International Journal of Scientific & Engineering Research, Volume 4, Issue 6, June-2013 221
ISSN 2229-5518

Kidney Segmentation in CT - Scan Image

P. Natarajan, Bhuvanesh Pratap Singh, Shashank Dwivedi, Shraiya Nancy

Abstract- In this paper an effective approach for extracting kidney in abdominal CT scan (Computed Tomography) images has been proposed. It has been divided into two stages. In the first stage a template evaluation method has been developed for extracting the desired region in an image on the basis of properties of an organ, which helps in processing to a confined region and is an automated process. The second stage uses the concept of intensity values of a pixel and separates the desired region from the original image on the basis of a computed threshold range. In addition to this it uses a set of morphological operations for fine coarse kidney segmentation and various filters for removing noise from an image.

Index Terms— CT (Computed Tomography), Filters, Image Subtraction, Morphological Operations, Segmentation, Template, Thresholding

1 INTRODUCTION

IMAGE processing is one of the most burning issues in medical technology and has assisted physician in various aspect, such as diagnosis of tumor in brain, lung cancer, kidney extraction etc. Image processing in simple terms, it is just the processing of an image under certain specified set of rules. Various techniques such as 1)Deformable model 2) Clustering Approach 3) Region growing [1] 4) Knowledge based model [2] and etc., have been developed for extracting kidney from the abdominal CT image and uses very intense algorithms for computing the extracted region. However these approaches laid the foundation of this research as it assisted in understanding the different intensity values of a pixel and separates the desired region from the template on the basis of a computed threshold range. However the image still doesn't have the clear view, so various set of morphological operations have been applied for carrying out the specific operations, so as to obtain the fine coarse kidney segmentation.

2 RELATED WORKS

Many approaches have been developed over the recent years, out of which the most recognized algorithms are

2.1 Deformable Model

It is a physical model that is formed by deforming edges by forming a closed centric structure under certain specified set of rules. The closed surface can be any mathematical polygon that surrounds the boundary and views the desired region in that polygon [2] [7] and is influenced by the external as well as internal conditions of an image. In the first step the edges has been deformed by relaxing the boundaries then the mathematical polygon (Square, circle, ellipse) has been formed by keeping the constant intensity variation so as to maintain the smoothness of the curve. The main advantage of this model is that they form closed parametric surface in an image, which make them more helpful in understanding the characteristics of an extracted region. The disadvantage of this model is that it needs initial parameters that have to be computed manually and sometimes the closed surface surpasses the boundaries in an image such in the case of abnormal kidney size.

2.2 Clustering Method

This method doesn't use the already trained data, so are termed as unsupervised model [2]. They often train themselves by iteratively processing the images this model is same as the artificial intelligence model in which agents train themselves by adapting into the new environment. They form clusters of data by grouping pixels of one intensity into one group and other to the other group and does this iteratively the most common algorithm used is fuzzy algorithms.

2.3 Region Growing

In this method first a seed point [1] [2] in an image is obtained manually then the region growing algorithm is applied so as to obtain the region of interest which has the same pixel arrangement. It is based on some predefined criteria which can be based on intensity homogeneity or pixel connectivity, if it uses the intensity homogeneity then the criteria is based on some computed threshold, which looks for the area that has the near most intensity and if uses the pixel connectivity then it performs the tracing algorithm that traces the pixels then it can be 4 way connectivity, 8 way connectivity or it can be 16 way connectivity that merely depends on the defined parameters. The main disadvantage with them is their first stage in which seed point is obtained manually, so it's not a fully automated system.

2.4 Knowledge Based Method

In this model the system uses knowledge or in other words

- *P.Natrajan is currently working as assistant professor senior in School of Computing Science and Engineering,VIT University,India, PH-9443645196. E-mail: pnatrajan@vit.ac.in*
- *Bhuvanesh Pratap Singh is currently pursuing bachelor degree program in School of Computing Science and Engineering,VIT University,India, PH-9626956618. E-mail:bhuvanesh.singh.mail@gmail.com*
- *Shashank Dwivedi is currently pursuing bachelor degree program in School of Computing Science and Engineering,VIT University,India, PH-8122878323. E-mail:shashank.dwivedi21@gmail.com*
- *Shraiya Nancy is currently pursuing bachelor degree program in School of Computing Science and Engineering,VIT University,India, PH-9159883146. E-mail:shraiya.nancy07@gmail.com*

the trained data for computing the extracting region. For the identification of organs [2] [3] it uses the concept of gray values as every organ have different gray value portion. So it keeps the record of every organs data and matches them with their gray value portion so as to find that particular organ. However sometimes it produces a wrong result because organs are surrounded by other organs as well so sometimes the unwanted part is also checked which is known as noise in an image. So it becomes vulnerable sometimes, so for improving it not only gray value [5] portion but how it is distributed and also checked as every organ has different spatial alignment in a body.

