International Journal of Advance in Computer Science & its application – IJCSIA 2018
Copyright © Institute of Research Engineers and Doctors , SEEK Digital Library
Volume 7 : Issue 2 [ISSN : 2250-3765] - Publication Date: 25 June , 2018

Improved Implementation of Histogram Shifting in Digital Watermarking Image using Threshold

Ahmed Sabeeh Yousif, Omar Ahmed Mahmood and Zaid Omar

***Abstract*— With advance of high speed computer networks, multimedia, transmission technology, an amount of information is being communicated in digital form .Numerous watermarking techniques have been developed to protect images with high security performance. For the proposed method, shifting is applied for embedding stage, add to that our contribution in this method involved the threshold concept to improve the visual quality, embedding capacity, data loss of the host image. The performance of the proposed watermarking schemes have been evaluated by using the watermarked images of size 512×512(standard images) and also applied (medical images), and the watermark (payload) is of the same size as the host image. Simulation results demonstrate that the proposed algorithm generates high performances in the visual quality, PSNR,SSIM between original image and watermarked image, and the hiding capacity compared to the previous works.**

***Index Terms*—Histogram shifting, Threshold, Embedding capacity, Visual quality.**

I. INTRODUCTION

Digital revolution is a nowadays milestone, in which digital data almost covers our lifestyle completely. Such a revolution is a consequence of the advances in the technology of capturing devices, which become available at affordable prices and better efficiency. In the context of data hiding, it is an interesting and challenging issue to be able to recover the host image from the watermarked image without any loss. Generally in all image watermarking applications it is preferable to be able to recover the original image without any degradation in quality but it is of crucial importance in some applications where high image fidelity is required, such as medical and military images and law enforcement image analysis . Medical image watermarking is used to hide the patient data in the medical images for confidentiality and copyright protection of both image and data. Medical images are transferred through internet for clinical diagnostic purposes. This may result in insecurity due to illegal interception which leads to misdiagnosis and lose of integrity. Reversibility means that original image is completely recovered from watermarked image without any distortion

Ahmed Sabeeh Yousif *(Corresponding Author)*
College of Technical Admin., Northern Technical University, Mosul, Iraq
Ahmedcomputereng86@yahoo.com
Omar Ahmed Mahmood *(Co-Author)*
College of Technical Admin., Northern Technical University, Mosul, Iraq
Zaid Bin Omar (Co-Author)
Faculty of Electrical Eng., Universiti Teknologi Malaysia, Malaysia

After embedded message has been extracted.The stego images are restored to their original states using reversible data hiding techniques after extracting the hidden data. Such techniques can be classified into three groups: (1) based on data compression; (2) based on pixel-value difference expansion [1], [2]; and (3) based on histogram shifting [3],

Fridrichet al. [4] losslessly compresses some selected bit plane(s) to leave space for data embedding. Difference expansion scheme by Tian [2] selects some expandable difference values of pixels, and embeds one bit into each of them. However, location map which difference values have been selected for the difference expansion should be also embedded with payload data. Alattar [5] [6] has extended Tian’s work by generalizing the difference expansion technique for any integer transform.

Some schemes have been proposed that use a mixture of both DE and histogram shifting. These schemes mainly use a difference histogram to expand the difference values. Kimet al. [7] and Luo et al.’s [8] schemes are good examples of these schemes. But these schemes suffer from overflow/underflow issue. In Kim’s scheme modulo 64 addition is used to circumvent overflow/underflow problem. Although it is better than using modulo 256 addition, it generates noise in watermarked image. In Luo’s scheme to prevent overflow/underflow the boundary pixels (pixels with value 0 or 255) are not used for embedding. But in this way not only we lose the capacity of pixels with values of 0 and 255, but also we need to use a boundary map to distinguish the pixels that originally was 0 or 255 before watermark embedding from those that was 1 or 254 and change into 0 or 255 after watermark embedding. Even in some test images like tiffany” the number of pixels with 0 or 255 values is relatively high and severely hurts the capacity of watermark embedding. The situation even gets worse in the case of medical images that are mainly composed of black backgrounds and white foregrounds. A lossless data hiding using histogram shifting by block division scheme was proposed by Che Wei et al [9]. A large data hiding capacity with good stego-image quality is achieved, with increased key size and use of location map. But the algorithm is not suitable for medical images which contain large dark background areas. Kuo, et al. [10], used the block division technique to increase the data hiding capacity but in this method data hiding capacity is small and stego-image quality is not good .

