



Review on Reversible Image Data Hiding With Contrast Enhancement

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Abstract: In this report, 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 image so that the original image is completely recoverable. The proposed algorithm is used for two sets of images to demonstrate its efficiency. To our best knowledge, 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, even better than three specific MATLAB functions used for image contrast enhancement.

Keywords: RDH, MATLAB, Image, Histogram

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. in the literature, most of the proposed algorithms are for digital images to embed invisible data or a visible watermark.

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 modification of image histogram provides less embedding capacity. in contrast, the more recent algorithms manipulate the more centrally distributed prediction errors by exploiting the correlations between neighboring 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 is 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. to our best knowledge, 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 study,

we aim at 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 is performed by modifying the histogram of pixel values. firstly, the two peaks (i.e. the highest two bins) in the histogram are found out. 2 the bins between the peaks are unchanged while the outer bins are shifted outward so that each of the two peaks can be split into two adjacent bins. to increase the embedding capacity, the highest two bins in the modified histogram can be further chosen to be split, and so on until satisfactory contrast enhancement effect is achieved. to avoid the overflows and underflows due to histogram modification, the bounding pixel values are pre-processed and a location map is generated to memorize their locations. for the recovery of the original image, the location map is embedded into the host image, together with the message bits and other side information. so blind data extraction and complete recovery of the original image are both enabled. the proposed algorithm was applied to two set of images to demonstrate its efficiency. to our best knowledge, 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, even better than three specific MATLAB functions used for image contrast enhancement.

II. OBJECTIVE

A. The main objective of the “reversible image data hiding with contrast enhancement” is to achieve real



- reversibility, separate data extraction and great improvement on the quality of marked images.
- B. To solve the problems related to data extraction and image restoration.
- C. With RDH algorithm for data embedding our objective is to retrieve the original image lossless

III. LITERATURE REVIEW

A. Related Work

Up till now more work or research has been done in reversible data hiding techniques. lots of efficient techniques are proposed till. the work done in reversible data hiding techniques are as follows:

we know it is very difficult to vacate the room losslessly from encrypted images. so by considering this in [1] kede ma, weiming zhang, xianfeng zhao, nenghai yu and fenghua li has proposed a technique for embedding the data in reversible manner using reserve room before encryption.

In [2] wen-chung kuo, po-yu lai, lih-chyauwu has proposed a adaptive reversible data hiding method. a new scheme based on histogram and slope method enhancing the data hiding capacity and also the efficiency increases and maintains the high quality of image.

In [3] kuo-ming, wen-kai su, ting-wen chen, li-ming chen has proposes the method which is the combination of data hiding, half-toning and vector quantization technique. in this the embedding of gray scale image in other image is done. this scheme is work as follows:

- image compression from gray scale to half tone using half-toning process.
- computation of difference between original image and the image on which we perform operations.
- then vq compression compress the difference obtain in above and embed it with secret data.

josé r; abraham .g, in [4] proposed the method in which a reversibly data hiding in encrypted gray scale image is done in separable manner. encryption of the image is done by content owner using encryption key by permuting the pixels. data hiding is done by using data hiding key using histogram modification method.

malik, anjali sardana, jaya in [5] has proposed another different approach for visual cryptography which consist of three steps:

1.sieving 2. division 3. shuffling to generate random shares. the advantage of this is that minimal computation requirement to generate the binary secret image without loss of quality of image.

yi-hui chen, ci-wei lan and chiaio-chih huang in [6] have proposed the another different approach for visual cryptography is authentication mechanism. in this two procedures are there :

- encryption procedure
- decryption procedure

A. Summery of Literature Review

The summery of literature review is as shown in table

Table 1
The Summery Of Literature Review

PAPER	ALGORITHM USED	RESULT(PSNR VALUE)
A Reversible data hiding method for encrypted images	AES algorithm	66.13db
Information hiding based on BMC for vector quantisation compressed images	Block Mach Coding algorithm	29.1 db
Reversible data hiding using visual cryptography	Reserving room before encryption	28db
Robust watermarking of compressed and encrypted JPEG2000 images	Spread spectrum(SS), scalar costa scheme quantization index modulation (SCS-QIM)	21db
Content based watermarking of images	Edge separation and image segmentation	20db

In above table it is shown that PSNR values of different methods are different. If PSNR value is high , then result image will have low noise and vice versa. So 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 image so that the original image is completely recoverable. To our best knowledge, 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, even better than three specific MATLAB functions used for image contrast enhancement.