3 METHODOLOGY

It has been divided into two stages; the first stage is called template evaluation method, which is an automated process while the second stage uses the concept of intensity homogeneity on the basis of computed threshold.

3.1 Template Evaluation

This method aims at extracting the desired form of the image rather than processing the whole image, this reduces the number of iterations done on the image. This is based on extracting the region of the image on the basis of certain properties. It creates an object in which the properties of the region are passed as parameters to create a template which holds the desired region. It is a full automated process.

3.2 Histogram Equalization

This technique is used to adjust the intensity of the image [2] and to enhance the contrast of the image to get the clear and enhanced image [12]. It will distribute the gray level of the image such that the gray levels are equally occupied by the image [11]. Therefore it will have uniform histogram in the image which is obtained by finding the gray scale of the image. It can increase the contrast of the image when the image has close contrast values [10]. This will convert the lower contrast to higher contrast and spread the frequent intensity value all over the image.

3.3 Filtering

Filter is used as a sharpening method. Sharpening methods is basically used to highlight the details of the image [9]. The purpose of filtering is to improve the visual quality of the image by removing or reducing the noise in the image with the use of filters [8].
Filtering is used to remove or reduce high spatial frequency noise from the image. Filters are normally used to smooth the image or to detect or enhance the edges of the image. Image is sharpened only when the noise is removed from the image or the contrast is enhanced in the image. This is used as a preprocessing to improve the image quality and result of later processing.

3.4 Threshold Evaluation

This method is based on the grouping of pixels based upon their intensities. It groups pixels of particular intensity into one group and the other into a different group based upon the computed threshold value.
After the process of threshold evaluation, the resultant image undergoes various morphological processes. The binary image is mostly imperfect in most ways. The morphological processes are the procedures that refine the image in the desired manner. These morphological operations are applied in a definite order, so that the desired results are achieved. Morphological operations are logical transformations which depend on the comparison of pixels in the neighbourhood with in a pattern. Morphological operations [12] are performed on binary images, which have the pixel values either 0 or 1. For simplicity, we will show a value of zero as black and a value of 1 as white. Various morphological operations exist but here are using a few that will help in achieving the segmented image of the kidney.

3.5 Various Morphological Operation

3.5.1 Clean

It performs the removal of isolated pixels individual 1s that are surrounded by 0s, just as the center pixel. That is if any white pixel is surrounded by many black neighboring pixels this operation will turn that white pixel in black as to clean the image [12] [13].

3.5.2 Open

It performs morphological open [12] [13] [14] which is erosion followed by dilation [12] [14]. This open is similar to erosion which will remove the bright pixels from the edge of the image. This operation is basically used to preserve the foreground regions which are in similar shape to the structuring element and by removing all other foreground pixels region.

3.5.3 Majority

If five or more pixels in the neighbourhood of a 3 by 3 matrix are 1, the remaining pixels are set to 1 if not they are set to 0. Therefore it will make the region as white if in 3 by 3 matrix 5 or more than 5 neighbouring pixels are white or else it will make it as black if 5 or more than 5 neighbouring pixels are black in colour in 3 by 3 matrix [13] [14].

3.5.4 Spur

It removes spur pixels [14]. It makes the pixel value to 0, if it consists of only one eight-connected pixel in its neighborhood. These pixels are connected diagonally to one another and they are connected only in one direction.

3.5.5 Thin

This is used to preserve the lines of the image at the same time thickness is eroded with n = Inf. Thin removes the object pixel so that the pixel value is set to 0, when the object without holes shrink to a stroke that are minimally connected and the object which has holes shrinks to connect the ring halfway between the near outer boundary and each hole. Thin operation also preserves the Euler number [12].

3.6 Image Subtraction

This is done by the pixel subtraction operator [12] [13] [14]. Two images are taken as input and upon subtracting them a third image is produced whose pixel values are a subtraction of those of the first image minus to that of the corresponding pixel of the second image.

3.6.1 Procedure

The images in image subtraction are subtracted in a single pass. The output pixel values are

$$A\,(i,j) = B_1(i,j) - B_2(i,j)$$

Or the absolute difference of the two input images is computed by:

$$A\,(i,j) = |\,B_1(i,j) - B_2(i,j)\,|$$

The kidney present in the image is extracted first. This happens on the principle of the most closely packed pixels present in the image. This leads to the extraction of the most closely packed pixels in the image. Hence the kidney is the one which is removed. The image which is obtained after removal of kidney is subtracted from the original image by applying morphological operations. Then the image is obtained which is free from all other noise and contains kidney [14].

