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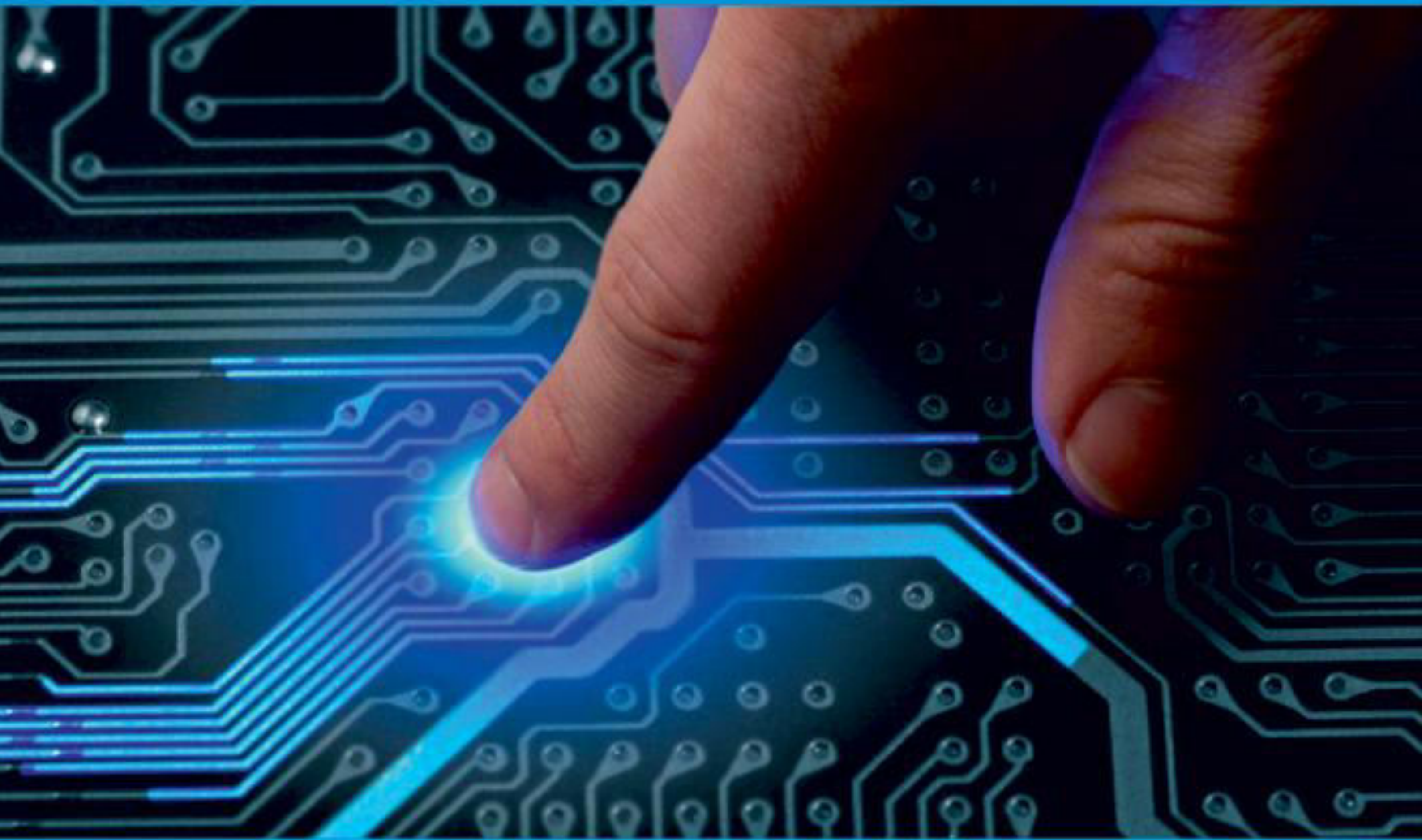

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Implementation Paper on Reversible Image Data Hiding with Contrast Enhancement

Ms.Ujma M. Patel[1], Prof. P.S. Malge[2]

Walchand Institute of Technology, Solapur, India[1,2]

ABSTRACT: The Reversible Data Hiding technique is used to ensure the security and to protect the integrity of the object from any modification by preventing intended and unintended changes. A novel reversible data hiding (RDH) algorithm is proposed for digital images. Instead of trying to keep the PSNR value high, the proposed algorithm enhances the contrast of a host image to improve its visual quality .The highest two bins in the histogram are selected for data embedding so that histogram equalization can be performed by repeating the process. The side information is embedded along with the message bits into the host images that the original image is completely recoverable. The proposed algorithm will be implemented on two sets of images to demonstrate its efficiency.