Figure Captions

IV. SYSTEM DEVELOPMENT

Data embedding in the reversible manner which is the data embedding without any loss embeds the data or payload into digital image in reversible manner. After data embedding the quality of original image may be degraded which is to be avoided. The attractive property of data embedding in reversible manner is reversibility, which is after data extraction the original quality image is restored back. Reversible data embedding hides some information in a digital image in such a way that an approved party image to its original state. The presentation of a reversible data-embedding algorithm can be measured using following,

- Data embedding capacity limit
- Visual quality
- Complexity

The data without any distortion embedding is the attractive feature of reversible data embedding. Data will certainly change the original content by embedding some data into it. Even a very slight change in pixel values may not be pleasing, particularly in military data and medical data. In such a circumstances, every small part of information is important. From the application point of view, since the differentiation between the implanted image and original



image is almost discernible from human eyes, reversible data implanting could be thought as a top secret communication channel since reversible data implanting can be used as an information transporter. Mainly the data hiding techniques are classified into two techniques:

1. Reversible data hiding technique
 2. Irreversible data hiding technique
1. Reversible data hiding technique: In this technique the message signal as well as the original cover can be with no loss recovered simultaneously.
2. Irreversible data hiding technique: In this technique the message signal can be recovered with no loss but the original cover can be lost. So in general reversible data hiding techniques can be used now a days.

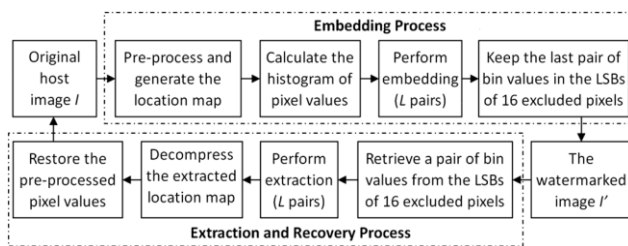


Fig. 1. Procedure of the proposed RDH algorithm.

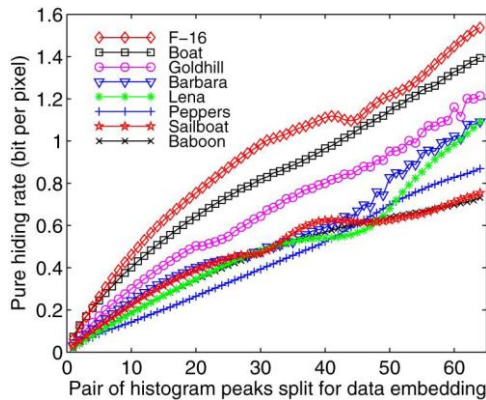


Fig. 2. The hiding rates generally increase with the number of histogram peaks used for data embedding.

A. Data Embedding by Histogram Modification

The algorithm to be presented is primarily for gray-level images but can be easily extended to color images. Given an 8-bit gray-level image I , the image histogram can be calculated by counting the pixels with a gray-level value j for $j \in \{j=0,1,\dots,254,255\}$. We use h_I to denote the image histogram so that represents $h_I(j)$ the number of pixels with a value j . Suppose I consists N of 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 and I_R , respectively. For a pixel counted in with value i , data embedding is performed

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

where i is the modified pixel value, and b_k is the k -th message bit (0 or 1) to be hidden. By applying Eq. (1) to every pixel counted in h_I , totally $h_I(I_S) + h_I(I_R)$ binary values are embedded. Given that there is no bounding value (0 or 255) in I (otherwise pre-process is needed), there will be $N+2$ bins in the modified histogram. That is, the bins between the two peaks are unchanged while the outer ones are shifted outward so that each of the peaks can be split into two adjacent bins (i.e. I_S-1 and I_S , I_R and I_R+1 , respectively).

The peak values and need to be provided to extract the embedded data. One way to keep them is to exclude 16 pixels in from histogram computing. The least significant bits (LSB) of those pixels are collected and included in the binary values to be hidden. After applying Eq. (1) to each pixel counted in for data embedding, the values of I_S and I_R (each with 8 bits) are used to replace the LSBs of the 16 excluded pixels by bitwise operation. 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 and with the value of I_S-1 , I_S , I_R and I_R+1 .

