

IMPLEMENTATION OF QUANTUM IMAGE HALFTONING ALGORITHM

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Abstract

Developing new computing methods and signal processing algorithms by borrowing from the principle of quantum mechanics is a very interesting and new research topic. By utilizing quantum algorithm in the process of computing, it is expected that this algorithm can solved the problems of image processing faster than using a classical algorithm. In this paper, a quantum digital image halftoning algorithm will be presented. The image would be processed using bitmap image (.bmp) and the applications would be created using Matlab R2009a. Test phase of the applications is using an image, lena.bmp. This application will show three new images as results of three halftoning methods: binary threshold method, ordered dithering method, and method with quantum algorithm. The method with quantum algorithm shows better than two others methods.

Kata Kunci: *image Processing, quantum Algoritm, halftoning method.*

INTRODUCTION

Image is a combination of points, lines, and areas which form an integral form of two-dimensional images, such as paintings /photographs and three-dimensional form, such as a statue (Agustian, 2003; Munir, 2004). Meanwhile image processing is an attempt to transform the image became the new image using certain techniques. Image processing is required in addition to improving the quality of the image, securing the information contained in the image, and made the image is easily interpreted by a human or a computer.

Image processing can be utilize the new algorithm namely quantum algorithm in the computational process (Anonim-1, 2013).

Developing new computing methods and signal processing algorithms by borrowing from the principle of quantum mechanics is a very interesting and new research topic. A Quantum algorithm is an algorithm that had related with the quantum computation. All of the image processing problems can be solved with a classical computer and a quantum computer too. The classical computers contains of quantum material and the

quantum properties has been used, but the process not yet using a quantum computing. A Quantum algorithm is interesting, because this algorithm may be able to solve some problems faster than classical algorithms. This might lead to a quantum algorithm will be more popular than classical algorithms (Anonim-1, 2013).. In this paper, a quantum digital image halftoning algorithm will be presented.

THEORY

Quantum Algorithm

The theory of quantum mechanics arise because of the failure of classical physics to explain a number of microphysical phenomena observed in the late nineteenth and early twentieth century (Anonim-1, 2003; Tseng and Hwang, 2003). Quantum mechanics is essential to understand the solid-state physics, lasers, semiconductor and superconductor devices, plasma, etc.. Now quantum mechanics can already be connected with computer science, information theory in communication and digital signal processing. Quantum algorithms are used to solve the problem of image processing; several of them are image halftoning algorithm, edge detection and visual cryptography (Tseng and Hwang, 2003).

Digital Halftoning

The halftoning is the process of drawing and color reproduction in the publishing industry. To complete this process, the image or color should be broken down into a pattern of dots called a halftone screen (halftone screen). The halftoning or analog halftoning is a process that simulates shades of gray by varying the size of tiny black dots arranged in a regular pattern. If you inspect a photograph in a newspaper, you will notice that the picture is

composed of black dots even though it appears to be composed of grays. This is possible because of the spatial integration performed by our eyes. Our eyes blend fine details and record the overall intensity (Agustian, 2003). The digital halftoning is similar to halftoning in which an image is decomposed into a grid of halftone cells (Anonim-2, 2013). Elements (or dots that halftoning uses in simulates shades of gray) of an image are simulated by filling the appropriate halftone cells. The more number of black dots in a halftone cell, the darker the cell appears.

SYSTEM DESIGN

Application Concept

The built application is an application that is used to process digital image halftoning technique using a quantum algorithm. Through this application, the image also will be processed by the binary threshold method (Anonim-4, 2013), ordered dithering method (Anonim-3, 2013), and method with quantum algorithm (Tseng and Hwang, 2003).

The first step, we will transform each pixel image $x(m,n)$ to be the quantum bits $|q(m,n)\rangle$. And we define the following equation (1, 2). So the probability $|c_0|$ and $|c_1|$ can be calculated by the following equation (3, 4). Where the value of the function $f(P)$ can be calculated from computation under this. While the value of $a = 0.5$ and a value of $b = 0.05$ (5), And P values obtained from (6), random number z uniformly distributed in the range $[0,1]$ per each measurement of qubit $|q(m,n)\rangle$. Then, if z is in the range $[0, |c_1|^2]$, then outcome $|o(m,n)\rangle$ is the state $|1\rangle$. Moreover, if z is in the range $(|c_1|^2, 1]$, then outcome $|o(m,n)\rangle$ is the state $|0\rangle$.

