Reversible Data Hiding Based on Block Median Preservation and image local characteristic

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Abstract

Reversible data hiding is a technique that can embed information into cover media (image, video, vo ice signal) and can recover the original cover media after extracting the embedded information. In this pa pa, we propose a new reversible data hiding methods that based on block median preservation and the i mage local characteristic. By using the median value of a block, a high payload can be got and by cons idering the image local characteristic, a lot of distortion can be avoided and a high PSNR can be got. In the experiment, our methods can generate better result than the previous reversible data hiding methods.

1. Introduction

Reversible data hiding is a process to hide data into cover media (audio, image or video) which has the abili ty to restore the embedded data and the cover media pe rfectly. In some sensitive applications, such as military d ata and medical data, the perfect recovery of the origina l cover media is highly desired.

Considerable amount of reversible data hiding schemes have been reported [1] – [8] since the first reversible data hiding scheme presented by Honsinger et al. [1]. T ian [2] proposed an approach based on difference expan sion. In order to recover the original cover media, a loc ation map is needed. The location map must be compre ssed to save embedding space for the to-be-embedded d ata bits, however, the low compression ratio of location map reduces the real embedding capacity. Thodi and R odrigues [3] improved the difference expansion method using a histogram shifting technique which avoids sendi ng the location map. Hyoon Joong Kim and Vasilisy [4] proposed a novel difference expansion method with the simplified location map. The size of the location map i s largely reduced which means more data bits can be e mbedded.

Ni [5] proposed a reversible data embedding method based on histogram. This method utilizes the zero or th e minimum points of the histogram of an image and sli ghtly modifies the pixel grayscale values to embed data into the image. The performance of the peak-signal-to-noise (PSNR) in this method is good which is guarantee d to be above 48dB. But when the histogram of the co ver image is a flat histogram, this method will not be a ble to embed data bits due to the large amount of over head information.

Luo [8] proposed a method that first divide the imag e into blocks and then use the median pixel value of th is block to predict the other pixel value. Then using the difference value between the original pixel value and t he predicted pixel value to embed data bits. Because th e correlation of neighboring bits is very high in natural images, this method can get a very high payload.

In this paper, we propose a method based on Luo[8]. In our method, when embed in each block, we separate the block bits into two sets, the inner set and the oute r set. First embed data into inner set, and use inner set pixel to evaluate the characteristic of this block. Using this information, we will decide whether to embed data into outer set. The experiment shows our method can r educe the distortion.

The remainder of this paper is organized as follows. In section 2, two related works are described. Our prop osed method is presented in section 3. In section 4, exp eriment results are analyzed. The last section is the con clusion of this paper.

2. Related Works

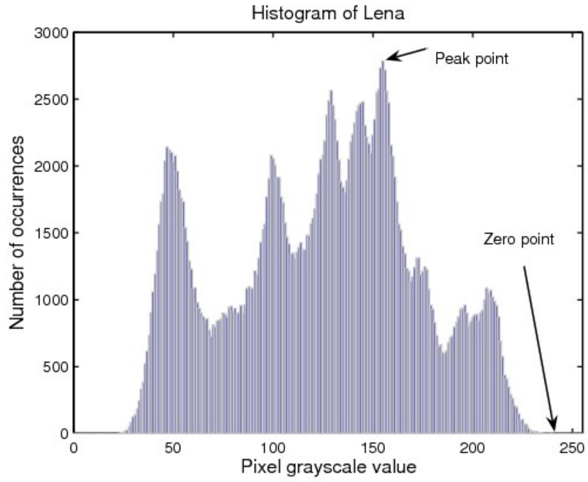
This section introduces the histogram-based reversible data hiding method in [5] and median value preservatio n method in [6], these two methods are highly related t o the proposed method.

A. Histogram-based reversible data hiding

In [5], Ni et al. proposed a reversible data hiding scheme based on histogram shifting and it utilizes the pair of peak point and zero point. For every cover image, a histogram can be generated by calculating the number of occurrences of all possible pixel values. As shown in Fig.1, a histogram can be generated using Lena image. The peak point of a histogram corresponds to the pixel grayscale value which has the largest number of occurrences. The zero point corresponds to the pixel grayscale value which has no occurrence or the least number of occurrences. Assume the peak point is P and the zero point is Z.

In data hiding process, move the whole part of the histogram between [P+1,Z-1] to the right by 1. This means all the pixel grayscale values in this range are added by 1. The pixel whose graysclae value is P will be used to embed data. Once meet a pixel whose graysclae value is P , check the to-be-embedded bit,. If the to-be-embedded bit is “1”, the pixel grayscale value is increased to P+1. If the to-be-embedded-bit is “0”, the pixel value remains P.

