International Journal of Computer Applications® (IJCA) (0975 – 8887)
International Conference on Advances in Computer Engineering & Applications (ICACEA-2014) at IMSEC,GZB

Implementing Morphological Operators for Edge Detection on 3D Biomedical Images

Sadhana Singh
M.Tech(SE)
SRMSCET,
Bareilly

Ashish Agrawal
M.Tech(SE)
SRMSCET,
Bareilly

Shiv Kumar Vaish
Asst. Professor
SRMSCET,
Bareilly

ABSTRACT
In this paper we describe the mathematical morphology in the form of high level image processing and mid level image processing. We study two approaches, for "color morphology" are vector approach and component-wise approach. In set theory approach, Mathematical morphology is developed by J.Serra and G. Matheron. Edge Detection is well known approach which aims at searching and detecting the points in a digital image at which the image brightness changes stridently. Edges are significant local changes of strength in an image. 3D biomedical images edge detection is an essential for object recognition of the human organs. Object recognition is a vital processing step in biomedical image segmentation. Important appearance can be extracted from the edges an image (e.g., corners, line, curves, etc.). In this paper, basic mathematical morphological operators are introduced at first then a mathematical edge detection algorithm is proposed to detect edges of the lungs CT image with salt-and-pepper noise and the Gaussian noise.

General Terms Object Recognition, 3D segmentation.

Keywords 3D Biomedical Images, Edge Detection, Morphological Operators, Structural Element.

1. INTRODUCTION
Biomedical images either treat the image as 1-D text sequence or the 2-D text sequence, but in this paper we treat the image as 3-D text sequencing. Biomedical images are obtained from positron emission tomography (PET) and different nuclear medicine imaging modalities play a significance role in modern biomedical research and clinical diagnosis, and it provides a window to internal human biochemistry that was not previously available [1].

In the 3D biomedical images, edge detection is a significant job for the object detection of the human organs such as lungs, ribs and brain and this is an essential pre-processing step in the biomedical images segmentation. The job of the edge detection decides the outcome of the final processed image. In morphological operations, for the interaction with a given image, a shape called 'structuring element' is used which is case of binary image and may hit or fit the image. Fig1 shows the various structuring element positions and their meanings. Conventionally, edge is detected according to some early brought forward algorithms like Sobel algorithm, Prewitt algorithm and Laplacian of Gaussian operator [2], but in this paper we define these operators on 3D biomedical images. These operators are belong to the high pass filtering, but which is not well for noise biomedical images edge detection because noise and edge belong to the range of high frequency.

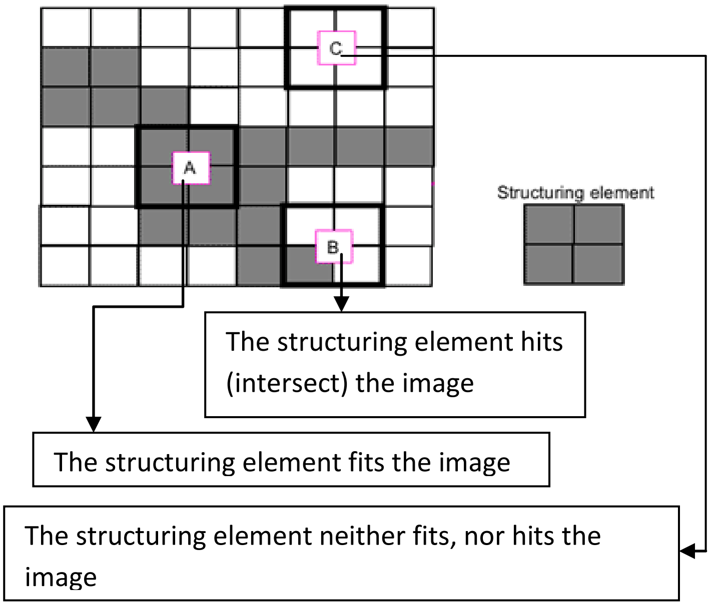

Fig 1: Structuring Elements [9]

Edge Detection is used to manufacture a line drawing of a scene from an image of that picture. The gradient edge detection method is used to detect the edges by looking for the maximum and minimum derivative in the first derivative of the image. The Laplacian edge detection method is used to detect the zero crossings in the second derivative of the images to locate the edge. Gradient methods are Sobel operator, Prewitt operator and Roberts's operator. Laplacian methods are Laplacian-of-Gaussian and Zero crossing.

Section 2 describes the literature survey of the edge detection on 3D biomedical images, section 3 describes the basics of mathematical morphological operators, section 4 describes the experiments and results and section 5 describes the conclusions and future scope.

2. LITERATURE SURVEY
Compared with common images, medical images essentially have the characteristics of unevenness and fuzziness. In the thesis, the authors suggest an approach of image processing based on the features of 3D-Biomedical images. First, using the space domain to enhance the image and improve clarity. And then process it by using mathematical morphology. After differ the top-hat [11] and bottom-hat transformation of gray scale morphology, the edge features are strengthened. Mathematical morphology is a method of nonlinear filters, which could be used for image processing including noise suppression, feature extraction, edge detection, image segmentation, shape recognition, texture analysis, image restoration and reconstruction, image compression etc. the method has been more and more widely used [3].

