HISTOGRAM BASED WATERMARKING USING ENTROPY TECHNIQUE IN DIGITAL IMAGES

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***Abstract*— This paper describes better image quality and to retain the integrity of the watermark after being embedding in to the original image and reduce perceptual degradation. This paper describes the interpolation and histogram equalization. After pre-processing entropy is calculated in different domains like gray scale, DCT and DWT to check high entropy value for watermark insertion as high entropy area would be less sensitive to attacks and provide robustness and guaranteed invisibility.**

***Keywords*— Interpolation, histogram equalization, secret key, PSNR**

I. INTRODUCTION

Watermarking is the process of computer-aided information hiding in a carrier signal. Watermarks may be used to verify the authenticity or the integrity of the carrier signal or to show the identity of its owner. It is prominently used for tracing copyright infringements and for banknote authentication. Watermarking tries to control the robustness at top priority.

Digital watermark could be a message, data and information that is embedded into digital content (audio, video, images or text) which will be detected or extracted later. Such message, data, information principally carries the copyright or possession info of the content.

A. Why Digital Watermarking

In order to protect copyrighted material from illegal duplication, two typical technologies have been developed. One approach uses key-based cryptographic methods which enable the appropriate security during the transmission process, but once the encrypted data is decoded, the control of redistribution and its spread fails. To address limitations of encryption, the main idea is to label a digital material with specific marks, which are called digital watermarks. Such technology can be used as ownership proof for distribution channel tracking and other applications in business and public domains.

Furthermore, watermarking technology enables the owner to obtain the copyright status of certain documents and distributors can be made accountable for the condition. Additionally, compatible media player technology (DRM used by Microsoft in Windows media player), Divx and DVD player, can detect distorted marks and refuse to play, display, or execute the media asset files.

B. Histogram Equalization

Histogram equalization is a technique for adjusting image intensities to enhance contrast. It basically provides a sophisticated method for modifying the dynamic range and contrast of an image.

Histogram equalization assigns the intensity values of pixels in the input image from this at the output side image contains a uniform distribution of intensities. It basically improves contrast of an image and this technique can be used on a whole image or on a part of an image. In this technique each pixel is assigned a new intensity value based on its previous intensity level.

The general histogram equalization formula is

$$h(v) = round\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right)$$

Where CDF min is the minimum value of the cumulative distribution function M × N gives the image's number of pixels where M is width and N the height and L is the number of grey levels used.

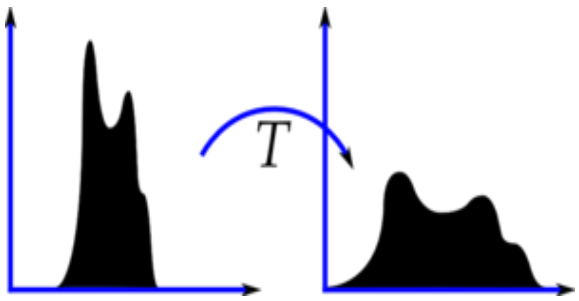

Fig. 1. Equalized Histogram

C. Entropy

Entropy is a measurement of uncertainty, the area with large entropy keeps balance between robustness and transparency as a result. In information theory, **e**ntropy is a measure of the

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uncertainty in a random variable. Image entropy is a quantity which is used to describe the business of an image, i.e. the amount of information which must be present in the image. Low entropy images, such as those containing a lot of black sky, have very little contrast and are venerable to attacks. An image that is perfectly flat will have entropy of zero. Consequently, they can be compressed to a relatively small size.

In order to keep effectiveness of media content communication, the area with more information provides high robustness. For another, the area with great uncertainty provides excellent masking effect, leading to high transparency. While the entropy is a measurement of uncertainty, the area with large entropy keeps balance between robustness and transparency as a result.

Formula to calculate the entropy value

$$Entropy = -\sum_i P_j Log_2 P_j$$

In the above expression, P_i is the probability that the difference between 2 adjacent pixels is equal to i, and Log_2 is the base 2 logarithm.

II. LITERATURE REVIEW

Simi Elizabeth Chacko et al. [1] proposed a data hiding method based on interpolation which calculates the interpolation error and the residual histogram of the interpolation errors of the host image to hide secret data. The residual image is obtained by interpolation and histogram shifting is applied to obtain the watermarked image. .The major advantages of this method are higher image quality and smaller computational cost as compared to other data hiding techniques. Image quality is evaluated in terms of peak to signal ratio (PSNR).Experimental results show that quality of watermarked image is higher for this scheme as compared to other existing watermarking schemes.