KEYWORDS: Reversible data hiding (RDH), PSNR, Contrast Enhancement

I. INTRODUCTION

Reversible data hiding (RDH) has been intensively studied in the community of signal processing. Also referred as invertible or lossless data hiding, RDH is to embed a piece of information into a host signal to generate the marked one, from which the original signal can be exactly recovered after extracting the embedded data. The technique of RDH is useful in some sensitive applications where no permanent change is allowed on the host signal. To evaluate the performance of a RDH algorithm, the hiding rate and the marked image quality are important metrics. There exists a trade-off between them because increasing the hiding rate often causes more distortion in image content. To measure the distortion, the peak signal-to-noise ratio (PSNR) value of the marked image is often calculated. In general direct modification of image histogram [2] provides less embedding capacity. In contrast, the more recent algorithms [5]–[8] manipulate the more centrally distributed prediction errors by exploiting the correlations between neighbouring pixels so that less distortion is caused by data hiding. Although the PSNR of a marked image generated with a prediction error based algorithm is kept high, the visual quality can hardly be improved because more or less distortion has been introduced by the embedding operations. For the images acquired with poor illumination, improving the visual quality is more important than keeping the PSNR value high.

Moreover, contrast enhancement of medical or satellite images are desired to show the details for visual inspection. Although the PSNR value of the enhanced image is often low, the visibility of image details has been improved. There is no existing RDH algorithm that performs the task of contrast enhancement so as to improve the visual quality of host images. So in this work, the aim is inventing a new RDH algorithm to achieve the property of contrast enhancement instead of just keeping the PSNR value high. In principle, image contrast enhancement can be achieved by histogram equalization. To perform data embedding and contrast enhancement at the same time, the proposed algorithm uses modification of the histogram . The proposed algorithm will be applied to two set of images to demonstrate its efficiency.

II. PROPOSED METHODOLOGY

The procedure of the proposed algorithm is illustrated in Fig. 1. The total L pairs of histogram bins are to be split for data embedding, the embedding procedure includes the following steps:

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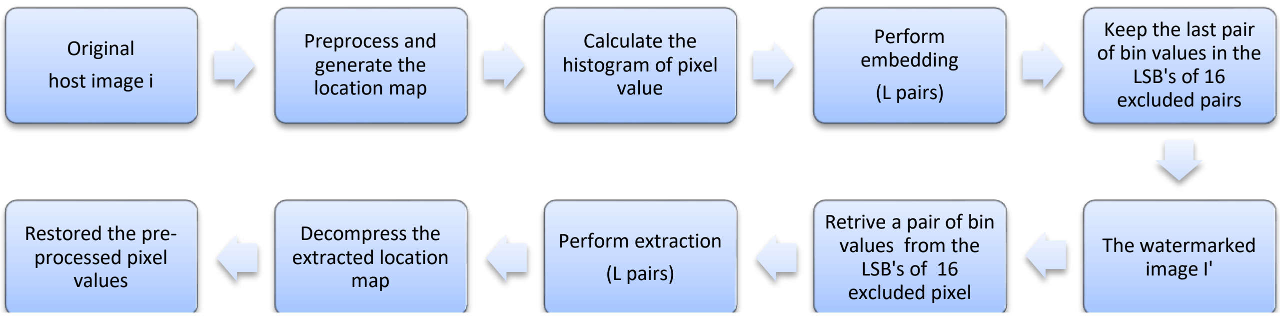