4 Architecture

The main steps involved in framing the architecture of the system are as follows:

First, the abdominal CT image is taken as input and the properties of a targeted organ are estimated, following which a template is generated, which is a mesh. The next stage comprises of converting the image into a grayscale, uses various filtering technique which is being used for filtering the image from any sort of noises, then the concept of intensity equalization is applied for a uniform distribution of intensity throughout the image. Finally, thresholding operations separate the desired kidney region on the basis of a computed threshold. Furthermore, morphological operations are applied for fine coarse segmentation of the extracted kidney region..

4.1 Flowchart

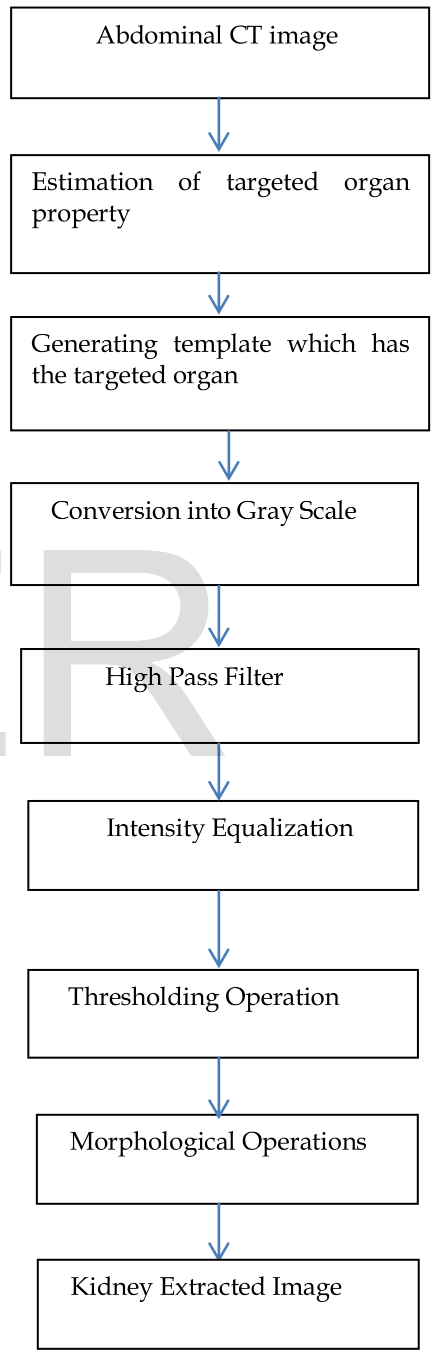

Fig 1 System Architecture

5 Results and Discussions

The main concern of this paper is the extraction of kidney from the CT images using various techniques in image processing. In the current scenario CT images provide a good overall view of the abdomen, but it fails to provide an accurate view of the kidney, so in an attempt to find out the exact position of the kidney the image needs to be preprocessed and various image processing technique like image segmentation, template formation, morphological operations, subtraction etc. are applied. This helps us to obtain better insight of kidney in CT images.

