AN EFFECTIVE LOW POWER HALFTONING BASED AUTHENTICATION AND SELF-RECOVERY OF TAMPERED IMAGES

Malini M
PG Scholar, Department of Electronics and Communication Engineering
Pandian Saraswathi Yadav Engineering College, Sivagngai

Abstract

Due to the advances in computer-based communication and health services over the past decade, the need for image security becomes urgent to address the requirements of both safety and non-safety in all applications. Methods of authentication and self-recovery of tampered information in digital images have been in constant development during the last years. This paper proposes a new LU decomposed half toning scheme for image authentication and self-recovery for medical applications. The proposed scheme locates image tampering as well as recovers the original image. A host image is broken into 4×4 blocks and LU is applied to figure out the transformation in the original image. Then generates the authentication watermarks, which are based on XOR operations on non-overlapping blocks, subsequently by using a halftoning technique the recovery watermark is generated. This work also proposes a new efficient QR decomposition and PSO based authentication bit scheme for image authentication and self-recovery to evaluate the quality of the obtained images, the objective criterion of peak signal-to-noise ratio (PSNR) and Tampering ratio are used. The experimental results demonstrate the effectiveness of our method in comparisons with other schemes reported in the literature, where the quality of the watermarked images, the quality of the reconstruction images and the recovery rate of each scheme were evaluated.

Introduction

With the development of digital portable devices, such as cell phone and digital camera, the images can be acquired more conveniently. The power of the image editing software become stronger. The authenticity and integrity are so important in digital content security that more and more researchers focus on this field. The watermarking technique, as one of the authentication methods, can detect the authenticity and localize the tampered area effectively, and it can also recover the modified or tampered image.

The algorithms of image self-recovery have three important parts: the authentication information, the recovery information and the mapping function to embed the authentication information and recovery information to the image. The authentication information has to detect the reality of the received image effectively, and it can localize the tampered area accurately. The mapping function can embed the information by modifying selected pixels, and it will influence the quality of the image.

Therefore, a better mapping function is a key part of the proposed algorithm. The target of the modified algorithm is to improve the embedded image quality and the tampered area recovery accuracy.

The algorithms of image self-recovery based on watermark can be classified into two types from the embedding field: the spatial embedding and the transform embedding. The spatial embedding methods can modify the pixels directly in the spatial domain. They are simple and effective. For example, the dual watermark to authenticate the tampered image and get a good recovery performance while the big tamper ratio appears. The image is divided into non-overlapping blocks of 2×2 pixels, and then the average values of each block are used to construct the recovery information, which is embedded into the two LSB planes. The scheme uses parity check and comparison between average intensities and the hierarchical structure is used to detect the tampered area. The good recovery performance even in a high tamper ratio. To lower the risk of making an incorrect prediction, the method produces parity check bits from pixels whose bits have been rearranged. The parity check bits are produced from pixels whose bits have been rearranged. The Hamming code is used to construct the authentication information. To improve the security of those algorithms, Arnold transform is applied in the procedure to map the relationship of the blocks.

The algorithms in the transform domain first map the image into the other domain, such as discrete wavelet transform (DWT), discrete cosine transform (DCT), and lifting wavelet transform (LWT). Due to characteristics of the transform domain, the authentication and recovery information are generated by coefficients of the transform domain. The index value of Vector Quantization (VQ) is used to recover information. This method can construct recovery information better. However, the index should be used in the watermarking extraction procedure, and this increases the extra information.

To improve the recovery performance and take advantage of spatial embedding, a a new LU decomposed half toning scheme for image authentication and self-recovery for medical applications. The proposed scheme locates image tampering as well as recovers the original image. A host image is broken into 4×4 blocks and LU is applied to figure out the transformation in the original image. Then generates the authentication watermarks, which are based on XOR operations on non-overlapping blocks, subsequently by using a halftoning technique the recovery watermark is generated.

In this section, first, several tamper detection and recovery techniques are reviewed, which published in recent years as related works. Then, the contributions of the proposed method are presented.

Lee and Lin [1] proposed an effective dual watermark for image tamper detection and recovery. Dual watermarking techniques can improve the quality of the recovered image. In this scheme, two copies of the watermark are embedded into two different positions in the whole image. Thus, it can provide a second chance to correct tampered block in case one copy is destroyed, but this method is not able to detect any content tampering that modifies bits in 5 most significant bits. Results illustrated resilience for covering, removing, cropping and replacing tampering and vulnerable against collage, vector quantization, and copy move tampering.

