MEDICAL IMAGING THROUGH HISTOGRAM EQUALIZATION AND CANNY EDGE DETECTION METHOD

MAZLINDA BINTI IBRAHIM

This dissertation is submitted as a partial fulfillment for the award of the Master of Science (Mathematics)

Faculty of Science
Universiti Teknologi Malaysia

NOVEMBER 2009

ABSTRACT

Medical images edge detection is an important work for object recognition of the human organs. It is an important pre-processing step in surgery planning to detect the location and size of cancerous tissues or tumor. Today, many edge detection methods were introduced in order to obtain the better result. One of the most popular methods is Canny edge detector. But, Laplacian and Sobel method are still taken into account to the researcher of edge detection. Computer Tomography scan is one of the modalities in medical imaging. Image reconstruction methods were used to obtain the final images in CT scan. Test images from CT scan were used to apply the Canny, Laplacian and Sobel methods using simulation with C++ programming. Comparisons were made and the result show that the combination of Canny edge detector and histogram equalization perform well to the tested images.

ABSTRAK

Pengesanan rangka dalam imej perubatan adalah satu langkah yang penting untuk pengenalpastian organ-organ manusia. Ia juga merupakan langkah awal yang penting dalam perancangan pembedahan untuk mengenalpasti lokasi dan saiz tisu yang berkanser ataupun tumor. Hari ini, banyak kaedah untuk pengesanan rangka diperkenalkan yang bertujuan untuk mendapat hasil yang lebih baik. Salah satu kaedah yang terkenal adalah pengesanan rangka Canny. Tetapi kaedah Sobel dan Laplacian masih mendapat perhatian daripada pengkaji pengesanan rangka. Pengesan komputer tomografi adalah salah satu kaedah dalam memperoleh imej perubatan. Kaedah pembangunan semula imej digunakan untuk mendapat imej terakhir dalam pengesan komputer tomografi. Imej yang diuji adalah daripada pengesan komputer tomografi untuk mengaplikasikan kaedah Canny, Laplacian dan Sobel menggunakan simulasi dengan pengaturcaraan C++. Perbandingan dibuat dan keputusan menunjukan kombinasi pengesanan rangka Canny dan kesamarataan histogram bertindak dengan baik keatas imej yang diuji.

TABLE OF CONTENTS

CHAPTER 5 RESULT AND DISCUSSION

CHAPTER 6 CONCLUSION DAN RECOMMENDATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Image means picture. It can be analogue or digital. An analogue image is an image which exists on a photographic film, video magnetic tape or signal from a broadcast transmission (Joshi, 2001). Meanwhile, a digital image is a representation of two dimensional image using ones and zeros or in binary numbers. Digital image data is represented in the form of grey scale, corresponding to the intensity. It can be processed using the digital computer. The term digital image usually refers to raster images also called bitmap images. Raster images have a finite set of digital values called picture elements or pixels.

Interest in digital image processing techniques dates back to the early 1920's when digitized pictures of world news events were first transmitted by submarine cable between New York and London. Application of digital image processing concepts, however did not become widespread until the middle 1960's, when third generation digital computers began to offer the speed and storage capabilities required for practical

implementation of image processing algorithms. Since then, this area has experienced vigorous growth, having been a subject of interdisciplinary study and research in such fields as engineering, biology, computer science, medicine and chemistry. The result of these efforts have established the value of image processing techniques in a variety of problems ranging from restoration and enhancement of space-probe pictures to processing of fingerprints for commercial transactions.

Image processing is an area of study for manipulating and modifying images. Image processing involves techniques for image enhancement, restoration and smoothing by moving, copying, deleting and modifying the contents of the pixels in the image. Before an object can be extracted from scenery, a way of assessing it shape and size is needed. This can be done using edge detection or segmentation, both of which are low-level image processing task, or their combination (Gudmundsson et all, 1998). The success of the higher level recognition is, therefore highly dependent on this lower level process.

Edge is the boundary between two regions, with relatively distinct grey level properties (Joshi, 2001). In a continuous image, a sharp intensity transition between neighbouring pixels is considered as an edge. Laplacian and Sobel are classical mathematical methods for the edge detection. The Laplacian edge detection method uses a two dimensional linear filter to approximate the second order derivative of pixel values of the image. The Sobel edge detection method uses two dimensional linear filters to process vertical edges and horizontal edges separately. One of the popular methods in edge detection is the Canny Edge Detector (Heath et all, 1997). This method was introduced by John Canny on 1986.

Due to the important of edge detection in image processing many methods were developing. In real world machine vision problems, numerous issues such as variable

scene illumination make edge and object detection difficult. There exists no universal edge detection method which works well under all condition (Panetta and Wharton, 2008).

The past 25 years have seen remarkable developments in medical imaging technology. Universities and industry have made huge investments in inventing and developing the technology needed to acquire images from multiple imaging modalities, such as CT, MRI, and Ultrasound. Every modality has its own working principle and system that enable us to obtain the final images. For example, X-ray computed tomography (CT) images are sensitive to tissue density and atomic composition, and the x-ray attenuation coefficient (Hajnal et all, 2001).

Image reconstructions methods were used in order to obtain the final images in the medical imaging modalities. As an example, in x-ray tomography, image reconstruction from projection method such as the filtered back projection method was applied. After the image was reconstruct, we now can apply the image processing techniques as desired.