Fig.1 is a flowchart of the application. First, we generate a random number z uniformly distributed in the range $[0,1]$ per each measurement of qubit $|q(m,n)\rangle$. Then, if z is in the range $[0, |c_1|^2]$, then outcome $|o(m,n)\rangle$ is the state $|1\rangle$. Moreover, if z is in the range $(|c_1|^2, 1]$, then outcome $|o(m,n)\rangle$ is the state $|0\rangle$.

Application Design

Designed interface will consist of a home and main menu. The first to be designed is the home page, there is a plan view in Fig.2

The second page is the main menu page of this application. As seen in

$$s_1 = \sum_{k=-1}^1 \sum_{l=0}^1 x(m-k, n-l) + x(m, n+1) + x(m, n+2) \quad \dots(1)$$

$$s_2 = y(m-1, n-1) + y(m-1, n) + y(m, n-1) \quad \dots(2)$$

$$|c_1|^2 = f(P) \quad \dots(3)$$

$$|c_0|^2 = 1 - f(P) \quad \dots(4)$$

$$f(P) = \frac{1}{1 + e^{-(P-a)/b}} \quad \dots(5)$$

$$P = \frac{s_1 - s_2}{5} \quad \dots(6)$$

Fig.4 below, there are 4 buttons and 4 axes (tool for displaying images in Matlab (Prestyo, 2011)).

Application Testing

In this section, the built application is tested. Application testing is conducted to assess the success of the application. To determine the success rate of application, the test is conducted with a image with extension (.bmp). When users click the button choose image will appear a case of Fig. 4. In this section, the user is asked to select the image to be processed.