In another work [2], a probability-based tampering detection scheme for digital images is proposed by Hsu and Tu. This scheme aims to use probability theory to improve tamper detection rate. In the tamper detection phase, first, the watermarked image is identified through the authentication watermark which is embedded in the image. Then, probability theory is employed to improve previously results and enhance the authentication rate. However, the main drawback is, it is not able to restore tampered regions. The experimental results demonstrate that the scheme performs well in terms of authentication accuracy rate.

Qian et al. [3] proposed a fragile watermarking scheme aimed at providing improved restoration capability based on discrete cosines transform. DCT coefficients of 8×8 blocks encoded into different numbers of bits and the authentication and restoration bits are hidden into the three least significant bit planes of the host image. On the receiving side, the authentication bits are extracted to authenticate the image, and the restoration bits are used to recover the contents of the tampered regions. Results showed that the accuracy rate of tampered detection has been decreased, due to the usage of the large block size.

In [4], authors proposed an effective self-embedding fragile watermarking for image tamper localization and recovery based on DCT. This scheme performed an improved tamper localization and recovery algorithm compared to previous methods. In the proposed scheme for enhancing the security of the algorithm, a non-linear chaotic sequence is been used. In the embedding phase, the watermark is generated by encoding DCT coefficients of each 2×2 blocks and hide in another block according to the block mapping.

In [5], an effective singular value decomposition (SVD)–based image tampering detection and self-recovery is proposed by Dadkhah et al. To improve the tamper detection rate, a mixed block partitioning approach for 4×4 and 2×2 blocks is utilized. The experimental results reveal that the proposed scheme is superior in terms of security, tamper localization, and recovery rate, over the other fragile tamper detection and recovery schemes. Also, this scheme can detect vector quantization and copy-move tampering.

Zhang et al. [6] proposed a self-embedding fragile watermarking method based on DCT and fractal coding. In this scheme, three copies of recovery watermark are embedded into different quadrants, which provide two chances for recovery in case one is destroyed.

Methodology

In this section, a new LU decomposed half toning scheme is presented for image authentication and self-recovery for medical applications. The proposed scheme locates image tampering as well as recovers the original image. A host image is broken into 4×4 blocks and LU is applied to figure out the transformation in the original image. Then generates the authentication watermarks, which are based on XOR operations on non-overlapping blocks, subsequently by using a halftoning technique the recovery watermark is generated.

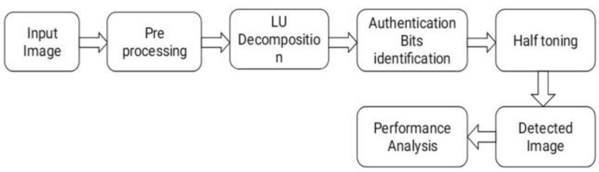

Figure 1 Proposed Architecture

The proposed scheme locates image tampering as well as recovers the original image. A host image is broken into 4×4 blocks and LU decomposition is applied by inserting the traces of block wise LU decomposition into the least significant bit (LSB) of the image pixels to figure out the transformation in the original image. Two authentication bits namely block authentication and self-recovery bits are used to survive the vector quantization attack. The insertion of self-recovery bits is determined with Arnold transformation, which recovers the original image even after a high tampering rate. LU decomposition -based watermarking information improves the image authentication and provides a way to detect different attacked area of the watermarked image. Halftone is the reprographic technique that simulates continuous-tone imagery through the use of dots, varying either in size or in spacing, thus generating a gradient-like effect. "Halftone" can also be used to refer specifically to the image that is produced by this process. Where continuous-tone imagery contains an infinite range of colors or greys, the halftone process reduces visual reproductions to an image that is printed with only one color of ink, in dots of differing size (pulse-width modulation) or spacing (frequency modulation) or both. This reproduction relies on a basic optical illusion: when the halftone dots are small, the human eye interprets the patterned areas as if they were smooth tones. At a microscopic level, developed black-and-white photographic film also consists of only two colors, and not an infinite range of continuous tones. For details, see grain. Just as color photography evolved with the addition of filters and film layers, color printing is made possible by repeating the halftone process for each subtractive color – most commonly using what is called the "CMYK color model". The semi-opaque property of ink allows halftone dots of different colors to create another optical effect, full-color imagery

