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A Digital Watermarking Technique Based on Multiple Halftones

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ABSTRACT

In this paper a digital watermarking based on multiple halftones is proposed. The main objective is to provide a digital watermarking technique using halftoning which embeds multiple watermark images with an additional feature of hiding a secret text. At the encoder Floyd-Steinberg Error Diffusion (ED) is employed along with Lookup tables to embed the images. At the decoder Least mean square is employed along with Naïve Bayes classifier for text retrieval. The ED offers good visual quality with reasonable computational complexity. Experimental results show that the proposed method requires only 2.9s for embedding the watermarks and desired text into an image of size 4096 × 4096, under the 32-bit Windows 7 platform running on 4GB RAM, Intel core i3.

Keywords: Digital watermarking, Halftoning, Error diffusion, Naïve Bayes classifier, Data hiding

I. Introduction

a. Digital watermarking

The pattern of bits inserted into a digital image, audio or video file that helps to identify the file's copyright information is referred to as Digital watermarking. The purpose of digital watermarks is to provide copyright protection for intellectual property that's in digital format. Digital watermarks are intended to be completely invisible, or in the case of audio clips, unhearable, unlike printed watermarks, which are designed to be somewhat visible. Additionally, the actual bits representing the watermark must be spread throughout the file in such a way that they cannot be identified and manipulated and the digital watermark must be robust enough so that it can withstand normal changes to the file. Digital watermarking is mainly used for the security of digital content and to protect the data from illegal users and it provides the ownership right for digital data. An important aspect of digital watermarking is robustness and imperceptibility against various types of attacks or common image manipulation like rotation, filtering, scaling, cropping and compression.

b. Digital halftoning

Digital halftoning is a technique for changing grayscale images into two-tone halftone images. Halftoning is an illustrative technique which transforms the original continuous tone digital image into a binary image consisting only of 1's and 0's. The value 1 means a black dot in the current position and 0 means to keep the corresponding position empty. The human eyes have the low pass spatial frequency property therefore they perceive patches of black and white marks as some kind of average grey when viewed from a sufficiently far distance. Thus these halftone images can bear resemblance to grayscale images when viewed from a distance due to the low-pass nature of Human Visual System. Halftoning is generally used for printing books, newspapers and magazines since these printing processes can only generate a limited number of colors - black and white.

In the existing system a high efficiency multi-layer half toning based watermarking method which adopts noise-balanced error diffusion is used to achieve high embedding capacity and improve security aspect. The encoder employs an efficient Direct Binary Search (DBS) and Look-Up-Table (LUT) method to embed multiple watermarks. The decoder simply utilizes the Least-Mean-Square (LMS) and naïve bayes classifier to extract the embedded watermarks in multi-layer framework with self-decoding capability.

The main objective of the proposed system is to provide a digital watermarking technique that utilizes halftoning method for embedding a secret text along with the watermark images. This method uses Error Diffusion (ED) at the encoder and Least Mean square at the decoder. The additional feature of embedding a secret text makes it more robust to external attacks. The multiple watermarks and the text are extracted from the host image by using Naïve bayes classifier with self decoding capability.

II. Overview of Existing Systems

Halftone processing is a technique to convert to grayscale images into two-tone binary images. The two-tone binary images are printing and display [5]. Various halftoning techniques such as Ordered Dithering (OD), Dot Diffusion (DD), Direct Binary Search (DBS), Error Diffusion (ED) and Block Replacement (BR) are present [7].

A new framework for data hiding in images printed with clustered dot halftones was presented in [1]. In this method image fidelity was emphasized thus achieving high operational rates while preserving halftone image quality. The Overall Minimal-Error Searching (OMES) modifies the halftone a value at the same position of all host images with the trained Substitution Table (S-table) was shown in [2]. The original combination of these halftone values are made as another meaningful combination for embedding watermark by the S-table, which is the key part in determining the image quality. The method in [3] encrypts the color image into high-quality n halftone shares generated via Direct Binary Search (DBS) with adaptive search and swap method. This scheme achieves lossless recovery and reduces the noise in the shares without any computational complexity.

Data Hiding by Stochastic Error Diffusion (DHSED) proposed in [4] embeds hidden binary visual patterns in two error diffused halftone images such that the hidden patterns can be visually inspected when the images are overlaid. A drawback of the DHSED method is that if the image has large areas of the same grey-level, hiding data causes some edge effects which may reveal the hidden data. Block-directed Parity-matched Error Diffusion (BPMED) proposed in [6] was developed in parity domain based on pixel block. Here, the parity sum of a pixel block is defined by comparing the average of the pixel block with an image dependent threshold. By altering the pixel block's parity based on noise-balanced block error diffusion, watermark is spread into the host image. The survey in [8] elaborates the most important methods of spatial domain &

transform domain and focuses the merits & demerits of these techniques. The method proposed in [9] enabled the embedding of a color image into a binary black-and-white halftone, while maintaining the image quality. The proposed technique was capable of embedding watermarks of three color channels into a binary halftone.

