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A Robust Combination of DWT and Chaotic Function for Image Watermarking

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***Abstract*—** with the increase in the digital media transfer and modification of image is very easy. This independency generate proprietorship problem of the user. So this paper focuses on this problem of increasing the robustness of the image against various attacks. Here new approach of protecting watermark of the image is done by DCT technique at selected blocks of chaotic function work effectively for fulfilling the requirement. Experiment is done on standard images and under compression attack. Results shows that proposed work is better as compare to previous existing research.

***Keywords*--** Color Format, Digital Watermarking, Frequency domain, LSB.

I. INTRODUCTION

As digital world is growing drastically people are moving towards different services provide by it. Some of this service is social network, online market. But this technology gives rise to new problem of piracy or in other words proprietary get easily stolen. So to overcome these different techniques are used for preserving the proprietary of the owner. One of such digital approach is watermarking which is a subsection of hiding information that is used to put some information in the original image which will specify the originality of the digital data like photographs, digital music, or digital video [1, 2, 4]. One of the basic causes of the copyright issue is the ease available of the internet and some software that can modify the content as per the user requirement. Watermark is broadly divide into two categories first is visible watermarking and other is invisible watermarking. Here watermark information seen by naked eyes is considered as visible watermarking as shown in fig. 1. While in case of invisible watermark data is not visible by naked eyes as shown in fig. 2, although watermark data is present in the original data. Data may be of any digital information like text file, image, video file, etc. Requirement of invisible watermark is popular in photography, movies, etc. So putting the signature in the image for validating the data is done. Although invisible embedding in carrier image is complex and challenging task but different techniques are working in this field. Proposed work will increase the hiding capacity and preserve carrier as well as watermark information.

Figure 1 Visible watermark in image data

Figure 2 Visible watermarks in image data

II. RELATED WORK

J. Wu, and J.Xie [22] propose an adaptive watermarking technique in DCT domain using HVS model and fuzzy c-means technique (FCM). In this method FCM technique is used to classify non-overlapping 88×original blocks into categories: one is suitable for watermarking with high imperceptibility and robustness and the other is unsuitable. Watermark is inserted in DCT mid-frequency coefficients of selected blocks. W. Zhang et el. [23] propose an adaptive digital watermarking approach. In this method FCM technique is used to determine the watermark strength of each image pixel, and then watermark is inserted adaptively to the N largest magnitude non-dc DCT coefficients of the host image. The both the method performs better against additive noise, compression and cropping etc. Yifei Pu. et el. [24] proposes a public adaptive watermark algorithm m for color images based on principal components analysis of

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generalized Hebb. The algorithm is based on principal component analysis of generalized Hebb adaptive algorithm in Artificial Neural Network and to do adaptive quantitative coding for principal component coefficients according to the proportion of marginal or textural information of the watermark image. In addition, it adaptively adjusts the embedding depth according to the images features to ensure the invisibility of the watermark. By way of disporting and stochastic embedding into color image watermark, it increases the embedding robust city of watermark. C. Podilchuk, W. Zeng [21] propose a watermarking technique for digital images that is based on utilizing visual models, which have been developed in the context of image compression. The visual model gives a direct way to determine the maximum amount of watermark signal that each portion of an image can tolerate without affecting the visual quality of the image. The watermark encoding scheme consists of a frequency decomposition based on an 8×8 framework followed by just noticeable difference (JND) calculation and watermark insertion. The watermark scheme is robust to different attacks such as JPEG compression, additive noise, scaling etc.

III. PROPOSED METHODOLOGY

Read Carrier Image: - Here as the image is the collection of pixels where each pixel is representing a number that are reflecting a number over there now for each number depend on the format it has its range such that for the gray scale format it is in the range of 0-255. So read an image means making a matrix of the same dimension of the image then fill the matrix correspond to the pixel value of the image at the cell in the matrix.

DWT (Discrete Wavelet Transform):- Apply DWT on pre-processed image. As the image are modify in the low frequency region so the effect of compression attack is very less. If direct change is done at this level then chance of watermark recovery get decrease and quality of video also degrade as at high frequency region human can detect it easily. Here whole image is dividing into four part name as LL, LH, HL, HH band where LL band is low frequency band.

