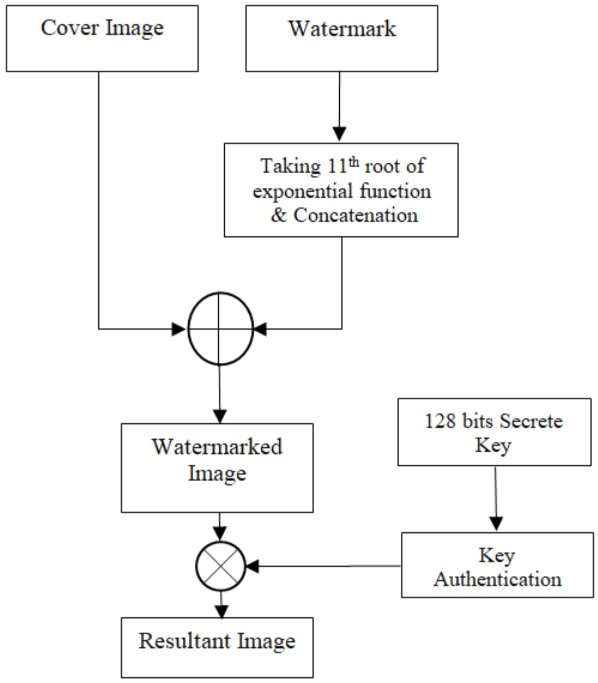

Fig 1. Watermark Embedding Approach

III. ANALYSIS

For experimental study, Matlab software is used with Intel Core i3 processor. Test data set is considered from Computer Vision Group, Spain for the examination with a symbolic image as watermark. The enactment examination includes Watermark to Document Ratio (WDR), Signal v/s Noise (PSNR), Correlation (NC), Mean Square Error (MSE), and among cover and resultant image. Statistical and mathematical analysis specified much enhanced results associated to present existing systems as tabulated below.

Figure 2 Watermark

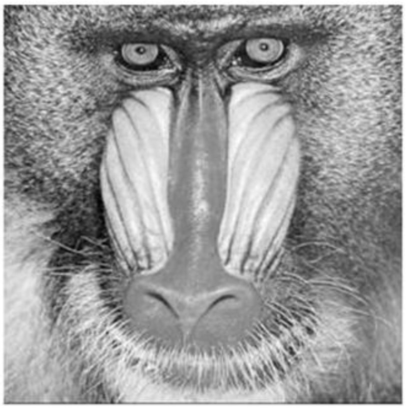

Figure 3 Cover image

Table-I PSNR between cover and watermarked images.

Images	PSNR (dB)
Lena	**49.29** (Discrete Wavelet Transformation)[8]
	29.589 (Discrete Cosine Transformation) [8]
	37.27 (Fourier Transformation) [8]
	41.28 (Wavelet-Cosine Transformation) [8]
	40.6926 (GA) [9]
	54.3217
Cameraman	**40.2608** (GA) [9]
	54.6052
Pirate	**52.3612** (GA) [9]
	54.4217
Donna	**54.3572**
Peppers	**54.5265**

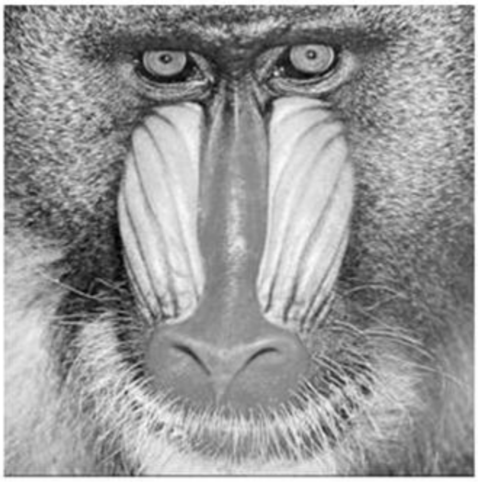

Figure 4 Watermarked Image

Figure 5 Retrieved Watermark

Table- II MSE between host and watermarked images

Images	MSE
Lena	**1** (Discrete Wavelet Transformation)[8]
	26 (Discrete Cosine Transformation) [8]
	12 (Fourier Transformation) [8]
	5 (Wavelet-Cosine Transformation) [8]
	1.024
Cameraman	**1.0283**
Pirate	**1.0041**
Donna	**1.0272**
Peppers	**1.0138**

Table- III Watermark to document ratio (WDR) between cover and Watermarked images.

Images	WDR (dB)	
Lena	-87.7824 [18]	-83.1099
Cameraman	-89.4073 [18]	-81.8535
Pirate	-	-85.67
Donna	-	-84.7652
Peppers	-	-83.5667

Table.-IV Mean Correlation (NC) between Cover and Watermarked images.

