Comparisons of Different Reversible Data Hiding Technique

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Abstract : Reversible data hiding (RDH) in images is a technique, 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. For the images acquired with poor illumination, improving the visual quality is more important than keeping the PSNR value high. The increase in PSNR does not provide guarantee of better contrast. So it is necessary to modify the RDH algorithm for satisfying the mainly two objectives; better PSNR and better visibility (contrast) of the image. A new modified RDH is proposed in this report. A new RDH algorithm is with the property of contrast enhancement. Basically the two peaks (i.e. the highest two bins) in the histogram are selected for data embedding so that histogram equalization can be simultaneously performed by repeating the process. The performance of this algorithm has been compared with prediction error based algorithm having PSNR value large and the visual quality can hardly be improved because more or less distortion has been introduced by the embedding operations and second algorithmthat utilizes the zero or the minimum points of the histogram of an image and slightly modifies the pixelgrayscale 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.

Keywords: Reversible Data Hiding(RDH), PSNR,contrast **enhancement**, histogram modification, location map, visual quality

I Introduction

With the development of information technology, manymultimedia, such as text, image and video, are transmitted byInternet. Especially, about personal privacy data, people do notwant to be compromised. Therefore, the secure transmission ofinformation has become more and more importance. How toachieve the purpose of data protection? In general, there are twowidely used methodologies, one is cryptography and the other issteganography. In cryptography, the sender transmits theplaintext to cipher text by using the receiver's public key andencryption algorithm. Then, this cipher text will be recovered bythe only particular receiver with the private key. Even thoughthe attacker got this cipher text, it is also unable to know thecontent of message. Unfortunately, this methodology will beinsecure when the private key is stolen or broken. Another wayto solve thisproblem is to hide secret data behind a meaningfulimage such that an unintended observer will not be aware of theexistence of the hidden secret message, i.e., it hides the secretdata into a meaningful host data to distract the attention of the

Observers .Most of themare irreversible, in other words, the original cover image cannotbe recovered with lossless from the stego-image. The coverimage is used to camouflage the secret data and the stego-imageis generated by the secret data is embedded in the cover image. In some applications such as military, medical it isalso desired that the original cover media can be recoveredbecause of the required high-precision nature.However, the stego-image's quality must be worse thanthe original image after the secret data embedded in the coverimage. Obviously, the stego-image will become worse when thesecret data needs the greater space to embed. Therefore, themajor goal of data hiding method is that original image can recover back exactly. The performance is measured by PSNR value of original image and extracted image but For the images acquired with poor illumination, improving the visual quality is more important than keeping the PSNR value high. The increase in PSNR does not provide guarantee of better contrast. So it is necessary to modify the RDH algorithm for satisfying the mainly two objectives; better PSNR and better visibility (contrast) of the image. A new modified RDH is proposed in this report.

II.Related Work

In 2006, Ni et al.[1] used the histogram's characteristic to embed the secret data. It is not only to enhance the high embedding capacity but also to maintain better view quality. However, they do not discuss how to transmit the zero points or minimum points to the receiver. In order to improve the above disadvantage, Hwang, et al. [2] proposed a robust reversible data hiding scheme based on histogram shifting method. In fact, they proposed the location map to store the reversible data and also give an answer to solve when the selected minimum point is not zero. Nevertheless, their solution will waste the storage quantity and decrease the original data hiding capacity. In order to enhance the data hiding capacity and embedding point adaptively, a new reversible data hiding scheme based on histogram and slope method will be proposed in this

Hao-tian et.al.[11],in their literature said that a new RDH technique instead of trying to keep PSNR value high, the proposed algorithm increases the contrast of host image to improve its visual quality. The two peaks (i.e. the highest two bins) in the histogram are selected for data embedding so that histogram equalization can be simultaneously performed by repeating the process. Theexperimental results have shown that the image contrast can be enhanced by splitting a number of histogram peaks pair by pair. T-he visual quality of the contrast-enhanced images generated by their algorithm is better preserved. The original image can be exactly recovered without any additional information.

III .Reversible Data Hiding Methods

1) Prediction Error Base method:

The statistics characteristic of the cover image'shistogram is close to Gaussian distribution by using theprediction error method.

A) Embedding Method

The embedding procedure as following:
Step 1. Divide the cover image by using 3 * 3 block.
Step 2. Take the block's center point as the base point andobtain the prediction error value between it and theSurrounding pixel.
Step 3. Get the histogram of statistical prediction errorabsolute value and select for the hidden locationaccording to secret data's length.
Step 4. Generate the embedding space. These pixels thatlocated in histogram between the minimum point andRight side of the selected point is shifted one pixelright.
Step 5. Embed the secret data into the region betweenselected point and the neighbor point.