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

Where b_k is the k -th binary value extracted from the marked image I . The extraction operations are performed in the same order as that of the embedding operations. 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. Pre-Process for Complete Recovery

In the aforementioned algorithm, it is required that all pixels counted in h_I are within $\{1, \dots, 254\}$. If there is any bounding pixel value (0 or 255), overflow or underflow will be caused by histogram shifting. To avoid it, the histogram needs to be pre-processed prior to the histogram modification operations. Specifically, the pixel values of 0 and 255 are modified to 1 and 254, respectively. Therefore, no overflow or underflow will be



caused because the possible change of each pixel value is $+1$ or -1 . To memorize the pre-processed pixels, a location map with the same size as the original image is generated by assigning 1 to the location of a modified pixel, and 0 to that of an unchanged one (including the 16 excluded pixels). The location map can be pre-computed and included into the binary values to be hidden. In the extraction and recovery process, it can be obtained from the data extracted from the marked image so that the pixels modified in the pre-process can be identified. By restoring the original values of those pixels accordingly, the original image can be completely recovered



Fig 3. Original image

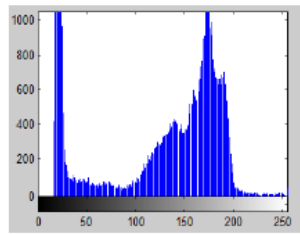


Fig 4. Histogram

The main advantage of the histogram shifting is it removes the underflow and overflow. During the addition of watermark to an original image caution must be taken to prevent the Negative or Gray level values called underflow and positive values called overflows.. Drawbacks of the Existing system is that they are Less Efficient, Causes Overflow and Underflow and result is having More Distortions.

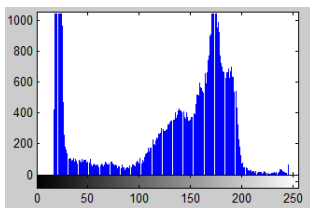


Fig 5. Shifted Histogram

B. Contrast Enhancement

Contrast Enhancement is the process of changing the intensity of the pixels of the input image in order to utilize maximum possible bins. Histogram equalization is one of the method of achieving image contrast enhancement, it is performed by modifying the histogram of pixel values. The two highest bins of the histogram are found out and then the bins between the peak values are kept unchanged whereas the outer bins are shifted outwards thereby dividing the two peaks in two adjacent bins. This process is used to obtain data embedding with contrast enhancement simultaneously. The highest two bins in the histogram can be further split and so on to achieve increased embedding capacity along with satisfactory contrast enhancement. To recover original image, the location map is fixed into the cover image with the bits of message and other additional information.



Fig 5 Original image



Fig .6 Enhanced image

1. Low contrast :-image values concentrated near a narrow range (mostly dark, or mostly bright, or mostly medium values)

2. Contrast enhancement :-change the image value distribution to cover a wide range Contrast of an image can be revealed by its histogram

Each of the two peaks in the histogram is split into two adjacent bins with the similar or same heights because the numbers of 0s and 1s in the message bits are required to be almost equal. To increase the hiding rate, the highest two bins in the *modified* histogram are further chosen to be split by applying Eq. (1) 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 L , the range of pixel values from 0 to $L-1$ are added by L while the pixels from $256-L$ to 255 are subtracted by L in the pre-process (noting L is a positive integer). A location map is generated by assigning 1s to the modified pixels, and 0s to the others.

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 the last two peaks to be 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 from the extracted data to identify the pixel values modified in the pre-process.

C. Procedure of the Proposed Algorithm

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

1) Pre-process: The pixels in the range of $[0$ to $L-1]$ and are processed as mentioned above excluding the first 16 pixels



in the bottom row. A location map is generated to record the locations of those pixels and compressed by the JBIG2 standard to reduce its length.

2) The image histogram is calculated without counting the first 16 pixels in the bottom row.

3) Embedding: The two peaks (i.e. the highest two bins) in the histogram are split for data embedding by applying Eq. (1) to every pixel counted in the histogram. Then the two peaks in the *modified* histogram are chosen to be split, and so on until L pairs are split. The bit stream of the compressed location map is embedded before the message bits (binary values). The value of L, the length of the compressed location map, the LSBs collected from the 16 excluded pixels, and the previous peak values are embedded with the last two peaks to be split.

4) The lastly split peak values are used to replace the LSBs of the 16 excluded pixels to form the marked image.

The data **extraction** and original image **recovery** process include the following steps:

- The LSBs of the 16 excluded pixels are retrieved so that the values of the last two split peaks are known.
- The data embedded with the last two split peaks are extracted by using Eq. (2) so that the value of L, the length of the compressed location map, the original LSBs of 16 excluded pixels, and the previously split peak values are known. Then the recovery operations are carried out by processing all pixels except the 16 excluded ones with Eq. The process of extraction and recovery is repeated until all of the split peaks are restored and the data embedded with them are extracted.
- The compressed location map is obtained from the extracted binary values and decompressed to the original size.
- With the decompressed map, those pixels modified in preprocess are identified. Among them, a pixel value is subtracted by L if it is less than 128, or increased by otherwise. To comply with this rule, the maximum value of L is 64 to avoid ambiguity. At last, the original image is recovered by writing back the original LSBs of 16 excluded pixels.

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