There are various edge descriptors like edge normal, edge direction, edge strength, edge position or strength that can be used in edge detection

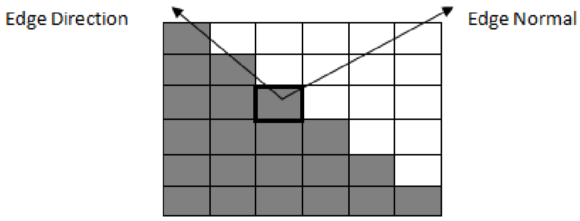

Fig 2: Position of edge descriptors[8]

3. BASICS OF MATHEMATICAL MORPHOLOGICAL OPERATORS

Mathematical morphology, a set based algebra which can be used in analysing and processing the geometrical shapes based data. The basic set theory of mathematical morphology was introduced by Matheron [4] in 1974 and refined by Serra [4, 6] in the 1980's.Mathematical Morphological operations basically are two types: erosion and dilation. For any binary signals, erosion is a Minkowski set subtraction (an intersection of set translation), and dilation is a Minkowski set addition (a union of set translation). These operators were extensive to operate on binary signals and on non-binary signals by Serra [5] and others [7]. There are two main types of morphological filters [7] which are 1) set processing and 2) function processing filters. In the set processing filters or theory binary signals are always transmitted as input and in result we get signals always in binary output signals, while function processing filters may accept binary or non-binary functions as input and yield non-binary functions as output [10][12].

Morphological operations are affecting the form, structure or shape of an abject. In this paper we have to perform the mathematical morphology on the 3D biomedical images which is in the RGB (Red Green Blue) form and then we convert this RGB image into the Gray. The 3D biomedical image are captured in this is Noisy. They are used in the pre and post processing of the shape of objects or the structure.
In the gray scale, images are show in the form of black and white pixels. Black pixel: in gray scale values for a 8 bits per pixel image indexed image its value will be 0 and white pixel: in gray scale values for a 8 bits per pixel image indexed image its value will be 255. So the gray scale images are shown in the form of [0,255].

3.1 Dilation Operation

The Dilation process is performed by laying the structuring element C on the image A and descending it across the image in a manner similar to complexity. Dilation is the operation of 'lengthening' and 'thickening'. 2 steps:

1) If origin of the structuring element coincides with a white pixel in the image, there is no change; move to next pixel.
2) If origin of the structuring element coincides with a black pixel in the image, make black all pixels from image covered by structuring element.

Notation: $A\oplus C$. This is defined as:

$$A\oplus C= \{z \mid (\hat{C})_z \cap A \neq \emptyset\} \quad (1)$$

Among them Ø is for empty set, C is for structuring element, and Ĉ is for reflection of collection C.

3.2 Erosion Operation

The erosion process is similar to the dilation, but we turn pixels to 'white' not 'black'. Erosion 'shrinks' or 'thins' the objects in the binary images. 2 steps:

1) If origin of the structuring element coincides with a white pixel in the image, there is no change; move to next pixel.
2) If origin of the structuring element coincides with a black pixel in the image, and at least one of the 'black' pixels in the structuring element falls over a white pixels in the image, then change the 'black' pixel in the image from 'black' to a 'white'.

Notation: $A\Theta C$: This is defined as:

$$A\Theta C = \{z \mid (C)_z \cap \bar{A} \neq \emptyset\} \quad (2)$$

Among them Ø is for empty set, C is for the structuring element, and Ā is for supplement of the collection C.

3.3 Opening Operation

Opening operation generally makes the curve of objects smooth, and disconnects narrow irregular and remove thin prostitutions. As the same case with binary images, opening operation first using b to erode f plainly, and then using b to do dilate operation on the results obtained. Using the structure element B to do the open operation on the set A, expressed as $A^{o}B$, definite as

$$f^{o}\, b= (f\ \Theta\ b) \oplus b \quad (3)$$

3.4 Closing Operation

Closing operation also makes outline smooth, but the opposite is that it usually eliminates discontinuity and narrows long thin gap, clears up small holes, and fill the ruptures of the contour line. As the same case with binary images, closing operation first using b to dilate f plainly, and then using b to do erode operation on the results obtained. Using the structure element B to do the open operation on the set A, expressed as A•B, definite as

$$f\bullet b= (f \oplus b)\ \Theta\ b \quad (4)$$

4. EXPERIMENTS AND RESULTS

Fig.3 shows the original 3D biomedical image on which we performed all the mathematical morphological operators and the edge detection operators. On the original image, firstly we add salt and pepper noise by using 'imnoise' command in Mat Lab and the result is shown in fig4. Then this noisy image is converted in gray image by using 'rgb2gray' command and the result is shown in fig.5.
Fig.6, 7, 8, 10 are the results of basic mathematical morphological operators like erosion, dilation, opening, closing. Fig 9, 11, 12 are the results of gradient operators-Prewitt, Robert and Sobel operators. Fig 13, 14, 15 are the results of Laplacian operators-Laplacian of Gaussian, Zero cross and Gaussian. Noise of the image is removed with the help of median filter and average filter, shown in fig 16, 17.