A. Watermarking Requirements

Watermarking is an application that is classified under the general framework of data embedding. Thus, watermarking, as an application of data embedding, has requirements that should be fulfilled when achieved on a host. Fulfilling these requirements is the criteria of evaluation the performance of any watermarking method. Figure 1 presents these requirements, namely, visual quality, embedding capacity and robustness against attacks. Practically, trade-off should be made between these three requirements. Because, for example, if found in [11] that increasing the robustness of a watermarking method decreases the visual quality, however, the embedding capacity is increased.

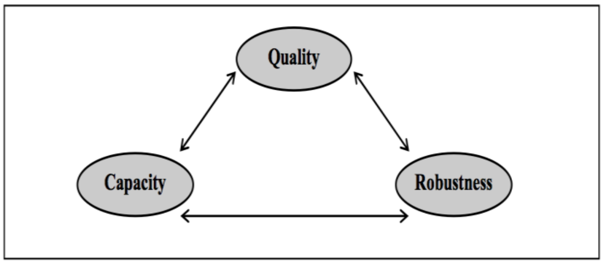


Figure 1: The three requirements of watermarking, in which a trade-off should be made between them.

B. Embedding capacity

Embedding capacity is the minimum amount of a payload that can be inserted into a particular image. This amount varies according to the applied watermarking method. Here, low SNR is common among watermarking channels, and it significantly reduces the embedding capacity. In images, the size of a watermark may vary between hundreds of bits to thousands of them [12].

The embedding capacity can be calculated using as a ratio between the size of embedded payload to the size of original image, as follows:

$$\text{Capacity} = \frac{\text{Total number of bits (payload)}}{\text{Total number of bits (hosting image)}} \qquad (1)$$

C. Visual quality

In imperceptible watermarking method, the presence of the embedded watermark into the image must be un-detectable. Hence, the same image, with or without an embedded watermark, should appear identical visually. Such a similarity should be fulfilled to any carried out test. In other word, the underlying hosting image should be affected due to embedding the watermark.

Practically, a normal user does not have an access to the original image in order to make a visual quality comparison between original and watermarked image. Hence, it is sufficient watermarking an image so that it is un-noticeable by human visual system (HVS) [13].

The measurement of performance of a watermarking method in term of visual quality can be achieved by a criterion referred to as Peak to signal noise ratio (PSNR).

$$\text{PSNR(db)} = 10\log_{10}\frac{P_{\text{peak}}^2}{\text{MSE}} \qquad (2)$$

Another criterion to evaluate the visual quality of an image is proposed in [14]. Here, SSIM is measure the difference between the original image *P* and watermarked image $\acute{P}_i$ as follows:

$$\text{SSIM}(P,\acute{P}_i) = \frac{(2\mu_P\mu_{\acute{P}}+C_1)(2\sigma_{P\acute{P}}+C_2)}{(\mu_P{}^2+\mu_{\acute{P}}{}^2+C_1)(\sigma_P{}^2+\sigma_{\acute{P}}{}^2+C_2)} \qquad (3)$$

A higher SSIM indicates a better visual quality of watermarked image. In order to reduce the complexity of computing SSIM, the image is blocked (say 8×8 pixels), and SSIM is achieved on each block individually.

The rest of the paper is organized as follows. Proposed Histogram shifting is briefly introduced in section I, And Details of the proposed method are given in section . Experimental results are presented in section II And finally the conclusion is given in section III.

II. PROPOSED HISTOGRAM SHIFTING WATERMARKING (HSW)

In HSW, an intensity level is chosen to accommodate one bit from the payload .Traditionally, the intensity level that does not occur in the histogram is selected. In some cases, an intensity level of low probability of occurrences is used. Here, we set a threshold value to select the intensity level for data embedding. The threshold determines the minimum number of pixels that such a intensity level should have in the histogram. We used a random bit streams a payload, because the amount of embeddable bits are variable according the statistic features of both standard images and medical images.

