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Reversible Image Data Hiding With The Fuzzy Histogram Equalization For Contrast Enhancement

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***Abstract:** Nowadays data security becomes very important task, for that, the community of signal processing has been thoroughly studied on Reversible Data Hiding (RDH), which can also pointing as invertible or lossless data hiding. In order to generate the marked signal the RDH is to embed a piece of data into a host signal, from the marked signal the original signal can be exactly recovered only after extracting the embedded data. This paper proposed algorithm which enhances the contrast of a host image to improve its visual quality. By splitting the highest two histogram bins into four, data embedding and histogram equalization are performed simultaneously, in order to handle the inexactness of grey level values in a best way. For image contrast enhancement Fuzzy histogram equalization (FHE) has been used. Furthermore, the obtained results show that the visual quality can be preserved after a considerable amount of message bits have been embedded into the contrast-enhanced images, even better than three specific MATLAB functions used for image contrast enhancement. This proposed method contains optimum results by giving best contrast enhancement and maintaining the local information of the original image and this method has been tested using several images and gives better visual quality as compared to the other conventional methods.*

***Keywords:** Fuzzy histogram equalization, Reversible Data Hiding (RDH), Contrast Enhancement.*

I. INTRODUCTION

Data hiding are most popular techniques used to secure data in a host media (like images) with small deterioration in host and thereafter to extract the secure data afterwards. Steganography is one such pro-security innovation in which secret message is embedded in a cover image. But, in this paper we are employing Reversible Data Hiding (RDH). RDH insert information bits by altering the host signal, but extracting the exact (lossless) restoration of the original host signal after extracting the embedded information. Reversible data hiding is a type of data hiding techniques wherein the host image can be recovered exactly. Being lossless makes this technique suitable for medical and military applications. One of the most important techniques which are used for reversible data hiding is Difference expansion (DE).

By using fuzzy histogram equalization image contrast enhancement can be achieved. In order to perform information embedding and contrast enhancement at the same time, the proposed algorithm is performed by modifying the Fuzzy histogram of pixel values. Firstly, the two peaks (i.e. the highest two bins) in the histogram are found out. The bins between the peaks are unchanged if any while the outer bins are shifted outward so that each of the peaks can be split into two adjacent bins. To increase the embedding capacity, the modified histogram can be further chosen to be split in order to gain highest two bins, and so on until satisfactory contrast enhancement effect is achieved.

There might be overflows and underflows occur in order to avoid such things due to histogram modification, the bounding pixel values are pre-processed and a location map is generated to memorize their locations. The location map is embedded into the cover image to recovery the original image, together with the message bits and other side information. So blind data extraction and complete recovery of the original image are both enabled. To demonstrate the efficiency of proposed algorithm it is applied to two set of images. According to the survey, it is the first algorithm that achieves image contrast enhancement by RDH. Furthermore, the evaluation results show that the visual quality can be preserved after a considerable amount of message bits have been embedded into the contrast-enhanced images.

II. RELATED WORK

D. Sheet et al. [1] has proposed Brightness Preserving Dynamic Fuzzy Histogram Equalization (BPDFHE1), digital images for their representation and processing uses fuzzy statistics. Representation and processing of images in the fuzzy domain enables the technique to handle the inexactness of gray level values in a better way, resulting in improved performance. Hao-Tian Wu et al.[2] has proposed algorithm that achieves image contrast enhancement by RDH. The evaluation results observe that the visual quality can be preserved after a considerable amount of message bits have been embedded into the contrast-enhanced images, even better than three specific MATLAB functions used for image contrast enhancement. Jaspreet Kaur et al. [3] has proposed survey on various data hiding algorithms. From the survey, it has been concluded that none of the protocol performs effectively in all fields. Therefore the paper ends with the future scope to overcome these issues. J. Huang et al. [4] has proposed Reversible image watermarking on prediction error by efficient histogram modification for the enhancement of image in order to obtain secret message with same accuracy. H. Ibrahim et al. [5] has proposed Brightness Preserving Dynamic Histogram Equalization for Image Contrast Enhancement, in this they have concluded that by using dynamic histogram equalization can achieve extraction of secret from safely.

III. PROBLEM STATEMENT

It becomes highly desirable to develop data hiding algorithms that work entirely on enhanced image. Enhance the contrast of an intensity image using histogram equalization to identify the peak value is difficult. The method has limitations such as the visual quality of the recovered secret message is decreased.

