Embedding and Extracting Two Separate Images Signal in Salt & Pepper Noises in Digital Images based on Watermarking

Khalil Shekaramiz,
M.S.c Student of Computer Architecture,
Faculty of Computer Engineering,
Najafabad Branch, Islamic Azad University,
Najafabad, Iran.
Digital Processing and Machine Vision Research center,
Najafabad Branch, Islamic Azad University,
Najafabad, Iran.
Khalil_shekaramiz@yahoo.com

Alireza Naghsh,
Assistant Professor,
Digital Processing and Machine Vision Research Center,
Najafabad Branch, Islamic Azad University,
Najafabad, Iran.
Department of Electrical Engineering,
Najafabad Branch, Islamic Azad University,
Najafabad, Iran.
naghsh.a@pel.iaun.ac.ir

***Abstract*—By the increasing exchange of information around the world and the use of computer networks, such as the Internet, having a secure environment for transmission is necessary. Watermarking means hiding the data, known as water marker in digital media, in which the information can be extracted and processed in a safe manner. Watermarking in the spatial domain is done at most in three Least Significant Bits (LSB) of an image. In this paper, we introduce a method for watermarking the two separate digital signals in six bits of applied salt & pepper noises to a digital image; since the salt & pepper noises are placed randomly throughout the image, the pixels' information of the two separate images can be replaced into the salt & pepper noises peer to peer, and then this embedded information in noises is extracted in other applications, and noises from these three images will be removed.**

Keywords—watermarking; embed and extract; salt & pepper noise; spatial domain.

I. INTRODUCTION

With the rapid growth of digital technology over the past decades, the speed of sending as well as embedding electronic media has increased, and copying of data without compromising the quality and with very little cost has become possible. Due to the rapid growth of technology, protection of digital media has become an important issue. Stability, security, and data integrity are the most important features that have been improved by the watermarking algorithms.

Watermarking which means "hiding data in digital media, is divided into two frequency and space areas. In order to integrate data in the spatial domain, pixel values are directly manipulated. These methods have less complexity, but are more fragile and not stable. But, in the frequency domain methods, the images conveyed to a frequency domain, and then watermarking is done by manipulating the values in the frequency domain, and at the end, the image is returned into spatial domain.

Compared with the spatial domain methods, it has been proven that methods in frequency domain for watermarking are more powerful and stable. Watermarking information may include image, text, audio, and video that are divided into three categories, from various aspects of resistance to attacks: resistant watermarking systems, semi-fragile watermarking systems, and fragile watermarking systems.

One of the problems in watermarking is that these systems are the target of many attacks. Watermarking attacks are divided into different categories: Removal attacks, cutting attacks, geometric attacks, compression attacks and conventional noises. Cutting attacks seek to undermine or completely eliminate watermarking information, so that the original data cannot be used after the attack. One of the most common attacks, is salt & pepper impulsive noise with different densities, which is a removal attack.

In this study, an algorithm is proposed in which the information of two separate images is placed into noises in an image. In each execution of the program in the algorithm, a pre-processing is done on the three input images and the salt & pepper noise is applied to the image of a certain percentage. Then, the information of the first and the second images is placed in the pepper and the salt noises, respectively. The proposed method for data embedding of the two separate image signals in salt & pepper noise can be seen in Fig. 1.

In the second algorithm at the receiver side, primarily the image containing the information of the two images (the output of the first algorithm) is received; then, pixel by pixel, the location of noises is checked and if the current pixel is noisy, the information within the pixel is extracted and the corresponding pixel is recovered, and finally three noisy

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images are produced. In the next step, the operation of noise removal of the images is done and all three will be reconstructed and displayed. The proposed algorithm for data recovery of the two separate signals in salt & pepper noises is shown in Fig. 2

