International Journal of Computer and Communication Technology

Volume 4 | Issue 1 Article 2

January 2013

Medical Images Edge Detection Based on Mathematical Morphology

J. Mehena
Department of Electronics & Telecommunication Engg. DRIEMS, Tangi, Cuttack, jmehena@gmail.com

Recommended Citation
Mehena, J. (2013) "Medical Images Edge Detection Based on Mathematical Morphology," *International Journal of Computer and Communication Technology*: Vol. 4 : Iss. 1 , Article 2.
DOI: 10.47893/IJCCT.2013.1162
Available at: https://www.interscience.in/ijcct/vol4/iss1/2

Medical Images Edge Detection Based on Mathematical Morphology

Prof. J.Mehena
Department of Electronics & Telecommunication Engg.
DRIEMS, Tangi, Cuttack

Abstract: Medical images edge detection is an important work for object recognition of the human organs and it is an important pre-processing step in medical image segmentation and reconstruction. Conventionally, edge is detected according to gradient-based algorithm and template-based algorithm, but they are not so good for noise medical image edge detection. In this paper, basic mathematical morphological theory and operations are introduced, and then a novel mathematical morphological edge detection algorithm is proposed to detect the edge of medical images with salt-and-pepper noise. The simulation results shows that the novel mathematical morphological edge detection algorithm is more efficient for image denoising and edge detection than the usually used template-based edge detection algorithms and general morphological edge detection algorithms. It has been observed that the proposed morphological edge detection algorithm performs better than sobel, prewitt, roberts and canny's edge detection algorithm. In this paper the comparative analysis of various image edge detection techniques is presented using MATLAB 8.0

Keywords- Medical image, edge detection, mathematical morphology, denoising

I.INTRODUCTION

Medical images edge detection is an important work for object recognition of the human organs, and it is an essential pre- processing step in medical image segmentation [1-2]. The work of the edge detection decides the result of the final processed image. Conventionally,edge is detected according to algorithms like Sobel algorithm, Prewitt algorithm and Laplacian of Gaussian operator [3], but in theory they belong to the high pass filtering, which are not fit for noise medical image edge detection because noise and edge belong to the scope of high frequency. In real world applications, medical images contain object http://www.metacafe.com/watch/1262772/pakistan_female_sex_market/boundaries and object shadows and noise. Therefore, they may be difficult to distinguish the exact edge from noise. Mathematical algorithm to detect a wide range of edges in images. Prewitt operator edge detection masks are the one of the oldest and best understood methods of detecting edges in images. Basically, there are two masks, one for detecting image derivatives in X and one for detecting image derivative in Y. To find edges, a user convolves an image with both masks, producing two derivative images (dx and dy). The strength of the

morphology is a new mathematical theory which can be used to process and analyze the images [4-9]. It provides an alternative approach to image processing based on shape concept stemmed from set theory [10], not on traditional mathematical modeling and analysis. In the
mathematical morphology theory, images are treated as sets, and morphological transformations which derived from addition and subtraction are defined to extract features in images. As the performance of classic edge detectors degrades with noise, morphological edge detector has been studied [11].

In this paper, a novel mathematical morphology edge detection algorithm is proposed to detect medical image edge. It is a better method for edge information detecting and noise filtering than differential operation, which is sensitive to noise. And it is a better compromise method between noise smoothing and edge orientation, but the computation is more complex than general morphological edge detection algorithms.

II. BASIC MATHEMATICAL MORPHOLOGICAL OPERATIONS

There are many techniques for edge detection such as Sobel operator, Prewitt operator, Roberts's edge detection and Canny edge detection.Sobel operator is used in image processing techniques particularly in edge detection. The sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical and is therefore relatively inexpensive in terms of computations. Canny edge detection operator was developed by John F. Canny
in 1986 and uses a multistage

edge at given location is then the square root of the sum of
the squares of these two derivatives. Roberts edge detection method is one of the oldest method and is used frequently in hardware implementations where simplicity and speed are dominant factors.

