Halftoning Techniques Based on Error Diffusion for Electronic Governance

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Abstract

Nowadays, Electronic Governance has to be managed so as to build various types of solutions for different applications. Images as a part of file format that need to be processed before being used in a specific application. Documents need to be secure during the transformation over the internet. This kind of techniques helps to protect or secure document with conversation in to secured form. Halftoning technique is used to convert a continuous-tone (grayscale) image into a binary image based on some algorithms like Error Diffusion (ED). Error diffusion is considered as one of the best algorithms, which produces high-quality images with reducing the computation cost. For halftoned images applications, it is necessary to measure the quality of halftoned image. In this paper, the efficient error diffusion algorithms applied for half-toning is based on Floyd-Steinberg, Jarvis and Stucki filters' error diffusion. Moreover, performance is evaluated by respective techniques, and its metrics such as MSE, PSNR, AD, MD, MAE and Universal quality index (UQI) represents a promising result to determine the best error diffusion algorithm for halftoning to secure the documents. This technique is also useful in the secured documentation in governance and may be used in digital banking

Keywords: Error diffusion; Halftoned image; Universal quality index; Error filters; Digital halftoning

1. INTRODUCTION

Electronic Governance can be defined as acombination of different media and communications tools, which can be, text, audio and images, used on all platforms of Information Technology (IT). It can be referring to any application that integrates text with images, animation, audio, video [1]. Management is a set of process that includes strategic planning, setting objectives, managing resources, deploying the human and financial assets needed to achieve objectives, and measuring results[2]. It can be defined as a link of multiple process to endorse solutions, address problems to accomplish the company's goals.

In Electronic governance, a manger must have systemic vision, full knowledge about IT techniques so as to prepared and able to adoptive solutions, plan policies, unify

production, distribution of communication and IT. Numerous specialized forms of multimedia comprise image processing systems intended specifically for handling visual data, images, graphics, or pictures [3].

Image processing is an essential technology for multimedia management system especially for visual data (i.e., images). As a fact, images special part of multimedia which required to be processed before being used for different applications. Therefore, a multimedia system manager must know the proper process of image for specific application.

Here, we introducing a halftoning technique as an application for multimedia management system. Halftoning is considered as a pre-processing method for converting different types of an image into a binary image in order to perform some applications. It is purposely a practical way of noise used to diffuse the quantization error randomly. Zhou et al. [4] have proposed a halftoning meth-od that results in less determinable artifacts.

In image processing, it is always required to print various color quantized images, which leads to the loss of details of an image. The non-available colors in the palette of halftoned image are approximated by a diffusion of available palette's colored pixels. Such diffusion is perceived by human eyes as a mixture of the colors via it. To overcome that problem, halftoning is used to produce a pattern into the image. However, this pattern becomes visible as it is not perceived by human visual system. In these situations, it has been shown that a blue noise halftone pattern is the slightest hideous and confusing pattern [5]. Blue noise dithering patterns are generated by error diffusion and ordered dithering techniques. However, the ordered dithering technique is able to generate a blue noise dithering without the propensity to debase into areas with artifacts. In particular, halftoned images with relatively few colors can be distinguished by a dotted appearance, or characteristic graininess [6]..

2. METHODOLOGY

The idea behind Halftoning is that pixels are grouped together in small blocks, and various pat-terns of binary pixels are used as one gray level pixel. By using a simple threshold operation, it is easy to quantize a gray level image into binary image, only through mapping its upper half into white and the other one to black. Yet, the simple threshold operation's drawback as the quality of resultant image is very poor, and according, it is essential to improve its quality by using the technique of dithering by distributing the quantized error. Dithering technology is used to regenerate the grayscale image with binary value to be ready to perform different applications related to dithered images like halftone visual cryptography [7].

2.1 Ordered Halftoning

In ordered dithering or halftoning method, a small mask matrix is generated as a threshold matrix in order to compare it to pixel-wise of gray level image. After the comparing process, the binary image with shade information will be generated [7. In ordered halftoning, different gray scale ranges are also presented by chosen binary pixels in square grids form. The pattern corresponds to a particular square grid is chosen to the appropriate gray level. Independently, the calculation of each grid depends on the

surrounding ones. As a result, the quality of the final halftoned image is reduced to contain some characteristic diagonal artifacts. To work with free-form and arbitrary palettes, it is not easy in ordered halftoning method [8].