Yana Zhang et al. [2] proposed the essence of information transmission in digital watermarking system and the dissymmetric digital watermarking framework lived on media content communication. Then we propose a universal entropy masking model for watermarking embedding algorithm to keep the balance between watermarks' imperceptibility and its robustness. Also we conclude from the experiments that a suitable domain of entropy calculation will result in optimal watermarking performance.

Hamza A. Ali et al. [4] proposed a robust digital image watermarking technique that attributes the watermarking process to signal modulation model. It is based on the histogram analysis for maximum intensity value of pixels. First, carrier image is properly segmented into blocks, then the histogram for each block is drawn and the peak frequency of occurrence for intensity moments in the carrier image is identified. Then bit values of the modulating (watermark) image are used to modulate the histogram peaks of the intensity.

Zhicheng Ni et al. [8] proposed a novel reversible data hiding algorithm, which can recover the original image without any distortion from the marked image after the hidden data have been extracted, is presented in this paper. This algorithm utilizes the zero or the minimum points of the histogram of an image and slightly modifies the pixel grayscale values to embed data into the image. It can embed more data than many of the existing reversible data hiding algorithms. It is proved analytically and shown experimentally that the peak signal-to-noise ratio (PSNR) of the marked image generated by this method versus the original image is guaranteed to be above 48 dB. This lower bound of PSNR is much higher than that of all reversible data hiding techniques reported in the literature. The computational complexity of our proposed technique is low and the execution time is short**.**

III. FORMULATION OF PROBLEM AND WORK METHODOLOGY

This paper describes the entropy based method is proposed for invisible watermarking in still grey scale images using discrete wavelet transform and histogram equalization. The original image is chosen where we want to embed the watermark for copyright protection. And embedding is done in such a way so that it is invisible to others. To embed the watermark, we firstly improve the quality of image and then calculate entropy of the original image in different domains because maximum randomness or uncertainty leads to better embedding of watermark and enhance robustness against attacks. Also in this proposed work secret key is embedded to enhance more security.

A. Work Methodology

The proposed technique is based on interpolation, Entropy calculation, histogram equalization and reverse bi-orthogonal DWT (discrete wavelet transform) domain. The original image is of 256*256 and watermark should be either equal to size of original image or less than that of the size of original image. The DWT domain improves the security and robustness during communication. The watermark is embedded into the DWT coefficients of the histogram equalized image.

In our proposed system we first implement interpolation over the original image using bilinear interpolation on the interpolated image we apply entropy filtration in order to find which domain is better for embedding the watermark. So we find that out of grey scale, DCT and DWT.

DWT domain has highest entropy so for embedding DWT is chosen as it is more secure and less vulnerable to attacks and the PSNR (peak signal to noise ratio) of the DWT domain over the original image is higher than other domain and. After that we do histogram equalization on the interpolated image to get the histogram equalized image and then we can apply reverse bi-orthogonal DWT wavelet to insert the watermark. Then again we can decompose the watermark by using R-bio wavelet and multiply the values of pixels of watermark by the factor alpha in order to insert the watermark uniformly anywhere in the histogram equalized image. The proposed work achieve quite interesting finding. The PSNR of the

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watermarked image over the equalized image is always comes out to be more than 80 for different images. Also in our proposed work watermarking is done with higher invisibility and secondly the security is provided while transmitting the image over the internet or communication channel.

B. Performance Analysis

For the performance analysis we use images of Lena, Boat, Lady as original image and Baboon as watermark image.

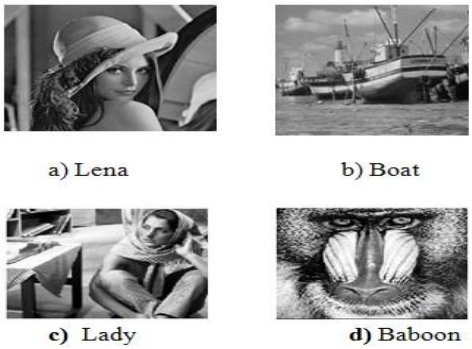


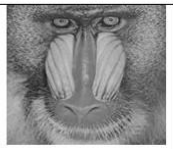
Fig. 2. ((a)-(c)) are the original images and (d) watermark image

For the performance analysis we use different original images and same watermark image of baboon to get the watermarked image and comparing the PSNR of different original and watermark image as shown in TABLE I. Here the interpolation error is removed first that estimate the missing pixels in high-resolution from the pixels in low-resolution

Then enhance the image quality after that find the domain then same images are used to check the different value of PSNR(peak signal to noise ratio) to check the quality of image between the original and the watermarked image. By applying histogram based technique we get different values of PSNR.

