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A REVIEW ON IMAGE HALFTONE PROCESSING

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ABSTRACT *- Halftone processing is a technique to convert grayscale images into two-tone binary images. The two- tone binary images are used in printing and display. An image having several bits for brightness levels is converted into a binary image consisting of black and white dots which looks similar to an input image. The similarity of images is measured by the differences in the weighted sums of brightness levels of pixels in a neighborhood surrounding each pixel. The problem of producing halftoned image is to obtain an optimal binary image that retains the intensity information contained in the image. In this paper, we will study data hiding and steganography via image halftoning*

***Keywords: Halftoning, Dithering Error-Diffusion, Block replacement*.**

INTRODUCTION

Halftoning is an application of image processing widely used in printing processes. With the evolution of computers and their use of typesetting, printing, and publishing, the field of halftoning that was previously limited in scope, called halftoning screen evolved into its successor—digital halftoning. Today, digital halftoning plays a key role in almost every discipline that involves printing and displaying. All newspapers, magazines, and books are printed with digital halftoning. It is used in image display devices capable of reproducing two-level outputs such as scientific workstations, laser printers, and digital typesetters. It is also important for facsimile transmission and compression. The grayscale digital image consists of 256 gray levels, while the black and white printers only have one colored ink. So, there is a need to replace wide range of grayscale pixels for printers. These 256 levels of gray have to be represented by placing black marks on white paper. Halftoning is a representation technique to transform 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. Since the human eyes have the low pass spatial-frequency property, human eyes perceive patches of black and white marks as some kind of average grey when viewed from sufficiently far distance . Our eyes cannot distinguish the small dots patterns and our eyes integrate the black dots and the non-printed areas as varying shades of gray. Fig. 1(b) shows a typical halftoning image.

(a) (b)

Fig.1: (a) The original image; (b) The halftone image

LITERATURE SURVEY

In 1993 Avideh Zakhor, Steve Lin, and Farokh Eskafi presents a new class of dithering algorithms for black and white images. The basic idea behind our technique is to divide the image into small blocks and minimize the distortion between the original continuous-tone image and its low-pass-filtered halftone. This corresponds to a quadratic programming problem with linear constraints. This problem is solved via standard optimization techniques. [1]

In 1988 Sdren Forchhammer and Morten Forchhammer says that in newspapers and magazines scanned documents contains halftone pictures, for transmission purposes in prepress is proposed. The halftone screen is estimated and the grey value of each dot is found, thus giving a compact description. At the receiver the picture is re-screened. A new data structure and related algorithms for handling the digital screen without restrictions on the screen parameters is presented. Data compression rates above 20 are obtained for halftone pictures. The algorithms are suited for implementation with fast dedicated hardware.[2]