A. Algorithm 1(Embedding Process)

In Histogram Shifting (HS), the image is raster scanned and its histogram is found. Then, an intensity level that does not exist in the histogram I is determined. If all intensity levels exist, then the level of lower Probability of Occurrence (PoO) is considered as I. After that, all pixels in the range from I+1 to 2^n are shifted by 1. The shifting is achieved by adding one to the original value of each pixel within that range.

Then, the image is raster scanned from the beginning again. If a pixel of intensity value= I is found, then such a pixel is used to embed on bit from the payload. Here there are two cases:

Case I: Payload = 1, then, I is mapped to I+1.

Case II: Payload = 0, then, I is kept without a change.

Finally, I is recorded along with the header of the modified image. Finally, I is recorded along with the header of the modified image. Figure 1.1, presents the embedding process using HS watermarking method.

International Journal of Advance in Computer Science & its application – IJCSIA 2018
Copyright © Institute of Research Engineers and Doctors , SEEK Digital Library
Volume 7 : Issue 2 [ISSN : 2250-3765] - Publication Date: 25 June , 2018

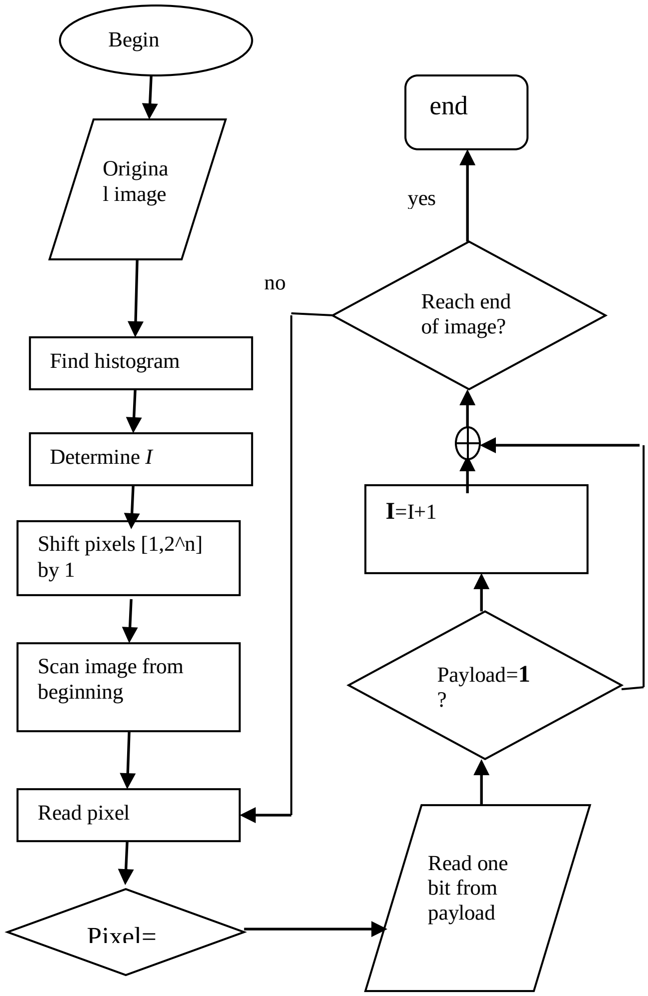


Figure 1.1:embedding process using HS watermarking method.

B. Algorithm 2 (Extracting Payload)

The extraction of payload starts with finding the value of I in the header of the modified image. Then, the modified image is raster scanned. If a pixel=I is found, then one bit of the payload, of value = 1, is extracted. If a pixel = I+1 if found, then one bit of the payload, of value = 0, is extracted.