TABLE I.

PSNR COMPARISON OF ORIGINAL IMAGES WITH WATERMARK IMAGE

ORIGNAL IMAGE	WATERMARK IMAGE	PSNR IN DIFFERENT DOMAIN	PSNR OF WATERMARKED IMAGE
		GRAYSCALE 48.698 DCT 47.864 DWT 49.541	86.410
		GRAYSCALE 51.434 DCT 50.5095 DWT 52.359	84.660
		GRAYSCALE 47.807 DCT 47.002 DWT 48.622	88.176

The TABLE I. shows that maximum PSNR value comes while we insert the baboon as a watermark into the original image.

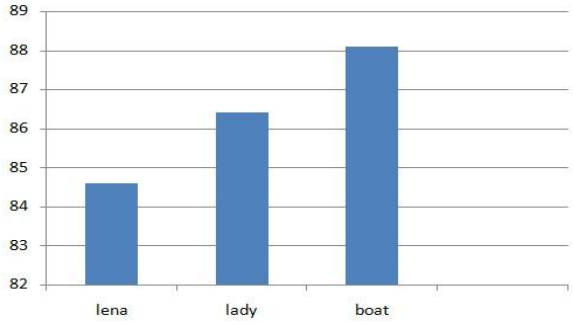


Fig.3.The graphical representation of PSNR of different original images

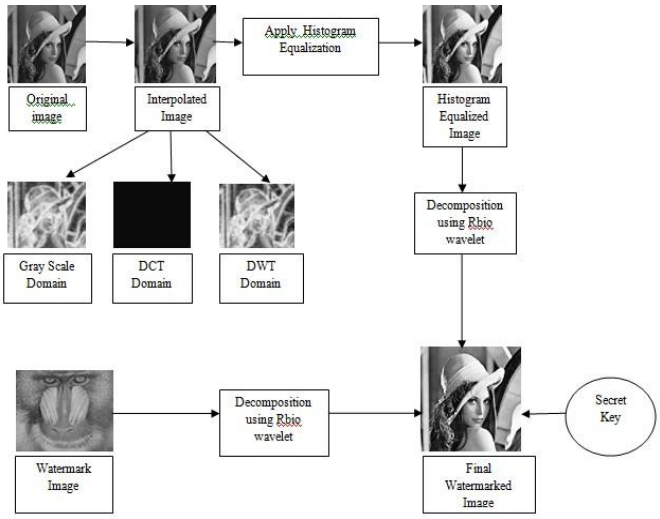


Fig.4. Image watermark embedding

Fig.4. To show the results we take original image of Lena with watermark of Baboon to be embedded in it. The watermark image baboon is embedded into original (Lena) to get watermarked image. This watermarked image is then transmitted over a public communication channel.

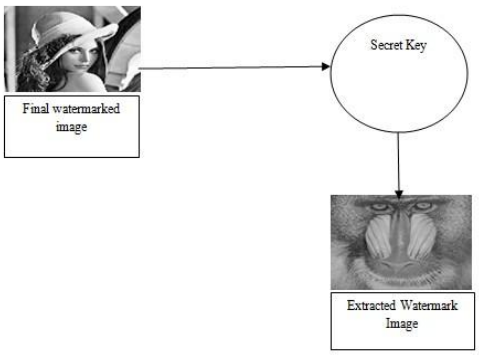


Fig.5.Image watermark extraction

Fig.5.shows the extracted watermark image of baboon extracted from the watermarked image.

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C. Histogram Equalized Image and Histogram Process