Fig:1 Original Lena image

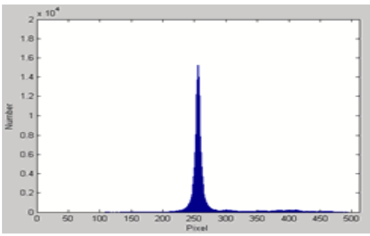

Fig:2 Histogram of Predict Error Method

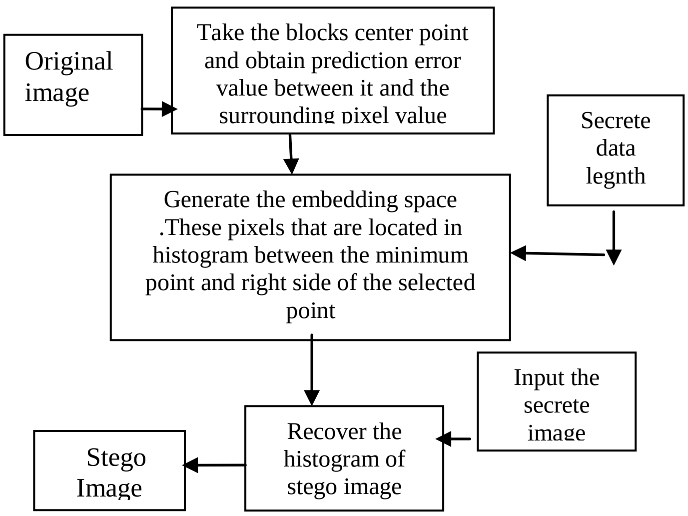

Fig:3 Data embedding procedure by prediction error method

B) Recovering of the secrete data

Recover the secret data by using the following steps:
Step 1. Divide the stego-image by using 3 * 3 block.
Step 2. Take the block's center point as the base point anobtain the prediction error value between it and theSurrounding pixel.
Step 3. Get the histogram of statistical prediction error absolute value and find out the hidden locationaccording to the change of curve's slope.
Step 4. Recover the secret data.
Step 5. Restore the cover image from the prediction error histogram.

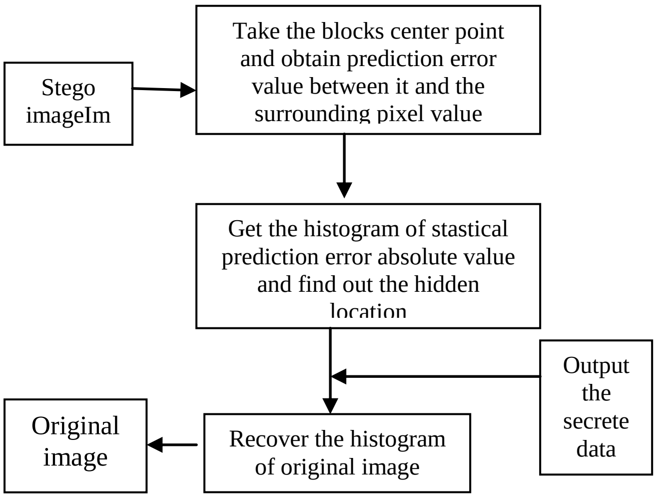

Fig 4 Data recovering process by prediction error method

C) Result:

Table 1 PSNR value by using prediction error based algorithm

Prediction error based method		Lena	Baboon
	Capacity (bits)	37,199	13,112
	PSNR(dB)	49.44	48.90

Fig:5 Recovered image

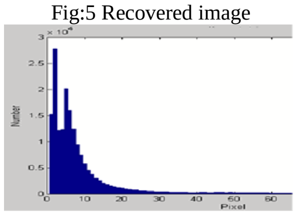

Fig 6 Stego-image's histogram by using Predict Error Method

From the results, it does not keep good embedding capacity and stego-image contrast quality but itmaintain the better security with better PSNR value.