III. Proposed System

In this paper, a data hiding technique using multiple watermarks is employed. The idea is to embed three secret images along with the desired secret text in a host image. Initially, a host image is taken. This host image is converted into a grayscale image and further converted into halftone image using error diffusion at the encoder. The three secret images of increasing sizes i.e., 32x32, 64x64 & 128x128 are taken. The smallest image is first embedded into the image of successive sizes and finally embedded into the host image. The secret text “image” is then hidden into the cover image. The three secret images and the hidden text are extracted using least mean square at the decoder.

This overall process is divided into three levels. i) HALFTONING

The halftoning technique is used to convert the gray-scale image into the binary image. The technique used is patterning Error diffusion. The patterning error diffusion utilizes a certain percentage of black and white pixels, often called patterns, to achieve a sense of gray scale in the overall point of view. The pattern consists of black and white pixels, where different percentages of the black pixels stand for the different graynesses. The halftoning process is to map the gray-scale pixels from the original image into the patterns with certain percentage of black pixels. The halftoned image is a binary image.

ii) Data Hiding

The three secret images of size 32x32, 64x64, 128x128 are taken. Each of the secret image is converted into a halftoned image using the above procedure. The 32x32 image is first embedded into the 64x64 image. The resultant image is then embedded into the 128x128 image. This final image is then embedded into the host or the cover image. Finally, the desired secret text is hidden into the cover image.

iii) Data Extraction

Extract the n secret image and data from the embedded cover image and then secret image (halftone format) converted into grayscale image.

IV. RESULTS AND DISCUSSION

a. Results

The proposed Error Diffusion (ED) algorithm was simulated using MATLAB 7.6 (R2008a).

The simulation was performed using Windows 7 32 bit platform with 4GB RAM, Intel core i3 processor, 1.7 GHZ and MATLAB 7.6(R2008a). In our experiment, the host image is of size 4096×4096 and the 3-layer watermark images are of sizes 128 × 128, 64 × 64 and 32 × 32 respectively.

The FIG I. shows the three secret images with (a) being of size 32x32, (b) is of 64x64 size and (c) is of size 128x128. The color image is first converted into its grayscale format and subsequently halftoned. These halftoned images are shown in FIG II. The host image in FIG III.is the one in which the three images and the text are hidden.

The next stage is the embedding process where the three images are embedded into one another and finally embedded in the host image. The secret text is then hidden into the host image. This is shown inFIG IV.

Finally, the three images and the text are retrieved from the host image in the halftone format and converted back to grayscale using inverse halftoning method. These conversions are shown in FIG V.