In 1995 SQren Hein, and Avideh Zakhor consider the problem of reconstructing a continuous-tone image from its halftoned image, where the halftoning process is done by error diffusion. We present an iterative nonlinear decoding algorithm for halftone to continuous-tone conversion and show simulation results that compare the performance of the algorithm to that of conventional linear low-pass filtering.[3]
In 1996 V Ostromoukhov, P. Emmel, N. Rudaz, I. Amidrol presented dither-based methods for the halftoning of images on multi-level printing devices such as multi-level inkjet printers are presented. Due to the relatively large size of single droplets, halftoning algorithms are still used. However, since halftoning occurs between the basic levels attainable by printing one, two or several droplets at the same position, artifacts are less visible than in equal resolution printers. When dithering algorithms are used for the halftoning task, the dither threshold tiles should have oblique orientations so as to make the halftoning artifacts less visible. They should be designed so as to break up the inherent artifacts of variable dot size printers.The resulting visual effects are shown by simulating the printed dots of a multilevel inkjet printer.[4]
In 1999 Thrasyvoulos N. Pappas, and David L. Neuhoff presented a least-squares model-based (LSMB) approach to digital halftoning. It exploits both a printer model and a model for visual perception. It attempts to produce an optimal halftoned reproduction, by minimizing the squared error between the response of the cascade of the printer and visual models to the binary image and the response of the visual model to the original gray-scale image. It has been shown that the one-dimensional (1-D) least-squares problem, in which each row or column of the image is halftoned independently, can be implemented using the Viterbi algorithm. Unfortunately, the Viterbi algorithm cannot be used in two dimensions. The two-dimensional (2-D) least-squares solution is obtained by iterative techniques. Experiments show that LSMB halftoning produces better textures and higher spatial and gray-scale resolution than conventional techniques.[5]
In 2000 Jan Puzicha, Marcus Held, Jens Ketterer, Joachim M. Buhmann, and Dieter W. Fellner says Image quantization and digital halftoning, two fundamental image processing problems, are generally performed sequentially and, in most cases, independent of each other. Color reduction with a pixel-wise defined distortion measure and the halftoning process with its local averaging neighborhood typically optimizes different quality criteria or, frequently, follows a heuristic approach without reference to any quantitative quality measure. This paper presents a new model to simultaneously quantize and halftone color images. The method is based on a rigorous cost–function approach which optimizes a quality criterion derived from a simplified model of human perception. It incorporates spatial and contextual information into the quantization and thus overcomes the artificial separation of quantization and halftoning. Optimization is performed by an efficient multiscale procedure which substantially alleviates the computational burden. The optimization algorithms are evaluated on a representative set of artificial and real-world images showing a significant image quality improvement compared to standard color reduction approaches.[6]
In 2001 Hirobumi Nishida presented a paper which describes a new approach to adaptive digital halftoning with the least squares model-based (LSMB) method. A framework is presented for the adaptive control of smoothness and sharpness of the halftone patterns according to local image characteristics. The method employs explicit, quantitative models of the human visual system represented as 2-0 linear filters (eye ,filters). In contrast with the standard LSMB method where the single eye filter is employed uniformly over the image. Because of the adaptive selection of eye filters for the pixels, image enhancement is incorporated into the halftoning process. Effectiveness of the approach is demonstrated through experiments using real data compared with the error-diffusion algorithm and the standard LSMB method. [7]
In 2001 Plzuiisak Thieiuiviboon, Aiitoizio Ortega, aizd Keith M. Chuyg presented a paper based on message-passing techniques, a novel iterative grid algorithm for the general two-dimensional (2D) digital least metric (DLM) problem is proposed and applied to image halftoning.A reduced complexity version of the proposed digital image halftoning technique is demonstrated. Results show that the quality of the halftone images is comparable to that of the state-of-the-art toggle/swap algorithm. Since the algorithm is not constrained by the specific metric used in this work, the proposed method is directly applicable to other digital image processing tasks [8]
In 2001 Chunghui Kuo, A. Ravishankar Rao and Gerhard Thompson said that the advent of electronic publication creates strong interest in converting existing printed documents into electronic formats. During this process, image reproduction problems can occur due to the formation of Moire patterns in the screened halftone areas. Therefore, optimal quality of a scanned document is achieved if halftone regions are first identified and processed separately. A wavelet based halftone segmentation algorithm is first designed to locate possible halftone regions using a decision function, then introduce a suboptimal FIR descreening filter to efficiently handle various screening frequencies and angles. Experimental results are offered to illustrate the performance of our algorithm.[9]
In 2002 Pingshan Li Jan P Allebach present a clustered minority pixel error diffusion halftoning algorithm for which the quantizer threshold is

modified based on the past output and a dot activation map. This method also effectively reduces structured worm-like artifacts in midtones that occur in Levien's algorithm. The dot distribution is further improved by using different error diffusion weights for different input gray levels.[10]

In 2002 Peter WM. Ilbery's paper is concerned with digital halftoning by error diffusion. It discusses error diffusion where the error distribution from a pixel to the next scanline, resulting from the complete processing of the current scanline, approximates a standard Cauchy distribution, having the form (l/π) $l/(l+x^2)$. Such error diffusion is capable of generating sparse halftone patterns, which are free of worm artifacts. It is argued that the well spread sparse halftone patterns are due to the remarkable properties of this particular distribution: the distribution is radially balanced. So, nearly this error distribution is an effective tool for designing error diffusion masks.[11]