Inverse Halftoning

Inverse halftoning or descreening is the process of reconstructing high-quality continuous-tone images from the halftone version. Inverse halftoning is an ill-posed problem because different source images can produce the same halftone image. Consequently, one halftone image has multiple plausible reconstructions. Additionally, information like tones and details are discarded during halftoning and thus irrecoverably lost. Due to the variety of different halftone patterns, it is not always obvious which algorithm to use for the best quality. There are many situations where reconstruction is desired. For artists, it is a challenging task to edit halftone images. Even simple modifications like altering the brightness usually work by changing the color tones. In halftone images, this additionally requires preservation of the regular pattern. The same applies to more complex tools like retouching. Many other image processing techniques are designed to operate on continuous-tone images. For example, image compression algorithms are more efficient for those images. Another reason is the visual aspect since halftoning degrades the quality of an image. Sudden tone changes of the original image are removed due to the limited tone variations in halftoned images. It can also introduce distortions and visual effects like moire patterns. Especially when printed on newspaper, the halftone pattern becomes more visible due to the paper properties.

By scanning and reprinting these images moiré patterns are emphasized. Thus, reconstructing them before reprinting is important to provide a reasonable quality.

Spatial and Frequency Filtering

The main steps of the procedure are the removal of halftone patterns and reconstruction of tone changes. In the end, it may be necessary to recover details to improve image quality. There are many halftoning algorithms which can be mostly classified into the categories ordered dithering, error diffusion, and optimization-based methods. It is important to choose a proper descreening strategy since they generate different patterns and most of the inverse halftoning algorithms are designed for a particular type of pattern. Time is another selection criteria because many algorithms are iterative and therefore rather slow.

The most straightforward way to remove the halftone patterns is the application of a low-pass filter either in spatial or frequency domain. A simple example is a Gaussian filter. It discards the high-frequency information which blurs the image and simultaneously reduces the halftone pattern. This is similar to the blurring effect of our eyes when viewing a halftone image. In any case, it is important to pick a proper bandwidth. A too-limited bandwidth blurs edges out, while a high bandwidth produces a noisy image because it does not remove the pattern completely. Due to this trade-off, it is not able to reconstruct reasonable edge information.

Further improvements can be achieved with edge enhancement. Decomposing the halftone image into its wavelet representation allows to pick information from different frequency bands. Edges are usually consisting of high pass energy. By using the extracted high pass information, it is possible to treat areas around edges differently to emphasize them while keeping low pass information among smooth regions.

Optimization-Based Filtering

Another possibility for inverse halftoning is the usage of machine learning algorithms based on artificial neural networks. These learning-based approaches can find the descreening technique that gets as close as possible to the perfect one. The idea is to use different strategies depending on the actual halftone image. Even for different content within the same image, the strategy should be varied. Convolutional neural networks are well-suited for tasks like object detection which allows a category based descreening. Additionally, they can do edge detection to enhance the details around edge areas. The results can be further improved by generative adversarial networks. This type of network can artificially generate content and recover lost details. However, these methods are limited by the quality and completeness of the used training data. Unseen halftoning patterns which were not represented in the training data are rather hard to remove. Additionally, the learning process can take some time. By contrast, computing the inverse halftoning image is fast compared to other iterative methods because it requires only a single computational step.

Lookup Table

Unlike other approaches, the lookup table method does not involve any filtering. It works by computing a distribution of the neighborhood for every pixel in the halftone image. The lookup table provides a continuous-tone value for a given pixel and its distribution. The corresponding lookup table is obtained before using histograms of halftone images and their corresponding originals. The histograms provide the distribution before and after halftoning and make it possible to approximate the continuous-tone value for a specific distribution in the halftone image. For this approach, the halftoning strategy has to be known in advance for choosing a proper lookup table. Additionally, the table needs to be recomputed for every new halftoning pattern. Generating the descreened image is fast compared to iterative methods because it requires a lookup per pixel.