FIG I. THREE SECRET IMAGES OF VARIOUS SIZES

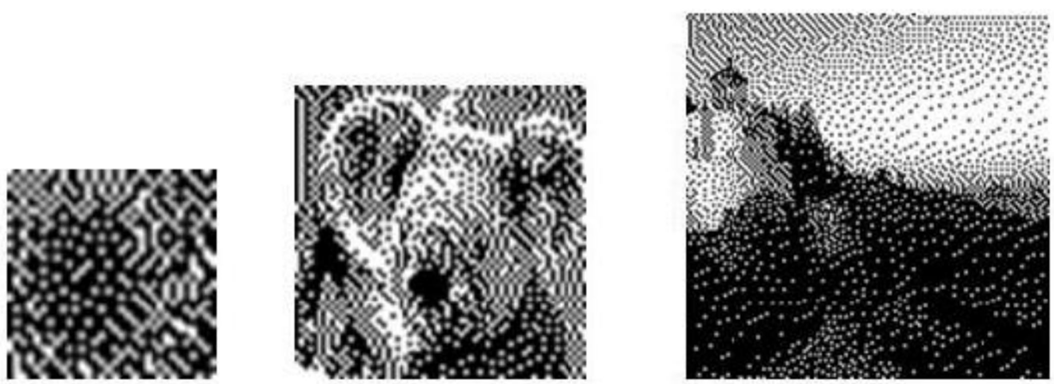

FIG II. HALFTONED IMAGES

FIG III. HOST IMAGE

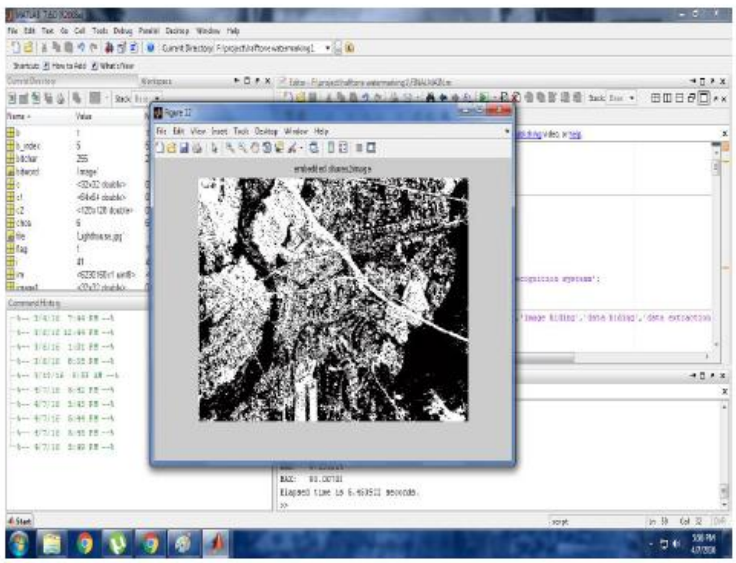

FIG IV. HOST IMAGE EMBEDDED WITH SECRET IMAGES AND TEXT

FIG V. EXTRACTED IMAGES

b. Graph

The bar graph shown in FIG VI.shows the comparison of PSNR value between the existing and the proposed system. The higher PSNR value of the proposed system shows the efficiency and noise reduction.

Also, the embedding capacity of the proposed work is higher than the existing system as shown in FIG VII.

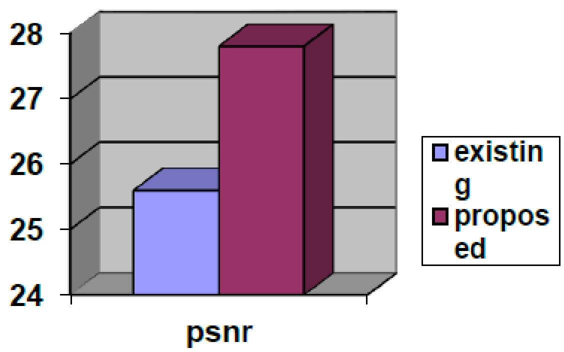

FIG VI. PSNR

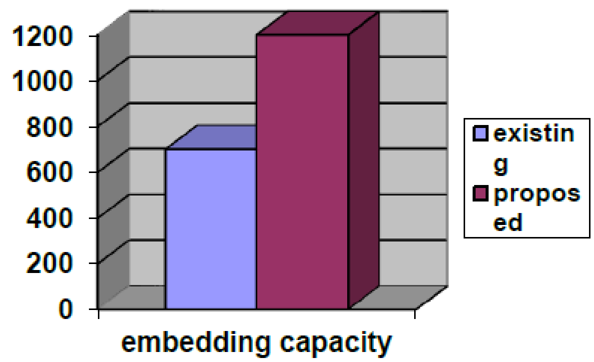

FIG VII. EMBEDDING CAPACITY

TABLE I. PSNR OF EXISTING & PROPOSED SYSTEM

MODEL	PSNR
existing	25.6
proposed	27.8

TABLE II. EMBEDDING CAPACITY OF EXISTING & PROPOSED SYSTEM

MODEL	EMBEDDING CAPACITY
existing	700
proposed	1200

V. CONCLUSION & FUTURE WORK

In this work, the LUT strategy is deployed to efficiently embed multiple watermark images and text into a set of multi-scale watermarks, which are then embedded into a host halftone image to significantly improve the embedding capacity and reliability. Results show that only 2.9 seconds are required for embedding multiple watermarks into a 4096 x 4096 image. The use of the naïve Bayes classifier yields a PSNR of 27.851dB. The decoded watermarks can be further overlapped for obtaining additional watermarks using the self-decoding strategy.

As future work, the effort can be put to embed more watermarks as well as the string length to be increased while maintaining the perceived image quality and minimizing the increment in processing time. Also, the retrieved image can be obtained as a colour image instead of the grayscale format while reducing the noise and computational complexity by using the suitable algorithm. All in all, the apparent superiority in terms of processing time in the proposed method meets the demand of the printing industry and the required robustness against any tampering frauds.

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