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# A NOVEL APPROACH FOR REVERSIBLE IMAGE WATERMARKING

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**Abstract—** *Digital watermarking is used for protecting digital data from illegal manipulations and distributions. It provides a robust solution to the problem occurs during intellectual property rights for online information. Digital watermarking have applications in different areas like broadcast monitoring, copy right protection etc. For some critical applications in the area such as law, medical and military system, it is very important to restore the original image without any distortions. Reversible watermarking techniques can be used for this purpose. Reversible watermarking is used to completely restore the original image This paper propose a robust method of digital watermarking for protecting digital information and recovering original image.*

***Key Words*— Watermarking, Gaussian filtering, pseudorandom noise, HFCM, Huffman coding, Histogram Shifting.**

## 1. INTRODUCTION

Digital watermarking is the technique of embedding of signal, secret information (watermark) into the digital media such as image, audio and video. Later the embedded information is detected and extracted to identify the real owner or identity of the digital media. Watermarking is used due to the following things, Proof of Ownership (copyrights and IP protection), Copying Prevention, Broadcast Monitoring, Authentication and Data Hiding. Watermarking consists of two modules watermark embedding module and watermark detection and extraction module. Digital watermarking technology has many applications in protection, certification, distribution, anti-counterfeit of the digital media and label of the user information. It has become a very important study area in information hiding. As an emerging technology, digital watermarking involves the ideas and theories of different subject coverage, such as signal processing, cryptography, probability theory and stochastic theory, network technology, algorithm design, and other techniques. Digital watermarking hides the copyright information into the digital data through certain algorithm. The secret information to be embedded can be some text, author's serial number, company logo, images with some special importance. This secret information is embedded to the digital data to ensure the security, data authentication, identification of owner and copyright protection. The watermark can be hidden in the digital data either visibly or invisibly. For a strong watermark embedding, a good watermarking technique is needed to be applied. Watermark can be embedded either in spatial or frequency domain. Both the domains are different and have their own pros and cons and are used in different scenario.

In this paper, we mainly study the different watermarking techniques. Sometimes cover image is importance as that of watermark in the field like military and medical .So in this paper propose a method to recover original image as well as watermark.

## 2. RELATED WORKS

Y. Xiang [1] proposes a novel dual-channel time-spread echo method for audio watermarking. It increase the robustness and perceptual quality. N. K. Kalantari [2] propose a robust image watermarking scheme in the ridgelet transform domain. So sparse representation of an image which contain line singularities is obtained. For achieving robustness and transparency, the watermark data is embedded in the selected blocks of the cover image by modifying the amplitude of the ridgelet coefficients which represent the most energetic direction. N. F. Johnson [3] proposes methods which based on inherent features within images that can be used to "fingerprint" images and it is an alternative method for image recovery. Nezhadarya [4] propose a robust quantization-based image watermarking scheme, which is called as gradient direction watermarking (GDWM) that is based on the uniform quantization of the direction of gradient vectors.

F. Davoine [5] proposes a compensation technique allowing to retrieve a watermark in an image attacked by random local geometric distortions, with the help of original image or its edges. In order to compensate the parts of geometric distortions that could be caused by Stirmark software, a flexible triangular 2-D mesh is used. J.-S. Tsai [6] propose a novel feature region selection method for robust digital image watermarking. This method tries to select a non-overlapping feature region set, which has the greatest robustness to resist various attacks and can preserve image quality as much as possible after watermarking. S. Pereira [8] propose a method for the secure and robust copyright protection for digital images. In this method digital watermark is embedded into an image using the Fourier transform.

J.Dugelay [7] propose an original blind watermarking algorithm which is robust to local geometrical distortions such as the deformations caused by Stirmark. M. Alghoniemy [9] proposes a method in which the watermark is used in an authentication context. Two solutions are proposed for this problem. Both geometric and invariant moments are used in the proposed techniques. X. Kang [10] proposes, a blind discrete wavelet transform-discrete Fourier transform (DWT-DFT) composite image watermarking algorithm which resist the alteration of image during both affine transformation and JPEG compression

## 3. HISTOGRAM SHAPE BASED METHOD FOR IMAGE WATERMARKING

Cropping and random bending are two common attacks in image watermarking. Tianrui Zong [12] propose a method to overcome this, consists of watermark embedding and decoding.

### 1. Watermark Embedding Process

The watermark-embedding process of the existing method is shown in Fig. 1. It consists of four steps: Gaussian filtering, histogram construction, pixel group selection, and HFCM based watermark embedding.