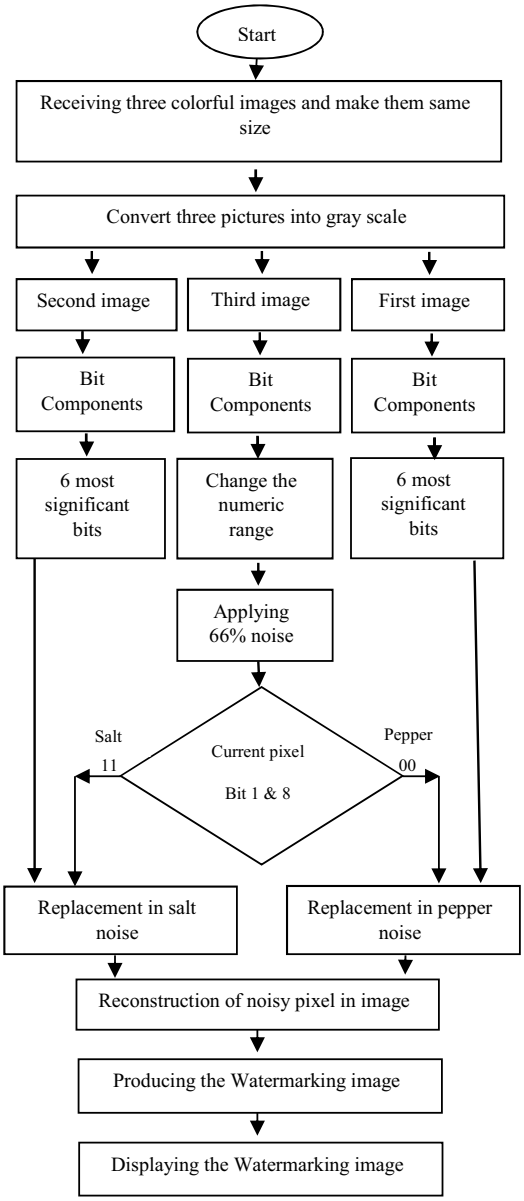

Fig. 1. Embedding Watermarking image flowchart

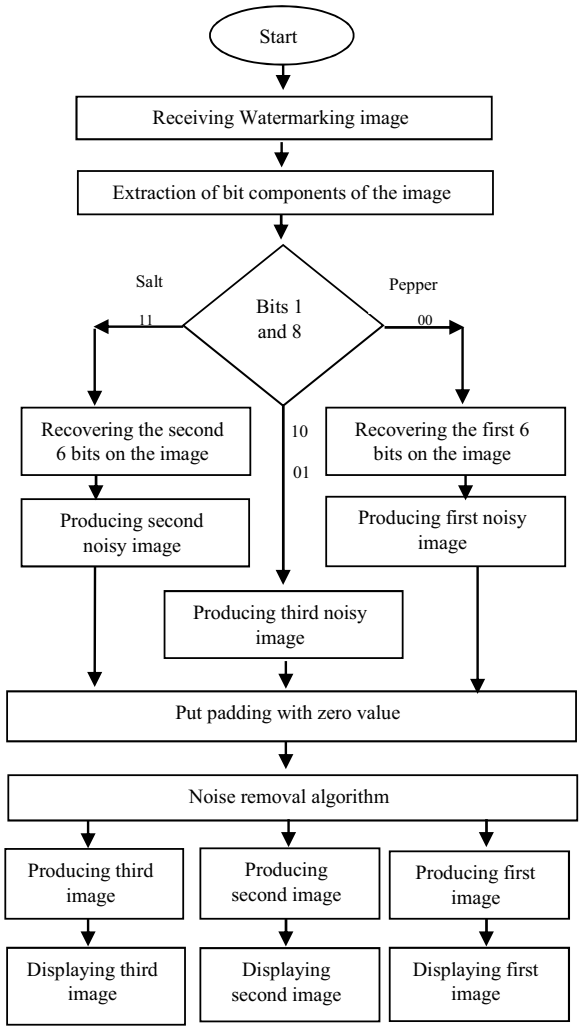

Fig. 2. Extracting Watermarking images flowchart

II. A REVIEW OF BACKGROUND

In 2011, a new design for watermarking algorithm was proposed by Bamatral et al. that used the combination of Least Significant Bit (LSB) and the reverse bit [1].