In 2003 Tung-Shou Chen, Jeanne Chen, Yu-Mei Pan says that the digital data are easily distorted or tampered with. Therefore, providing protection from distortions or to authenticate poses a great challenge to information security and image processing. In this paper, we propose a crisscross checking technique for halftone images. The host image is divided into row and column blocks from which scrambled code-blocks will be generated. The MD5 and RSA algorithms will be applied to code-strings containing code-blocks to generate encrypted sign messages. These messages will be hidden in the blocks. During the detection process, the row and column blocks will be checked for these messages. A block will be marked as tampered when an error bit is located. [12]

In 2003 C. Ahsew, A. G. Constantmidesf, L. Htisson says that the colour image printing and display devices do not have the capacity to deal with true colours. To overcome this limitation, these devices need to apply a quantization method to reduce the number of colours present in the image. The research of this paper focuses on the study of a special set of quantisation methods known as dithering techniques. The results of this research show that the quality of the quantised image is improved because the quantisation noise is filtered more efficiently by the noise-shaping filter. [13]

In 2003 Vladimir Misic, Kevin J. Parker present some novel tools for the analysis of bluenoise binary patterns. This new metrics characterize the morphological content of a mask that is quantified using simple one-pass filtering. An analytical filter expression is given. As a result, one can balance the structural content of the mask—diagonal, vertical, and horizontal interconnections of the majority (or minority) pixels—at the same level. In addition, it is possible to improve the overall mask quality. [14]

In 2010 Marzieh Amini, Khashayar Yaghmaie, Hamidreza Sadreazami says that a new halftone image watermarking is presented based on digital wavelet transform combined with singular value decomposition technique. Experimental results show good robustness against some common signal processing attacks. [15]

In 2010 Yik-Hing Fung and Yuk-Hee Chan says that Multiscale error diffusion (MED) is superior to conventional error diffusion algorithms as it can eliminate directional hysteresis completely and possesses a good blue noise characteristic. In this paper, they propose a MED algorithm to produce halftones of desirable green noise characteristics. With a close-to-isotropic diffusion filter, the algorithm can effectively remove pattern artifacts, eliminate directional artifacts and preserve original image details. It provides better performance in terms of various aspects including dot distribution, anisotropy and output image quality as compared with other conventional green noise error diffusion algorithms. [16,41,42,43]

In 2010 Phichit Kajondecha says that Digital halftoning is a type of image processing that is important for output device. The paper aims at investigating the quality of halftone dot reproduction by utilizing halftone dot simulation. The result of experiment presents the quality of simulated halftone dot those benefits for soft proof on output device. [17,45,46,47]

In 1994 A new method for coding scanned halftone images is proposed. It is information-lossy, but still preserving the image quality, compression rates of 16-35 have been achieved for a typical test image scanned on a high resolution scanner. For comparison, the test image was coded using existing (lossless) methods giving compression rates of 2-7. The best of these, a combination of predictive and binary arithmetic coding was modified and optimized achieving a compression rate of 9. [18]

DATA HIDING

In 2000 Ming Sun Fu, Oscar C. Au analyze the sources of the artifacts in DHPT and propose an improvement by using smart pair toggling. Simulation results suggest that the proposed Data Hiding by Smart Pair-Toggling (DHSPT) algorithm can hide the same amount of data while generating halftone images with considerably better visual quality than DHPT. [19,49]

In 2003 Soo-Chang Pei and Jing-Ming Guo propose a low-complexity algorithm for embedding watermark into two or more error-diffused images. The first one is only a regular error-diffused image, and the others are achieved by applying the proposed noise-balanced error diffusion technique (NBEDF) to the original gray-level image. The visual decoding pattern can be perceived when these two or more similar error-diffused images are overlaid each other. Furthermore, with the proposed modified version of NBEDF, the two halftone images can be made from two totally different gray-tone images and still provide a clear and sharp visual decoding pattern.[20]