Dilation, erosion, opening, closing are the basic mathematical morphological operators.

Dilation is defined as the maximum value in the window. Hence the image after dilation will be brighter or increased in intensity. It also expands the image and mainly used to fill the spaces. Erosion is just opposite to dilation. It is defined as the minimum value in the window .The image after dilation will be darker than the original image .It shrinks or thins the image. Opening and closing both parameters are formed by using dilation and erosion. In opening, firstly image will be eroded and then it will be followed by dilation. In closing, first step will be dilation and then result of this is followed by erosion. All above operators perform their tasks by using structuring elements, which is a matrix of 0's and 1's.structuring elements
have various sizes and shapes.

In the following, we introduce some basic mathematical morphological operators of gray-scale images. Let F(x,y) denote a gray-scale two dimensional image, *B* denote structuring element. Dilation of a gray-scale image F(x,y) by a gray-scale structuring element - B(s,t) is denoted by

$(F \oplus B)(x,y) = \max\{F(x-s, y-t) + B(s, t)\}$ (1)

Erosion of a gray-scale image F(x,y) by a gray-scale structuring element B(s,t) is denoted by

$(F\Theta B)(x,y)=\min\{F(x-s,y+t)-B(s,t)\}$ (2)

Opening and Closing of gray-scale image F(x,y) by gray-scale structuring element B(s,t) are denoted respectively by

$F \circ B = (F \Theta B) \oplus B$ (3)

$F \bullet B=(F \oplus B) \Theta B$ (4)

Erosion is a transformation of shrinking, which decreases the gray-scale value of the image, while dilation is a transformation of expanding, which increases the gray-scale value of the image. But both of them are sensitive to the image edge whose gray-scale value changes obviously. Erosion filters the inner image while dilation filters the outer image. Opening is erosion followed by dilation and closing is dilation followed by erosion. Opening generally smoothes the contour of an image, breaks narrow gaps. As opposed to opening, closing tends to fuse narrow breaks, eliminates small holes, and fills gaps in the contours. Therefore, morphological operation is used to detect image edge, and at the same time, denoise the image.

III. MORPHOLOGICAL EDGE DETECTION ALGORITHM

Morphological edge detection algorithm selects appropriate structuring element of the processed image and makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and the synthesization operations of them to get clear image edge. In the process, the synthesized modes of the operations and the feature of structuring element decide the result of the processed image. Detailedly saying, the synthesized mode of the operation .reflects the relation between the processed image and origin image, and the selection of structuring element decides the effect and precision and the result. Therefore, the keys of morphological operations can be generalized for the design of morphological filter structure and the selection of structuring element. In medical image edge detection, we must select appropriate structuring element by texture features of the image. And the size, shape and direction of structuring element must been considered roundly. Usually, except for special demand, we select structuring element by 3×3 square.

By the operation features of morphology, erosion and dilation operations satisfy:

$F \Theta B \; F \subseteq F \oplus B$ (5)

Opening and closing operations satisfy:

$F \circ B \subseteq F \subseteq F \bullet B.$ (6)

The edge of image F, which is denoted by $E_d(F)$, is defined as the difference set of the dilation domain of F and the domain of F. This is also known as dilation residue edge detector:

$E_d(F) = (F \oplus B) - F$ (7)

Accordingly, the edge of image F, which is denoted by $E_e(F)$, can also be defined as the difference set of the domain of F and the erosion domain of F This is also known as erosion residue edge detector

$E_e(F) = F-(F\Theta B)$ (8)

The dilation and erosion often are used to compute the morphological gradient of image F, denoted by G(F):

$G(F) = (F \oplus B) - (F\Theta B)$ (9)

The morphological gradient highlights sharp gray-level transition in the input image

The opening top-hat transformation of image F, which is denoted by $TH_o(F)$, is defined as the difference set of the domain of F and the opening domain of F. It is defined as

$TH_O(F) = F - (F \circ B)$ (10)

(5.6.10)

Similarly, the closing top-hat transformation of image F, which is denoted by $TH_e(F)$, can also be defined as the difference set of the closing domain of F and the domain of F , It is defined as

$TH_c(F) = (F \bullet B) - F$ (11)

The top-hat transformation, which owes its original name to the use of a cylindrical or parallelepiped structuring element function with a flat top, is useful for enhancing detail in the presence of shading.