LU Decomposition

Let A be a square matrix. An LU factorization refers to the factorization of A, with proper row and/or column orderings or permutations, into two factors – a lower triangular matrix L and an upper triangular matrix U:A=LU In the lower triangular matrix all elements above the diagonal are zero, in the upper triangular matrix, all the elements below the diagonal are zero. For example, for a 3 × 3 matrix A, its LU decomposition looks like this:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} = \begin{bmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & 1_{33} \end{bmatrix} \begin{bmatrix} u_{11} & u_{12} & u_{13} \\ 0 & u_{22} & u_{23} \\ 0 & 0 & u_{33} \end{bmatrix}.$$

Without a proper ordering or permutations in the matrix, the factorization may fail to materialize. This is impossible if A is nonsingular (invertible). This is a procedural problem. It can be removed by simply reordering the rows of A so that the first element of the permuted matrix is nonzero. The same problem in subsequent factorization steps can be removed the same way; see the basic procedure below.

LU Factorization with Partial Pivoting

It turns out that a proper permutation in rows (or columns) is sufficient for LU factorization. LU factorization with partial pivoting (LUP) refers often to LU factorization with row permutations only:

PA=LU

where L and U are again lower and upper triangular matrices, and P is a permutation matrix, which, when left-multiplied to A, reorders the rows of A. It turns out that all square matrices can be factorized in this form, and the factorization is numerically stable in practice. This makes LUP decomposition a useful technique in practice.

LU Factorization with Full Pivoting

An LU factorization with full pivoting involves both row and column permutations:

PAQ=LU

where L, U and P are defined as before, and Q is a permutation matrix that reorders the columns of A.

LDU Decomposition

An LDU decomposition is a decomposition of the form

A=LDU

where D is a diagonal matrix, and L and U are unitriangular matrices, meaning that all the entries on the diagonals of L and U are one.

Above we required that A be a square matrix, but these decompositions can all be generalized to rectangular matrices as well. In that case, L and D are square matrices both of which have the same number of rows as A, and U has exactly the same dimensions as A. Upper triangular should be interpreted as having only zero entries below the main diagonal, which starts at the upper left corner.

PSO

- PSO is a robust stochastic optimization technique based on the movement and intelligence of swarms.
- PSO applies the concept of social interaction to problem solving.
- It was developed in 1995 by James Kennedy (social-psychologist) and Russell Eberhart (electrical engineer).
- It uses a number of agents (particles) that constitute a swarm moving around in the search space looking for the best solution.
- Each particle is treated as a point in a N-dimensional space which adjusts its "flying" according to its own flying experience as well as the flying experience of other particles.

Result and Discussion

In this section, the simulation results are simulated and implemented using the MATLAB and the Xilinx software which is given in the following. The imaging results are taken in the MATLAB and the area comparison are taken from the Xilinx with the accurate synthesis report of existing and the proposed system.

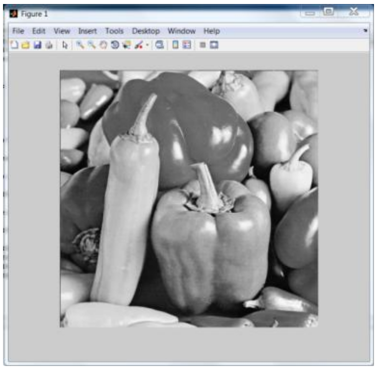

Figure 2 Actually Send Input Image

Above figure 2 shows input image for our embedding process .in this stage image converted into gray scale image and resized to required stage

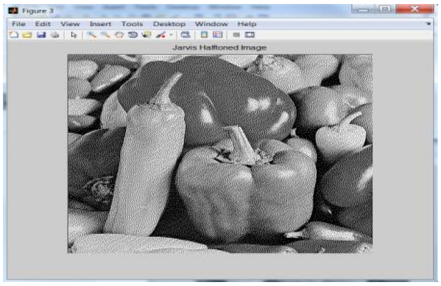

Figure 3 Halftoned Image

Above figure 3 shows the halftoned image of the input image by performing halftoning.