Images	NC
Lena	1 (Discrete Wavelet Transformation)[8]
	0.984 (Discrete Cosine Transformation) [8]
	0.994 (Fourier Transformation) [8]
	0.999 (Wavelet-Cosine Transformation) [8]
	0.999
Cameraman	0.999
Pirate	0.999
Donna	0.999
Peppers	0.999

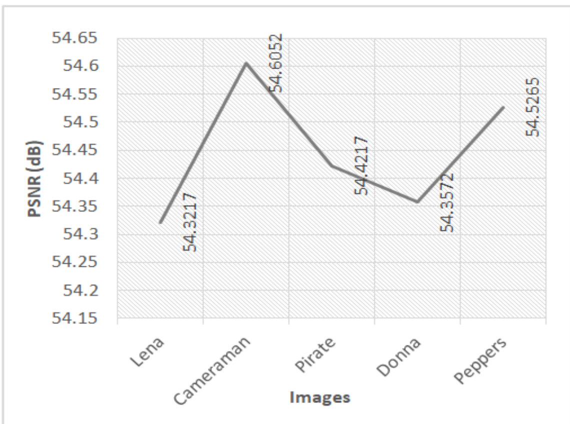

Figure. 6 Variations of PSNR (dB) for standard images

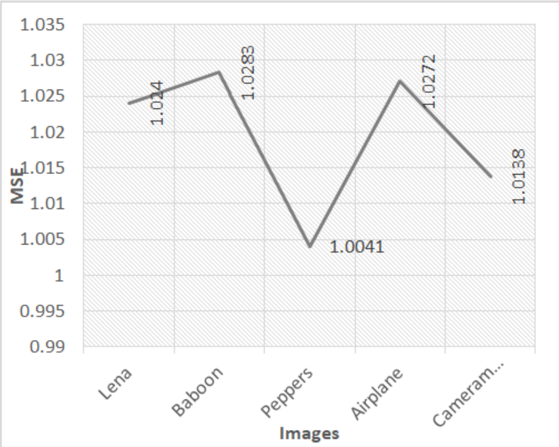

Figure. 7 Variations of MSE for standard images

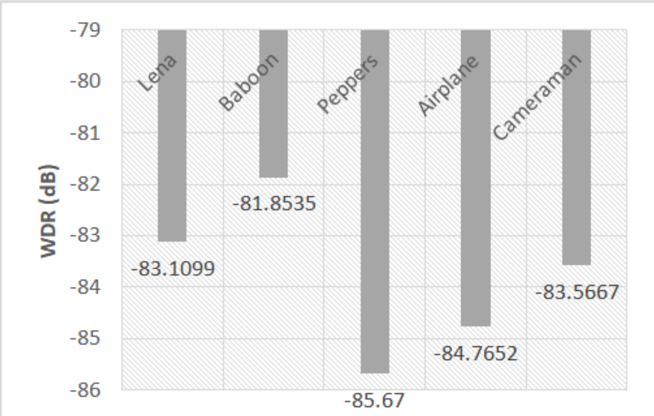

Figure. 8 Variations of WDR (dB) for standard images

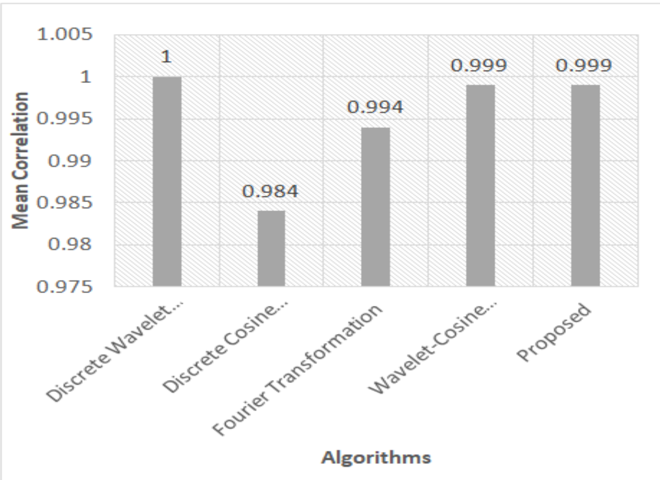

Figure. 9 Comparison of NC for existing techniques

IV. CONCLUSION

In the watermarking principle based on exponential operator, the watermark is imperiled to 11th root of exponential function and there after entrenched onto the cover data. With this approach, due to robust attacks, the entrenched watermark is not much pretentious. The observation perceived that very high PSNR and very less MSE are accomplished by resultant data in par with other existing approaches. Also it is discerned about the correlation between cover and resultant images is almost equal to 1, as perceived in wavelets. All the empirical analysis shows that, the exponential watermarking technique gives better results in comparison with exiting algorithms. Further, the anticipated approach can be mutual with filters to enhance the algorithmic efficiency with noise interference.

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