Data extraction is the reverse process of data hiding. Scan the marked image in the same sequential order as used in the data hiding procedure. If a pixel with its grayscale value P+1 is encountered, a bit “1” is extracted. If a pixel with its value P is encountered, a bit “0” is extracted. Scan the image again, for any pixel whose grayscale value is between [P+1,Z], the pixel value is subtracted by 1.



(Figure 1) Histogram of Lena Image

B. Median Preservation Block method

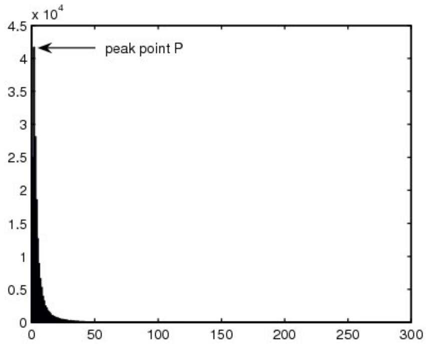
Luo[8] use a median preservation technique that increase the payload much. In his method, first divide cover image into blocks. As shown in figure 2. Then sort these pixel values and rearrange them in ascending order. Select the median value of these pixels as the predicted value for the other pixels. Generate a difference histogram by using the differences generated between predicted pixel value and original pixel value. As shown in Figure 3, the histogram has a very large peak value which shows more bits can be embedded.

In order to extract the embedded data, in embedding process, the median value should not be changed and the median value should keep to be median value when the other pixel values are changed. So when embedding the data bits, the pixel value that smaller than the median pixel value can only be decreased or remain unchanged and the pixel value that bigger than the median pixel can only be increased or remain unchanged.

So when extracting the embedded data, the decoder can find the same median value and can extract the data bits successfully.

a_1	a_2	a_3
a_4	a_5	a_6
a_7	a_8	a_9

(Figure 2) Blocks of Image



(Figure 3) Difference Histogram of Lena Image

O_1	I_2	O_2
I_3	I_1	I_5
O_3	I_4	O_4

(Figure 4) Separate block pixel values into two sets.

3. Proposed method

In our proposed method, the local characteristic of image will be considered when embedding data.

The following is the embedding process of our method.

1. Divide the cover image into blocks.
2. In each block, separate the pixel values into two subsets, the inner set and outer set. As shown in Figure 4.
3. First embed bits using inner set pixels. For inner set pixels, select the median pixel value among them. And then use the median value to predict the other pixel values. If the difference is equal to 1, this pixel is used to embed bits, if the difference is bigger than 1, just increase the difference. If the difference is 0, the difference keeps its value unchanged.
4. After embedding with inner pixel, use I_2,I_3,I_4,I_5 to calculate the local characteristic. Variance is used as the local characteristic. If the variance is bigger than a threshold T, go to step 6, otherwise go to step 5.
5. Use I_1,O_1,O_2,O_3,O_4 as a block to embed data bits
6. If this is the last block, the embedding process is finished, otherwise go to step 2.

In our methods, if the variance is very big which means the block has small probability to embed data, so we will not use outer pixel the embed data and the outer pixels value keeps unchanged. If the variance is small, which means the outer pixel will have big probability to embed data and we will use them to embed data.

The extracting process is the reverse process of embedding.

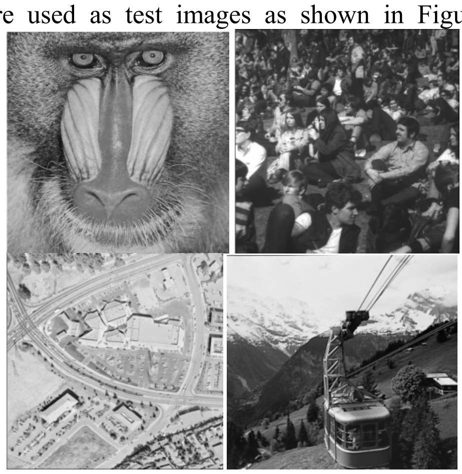
The following is the extracting process.

1. Divide the stego image into blocks.

2. In each block, calculate variance of I_2,I_3,I_4,I_5. If variance is bigger than T, go to step 3. Otherwise extract data bits from O_1,O_2,O_3,O_4,I_1. Find the median value ,use the median value to predict the other pixel value . If the difference value is 1, extract bit ‘0’, if the difference value is 2, extract bit ‘1’ and decrease the difference value by 1. If the difference value is bigger than 1, decrease the difference value by 1. If the difference value is equal to 0, the difference value keeps unchanged.
3. Extract data from I_1I_2,I_3,I_4,I_5.
4. If this is the last block, the extracting process is finished, otherwise go to step 2.