1.2 Problem Statement

Given an image of size $m \times n$. In what way can the image be reconstructed so as to produce binary versions which clearly display the high and low intensity pixels? The binary version is an image with black and white colour which the white colour shows the boundary of the object in the image. The white color indicates the edges and the black color indicate no edges. In medical field, the binary version of the image is a preliminary

stage in any medical decision. The selection of edge detection method is also an important step because not all method can detect the desire edges.

One of the available methods in edge detection is Canny edge detection. Canny edge detector used the first derivative of a Gaussian $G(x)$ as the optimal filter where;

$$G(x) = \exp\left(-\frac{x^2}{2\sigma^2}\right)$$

where σ is the standard deviation of the Gaussian function and x is the value from origin in one dimension case. Then, the edge point is defined to be a local maximum in the direction of n of the operator G_n applied to the image I , where $G_n = n \cdot \nabla G$ where n is normal to the edge direction. At local maximum, we have $\frac{\partial}{\partial n} G_n * I = 0$. Then the problem becomes to find the location of local maxima in the image. Since an image contains higher number of pixel, we need to use the simulation to find the edges.

1.3 Objectives

The objectives of this study include:

a) To apply the Laplacian , Sobel and Canny edge detection method on the medical images.

b) To develop a simulation of Laplacian, Sobel and Canny edge detection method.

c) To compare the performance of Laplacian, Sobel and Canny edge detection using visual assessment.

1.4 Scope

This project use Laplacian, Sobel and Canny edge detector for detecting the edges. Comparisons were made to determine which method is the best using visual assessment. Laplacian and Sobel edge detection have one parameters meanwhile Canny edge detection has three parameters. The parameters values are just any values and we do not study the best parameters values for each method. We apply the method to the medical images from x-ray tomography. Some discussion about image reconstruction from projection in x-ray tomography also included. The test image is the liver image which we aim to locate a tumor.

1.5 Project Outline

This project contains six chapters. The presentation of this project started in Chapter 1 with discussion of problem statement and objectives. It also includes scope and project outline. Chapter 2 discusses the edge detection methods. These include the Laplacian and Sobel method first. The chapter also introduces the Sobel multidirectional, the Canny edge detection method and histogram equalization.

Chapter 3 begins with a look at medical images. The discussion also includes image reconstruction from projection in x-ray tomography. This lead to Radon transform for filter back projections in x-ray tomography.

REFERENCES

Epstein, C.L. (2003). Introduction to the Mathematics of Medical Imaging. USA. Prentice Hall.

Canny, J. (1986). A Computational Approach to Edge Detection. IEEE on Pattern Analysis and Machine Intelligence. Vol. 8 , Nov. 1986

Chung, S.H, Ho, S.B.(2008). Classification of Liver Diseases MRI Images Using First Order Statistics-Grid Computing Approach. IEEE.

Gonzalez, R.C. Woods, R.E. (2008). Digital Image Processing. USA. Preason.

Gudmundsson, M. Essam A.El-Kwae, M.R Kabuka. (1998). Edge Detection in Medical Images Using a Genetic Algorithm. IEEE Transaction on Medical Imaging, Vol.17, No.3 June 1998.

Hajnal, J.V, Hill, D.L.G, Hawkes, D.J. (2001). Medical Image Registration. USA. CRC Press.

Heath, M. Sarkar, S. Sanocki, T. Browyer. K. (1998). Comparison of Edge Detection. Computer Vision and Image Understanding. Vol.69. No.1 Jan 1998.

Hiroyuki Kudo, (2006). Analtical Image Reconstruction Methods for Medical Tomography-Recent Advances and A new Uniqueness Result. Mathematical Aspects of Image Processing and Computer Vision,

Joshi, M.A. (2001). Digital Image Processing An Algorithmic Approach. India. Prentice Hall.

Lee, M.K Leung, S.W. Pun, T.L Cheung, H.L. Edge Detection by Genetic Algorithm. IEEE.

Nattere, F. Wubbeling, F. (2001). Mathematical Methods in Image Reconstruction. USA. SIAM.

Panetta K.A, Wharton E.J. " Logarithmic Edge Detection with Application". Journal of Computer, Vol. 3. No.9 Sept 2008.

Parker, J.R. (1997). Algorithms for Image Processing and Computer Vision. USA. John Wiley & Sons.

Pitas,I. (1993). Digital Image Processing Algorithms. UK.Prentice Hall. (1993).

Quinto, E.T , "An Inroduction to X-ray tomographic and Radon Transforms". Proceedings of Symposia in Applied Mathematics.American Methematical Society. 2005.

Rice, S.O. (1945). "Mathematical Analysis of Random Noise". Journal of Bell Syst Tech.vo1 24.

Salleh, S. (2008). " C++ Numerical and Visual Programming". Universiti Teknologi Malaysia.

Shirai, Y. (1994). Reply to Performance Characterization in computer Vision. CVGIP. Image Understanding .

Sonka, M. Hlavac, V. Boyle, R. (2008). Image Processing, Analysis, and Machine Vision. USA. Thomsan.

Suri, J.S, Setarehdan, S.K. Singh, S. (2002). Advanced Algorithmic Approaches to Medical Image Segmentation. UK. Spinger.

Zhao Yu-qian,G.Wei-hua,C.Zhen-cheng,T.Jing-tian,L.Ling-yun. (2005). Medical Images Edge Detection Based on Mathematical Morphology. IEEE. Engineering in Medicine and Biology 27th Annual Conference Shanghai, China. 1-4 Sept. 2005.