Fig.6.Histogram equalized image

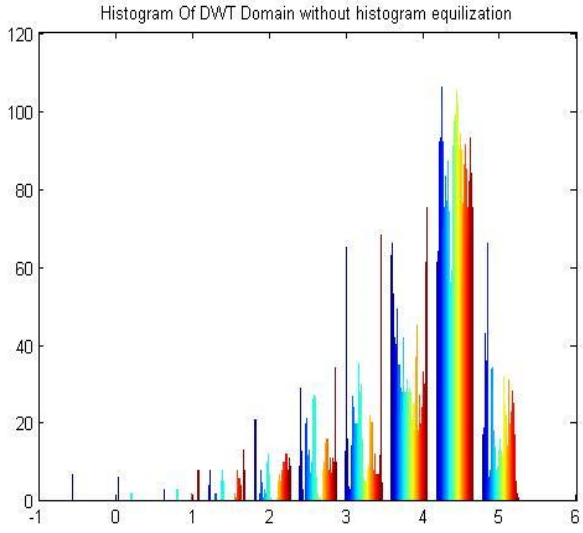

Fig.7. Histogram of DWT Domain without histogram equalization

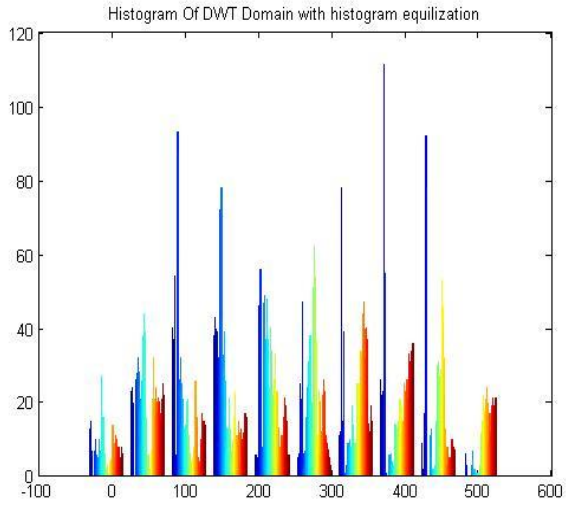

Fig.8.Histogram of DWT Domain with histogram equalization

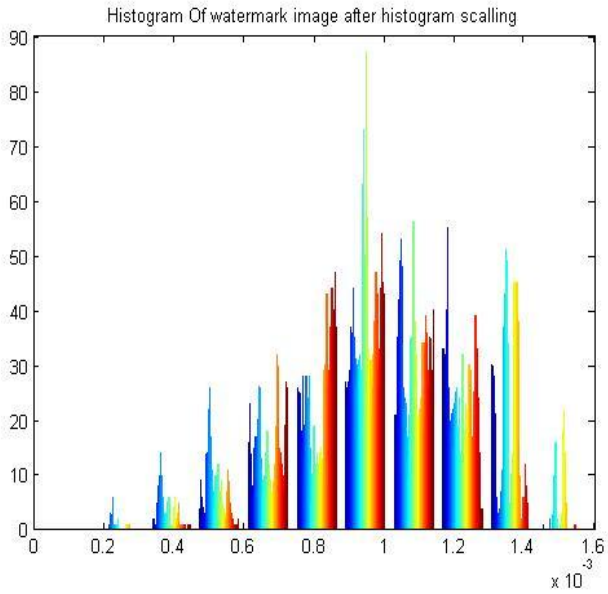

Fig.9. Histogram of watermark image after histogram scaling

D. Comparison Result with Different Authors

Comparison result in terms of quality for Lena and baboon. The proposed approach is compared with different authors to show our better results as specified below. As the PSNR of different authors are compared and it is found that our work is better among all.

TABLE II.

COMPARISON RESULT IN TERMS OF QUALITY

Schemes	Lena Image	Baboon Image
	Quality (PSNR)	Quality (PSNR)
J.Hwang	48.22	48.20
C.C. Lin	46.22	47.61
P.Tsai	51.33	52.95
Lixin Luo	48.82	48.36
Simi Elizabeth chacko	68.59	68.53
Proposed	84.66	83.17

Comparison result in terms of quality for Lena and baboon. The proposed approach is compared with different authors to show our better results [1].

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IV. CONCLUSION

The watermarking is used to transfer copyright information over open channel. The technique proposed here is based on interpolation, histogram equalization, entropy filtration and Rbio DWT. The invisible watermark is added to the original image to make it more protected. The integrity of the data embedded in the original image retains. It is observed that the proposed techniques comes up with a good PSNR(Peak Signal to Noise Ratio) and enhanced security and also the secret key by the user or authorized person is added and is used at another side when one want to extract the hidden data(watermark) from the original image. If anyhow the key entered by the user is wrong then user is not able to extract the watermark. Any intruder cannot find that there is some watermark is added into the original image and when trying he/she fails and would not be able to copy it or extract anything.

In methodology we adopted here for the implementation of proposed algorithm. And also we discuss the results of our proposed algorithm and findings shows that as far as existing literature is concerned, we have achieved better quality. We have used Rbio wavelet for decomposition of the image and provide much better results. Also we have calculated PSNR for different values of alpha and finding shows that at value of alpha=0.001, the PSNR of image is maximum.

If we further trying to reduce the value of alpha, the PSNR of the image does not show any significant improvement that's why we take the value of alpha=0.001 and at this time the value of PSNR is approximately equal to 88.17.

And also we enhance the quality of the image by removing its noise by using histogram equalization, interpolation so far none of the researchers had been focused on this side of watermarking.

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