In [2], Chopra and his colleagues in 2012, used the watermarking in digital images with the Least Significant Bit (LSB) for gray images. The purpose was to protect the data copyright against the modification and misuse of valuable information, with the help of replacing Least Significant Bit (LSB) by the most significant bit.

In 2012 [3], Sharmal and colleagues investigated the digital watermarking using the Least Significant Bit (LSB) and image watermarking methods and their attacks, and they evaluated the digital watermarking scheme based on Least Significant Bit (LSB) by replacing the different bits with most significant bit in the image. By putting the data in the first bit, such as Least Significant Sign Bit (LSB), watermarking image was produced without any interference. But, by embedding data in the second bit to the highest bit, it is blurred up.

In 2013, in [4] the improved watermarking scheme in Least Significant Bit (LSB) was used for authenticity and accuracy. In the Least Significant Bit (LSB), the embedded capacity is low, but only one bit per pixel is used which is irreversible, and therefore, cannot be used for sophisticated applications. In this scheme, a new strategy that compensates the bit reversibility and embedding capacity is improved with the help of two bits per pixel.
Mousavi and his colleagues took advantage of medical images in watermarking in 2014. In this paper, the basic structure of a security system is expressed. Expanding and sharing the medical images among clinicians is done for much better and exact diagnosis, which is done for preventing manipulation by unauthorized persons and the security of medical images [5].

Sain and his colleagues examined watermarking in Least Significant Bit (LSB) with different noises in 2015. Information security, verification, validation, and authentication of documents and hidden data of Least Significant Bit (LSB) and noise impact were the main goals of this study. In that study, the collision of different noises on watermarking, practical analysis of noise collision and its impact on watermarking of Least Significant Bit (LSB) is explained and is simulated by the Matlab Software, and its results were investigated using the criteria of signal to noise ratio and slope coefficient [6].

In 2016, Mousavi and his colleagues offered a plan, in which the resistance of watermarking in medical image against salt & pepper noise was used for magnetic brain images. It is likely that these transferred magnetic images of brain between specialists and hospitals are at risk of salt & pepper noise and the embedded watermarking within medical images is disappeared. The proposed watermarking methods are weak against salt & pepper noise, while this plan is resistant against the severity of salt & pepper noise of brain magnetic pictures. Quality of image watermarking is evaluated using the signal to noise criteria, bit error rate and the structural similarity, and it indicates that bit-error rates is lower compared to current method and higher, compared to signal to noise [7].

In 2013, a 9×9 Sudoku was used for watermarking, which increases the cutting percentage for recovering a portion of the secret image. The plan's limitation was that knowing the code for solving the Sudoku puzzle for detection of watermarking information was necessary [8].

In [9], the Sudoku key was used for strengthening the watermarking digital image against the salt & pepper noise. This means that the watermarking is organized in a pattern that this information pattern can improve the watermarking detection considerably.

In 2015, Saaneei et al., used Sudoku puzzle to strengthen the digital images against cutting and the salt & pepper noises. Because of the unique features of the scattered information in the Sudoku puzzle, acceptable results have been obtained in strengthening against attacks [10].

In 2012, a fuzzy-based median filter was introduced to remove salt & pepper noise, in which the median filter based on fuzzy logic effectively removed salt & pepper noise, while the image details were retained under the high- and low-intensity noises. Experiments on different images showed that performance of the proposed filter is better than traditional median filters [11].
In 2013, in [12[various filters were introduced such as duplex filter, median filter, small shock wave, fuzzy filters, which they caused a number of filters to develop a number of other filters [12]. These filters were used on a number of images and on a wide range of visual applications. Also, these filters were applied on medical images.
Hsieh and his colleagues introduced a fast and efficient median filter using the previous data to restore normal pixels. This proposed median filter removes the salt & pepper noise in images up to 99%, which is satisfactory, such that it recognizes the lowest and highest value as the up and down noise directly, without leaving any noise in the extracted image, creating a resistant filter [13].