III. EXPERIMENTAL RESULT

The aforementioned watermarking method was applied to a set of 10 standard images(images are gray-scale of 512 x 512 pixels and of depth of 8 bits) and 5 medical images that are widely used in image processing researches. These images are gray-scale images. Figure 1.2 shows the set of standard images. Figure 1.3 shows the set of medical images. The practical implementation of watermarking and visual quality evaluation is carried out using Matlab 7.12.0. In this section, we will show the feasibility and the performance of proposed method in terms of pure payload and image quality over the relevant techniques proposed.

It can be observed that, choosing an intensity of minimum value in the histogram results a low embedding capacity. Such a low capacity is shown in Table 1,1.2 (under the column of Threshold = 0 in Table 1). The majority of images have 0 bits as an embedding capacity because the minimum value in the histogram is 0. Even in case of having a minimum>0, such as in fourth and tenth images, the capacity is low.

Setting the threshold to higher value results in a better embedding capacity. We set the threshold (T=0) to 10, 100 and 1000. The capacities at these thresholds are shown in Table 1,1.2. The variance in the embedding capacity is due to the variance in statistical properties of each image. Table 1.1,1.3 shows the intensity levels that are selected for data embedding at T=100.

In term of visual quality, Table 1.4,1.5 and Table 1.6,1.7 show the SSIM and PSNR(db) for the watermarked images for standard and medical images, respectively. A higher SSIM/PSNR indicates a better visual quality. The SSIM values are between 0 and 1. 0 indicates no match between original and watermarked image, whereas 1 indicates the complete match. A PSNR higher than 30 indicates a good visual quality. In Table 5, majority of values are close together due to the low distortions in these images. In such images, the differences occur at small fractions, which are eliminated by approximations. It is noticeable that SSIM and PSNR reduce as the embedding capacity increases, such as at Threshold values 100 and 1000. This is because more pixels are changed due to watermarking insertion. Figure 1.4 shows Baboon image before and after the insertion of the payload. Figure 1.5 show the medical image before and after insertion of payload .

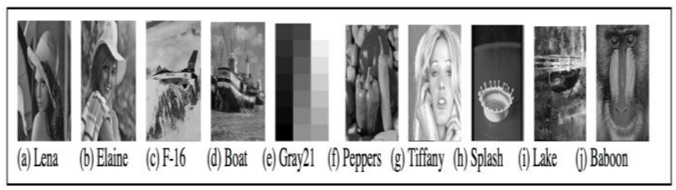
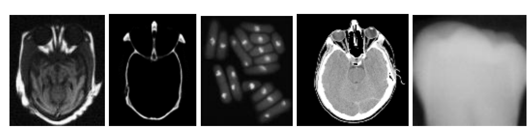


Figure 1.2: The set of testing standard images



(1) (2) (3) (4) (5)

Figure 1.3:The set of testing medical images.

No	Image	Capacity (bits) T=0	Capacity (bits) T=10	Capacity (bits) T=100	Capacity (bits) T=1000
1	Tiffany	1	18	94	1038
2	Lake	1	1	1	1501
3	Splash	1	3	152	903
4	Pepper	3	9	76	989
5	Lena	1	69	137	1046
6	Gray21	1	12646	59	1
7	F-16	1	5	88	1078
8	Elaine	1	13	57	1329
9	Boat	1	14	197	654
10	Baboon	2	32	132	1130

International Journal of Advance in Computer Science & its application – IJCSIA 2018
Copyright © Institute of Research Engineers and Doctors , SEEK Digital Library
Volume 7 : Issue 2 [ISSN : 2250-3765] - Publication Date: 25 June , 2018

Table 1: Embedding capacity in HSW at T=0, 10, 100 and 1000 respectively in standard images.