Fig.1. Procedure of the proposed RDH algorithm

Pre-process: The pixels in the range of [0, L-1] and [256-L, 255] will be processed and the pixel values in the range 0 to L-1 will be added by L while the pixels in the range 256 –L to 255 will be subtracted by L, excluding the first 16 pixels in the bottom row.
The image histogram will be calculated without counting the first 16 pixels in the bottom row.
Embedding: The highest two bins in the image histogram are split for data embedding. Again the two peaks in the modified histogram are taken to be split and continue until L pairs are split. The value of L, LSBs of the 16 excluded pixels and the previous peak values are embedded along with the last two peaks to be split.
The lastly split peak values will be used to replace the LSBs of the 16 excluded pixels to form the marked image.
The extraction and recovery process include the following steps:
1. The LSBs of the 16 excluded pixels can be recovered to know the last two peak values.
2. The data embedded with the last two pixels will be extracted and the recovery operations can be done on all the pixels except the 16 excluded ones. The process will repeat until all the data gets extracted.
3. The original image can recovered by updating back the original LSBs of 16 excluded pixels.

III. RESULT AND ANALYSIS

Table 3.1 shows the statistical results of image Lena by changing the values of L, three evolution values were calculated. It can be seen that the contrast of test images was gradually enhanced by splitting more histogram peaks. Taking Lena and stego as an example, the performance comparison of different splitting pair values are done and it concludes that the proposed method can provide better performance when the number of splits increased. Different parameters are extracted from Embedded Image and Recovered Image as shown in Table 3.2 and its graphical representation is shown in Fig.5 from which we can conclude that recovered image is approximately same when compared with original image.

Fig.2 Original and Embedded image

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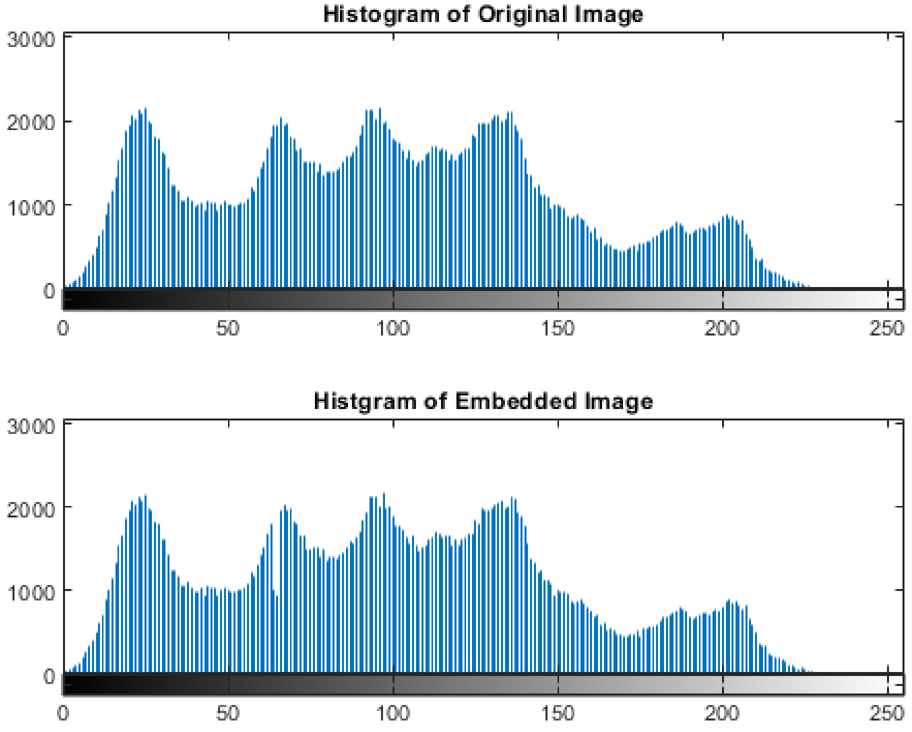

Fig.3 Histogram of Embedded Image

Fig.4. Embedded and Recovered mage

Algorithm	RCE	REE	RMBE	RSS	PSNR(db)
Prop.50	0.841	0.917	0.9997	0.841	48.916
Prop.60	0.7939	0.891	0.9998	0.7939	49.166
Prop.70	0.757	0.8701	0.9999	0.757	49.373