Image noise reduction techniques were investigated in 2014. In fact, the aim was to examine a number of techniques that can be helpful in eliminating the noise. Therefore, some issues such as the type of noises, and the noise removal techniques and their different functions have been investigated [14].

III. PROPOSED METHOD

In this article, the information of two separate digital images into the salt & pepper noise in the first algorithm was embedded using the watermarking method in spatial domain, and then this embedded information was extracted and the desired images was reconstructed and displayed by the second algorithm.

A. Embeding information of two separate images in digital image salt & pepper noises

In the beginning, three images are received by the algorithm and the pre-processing is performed on them, including making them gray in the same size (Figs.1, 2 and 3). Then, an image is selected as host image and the range of its pixels changes from [0-255] to [1-254] (Fig. 5).

This operation is done by reversing the eighth bit of each pixel and putting it in the place of the first pixel. Thus, the first and eighth bits of each pixel in matrix of host image are not similar to each other. This similarity between the first and eighth bits, is the key for embedding and extracting in the next steps (Fig. 6).

In the next step, 66% salt & pepper noise is applied into the image (Fig. 7). And finally, in order to embed information, two images in the salt & pepper noise in host image are sweeping from the beginning pixels in the image by a function. If the current pixel contains the pepper noise, 6 bits (bits 3 to 8) of the current pixel in the first image (Fig. 3) will be replaced in 6-bit pixel pepper noise (bits 2 to 7) in the host image, and if the current pixel contains salt noise, 6 bits (bits 3 to 8) of the current pixel in the second image (Fig. 4) will be replaced in the 6-bit pixel salt noise(bits 2 to 7) in the host image; and if that pixel contains information of host image, the algorithm will continue until achieving the next noisy pixel in the host image. In the end, an image containing the watermarking information of the first and second images in

the salt & pepper noises of the third image will be displayed (Fig. 8).

Fig. 3. First image

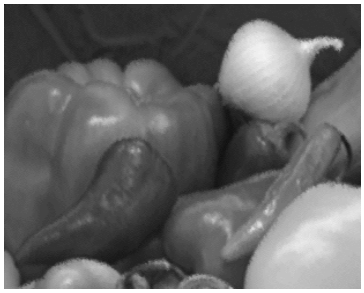

Fig. 4. Second image

Fig. 5. Third image

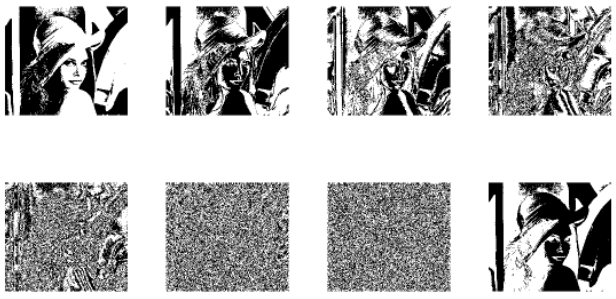

Fig. 6. Bit components of the host image

Fig. 7. Noisy host image

Fig. 8. Watermarking image

B. Recovering the data from two separate images of salt & pepper noises in digital image

In this algorithm, primarily the image containing the information of two images in the salt & pepper noise (the watermarked image) that was produced in the previous section, is received. Two matrixes with the size identical with the received image with zero pixel values are produced. Then, from the beginning of the matrix of the received image, the two first and eighth bits of it is reviewed pixel by pixel by a function. This review includes three modes:

- If the two bits are zero, it means that this pixel has already been a pepper noise; thus, the information in the (2-7) second to seventh bits of this pixel has been read, and after the decimal summation, this value is placed in the pixel location of the first matrix with the size identical with the watermarking image. Then, the value of the number zero is placed in the pixel of the watermarked image for reconstruction, and the first watermarking image is obtained (Fig. 9).