Fig. 5.1. CT Scan of Original Image

Fig. 5.2. Histogram Equalized Image

Fig. 5.3. Filtered Image

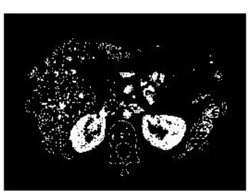

Fig. 5.4. Threshold Segmented

Fig. 5.5. Morphological (Clean) Applied Image

Fig. 5.6. Morphological (Close) Applied Image

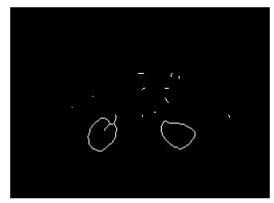

Fig. 5.7. Morphological (Thin) Applied Image

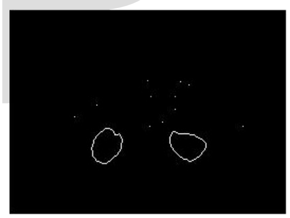

Fig. 5.8. Morphological (Spur) Applied Image

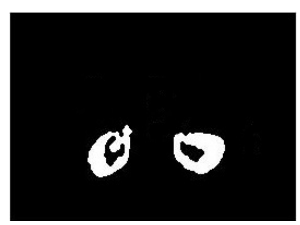

Fig. 5.9. Final Kidney Obtained Image

6 Conclusion

In the course of this research it is concluded that morphological processing techniques in image processing are significantly helpful in image extraction and image filtering. Morphological processes provide us with vast number of dependent and independent operations which can be used to change the structuring elements of the image as per requirements. Likewise processes dilate; spur, close etc. have played an enormous role in the extraction of kidney from the CT images. The images were first preprocessed by using the techniques of gray scaling, histogram equalization and filtering. Features of image processing have also helped us in generating a template which leads to less number of iterations that are performed on the image. Then threshold segmentation is done on the template to extract the desired region. And finally image subtraction is used to obtain an image which contains the extracted kidney from the CT image.

REFERENCES

[1] Daw-Tung Lin, Member IEEE, Chung-Chih Lei, and Siu-Wan Lung.," Computer-Aided Kidney Segmentation on Abdominal CT Images "IEEE Transaction on Information Technology in Bio Medicine, Vol. 10, No. 1, January 2006.

[2] Dzung L. Pham, Chenyang Xu2, and Jerry L. Prince, Department Of Electrical And Computer Engineering," Current Methods In Medical Image Segmentation "The Johns Hopkins University, Baltimore, Maryland, Annu. Rev. Biomed.Eng. 2000.2:315-337, 05/20/07

[3] Masaharu Kobashi And Linda G. Shapiro," Knowledge-Based Organ Identification From Ct Images" Department Of Computer Science And Engineering, University Of Washington, Seattle, Wa 98195, U.S.A, Pattern Recognition, Vol. 28, No. 4,pp.475-491, 1995, Elsevier Science Ltd.

[4] Maria Vagas - Vera and Enrico Motta," An Ontology-Driven Similarity Algorithm" Knowledge Media Institute. The Open University, Walton Hall Milton Keynes MK7 6AA, England.

[5] Seung-Wha Yoo, Jun-Sik Cho, Seung-Mu Noh, Kyung-Suk Shin," Organ Segmentation by Comapring Gray Value Portion on Abdominal CT Images" Dept of Information Communications Engineering, Chungam National University. 0-7803-5747-7.

[6] Sin-Hong Kim*, Seung-Wha Yoo**, Seon-Joo Kim**, Jong-Chul Kim***, Jong-Won Park**," Segmentation Of Kidney Without Using Contrast Medium On Abdominal CT Image" *Div. Of Computer, Juseong College, Chung-Buk, 363-794, Korea, **Dept. Of Information Communications Engineering, Chungnam National University, Taejon, Korea, ***Dept. Of Diagnostic Radiology, Chungnam National University, Taejon 305-764, Korea, 0-7803-5747-7.

[7] Baigalmaa Tsagaan, Akinobu Shimizu, Hidefumi Kobatake, Kunihisa Miyakawa*," Segmentation Of Kidney By Using A Deformable Model" Yosinori Hanzawa Tokyo University Of Agriculture And Technology, Graduate School Of Bio-Applications And Systems Engineering, Naka-Cho 2-24-16, Koganei-Shi, Tokyo,184-8588 Japan, *Department Of Radiology, National Cancer Center Hospital, 5-1-1 Tsukiji, Chuo-Ku, Tokyo104-0045 Japan.

[8] Rajesh C. Patil, Dr. A. S. Bhalchandra,"Brain Tumour Extraction from MRI Images", International Journal of Electronics, Communication & Soft Computing Science and Engineering, ISSN: 2277-9477, Volume 2, Issue 1,April 2012.

[9] Dr.M.Karnan, K.Selvanayaki, "Improved Implementation of Brain MRI Image Segmentation Using Meta Heuristic Algorithms", IEEE International Conference on Computional Intelligence and compting Research (ICCIC), pp: 1 -4, 2010.

[10] Ehab F. Badran, Esraa Galal Mahmoud, and Nadder Hamdy, "An Algorithm for Detecting Brain Tumors in MRI Images". IEEE International Conference on Computer engineering and Systems(ICCES), pp: 368 - 373, 2010.

[11] Natarajan.P, Krishnan's,"MRI Brain Image Edge Detection with Windowing and Morphological Erosion", IEEE International Conference on Computational Intelligence and computing Research, pp: 94-97, 2011.

[12] W.Gonzalez, "Digital Image Processing", 2nd ed. Prentice Hall, Year of Publication 2008.

[13] Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Second Edition.

[14] Rafael C. Gonzalez, Richard E. Woods, Steve L. Eddins, Digital Image Processing Using MATLAB, 2003.