2)Reversible data hiding Algorithm

In this algorithm the histogram, first find a zero point, and then a peak point.A zero point corresponds to the grayscale Value which no pixel in the given image assumes, e.g., as shown in Fig. 6.A peak point corresponds to the Grayscale value which the maximum number of pixels in the given image assumes, e.g., as shown in Fig.7

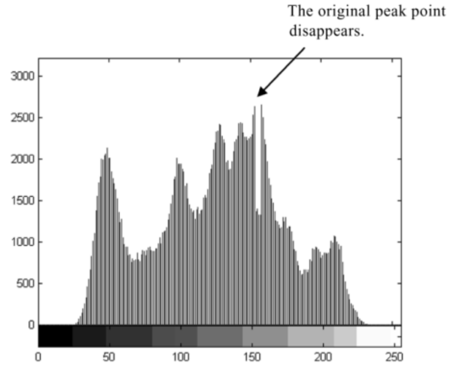

Fig.9 Histogram of the marked Lena image.

only the simple case of one pair of minimum point and maximum point is described here because, as shown above, the general cases of multiple pairs of maximum and minimum points can be decomposed as a few one pair cases That is, the multiple pair case can be treated as the multiple repetition of the Note that zero point defined above may not exist for some image histograms. The concept of minimum point is hence more general. By minimum point, we mean such a grayscale value, that a minimum number of pixels assume this value, i.e.,is minimum. Accordingly, the peak point discussed above is referred to as maximum point.

A) Embedding Algorithm One Pair of Maximum and Minimum Points*:*

For an image, each pixel grayscale value.
1) Generate its histogram.
2) In the histogram, find the maximum pointand the minimum point zero.
3) If the minimum point, recode the coordinateof those pixels and the pixel grayscale value as overhead bookkeeping information.
4) Without loss of generality.Move the wholepart of the histogram with to the right by 1 unit. This means that all the pixel grayscale values(satisfying) are added by 1.
5) Scan the image, once meet the pixel whose grayscale value is check the to-be-embedded bit. If the to-be embedded bit is “1”, the pixel grayscale value is changedto. If the bit is “0”, the pixel value remains. Data extraction for one pair case.

B) Extraction Algorithm

1) Scan the marked image in the same sequential order as that used in the embedding procedure. If a pixel with its Grayscale value is encountered, a bit “1” is extracted. If a pixel with its value is encountered, a bit “0” is extracted.
2) Scan the image again, for any pixel whose grayscale value. The pixel value is subtracted by 1.
3) If there is overhead bookkeeping information found inthe extracted data, set the pixel grayscale value (whose Coordinate is saved in the overhead) as .In this way, theoriginal image can be recovered without any distortion

C) Result:

Table 2: Result Analysis by reversible data hiding

Images	PSNR of marked image	Pure payload bits
Lena	48.2	5460
Baboon	48.2	5421

The algorithm of reversible data hiding technique is able toembed about 5–80 kb into a 512x512x 8 grayscale image while guaranteeing the PSNR of the marked image versus theoriginal image to be above 48 dB. The increase in PSNR does not provide guarantee of better contrast

3)A new RDH algorithm for contrast enhancement

The increase in PSNR does not provide guarantee of better contrast. So it is necessary to modify the RDH algorithm for satisfying the mainly two objectives; better PSNR and better visibility (contrast) of the image. A new modified RDH is proposed in this report.

A) Data Embedding Process:

The input color image is selected. The corresponding color components are extracted and displayed. Histogram is calculated without counting the first 16pixels in the bottom Embedding Process

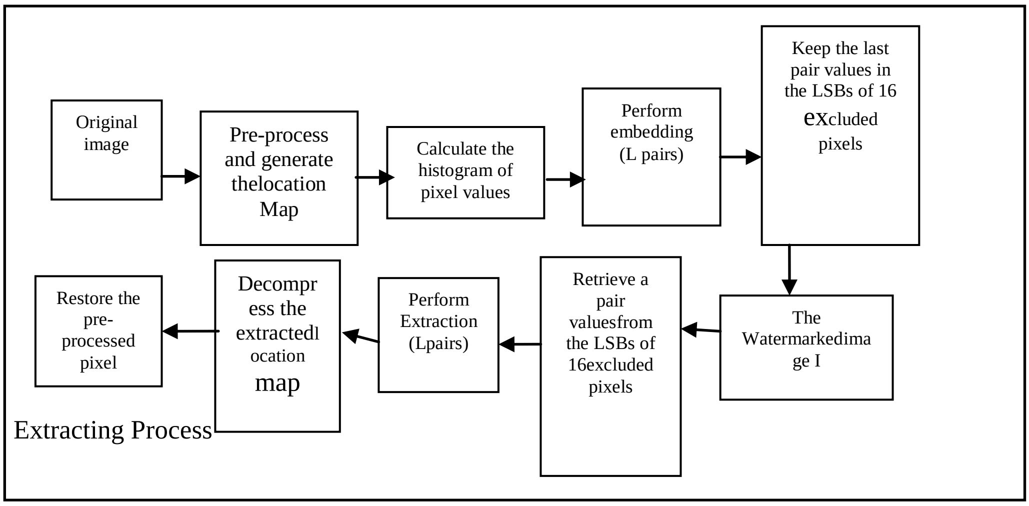

Fig: 10 New RDH algorithms

The two peaks (i.e. the highest two bins) in the histogram are split for data embedding to every pixel counted in the histogram. Then the two peaks in the modified histogram are chosen to be split, and so on until pairs are split. The bitstream of the compressed location map is embedded before the message bits (binary values). The value of , thelength 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. The lastly split peak values are used to replace the LSBs of the 16 excluded pixels to form the marked image.