IV. PROPOSED SYSTEM

Figure 1 shows the block diagram of proposed system, firstly the secret message which we are supposed to hide it in an cover image is processed to binary conversion , then the cover image is pre-processed from RGB to Gray scale conversion here we are adopting Fuzzy Histogram Equalization algorithm to get the most accuracy when compared to conventional methods, calculating the histograms from the results of FHE method, those results along with the binary converted secret message is now embedded together and apply LSB(Least Significant Bit) technique in that we are considering 16 excluded pixels as this we get a fully embedded image, this portion of our proposed algorithm will refer as embedding stage. Next as soon we complete embedding stage consider the embedded mage which we got from the embedding stage and again apply LSB (Least Significant Bit) technique in that we are considering 16 excluded pixels, result is deployed to extraction and convert the binary values of secret image into character conversion. The result gives the extraction of secret message with more effectively without any single data loss.

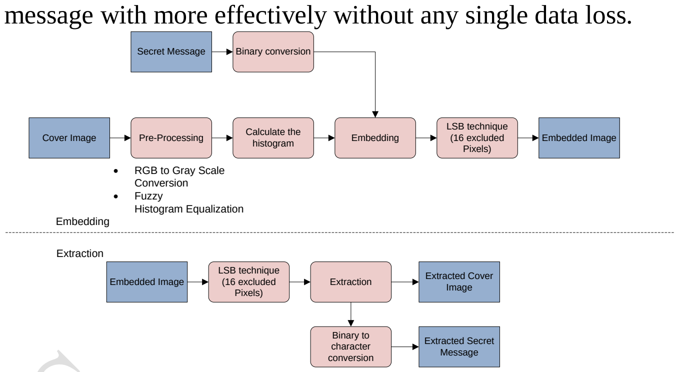


Figure 1: Block Diagram of Proposed Work

A. DATA EMBEDDING BY HISTOGRAM MODIFICATION

The algorithm proposed is basically for gray-level image "I" but can be easily extended to color images. Given an 8-bit gray-level image, by counting the pixels with a gray-level value "j" the image histogram can be calculated as fallows

Wherej $\in \{0, 1 \ldots\ldots\ldots, 254, 255\}$. To denote the image histogram we use h_I so that $h_I(j)$ represents the number of pixels with a value j. In case "I" consists of "N" different pixel values. Then there are "N" nonempty bins in h_I , from which the two peaks (i.e. the highest two bins) are chosen and the corresponding smaller and bigger values are denoted by $I_S$andI_R, respectively. For a pixel counted in $h_I$with value i, data embedding is performed by

$$i' = \begin{cases} i-1, \text{for} i < I_s \\ I_S - b_k, \text{for} i = I_S \\ i, \text{for } I_S < i < I_R \\ I_R + b_k, \text{ for } I = I_R \\ i+1, \text{for } i > I_R \end{cases} \quad (1)$$

Where $i'$is the modified pixel value, and b_k, is the k-th message bit (0 or 1) to be hidden.

The peak values need to be provided to extract the embedded data. From histogram computing we need to keep those peak values is to exclude 16 pixels in I. The least significant bits (LSB) of those pixels are collected and included in the binary values to be hidden. To extract the embedded data, the peak values need to be retrieved and the histogram of the marked image i' is calculated excluding the 16 pixels aforementioned. Then the following operation is performed on any pixel counted in the histogram

$$b'_k = \begin{cases} 1, \text{if } i' = I_S - 1 \\ 0, \text{if } i' = I_S \\ 0, \text{if } i' = I_R \\ 1, \text{if } i' = I_R - 1 \end{cases} \quad (2)$$

Like embedding operations, the extraction operations are performed in the same way. According to Eq. (1), the following operation is performed on every pixel counted in the histogram to recover its original value:

$$i = \begin{cases} i' + 1, \text{ for } i' < I_S - 1 \\ I_S, \text{for } i' = I_S - 1 \text{ or } i' = I_S \\ I_R, \text{for } i' = I_R \text{or } I' = I_R + 1 \\ i' - 1, \text{for } i' > I_R + 1 \end{cases} \quad (3)$$

The original LSBs of 16 excluded pixels are obtained from the extracted binary values. The excluded pixels can be restored by writing them back so as to recover the original image.