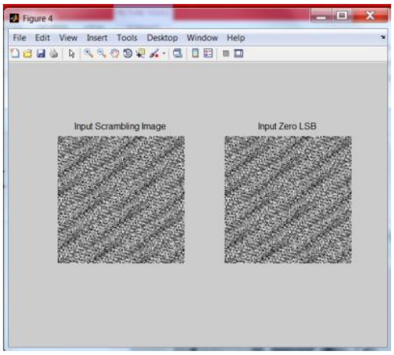

Figure 4 Scrambled and LSB Numbered Image

Above Figure 4 shows scrambled image and LSB renumbered image for our embedding process. In this stage image authentication bits are identified using Arnold sampling

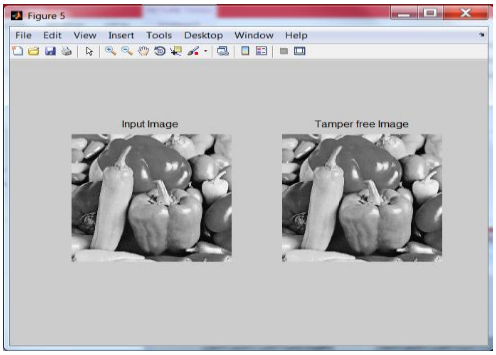

Figure 5 Input and Tamper Free Image

Above figure 5 shows final tamper free image in our embedding process.

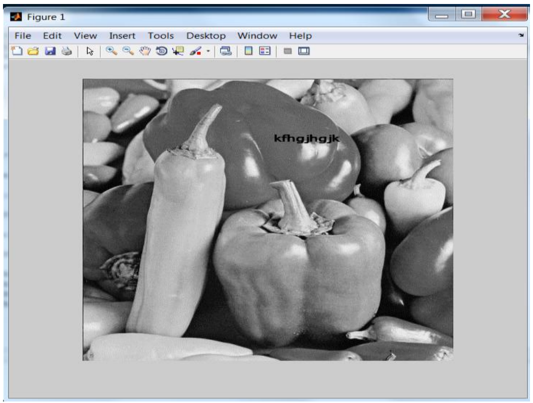

Figure 6 Received Tamper Image

Above figure 6 shows received image after unknown attacker attacked.

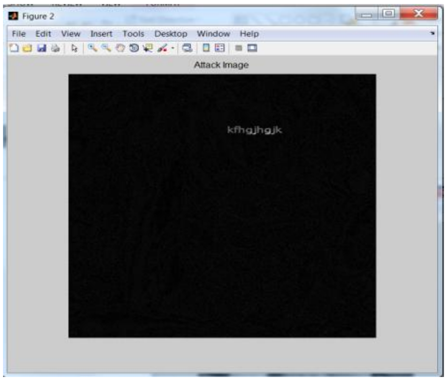

Figure 7 Tamper Detected Image

Above figure 7 shows tamper identified image using our authentication bits.

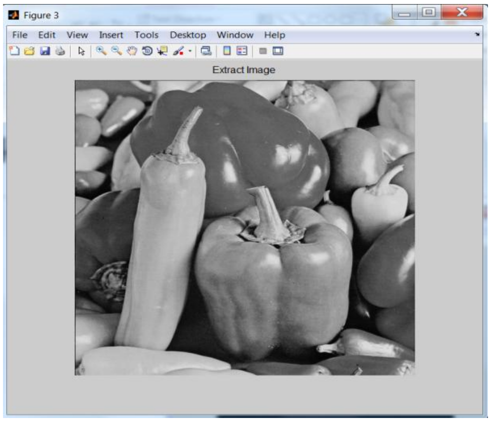

Figure 9 Recovered Image

Above figure 9 shows recovered image by performing LSB zero and LU decomposition

Performance Evaluation

Below table shows improved SNR calculation before and after embedding and extraction

Table 1 PSNR Values of Images

S.No	Image set	PSNR
1	1	50.2302
2	2	51.0662
3	3	51.1394
4	4	50.7783

Conclusion

Watermarking is a crucial technique in the copyright identification mechanisms of digital assets. It is widely recognized as one of the key issues of data copyright protection in this work we considered the defect of traditional watermarking schemes, while dealing with the nonnumeric attributes. This project presents a LU and halftoing based tamper detection scheme using grouped block method to offer more security and provide a supplementary way to locate the attacked areas inside different medical images. Two authentication bits namely block authentication and self-recovery bits were used to survive the vector quantization attack. The usage of authentication makes it possible to recover the tampered region from the neighboring blocks, which ultimately increases the NCC and PSNR of the recovered host.

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