In 2005 Jing-Ming Guo says that the well known least-mean-square (LMS) method is applied for designing an adaptive filter used to produce a high quality halftone image. The experimental results show that the proposed LMS-designed halftoning achieves the extra benefit of edge enhancement and eliminates the annoying worm effect in error-diffused image. The experimental results demonstrated both techniques achieve excellent image quality and decoded visual patterns. [21]

STEGANOGRAPHY

In 2005 Woong Hee Kim, and Ilhwan Park says that Steganography is the art of hiding and transmitting data through apparently innocuous carriers in an effort to conceal the existence of the data. A lot of steganography algorithms use the digital image data as a carrier. In data hiding scheme of halftoning and coordinate projection, still image data is used as a carrier, and the data of carrier image are modified for data embedding. In this paper, three features for analysis of data hiding via halftoning and coordinate projection and also a classifier using the proposed three features were proposed. [22,51,52]

In 2009 Jing-Ming Guo presents a reasonable computational complexity watermarking algorithm to embed hidden pattern into two or more halftone images with Adaptive Noise-Balanced Error Diffusion (ANBEDF). One halftone image is obtained by traditional error diffusion, and the others are obtained by ANBEDF. The experimental results show that higher decoding rate is available under the same image quality performance as former approaches in the literature.[23]

In 2006 Zhi Zhou, Gonzalo R. Arce, and Giovanni Di Crescenzo say that Visual cryptography encodes a secret binary image (SI) into n shares of random binary patterns. If the shares are xeroxed onto transparencies, the secret image can be visually decoded by superimposing a qualified subset of transparencies, but no secret information can be obtained from the superposition of a forbidden subset. In this paper, a novel technique named halftone visual cryptography is proposed also to achieve visual cryptography via halftoning. Based on the blue-noise dithering principles, the proposed method utilizes the void and cluster algorithm to encode a secret binary image into n halftone shares (images) carrying significant visual information. [24]

In 2008 Debasish Jena, Sanjay Kumar Jena says that Visual Cryptography is a new cryptographic technique which allows visual information (pictures, text, etc.) to be encrypted in such a way that the decryption can be performed by human, without any decryption algorithm. Here they give a Data hiding in halftone images using conjugate ordered dithering (DHCOD) technique which is used to hide a binary visual pattern in two or more ordered dither halftone images, which can be from the same or different multi-tone images. In proposed scheme the shares using basic visual cryptography model and then embed them into a cover image using a DHCOD technique, so that the shares will be more secure and meaningful. [25]

In 2009 Zhongmin Wang, Gonzalo R. Arce, and Giovanni Di Crescenzo says that Halftone visual cryptography (HVC) enlarges the area of visual cryptography by the addition of digital halftoning techniques. In this paper, HVC construction methods based on error diffusion are proposed. The secret image is concurrently embedded into binary valued shares while these shares are halftoned by error diffusion—the workhorse standard of halftoning algorithms. Error diffusion has low complexity and provides halftone shares with good image quality. A reconstructed secret image, obtained by stacking qualified shares together, does not suffer from cross interference of share images. Factors affecting the share image quality and the contrast of the reconstructed image are discussed. Simulation results show several illustrative examples. [26]

CONCLUSION

In this paper, we review the various existing techniques for digital halftone processing. The inverse halftoning technique has only part of research in recent years. For estimating a dither matrix or the error-diffusion kernel from the respective halftones only a very few methods are known. For efficiency and robustness the kernel estimation area can be explored further. Now a day's researchers have generated both good quality and compressible halftones by looking at the problem of designing of halftoners. The proliferation of networking and the exchange of digital data motivated watermarking and steganography for halftone images which are relatively new areas. We have reviewed a number of approaches in watermarking halftones and embedding halftones into each other. Certainly many more aspects of halftone processing this problem can be considered in the future.

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