B. CONTRAST ENHANCEMENT USING FUSSY HISTOGRAM EQUALIZATION

For the representation and processing of digital images Fuzzy Histogram Equalization (FHE) uses fuzzy statistics. in the fuzzy domain Representation and processing of images enables the technique to handle the inexactness of gray level values in a best way, as the result of this will get very much improved performance. As image size and nature of the histogram changes it will affect the execution time since execution time is purely depending on the histogram values and the image size. FHE technique manipulates the image histogram in such a way that no remapping of the histogram peaks takes place, there will be only redistribution of the gray-level values in the valley portions between two consecutive peakstakes place. This technique consists of many operational stages they are Fuzzy Histogram Computation, Partitioning of the Histogram, Dynamic Histogram Equalization of the Partitions and Normalization of the image brightness.

The technique of enhancing color images becomes very much interest topic now a days, since most electronic equipments acquire and display color images.Most of the conventional methods apply equalization of the red, green, and blue planes in the RGB images. However, this approach has an inherent problem of changing the hue of the output image. This method produces better perceptible results as compared to equalizing the R, G, and B planes separately.

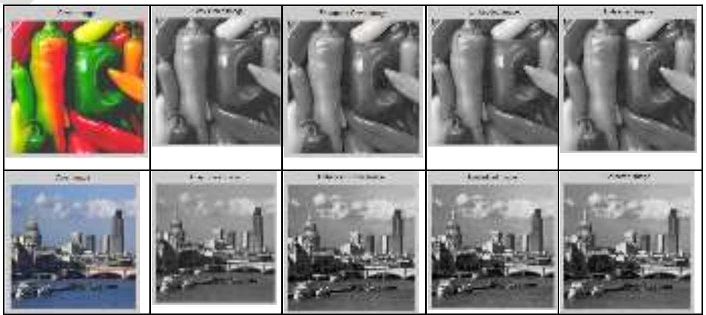
As explained in the Data Embedding by Histogram Modification section above, according to the requirement numbers of 0s and 1s in the message bits must be almost equal so from this the resulting histogram's two peaks are split into two adjacent bins. The highest two bins in the modified histogram are further chosen to be split by applying Eq. (1) in order to increase the data hiding rate to all pixels counted in the histogram. The same process can be repeated by splitting each of the two peaks into two adjacent bins with the similar heights to achieve the histogram equalization effect. In this way, data embedding and contrast enhancement are simultaneously performed. Given that the pair number of the histogram peaks to be split is , the range of pixel values from 0 to L-1 are added by L while the pixels from 255-L to 255 are subtracted by L in the pre-process.

The location map can be pre-computed and compressed to be firstly embedded into the host image. The value of L , the size of the compressed location map, and the previous peak values, in contrary, are embedded with result obtained by peak value split, whose values are stored in the LSBs of the 16 excluded pixels. In the extraction process, the last split peak values are retrieved and the data embedded with them are extracted with Eq. (2). After restoring the histogram with Eq. (3), the data embedded with the previously split peaks can also be extracted by processing them pair by pair. At last, the location map is obtained fromthe extracted data to identify the pixel values modified in the pre-process.

III. EXPERIMENTAL RESULTS

Below figures show the experimental results of our proposed work.

Fig.2(a) is the cover image, which is considered as input image, along with the binary converted secret message. This image is converted into gray scale image shown in Fig.2(b) this gray scale image is enhanced by using Fuzzy Histogram Equalization method , then the resulting image is shown in Fig(c) along with the binary converted secret message is embedded by applying LSB technique to get embedded image shown in Fig.2(d), then the whole embedded image has to subjected to extraction process i.e. similar to the embedded process by applying LSB technique, lastly will get an extracted image which contains our secret message. So from proposed algorithm will get most accurate results when compared with other conventional methods.



(a) Cover Image	(b) Gray Scale Image	(c) Enhanced Cover Image	(d) Embedded Image	(e) Extracted Image

Figure 2: Results of proposed Work

IV. CONCLUSION

In this paper, a new reversible data hiding algorithm has been proposed with the property of contrast enhancement by Fuzzy histogram equalization (FHE). Basically, the two peaks in the histogram are selected for data embedding and also for data extraction so that histogram equalization can be simultaneously performed by repeating the process. The experimental results have demonstrated that the image contrast can be enhanced by splitting a number of histogram peaks pair by pair. Compared with the special MATLAB functions, the visual quality of the contrast-enhanced images generated by our algorithm is better preserved. Finally, the original image can be exactly recovered without any loss of information.

Hence the proposed algorithm has made the image contrast enhancement reversible.

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