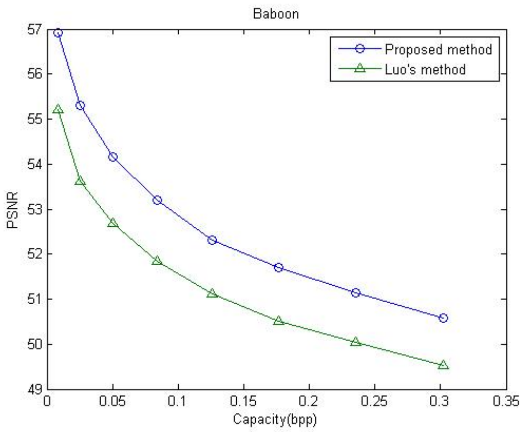
4. Experiment results.

In this section, we will show the performance of our method in embedding capacity vs. image quality and the comparison with the methods in[8]. Four images are used as test images as shown in Figure 5.

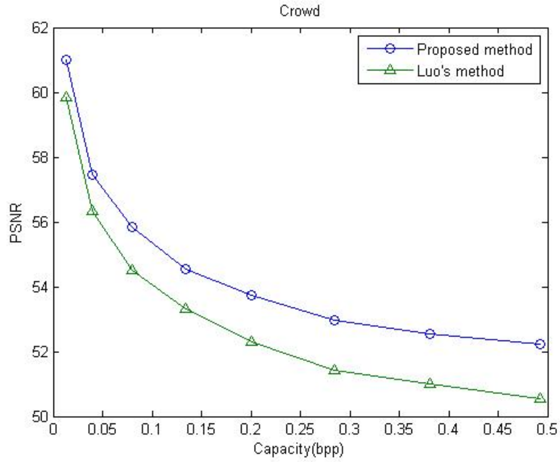


(Figure 5) baboon, crowd, aerial, cablecar

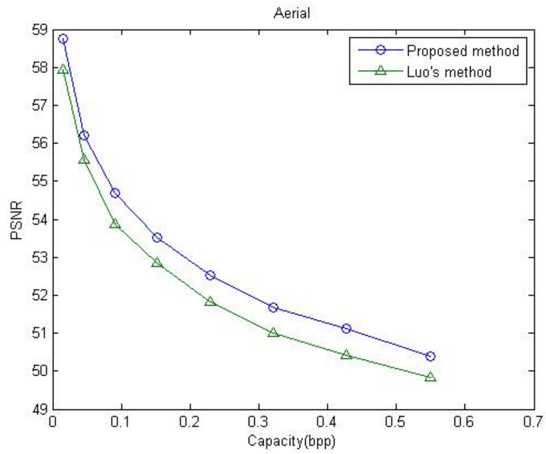
The experiment are shown in Figure 6-Figure 9.



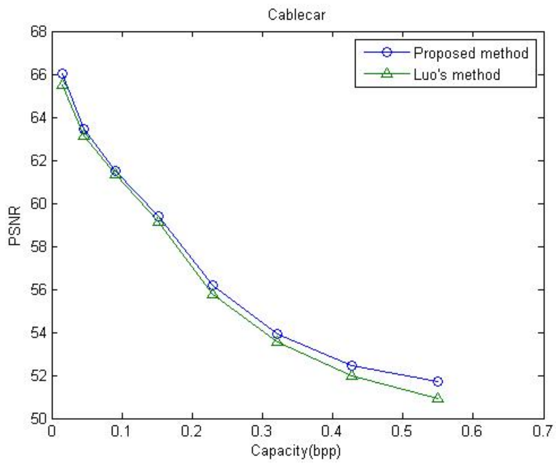
(Figure 6) Baboon . Capacity Vs. PSNR



(Figure 7) Crowd . Capacity Vs. PSNR



(Figure 8) Aerial . Capacity Vs. PSNR



(Figure 9) Cablecar . Capacity Vs. PSNR

In the experiment, our method can always have a better performance than Luo’s method. But the comparison of each image is different. When using baboon , our method’s PSNR is about 2dB higher. When using crowd image, our performance becomes better with more bits embedded. The performance of aerial image is about 1dB higher. As shown in Figure 9, our method has a similar performance when using cablecar image.

Based on these experiments, we can conclude that our method has a huge improvement over Luo's method when the image has a lot of complex texture. When the image is smooth, our method will have a not so huge improvement.

5. Conclusion

In this paper, we have proposed a new reversible data hiding method that has large embedding capacity and low distortion. By considering local characteristics of image, our method can avoid a lot of distortion, thus has a better PSNR.

Acknowledgements

This research is supported by Ministry of Culture, Sports and Tourism(MCST) as Korea Culture Content Agency(KOCCA) in the Culture Technology(CT) Research & Development Program 2011.

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Biography

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