Fig. 9. First extracted image

- If two bits are one, it means that the pixel has already been a salt noise. When the information in the bits of (2-7) is read and after decimal summation, this value is placed in the pixel of second matrix with the same size of the watermarked image. Then, the amount of 255 is placed in the pixel of watermarked image in order to reconstruct the salt noise, and the second watermarked image is obtained (fig. 10).

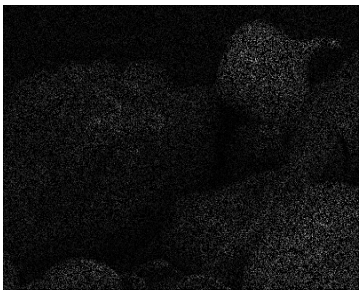

Fig. 10. Second extracted image

- If the two bits are different, it means that this pixel contains the original information of watermarked image. Therefore, the next pixel is selected for review. Finally, the host image containing the salt & pepper noise is produced (Fig. 11).

Fig. 11. Third extracted image

C. Renoising from 3 separate images in digital image

In this step, using the 3*3 average window method and the use of zero padding around the extracted images, the salt & pepper noise is eliminated in three images and it would be displayed (Figs. 12, 13 and 14).

Fig. 12. First image which the noise is removed

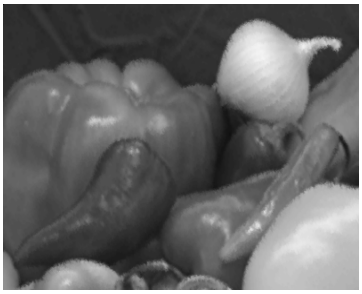

Fig. 13. Second image which the noise is removed

Fig. 14. Third image which the noise is removed

IV. Results of Simulation Based on Evaluating the Watermarking Images

To review the proposed method and evaluate the watermarked image, the evaluation criteria mentioned in the Table.1 have been used.

TABLE 1. Criteria For Evaluating Watermarking Image

Evaluation Criteria	*Equation*
Mean Square Error (MSE)	$\frac{1}{MN}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\left(I(i,j)-IW(i,j)\right)^2$
Peak-Signal-to-Noise Ratio(PSNR)	$10\times\log 10\frac{MAX_I^2}{MSE}$

In this equation, I(i,j) defines the main image, and I_w is the watermarked image, while the image dimension is N×M.

Using the method described in Part III, the results of proposed method for the production of watermarking images of host image and two other pictures are summarized in the table. 2.

V. Conclusion

In this study, a new design was proposed for extracting and embedding the information in two digital images in the Salt & Pepper noises of the digital images, separately. Using the characteristics of Salt & Pepper noises, such as random dispersion in the levels of image pixels and their value of zero and 255 with respect to the original pixels of the host image, as well as using the watermarking advantages in the area of location by LSB method, in the maximum 3 bits of every pixel of the image, watermarking the information is possible, but

this algorithm has a large volume for embedding the information, and the embedding capacity of the information in the pixels containing the Salt & Pepper noises inserted to the image has increased to 6 bits, and this embedded information can be recovered in a safely manner. Also, using removal method of a strong Salt & Pepper noise, we can enhance the rate of PSNR criterion for the images recovered from the Salt & Pepper noise.This algorithm is not resistant against salt & pepper noise and attacks cutting attacks.After reviewing the algorithm in Matlab that was identified in part 3, the Watermarking image obtained that is reviewed with the specified criteria in Table 1, and the results of this experiment is included in table 2.

TABLE 2. EQUATION RESULT

Evaluation criteria	**Equation result with size(400*600)**		
	Pic1 trees	***Pic2 onion***	***Pic3 lena***
Mean Square Error (MSE)	56.7532	118.4607	15.8923
Peak-Signal-to-Noise Ratio(PSNR)	30.5909	27.3951	36.1189

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