Fig 3: Original 3D Biomedical Image

Fig 4: Salt and Pepper Noise

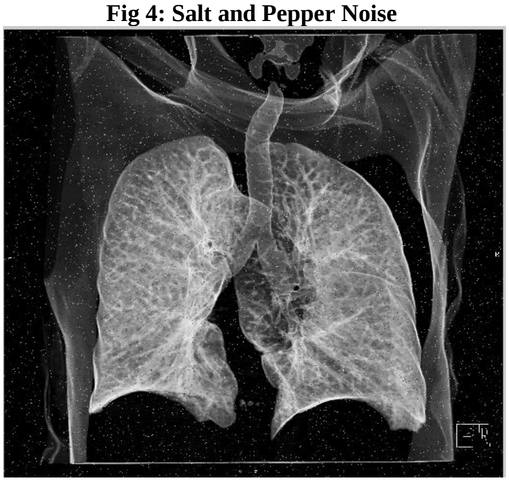

Fig 5: Gray Image

Fig 6: Erosion operation

Fig 7: Dilation Operation

Fig 8: Closing Operation

Fig 9: Prewitt Gradient Operator

Fig 10: Opening Operation

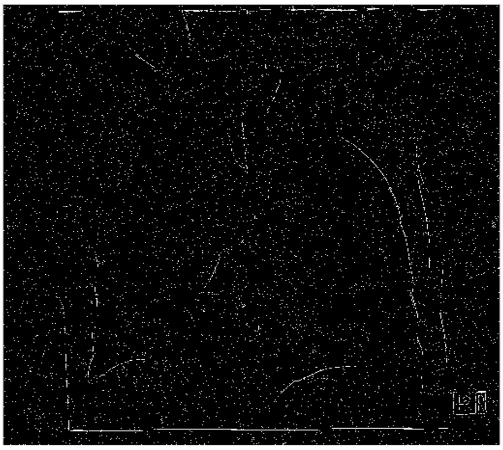

Fig 11: Robert Gradient Operator

Fig 12: Sobel Gradient Operator

Fig 13: Log Operator

Fig 14: Zero Cross Operator

Fig 15: Guassian Operator

Fig 16: Salt-Pepper Noise Removal by Median Filter

Fig 17: Salt-Pepper Noise Removal by Average Filter

5. CONCLUSIONS AND FUTURE SCOPE

In this paper, a mathematical morphological operator is planned to detect lungs CT 3D biomedical image edge. The experimental results show that the algorithm is more proficient for 3D biomedical image denoising and edge detecting than the generally used template-based edge detection algorithms such as Laplacian of Gaussian operator, Sobel operator, Prewitt operator, Roberts operator and zero crossing operator.

In future we implement 3D biomedical image denoising and edge detection by using the vector-based algorithms such as canny edge detector, marrs-hildreth operator.

6. ACKNOWLEDGEMENTS

We would like to acknowledge and extend my heartiest gratitude to Mr. Shiv Kumar Vaish for their guidance and support and most importantly my family, friends and my God for making this possible.

7. REFERENCES

[1] David Dagan Feng, "Information Technology Applications in Biomedical Functional Imaging", IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE, Vol. 3, NO.3, pp. 221-230. March 2000.

[2] 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.

[3] Zhao Fang, Ma Yulei, Zhang Junpeng, "Medical Image Processing on Mathematical Morphology", 2nd International Conference on Computer Application and System Modelling, 2012.

[4] G. Matheron, *Random Sets and Integral Geometry*. New York: Wiley, 1974.

[5] J. Serra, *Image Analysis and Mathematical Morphology*, Vol. 1. London: Academic, 1982.

[6] J. Serra, Editor. *Image Analysis and Mathematical Morphology*, Vol. 2: Theoretical Advances. London: Academic, 1988.

[7] P. Maragos and R. W. Schafer, "Morphological filters—Part I: Their set theoretic analysis and relations to linear shift-invariant filters," *IEEETrans. Acoust., Speech, Signal Process.*, vol. 35, no. 8, pp. 1153-1169, 1987.

[8] Edge detection, Trucco, Chapt 4 AND Jain et al., Chapter 5

[9] https://www.cs.auckland.ac.nz/courses/compsci773s1c/lectures/ImageProcessing-html/topic4.htm /

[10] Jonathan W. Valvano, John A. Pearce, Rebecca Richards-Kortum, Ronald E. Barr, J. K. Aggarwal, Mark Allen Schulze, Dissertation: "Biomedical Image Processing with Morphology-Based Nonlinear Filters", The University of Texas at Austin December 1994.

[11] Aboul ella Hassanien, Ajith Abraham, "Rough Morphology Hybrid Approach for Mammography Image Classification and Prediction", International Journal of Computational Intelligence and Applications, ijcia2008.

[12] Aboul Ella Hassanien, Ajith Abraham, James F. Petersand Gerald Schaefer, "An Overview of Rough-Hybrid Approaches in Image Processing".