Table 3.1 Statistical evolution of lena images

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Parameters	Embedded Image	Recovered Image
Contrast	0.0257	0.0256
Correlation	0.0598	0.0609
Energy	0.9543	0.9541
Homogeneity	0.9885	0.9885
Mean	0.0005	0.0005
Standard_Deviation	0.0432	0.0432
Entropy	2.8752	2.8719
RMS	0.0432	0.0432
Variance	0.0019	0.0019
Smoothness	0.9722	0.9718
Kurtosis	8.168	8.1531
Skewness	0.2746	0.2734

Table 3.2 Comparison of different parameters between Embedded Image and Recovered Image

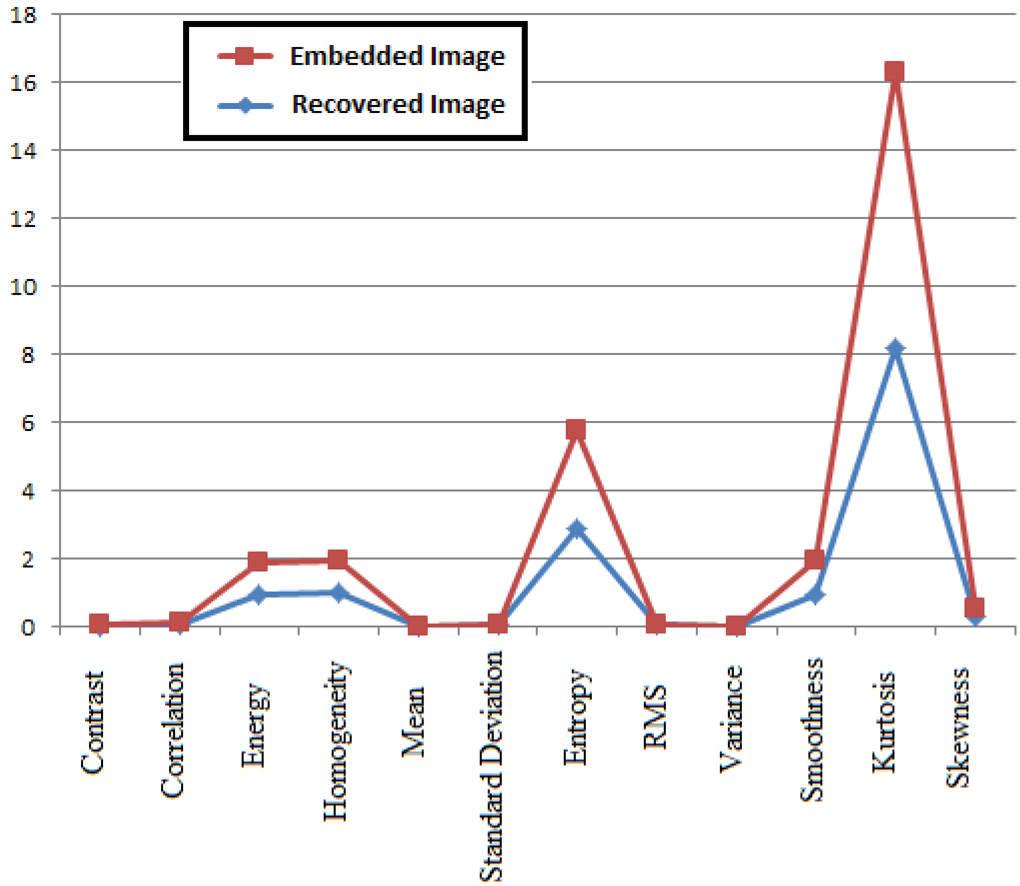

Fig 5. Graphical Representation on of different parameters between Embedded Image and Recovered Image

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IV. CONCLUSION

In this proposed work, a new reversible data hiding algorithm is suggested with the property of contrast enhancement. Basically, the two peaks (i.e. the highest two bins) in the histogram will be selected for data embedding so that histogram equalization can be simultaneously performed by repeating the process .The image contrast can be enhanced by splitting a number of histogram peaks pair by pair. Also the original image can be exactly recovered without any additional information. The hiding rate can be increased by using more histogram peaks for data embedding.

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