2.2 Error Diffusion Halftoning

For improving the performance of diffusion in an image, ED is a standard and bright technique with an ability to reduce the pattern noise and remove the affection of the boundary and 'black-hole' [9]. In fact, error diffusion is seen as a standard workhorse among the existing halftoning methods. This is due to its simplicity and efficiency in halftoning a grayscale image. Moreover, it has an ability to provide halftone shares with quite good quality. The mechanism of error diffusion is to diffuse the error at each pixel of an image. To diffuse the error at each pixel, the quantization error is filtered and feedback to the input. The error filter process diffuses the quantization error on one pixel away to the neighbouring gray pixels. In nature, the error diffusion noise is of high frequency or "blue noise", and, for human vision, it can provide pleasing halftone images [10]. The fig. 1 shows that the binary error diffusion diagram where the (m,n)th pixel of the input grayscale image is indicated by the f(m,n), the sum of input pixel value and the past diffused error is indicated by the d(m,n) and the output quantized pixel value is indicated by g(m,n) [11].

3. EXPERIMENTAL RESULTS AND PERFORMANCE ANALYSIS

This section present and discuss the experimental results of halftoning algorithms based on error diffusion that are implemented on Lena image of size 512×512 and Baboon image of size 256×256 as grayscale images. Halftoned images resulted through using different error diffusion filters as an observed in figure (4 (a) & (b)).

The three different filters of error diffusion that diffuse the error quantization to more neigh-boring pixels produce more visually enhanced halftoned images. The Jarvis filter occurs to be able to produce most visually enhanced halftoned image. This filter diffuses the error to 12 neigh-boring pixels and also the divisor in which the weights are distributed is the largest among all the filters with 48. So it takes more time to diffuse the error. In Stucki filter, with weight of 42, occurs to be computationally efficient in term of time, and in the amount of diffusion of quantization error. Therefore, the results produced by the Stucki filter are better than the results obtained by the Floyd-Steinberg filter.

As shown in table I, the results completely close with no much of visual difference as com-parison of halftoned images that are obtaining by applying different filters based on mathematical metrics such as MSE, PSNR, AD, MD, MAE and UIQ.
Regarding to values of PSNR and UIQ in the above table, it can be seen that the better halftoned images can be obtained by using filters that diffuse the error to more neighbouring pixels. Jarvis filter introduced the best results and the Stucki filter the good choice than Floyd-Steinberg filter. While calculating PSNR we can find that, the higher the PSNR is, the better the quality of the halftoned image is. Also more error is diffused better visual quality obtained. From UIQ it is very clear that with higher UIQ the halftoned image look like the original image.

Table 1. Metrics of Measures Halftone Images for All Filters.

Metrics		**Error diffusion filters**		
		Floyd-Steinberg	Jarvis	Stucki
MSE	Lena Image 512×512	0.044495	0.043674	0.043674
PSNR		5.343	5.3739	5. 3432
AD		108	107	108
MD		244	244	244
MAE		108	107	107
UIQ		0.00295	0.0030928	0.00306
MSE	Baboon image 256×256	5161.6	5160.3	5160.4
PSNR		4.8103	4.8115	4.8113
AD		47	47	47
MD		125	125	125
MAE		47	47	47
UIQ		0.001898	0.0023104	0.002258

4. CONCLUSION

As a conclusion of this paper, different filters of error diffusion have been applied to convert a grayscale image to halftone image.. On the basis of experimental result it is concluded that the error diffusion filters have a low complexity and the half toned images have a better quality which is useful to secure the documents. Consequently, it is come to know that the more diffusion of error to the neighboring pixels proves to be a better filter. However, its algorithms became slower as shown in Jarvis and Stucki filters. Finally, in future work use the better filter in secret sharing scheme is to be used for halftone visual cryptography. This kind of visual cryptography is more secured in secrete sharing in banking and electronic governance. This can be achieved by the above methods.

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