Image	1	2	3	4	5	6	7	8	9	10
Intensity	64	162	170	204	203	1	208	236	219	184

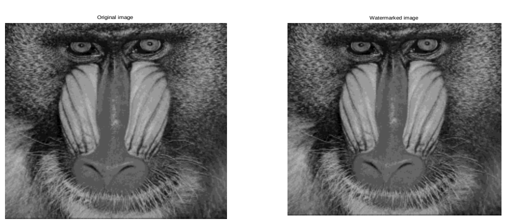
Table 1.1: The selected intensity levels of embedding at T=100 in standard images

NO	Capacity (bits) T=0	Capacity (bits) T=10	Capacity (bits) T=100	Capacity (bits) T=1000
1	1	9	94	802
2	7	12	15	558
3	1	3	87	955
4	112	1	1	1
5	3	11	150	1051

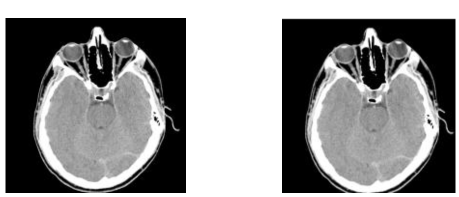
Table1.2: Embedding capacity in HSW at T=0, 10, 100 and 1000 respectively in medical images.

Image	1	2	3	4	5
Intensity	249	15	192	11	6

Table 1.3: The selected intensity levels of embedding at T=100 in medical images.



(a) Original image (b) Watermarked image
Figure 1.4: Comparison between original and watermarked image of Baboon. Watermark is achieved using HSW at T=1000.



(a) Original image (b) Watermarked image
Figure 1.5: Comparison between original and watermarked medical image. Watermark is achieved using HSW at T=1000.

Image	T= 0	T=10	T=100	T=1000
1	0.9889	0.9889	0.9889	0.9889
2	0.9930	0.9932	0.9931	0.9930
3	0.9904	0.9907	0.9906	0.9906
4	0.9901	0.9901	0.9901	0.9900
5	0.9909	0.9909	0.9911	0.9910
6	0.9989	0.9987	0.9987	0.9985
7	0.9901	0.9910	0.9910	0.9900
8	0.9857	0.9857	0.9857	0.9857
9	0.9905	0.9905	0.9905	0.9857
10	0.9918	0.9918	0.9918	0.9918

Table 1.4: SSIM in HSW of standard images.

images	T=0	T=10	T=100	T=1000
1	0.9998	0.999	0.999	0.999
2	0.999	0.99	0.998	0.997
3	0.999	0.990	0.990	0.994
4	0.899	0.87	0.87	0.89
5	0.995	0.95	0.995	0.99

Table 1.5: SSIM in HSW of medical images.

Image	T=0	T=10	T=100	T=1000
1	34.7028	34.7029	34.7031	34.7633
2	32.2224	32.3211	32.3173	32.2271
3	41.1717	42.1313	42.0334	41.9221
4	36.3619	36.3691	36.3689	36.2265
5	38.3154	38.3157	38.7888	38.7044
6	46.5808	48.3529	47.5224	46.7221
7	37.1895	37.5565	37.5564	37.2333
8	34.0682	34.0682	34.2418	34.2175
9	35.378	35.3783	35.3768	35.3576
10	31.4001	31.3069	31.3999	31.3131

Table 1.6: PSNR(db) in HSW of standard images.

images	T=0	T=10	T=100	T=1000
1	43	44.45	44.43	43.38
2	46.8	46.7	46.5	46.4
3	46	50.8	50.2	49.8
4	39.6	39.8	39.2	39.8
5	47.5	47.5	44.5	45.5

Table 1.7: PSNR(db) in HSW in medical images.

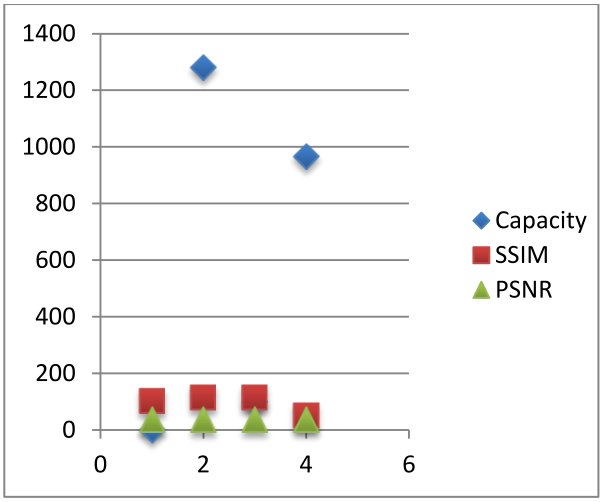


Figure 1.6:Shows the average embedding capacity versus averages SSIM and PSNR.