Chaotic Function:- In this step original image from the database is jumble by utilizing the chaotic matrix where each pixel position is multiply by the matrix, then new position is obtain for the pixel value. In similar fashion all pixels of the image is randomize. Chaotic Matrix =

$$\begin{vmatrix} 1 & 1 \\ \lambda & \lambda+1 \end{vmatrix}$$

CM (Chaotic Matrix), λ is variable range from 1, 2…n. Let P is matrix represent [row, column], then multiple CM and p, will give N matrix which is a new pixel position of the older pixel. N=CM*P

Make Image Block: Here image is dividing into same size of three blocks. Here size is same as 8X8 in this case 8 means number of pixel in the row and column should be 8X8=64 pixels. Now watermark is also dividing into same set of blocks of 8X8 so that Euclidean distance between those blocks can be calculated. Finally block which has minimum distance from the carrier image is replaced.

Eludician Distance: - In this step distance between the blocks of the image is calculated. This formula is same as the Pythagoras theorem. Let X and Y is the image feature for distance calculation. $D = \sqrt{sum((X-Y)^2)}$ So as per the D value of the watermark block embedded block in carrier image is selected.

Embedding Block: - As work is done on image so embedding is done on the matrix of the image, so whole operation of embedding is done by finding the minimum distance image from the watermark block. As most matching block have minimum distance and replace that block with watermark block. In similar fashion other blocks of the carrier image is replace. In order to increase the transparency block size can be reduced.

IDWT (Inverse Discrete Wavelet Transform):- Finally IDWT is applying on the embedded image this will retransform the matrix in original form. This is necessary as matrix is dividing as per LL, HL, LH, HH quadrants. After IDWT all the blocks are combining back to single image.

3.1 Proposed Encryption Algorithm

Input: O [Original Image], w [Watermark]

Output: EI [Embedded Image]

Loop 1: C // c: Cycle of chaotic function.

[LL LH HL HH]←DWT (O)

While distance between new LL and original LL < T // T is Threshold

LL←Chaotic_function (LL)

If c= Embedding_position

BLL[n] ←Blocks (LL) // n number of blocks

BW[m] ←Blocks (W) // n number of blocks

Loop 1: m

Loop 1: n

D[n] ←Euclidean (BLL[n], BW[m])

x←Min (D) // MSB three bit

BLL[n] ←BW[m]

End Loop

End Loop

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LL←Combine_Block (BW)

End While

EI←IDWT (LL LH HL HH)

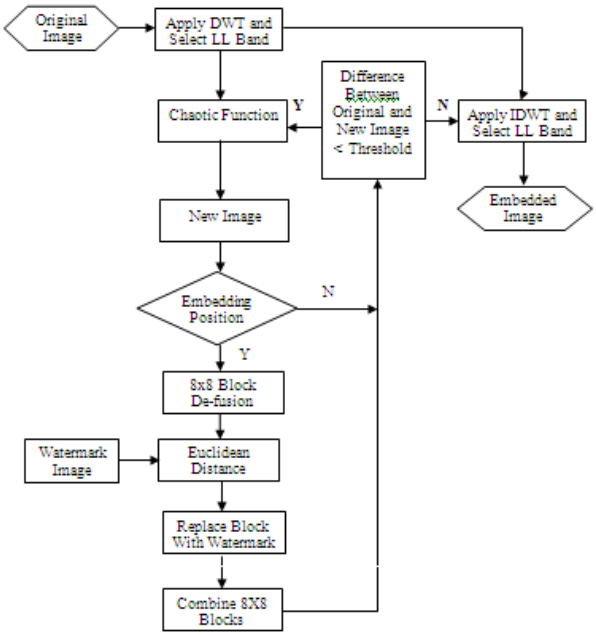

Figure 3 Block diagram of proposed Embedding Work

3.2 Extraction

In this step whole process of extraction is explained which is almost same as done in embedding. Here input is embedded image while output is extracted image. Here DWT is applying on the embedded image then LL band is select for rest of operations. Now LL band undergoes a chaotic function where at fix number of rotation it get stop. This position is same as done at embedding time. Now matrix at this position is use for extraction of watermark data. Divide matrix into same size of blocks as done in embedding, and then find the replaced and non-replaced blocks of the input matrices. So this extraction of data is repeat in each block till all watermark information is not extract from the matrix. Once watermark is extract then remaining chaotic rotation is continue to get image in original form.