#### A .Gaussian Filtering

Robustness to common signal processing attacks can be achieved by embedding watermarks into the low-frequency component of an image. Thus, we first pre-process the host gray scale image I by a 2-D Gaussian low-pass filter.

$$F(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

where (x, y) denotes the position of the pixel and σ is the standard deviation of the distribution, which is usually chosen as = 1. The filtered image $I_{low}$ can be expressed as

$$I_{low}(x, y) = F(x, y, \sigma) * I(x, y) \quad (2)$$

where ∗ denotes the convolution operator. If $I_{high}$ stands for the high-frequency component removed by the Gaussian filtering from the host image I, it follows:

$$I_{high}(x, y) = I(x, y) - I_{low}(x, y). \quad (3)$$

#### B. Histogram Construction

Assume that the filtered image $I_{low}$ has K gray levels, e.g., an 8-bit gray scale image has K = 256 gray levels, ranging from 0 to 255. The histogram of an image illustrates the number of pixels versus the gray level values. Clearly, the shape of the histogram is related to the image content. To introduce security into the method, a pseudonoise ( PN ) sequence p(n) =[p(1), p(2),..., p(K)] of length K is used as a security key to randomly select S gray levels from the K available gray levels, and corresponding histogram $H_{S,}$ constructed.

#### C. Pixel Group Selection

After constructing the histogram $H_S$ take each $L_B$ neighbouring gray levels in $H_S$ to form a bin. In total, one can form $M_B$ bin. Further, take each two neighbouring bins to form a group, which will yield $M_B/2$ groups. . For the ith group, the two bins (called Bin_1 and Bin_2) contain $h_B$ (2i − 1) and $h_B$ (2i) pixels. Next, we select the pixel groups that are suitable for hiding watermarks. Let $N_S$ be the total number of pixels corresponding to the S selected gray levels. The number of pixels in the ith group is denoted as $h_G$ (i). To make the selection of pixel groups adaptive to the histogram shape, propose a pixel group selection criterion based on the ratio (g (i)) between $h_G$ (i) and $N_S$, and this is compared with a default threshold. If it is greater than threshold, that group is selected for watermarking. If $L_G$ pixel groups are suitable for embedding watermarks. Denote the number of watermarks to be embedded by $L_W$. If $L_W = L_G$, all of the $L_G$ pixel groups will be chosen to embed watermarks. If $L_W < L_G$, the $L_W$ pixel groups with the highest g (i) values will be chosen to embed the $L_W$ watermarks. . To minimize the unwanted situation such as change due to attack, from happening, introduce a safe band for g(i) between the $L_W$ chosen pixel groups and the non chosen pixel groups in the embedding process.

D. HFCM-Based Watermark Embedding

Watermark Embedding via Pixel Transfer Between Bins: Assume that $w_1$, $w_2$,...,$w_L$ are the watermark bits to be embedded into the $L_W$ chosen groups, respectively. It is known that each chosen group, say the ith group, is composed of two bins: Bin_1 containing $h_B$ (2i − 1) pixels and Bin_2 containing $h_B$ (2i) pixels. .

If $w_i = 1$, a certain number of pixels (say $N_1$) should be transferred from Bin_2 to Bin_1 such that $h_B(2i-1) \geq 2h_B(2i)$. Similarly, if $w_i = 0$, some pixels (say $N_0$) need to be transferred from Bin_1 to Bin_2 such that $h_B(2i-1) \leq (1/2)$ hB (2i). The minimum $N_0$ and $N_1$ are

$$N_0 = \frac{2h_B(2i-1)-h_B(2i)}{3}$$
$$N_1 = \frac{2h_B(2i)-h_B(2i-1)}{3} \quad (4)$$

## 2. Watermark Decoding Process

The watermark decoding process is shown in Fig. 5, which involves Gaussian filtering, histogram construction, identification of watermarked groups, and watermark extraction.

A. Gaussian Filtering

Since Gaussian low-pass filter is not invariant to scaling attacks, the dimension of the 7 × 7 Gaussian mask used in the embedding process may be varied in the received image I after scaling attacks. Hence, same as the method in [32], an σ-based matching scheme is employed to determine the size of the Gaussian mask to be used in the decoding process. The obtained Gaussian mask is applied to I to extract the corresponding low-frequency component $I_{low}$ .

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B. Histogram Construction

Based on the security key, find the S gray levels $K_1$, $K_2$,..., $K_S$ used for watermark embedding, from the K possible gray levels. Then, construct the histogram of $I_{low}$, denoted as $H_S$ , by mimicking the same in embedding.

C. Identification of Watermarked Groups

Take each $L_B$ neighbouring gray levels in $H_S$ to form a bin and take each two neighbouring bins as a group. Compute the number of pixels in each bin, $h_B$ (i), and that in each group, $h_G$ (i), by referring to (7) and (8), respectively. After that, calculate $N_S$ and then g (i) by imitating (9) and (10), respectively. The $L_W$ groups with the highest g(i) values are identified as watermarked groups.

D .Watermark Extraction

For the ith watermarked group, $h_B$ (2i − 1) and $h_B$ (2i) denote the number of pixels in the first bin and that in the second bin, respectively. If the ratio between $h_B$ (2i − 1) and $h_B$ (2i) is greater than the extracted watermark bit is 1; otherwise, watermark bit 0 is extracted.

The disadvantage of the paper is that it only extract the watermark and it cannot recover the original image and less perceptual quality. In order to improve that, we propose the new approach.