From figure 1.6, Obviously, as the embedding capacity increases, the visual quality decreases. In other words, high embedding capacity results low SSIM and PSNR, which indicates more distortion due to watermark embedding. Hence, a trade-off should be between the embedding capacity and visual quality in the standard images.

IV. CONCLUSION

A reversible watermarking scheme was presented in this paper that aimed for increasing the embedding capacity with high visual quality images, lossless data hiding by utilizing a new strategy of using threshold in the histogram shifting method. We used a random bit streams as payload, because the amount of embeddable bits are variable according the statistic features of each image. SSIM and PSNR both were able to detect the visual distortion in watermarked images. No significant difference is found between their evaluation performances. The modified method is more suitable for medical images and standard images shown in the experimental result.

REFERENCES

[1] H. J. Kim, V. Sachnev, Y. Q. Shi, J. Nam, and H. G. Choo, "A novel difference expansion transform for reversible data embedding", IEEE Transactions on Information Forensics and Security, vol. 3, pp. 456-465, 2008.

[2] J. Tian, "Reversible data embedding using a difference expansion", IEEE Transactions on Circuits Systems and Video Technology, vol. 13, no. 8, pp. 890-896, 2010.

[3] J. H. Hwang, J. W. Kim, and J. K. Choi, "A reversible watermarking based on histogram shifting", Proceedings of 5th International Workshop on Digital Watermarking (IWDW 2006), Lecture Notes in Computer Science (LNCS) 4283, pp.348-361,2006.

[4] J. Fridrich, M. Goljan, and R. Du,"Invertible Authentication", Proc. SPIE Security and Watermarking of multimedia Contents III, Vol. 4314, pp. 197-208, 2001.

[5] A.M. Alattar,"Reversible Watermark Using the Difference Expansion of Triplets",Proc. Int. Conf. Image Processing, Vol. 1, pp. 501-504, 2003.

[6] A.M. Alattar, "Reversible Watermarking Using the Difference Expansion of a Generalized Interger Transform", IEEE Transactions on Image Processing, Vol. 13, No. 8, pp. 1147-1156, 2004.

[7] H. J. Kim, V. Sachnev, Y. Q. Shi, J. Nam, and H.-G. Choo, "A novel difference expansion transform for reversible data embedding," IEEE Transactions on Information Forensics and Security, vol. 3, no. 3, pp. 456–465, SEP 2008.

[8] M. Celik, G. Sharma, A. Tekalp, and E. Saber, "Lossless GeneralizedLSB Data Embedding," IEEE Transactions on Image Processing, vol. 14, no. 2, p. 253266, FEB 2005.

[9] Che-Wei Lee and Wen-Hsiang Tsai,"A Lossless Large-Volume Data Hiding Method Based On Histogram Shifting Using an Optimal Hierarchical Block Division Scheme", International Journal of Information Science And Engineering, pp. 1265 1282, 2010.

[10]] W. C. Kuo, D. J. Jiang, and Y. C. Huang, "A reversible data hiding scheme based on block division", Proceedings of 2008 International Congress on Image and Signal Processing (CISP 2008), vol. 1, pp. 365-369, 2008.

[11] Gulati, K. (2003). Information Hiding Using Fractal Encoding. Master Thesis. Indian Institute of Technology Bombay, Mumbai.

[12] Piva, A., Barni, M., Bartolini, F., and Cappellini, V. (1999). Capacity of the watermarking channel: How many bits can be hidden within a digital image. Security and Watermarking of Multimedia Contents, Proceedings of SPIE, Wong, Delp. San Jose, CA, 3657: 437-448.

[13] M. A. Abdou and A. A. Saleh, "A Robust Time Efficient Watermarking Technique for Stereo Images," *Journal of Computational Engineering*, 2015..

[14] Y. Shahriari et al., "Perceptual Image Processing Based Ecg Quality Assessment," Journal of Electrocardiology., vol. 49, no. 6, pp. 937, 2016.