IV. Experiment and Result

This section presents the experimental evaluation of the proposed Embedding and Extraction technique for privacy of image. All algorithms and utility measures were implemented using the MATLAB tool. The tests were performed on 2.27 GHz Intel Core i3 machine, equipped with 4 GB of RAM, and running under Windows 7 Professional. Experiment done on the standard images such as mandrilla, Lena, pirate, etc. Result is compare at two condition first is without attack and other is at noise and filter attack.

4.1 Evaluation Parameter

Peak Signal to Noise Ratio (PSNR):- it is use to find the amount of data present from the received signal as it may corrupt by the presence of some noise. So it is term as the peak signal to noise ratio. PSNR is the ratio between the maximum possible received information and the noise that affects the fidelity of its representation.

$$\text{PSNR} = 10\log_{10}\left(\frac{Max\_pixel\_value}{Mean\_Square\_error}\right)$$

figure 4 Represent dataset images.

Structural Similarity index: - SSIM term is a method for finding the similarity between two images. The SSIM method use for evaluating the image quality based on an initial uncompressed or distortion-free image as reference. It is introduce to improve the traditional schemes like PSNR and MSE, which have proven to be inconsistent with human eye perception.

Extraction Rate: - This is the reverse of the BER where value is obtained by the ratio of the correct bits received after extraction to the total number of bits embeds at the sandier. The extraction rate η is defined as follows:

$$\eta = \frac{n_c}{n_a} \times 100$$

Where n_c is the number of correctly extracted bits, and n_a is the total number of embedded bits.

From given table 2 and 3 it is obtain those three images are chosen for testing, in presence of ideal condition. It is observed that proposed work is better as compare to the Embedding method in [9]. As in proposed work watermark information is add in the image separately. From given table 4, 5, 6 and 7 it is obtain that three images are chosen for testing, in presence of different attack. It is observed that proposed work is approximately same as compare to the Embedding method in [9]. As in proposed work watermark information is add in the DWT LL band of image separately. From above tables it is obtain that ETA values of the information received has high percentage of recovery in presence of noise attack. While ETA values of the information received has low percentage of recovery in presence of filter attack.

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PREVIOUS WORK [9] IDEAL CONDITION			
Image	SNR	PSNR	ETA
Pirate	35.3476	27.9248	100
Lena	14.5990	27.8410	100
Mandrila	29.0891	35.1771	100

Table 1 Values at ideal conditions of previous embedding method [9].

PROPOSED WORK IDEAL CONDITION			
Images	SNR	PSNR	ETA
Pirate	31.8776	80.3592	100
Lena	32.6006	80.1772	100
Mandrila	35.8555	77.3721	100

Table. 2 Values at Ideal condition Proposed Work method.

PROPOSED WORK NOISE ATTACK			
Images	SNR	PSNR	ETA
Pirate	21.1258	53.8063	13.5417
Lena	21.1847	53.7474	15.1042
Mandrila	11.3012	36.0267	8.1597

Table. 3 Noise attack on proposed Embedding method.

PREVIOUS WORK NOISE ATTACK			
Images	SNR	PSNR	ETA
Pirate	10.8903	30.7714	1.5015
Lena	11.6892	30.7823	1.5442
Mandrila	6.6656	35.8815	0.6744

Table. 4 Noise attack on previous Embedding method [9] method.

PROPOSED WORK FILTER ATTACK			
Images	SNR	PSNR	ETA
Pirate	14.3139	60.6182	2.7778
Lena	14.6503	60.2818	9.0278
Mandrila	13.3426	61.5894	2.0833

Table. 5 Filter attack on proposed Embedding method.

PREVIOUS WORK FILTER ATTACK			
Images	SNR	PSNR	ETA
Pirate	13.8055	27.8562	2.2501
Lena	14.3529	28.1186	2.2640
Mandrila	8.0723	34.4749	0.1435

Table. 6 Filter attack on previous Embedding method [9].

V. CONCLUSION

In this paper a new approach of watermarking is studied in detail. . So this work has presented a novel approach of the embedding and extraction of the digital message in the image which is quit unique as well as different from the various existing methods. Result shows that the proposed work is producing the results which maintain the image quality as well as robustness against the data insertion. As research is a continuous process of achieving new heights so in future one can apply same work for color images.

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