B) Data Extraction Process by new RDH Algorithm

The watermarked image is selected. The peaks are entered for data bits extraction. 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 using peak LSB extraction.so that the value of, 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. The process of extraction and recovery is repeated.

C) Contrast Enhancement by new RDH Algorithm

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 modifiedhistogram 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 peaksinto two adjacent bins with the similar heights to achieve the histogram equalizationeffect. In this way, data embedding and contrast enhancement are simultaneously performed. Given thatthe 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 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, 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 afterrestoring the histogram with the data embedded with the previously split peaks can also be extracted by processing them pair by pair.

1) Extracted Image

Original image can be exactly recovered after extracting the embedded data, their is no prominent change in the original signal.

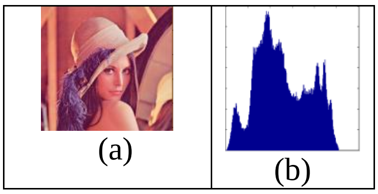

Fig 11: Extracted Image (b) Histogram of extracted image

2) Original and Contrast enhanced image

Contrast of images is gradually enhanced by splitting more histogram peaks in the proposed algorithm.

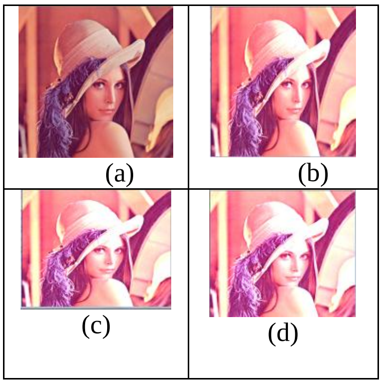

Fig: 12 The original and contrast-enhanced images

The original and contrast-enhancedimages of "Lena" by splitting 10, 15and 20 pairs of histogram peaks in the proposed algorithm. (a) Original imageof "Lena". (b) 10 pairs: 0.252 bpp, 25.6645dB. (c) 15 pairs: 0.314 bpp, 26.6234 dB.(d) 20 pairs: 0.398 bpp, **20.1457 dB.**

D) Results of new RDH algorithm

Table 3 shows the analysis of original image and contrast enhanced image by using proposed algorithm with 10,15 and 20 pairs of histogram peaks

Table3. Result Table

Pairs	PSNR	RCE	REE	RMBE	RSS	Bpp
10 p	25.6645	0.5321	0.5003	0.9891	0.9456	0.252
15 p	23.6234	0.5487	0.5015	0.9592	0.9241	0.314
20 p	20.1457	0.5495	0.5425	0.9234	0.9042	0.398

The PSNR is decreasing as splitting are increased from 10 to 20. The relative contrast error (RCE) and relative entropy error (REE) values are more than 0.5.It means that the proposed method provides enhanced contrast and increased image data. The relative mean brightness error (RMBE) and relative structural similarity (RSS) values are near to 1.It means that the proposed method provides lessdifference in mean brightness from the original image and greater structural similarity between them.

VII. Conclusion

In this report performance of prediction error based algorithm having PSNR value large and the visual quality can hardly be improved because more or less distortion has been introduced by the embedding operations and inSecond algorithm reversible data hiding that utilizes the zero or the minimum points of the histogram of an image and slightly modifies the pixelgrayscale values to embed data into the image. It can embed more data than many of the existing reversible data hiding algorithms. It is proved 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 but it does not have better visual quality in image.

A new reversible data hiding algorithm has been proposed with the property of contrast enhancement. Basically, the two peaks (i.e. the highest two bins) in the histogram are selected for data embedding so that histogram equalization can be simultaneously performed by repeating the process. The experimental results have shown that the image contrast can be enhanced by splitting a number of histogram peaks pair by pair. Moreover, the original image can be exactly recovered without any additional information. The quality of image is increased compared to other methods. The future scope of this project is to increase the data hiding capacity in host image

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