The effect of erosion and dilation operations is better for image edge by performing the difference between processed image and original image, but they are worse for noise filtering. As opposed to erosion and dilation, "opening and closing operations are better for filtering. But because they utilize the complementarity of erosion and dilation, the result of processed image is only correlative with the convexity and concavity of the image edge. Accordingly what we get is only the convex and concave features of the image by performing the difference between processed image and original image, but not all the features of image edge.

In this paper, a novel mathematical morphology edge detection algorithm is proposed. Opening-closing operation is firstly used as preprocessing to filter noise. Then smooth the image by first closing and then dilation. The perfect image edge will be got by performing the difference between the processed image by above process and the image before dilation, The following is the morphological algorithm:

$$(M \bullet B) \oplus B - M \bullet B \qquad (12)$$

$$\text{Where, } M = (F \bullet B) \circ B \qquad (13)$$

IV.SIMULATION RESULTS AND ANALYSIS

In this section, the proposed morphological edge detection algorithm is compared with a variety of existing methods for edge detection. Fig.1 is the original MRI image. Fig.2 is the MRI image with salt-and-pepper noise. Fig.3, Fig.4, Fig.5 and Fig.6 are the results of processed MRI image after respectively applying Sobel, Prewitt, Robert and Canny edge detection algorithms.Fig.7 is the result of processed MRI image using Morphological gradient operation.Fig.8, the novel morphological edge detector proposed in this paper is succeed in edge detection, but more important than the template-based edge detection algorithm mentioned before, it also filters the noisy successfully.

V.CONCLUSION

In this paper, a novel mathematical morphological algorithm is proposed to detect medical MRI image edge.

Fig.1. Original MRI image

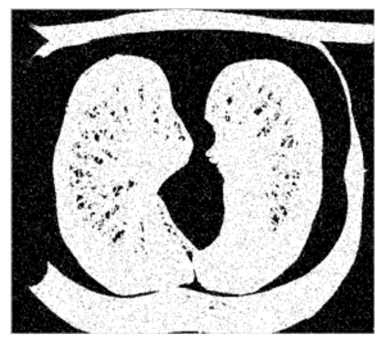

Fig.2. Original MRI image with salt & pepper noise

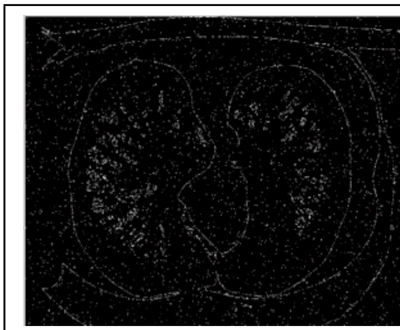

Fig.3.MRI image processed by Sobel operator

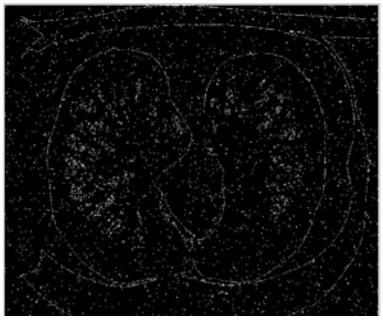

Fig.4.MRI image processed by Prewitt operator

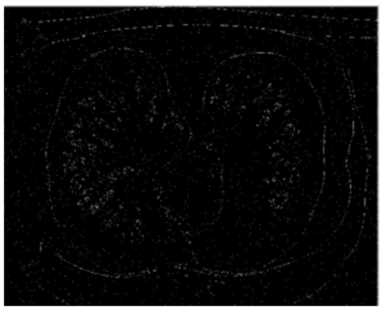

Fig.5.MRI image processed by Robert operator

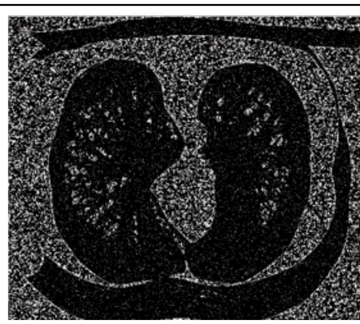

Fig.6.MRI image processed by Canny edge detection algorithm

The simulation results show that the algorithm is more efficient for medical image denoising and edge