## 4. IMAGE WATERMARKING BASED ON REVERSIBLE TECHNIQUE

For some critical applications such as the law enforcement, medical and military image system, it is crucial to restore the original image without any distortions.

To solve the disadvantage of existing system, that is to recover original image we propose a new image watermarking based on reversible technique. The main two stages of this method includes watermark embedding and decoding process.

### 1. Watermark Embedding Process

In this stage two additional steps are done for recovering the original image at decoding stage. They are Histogram shifting and Huffman coding on the copies of original image. After that encoded image is embedded into the histogram shifted copy of original image. Then watermark is embedded into that image. Additional steps are described below. The framework of proposed watermark embedding system is shown in figure 1.

A. Histogram Shifting

In order to enhance the robustness of the reversible watermarking, the embedding target is replaced by the histogram of a block.

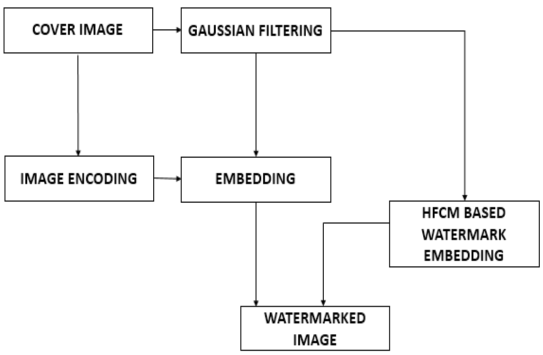


**Fig-1**: Proposed watermark embedding system framework.

The algorithm steps are:

1. Scan the cover image and construct its histogram
2. The gray value for which the histogram is highest is denoted the peak point a, and the gray value for which the histogram is lowest is denoted by the minimum point b
3. If Hi (b) =0, then b is called a zero point. For simplicity, we assume a<b
4. Scan the image and record the positions of those pixel values to b and place them into the location map L
5. Shift the histogram Hi(x), x ϵ (a, b) to the right to vacate the histogram bin at a+1
6. Extract a data bit s from secret data S. Scan the image once more
7. If the scanned pixel value is a and the data bit to be embedded is 1, then set the pixel value to a+1
8. If the data bit to be embedded is 0, no change has to be done on the scanned pixel [3]

The similar process is required to be followed for the lossless recovery of the Original Image and the watermark.

### B .Huffman Encoding

Huffman coding is a particular type of optimal prefix code that is commonly used for lossless data compression. Sometimes it is called prefix free code that is the bit string representing some particular symbol is never a prefix of code of another symbol. Huffman coding is based on the frequency of occurrence of a data item (pixel in images). The principle is to use a lower number of bits to encode the data that occurs more frequently. Codes are stored in a Code Book which may be constructed for each image or a set of images. In all cases the code book plus encoded data must be transmitted to enable decoding. The Huffman algorithm is a bottom up approach and it is given as:

•First

1. Sort the gray levels by decreasing probability
2. Sum the two smallest probabilities.
3. Sort the new value into the list.
4. Repeat 1 to 3 until only two probabilities remains.

•Second

1 .Give the code 0 to the highest probability, and the code 1 to the lowest probability in the summed pair.

2. Go backwards through the tree one node and repeat from 1 until all gray levels have a unique code.

## 2. Watermark Decoding Process

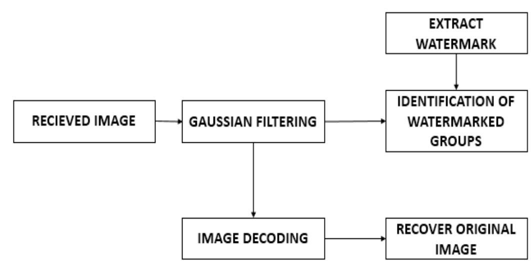


**Fig-2:** Proposed watermark decoding system framework.

In this stage, additional step included is Huffman decoding .Here the watermarked image undergo Gaussian filtering and histogram of corresponding image is constructed. Then from that image, original image is recovered using Huffman decoding and also watermark is extracted using key. The framework of proposed watermark decoding system is shown in figure 2.

### A. Huffman Decoding

Decoding is the process of turning an encoded message back into the original message. A Message is uniquely decodable if it can only be decoded in one way.

After the code has been created, coding and/or decoding is accomplished in a simple look-up table manner. The code itself is an instantaneous uniquely decodable block code. It is called a block code, because each source symbol is mapped into a fixed sequence of code symbols. It is instantaneous, because each code word in a string of code symbols can be decoded without referencing succeeding symbols. It is uniquely decodable, because any string of code symbols can be decoded in only one way. Thus, any string of Huffman encoded symbols can be decoded by examining the individual symbols of the string in a left to right manner.

## 5. CONCLUSION

Digital watermarking can be used to protect digital information from illegal manipulations and distributions. This paper proposed a robust reversible image watermarking, which increase the perceptual quality and we can recover the original image. It can be used in military and medical purpose.

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