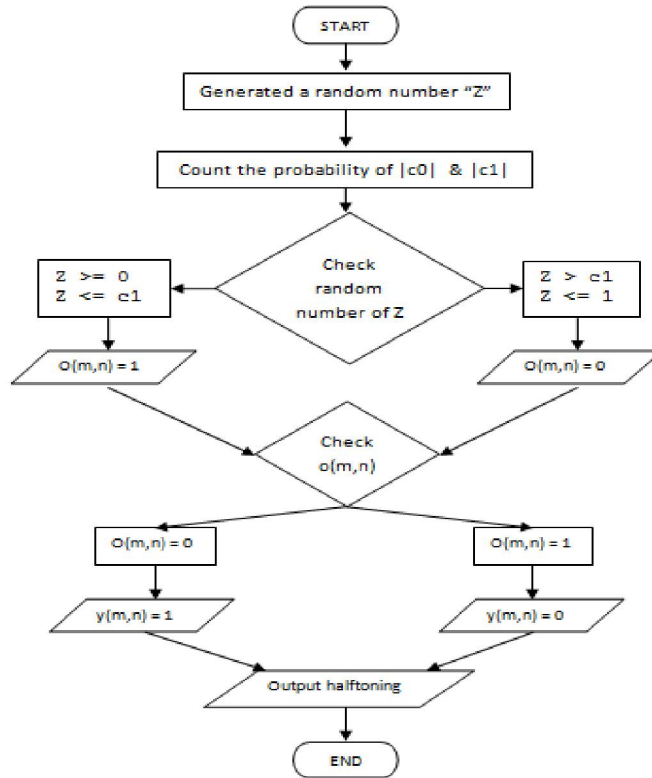


Figure 1. Flowchart

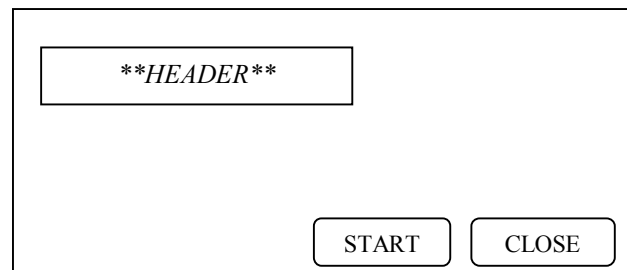


Figure 2. Display home page

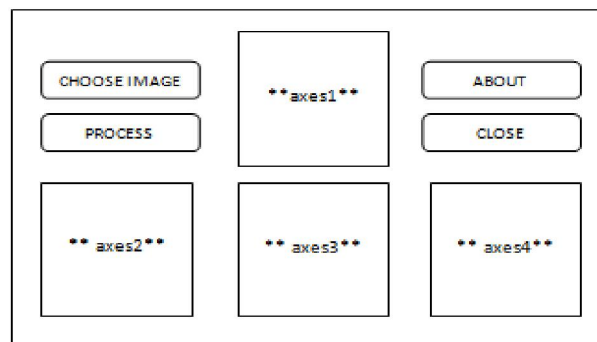


Figure 3. Display main menu

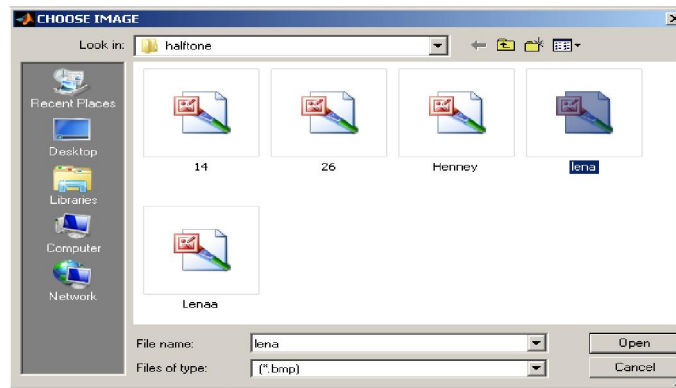


Figure 4. Output select image

Here is a application testing with lena.bmp. Fig.5 below is one of the images that are input in the process of this testing. The image must be a bitmap image.



Figure 5. Image lena.bmp

Then the image that has been selected will appear in the earlier part axes1. And to process the image, click the button process. Application will

automatically process images according to the methods and display three new image results, as shown in Fig.6.

Fig.6 is the result of image processing. Every image is different from each other. Image-1 is dominated a black color than the other two images, so the image isn't clear. Image-2 consist of a lot of black and grey dots that are irregular. And Image-3 is a image result that has been processed using quantum computation. It shows that quantum algorithms can process the image with halftoning method. The method with quantum algorithm shows better than two others methods.

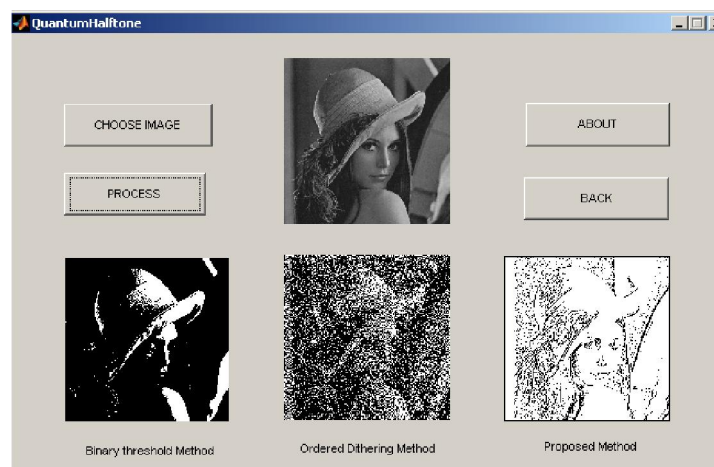


Figure 6. The results of applications with image lena.bmp

CONCLUSION

Application of quantum algorithm implementation on digital image processing with halftoning method has been built. Development of this application uses a Matlab 2009 software. The image that to be processed is only a bitmap image (*.bmp). The image would be processed using quantum computation. The results of the image processing are images of binary method, dithering method, and method with quantum algorithm. This application only can produce black-and-white output. The method with quantum algorithm shows better than two others methods.

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