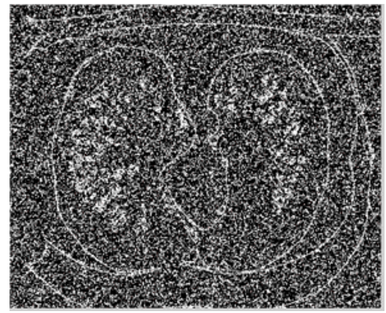

Fig.7.MRI image processed by morphological gradient operation

Fig.8.MRI image processed by novel morphological edge detector

detection than the usually used template-based edge detection algorithms such as Sobel, Prewitt, Robert and canny edge detector, and general morphological edge detection algorithm such as morphological gradient operation

REFERENCES

[1] ***M.I. Rajab, M.S. Woolfson, and S.P. Morgan, "Application of region-based segmentation and neural network edge detection to skin lesions," Computerized Medical Imaging and Graphics, vol. 28, pp. 61–68, 2004.***

[2] ***H. Tang, E.X. Wu, Q.Y. Ma, D.Gallagher, G.M. Perera, and T. Zhuang, "MRI brain image segmentation by multi-resolution edge detection and region selection," Computerized Medical Imaging and Graphics, vol 24, pp. 349–357, 2000.***

[3] ***Huertas, A. and Medioni, G., "Detection of intensity changes with sub pixel accuracy using Laplacian-Gaussian masks," IEEE Trans. On Pattern Analysis and Machine Intelligence, PAMI, vol. 8, pp. 651–664, 1986.***

[4] ***Maragos P., "Differential Morphology and Image Processing," IEEE Trans Image Processing, vol. 5, pp. 922–937, June 1996.***

[5] ***Ortiz F, and Torres F, "Vectorial Morphological Reconstruction for Brightness Elimination in Colour Images," Real-Time Imaging, vol. 10, pp. 379–387, June 2004.***

[6] ***Jing Xiao-jun, Yu Nong, and Shang Yong, "Image Filtering Based on Mathematical Morphology and Visual Perception Principle," Chinese Journal of Electronics, vol. 13, pp. 612–616, April 2004.***

[7] ***Richard A P, "A New Algorithm for Image Noise Reduction Using Mathematical morphology," IEEE Transaction on Image Processing, vol. 4, pp. 554–568, March (1995).***

[8] ***Chen T., and Wu Q.H., Rahmani-Torkaman R., Hughes J., "A pseudo top-hat mathematical morphological approach to edge detection in dark regions," Pattern Recognition, vol. 35, pp. 199-210, 2002.***

[9] ***Rivest Jean, "Morphological Operators on Complex Signals," Signal Processing, vol. 84, pp. 133–139, January 2004.***

[10] ***J. Serra, Image Analysis and Mathematical Morphology, Academic Press, New York, 1982.***

[11] ***Lee J.S.J., Haralick R.M., and Shapiro L.G., "Morphological Edge Detection," IEEE J. Robot. Automat, vol. 3, pp. 142–156, February 1987.***

ABOUT THE AUTHOR

Jibanananda Mehena *is presently working as Asst.Prof. in the department of Electronics & Telecommunication Engg.,DRIEMS,Tangi,Cuttack.He received his M.Tech in Electronics Engg. from Visvesvaraya National Institute of Technology(VNIT),Nagpur. His areas of interest includes VLSI,Signal and Image processing. He has authored four books to his credit. He has published different research papers in National and International Conferences.*