RENAL STONE DETECTION AND ANALYSIS BY CONTOUR BASED ALGORITHM

Shahina M K
M.Tech, Department of Electronics and Communication Engineering
Marian College of Engineering
Trivandrum, Kerala, India.
shahinamks@gmail.com

Hema.S.Mahesh
Asst. Professor, Department of Electronics and Communication Engineering
Marian College Of Engineering,
Trivandrum, Kerala, India.
hemasmahesh@gmail.com

***Abstract* – Nephrolithiasis, is a type of kidney disease where a mass of tissue forms in the urinary tract. These are known as kidney stones and they usually leave the body through the urine stream. Some non-symptomatic cases occur where the stone may be too small and never causes a problem. As the size increases gradually, particularly when the stone goes unnoticed, it may pose health problems such as severe back pain and abdominal pain. Due to the increase in the amount of some minerals these stones are formed in one or both of the kidneys. Timely treatment of the kidney stones rarely cause any problems. These stones are of various sizes and shapes. The size ranges from as small as a sand particle to as big as a pea. Unusual cases have also been reported where the size could go up to the size of golf balls. Urine analysis and radiographic studies are helpful in the kidney stone diagnosis. Location and the severity of the pain aides in the clinical diagnosis. Thus, detection and analysis of kidney stone is an important aspect in the diagnosis of kidney stone diseases. The location and size of the kidney stone is done using GAC segmentation in addition to feature extraction and morphological operations.**

Index Terms – Biomedical Image Processing, kidney stone detection, location and size.

I. INTRODUCTION

Nephrolithiasis is a threat to the human race in the field of medicine. The stones may go unnoticed in the starting stage which may become life threatening if left untreated. Nowadays more people are affected by kidney ailments due to other underlying diseases such as diabetes, hypertension, etc. currently methods are available in radiology which include Ultrasound, CT scan, X-Ray, MRI, etc. Out of these, the most simple and non-invasive method is the Ultrasound technique. For exceptional cases RRFA algorithm is used during laproscopic surgery. On the details regarding the medical side, it is important to know that the factor leading to renal stone disease is Hyaluronan,and Nacetyl glucosamine (GlcNAc) disaccharides. Ultimately these result in the formation of stones or other renal diseases like urine concentration, crystallization inhibition,etc.

Ultrasound imaging technique is far more feasible than other radiologic methods since there are no harmful rays used. Ultrasound diagnosing is the other name for this technique. Ultrasound is mainly used in medical treatments for detection of various diseases. Ultrasound imaging is the best option in the imaging techniques as it is of low cost and non- invasive. These are the same reasons why it is used in diagnosis of kidney stones as well. There are other available methods for biomedical imaging like CT scan, MRI, etc. But US is always preferred more than the others due to its advantages. A major disadvantage of US also exists, i.e., noise present and low clarity which deteriorate the efficiency of detection. Speckle is a type of noise that exists while imaging and decreases the visual appearance of the ultrasound images. It affects the finer details like edges and boundaries which is crucial in diagnosis. Speckle noise is harder to eliminate since it is a multiplicative noise and not as easy as to remove like additive noise. So the process done to convert multiplicative noise to additive noise, i.e., log transformation is applied here. Thus speckle noise is reduced. Several filters were experimented to do this process. The best filter was taken based on the performance metrics such as (i)Peak Signal to Noise Ratio (PSNR), (ii)Mean Square Error (MSE), (iii) SSIM(Structure Similarity Index). PSNR is a quality measurement between the original and a de- noised image. Filtered image quality is directly proportional to the PSNR value. Mean squared error (MSE) of an estimator calculates the average of the squares of the "errors", that is, the difference between the estimator and what is estimated. The structural similarity index is a method for calculating the quality of digital television and movie pictures, as well as other kinds of digital images and videos. SSIM is a measure of the similarity between two images.

Contrast enhancement methods are done to correct the contrast of the US image, which inherently is of low contrast. Since subjective quality of biomedical images is more important for human interpretation, contrast enhancement is one of the vital steps in the preprocessing segment. Various methods available are divided into two categories, namely spatial and frequency domain methods which include image filtering, de-noising, image subtraction, equalization, etc. In the biomedical imaging section, adaptive equalization provides more desired effects since it has a localized way of contrast correction and enhancing edges in each area of the image.

978-1-5386-9482-4/19/$31.00 ©2019 IEEE

Biomedical image processing is a fast developing field; wherein the features extracted from images is used in medical diagnosis. This paper concentrates on the fundamentals and the applications of biomedical image processing.

Fundamentally, some preprocessing techniques are used such as deblurring, noise removal, contrast enhancement, etc. An extensive research has been done in the automation of cancer cytology; it is required that some prototypes are available. The 1970s is considered to be a golden era in imaging methods particularly for the biomedical area; the computerized tomographic scanner and the white blood cell analyzer have the most successful imaging devices, but still Ultrasound imaging is considered to be more efficient since it is cost effective and non-invasive.

II. LITERATURE SURVEY

In their paper titled "Speckle Noise Reduction and Segmentation of Kidney Regions from Ultrasound Image", Rahman and Shorifuddin have developed a method for speckle noise reduction and segmentation in a Ultrasound image. It provides image quality enhancement as well as detection [1].

In the paper, "Feature Extraction of Kidney Ultrasound Images based on Intensity Histogram and Gray Level Co-occurrence Matrix", Hafizah, compared the performance of different intensity histogram methods, proposed kidney US images and divides them into four different categories: normal, bacterial infection, cystic disease, and kidney stones, using gray level co-occurrence matrix (GLCM). This categorization helps doctors to identify the abnormalities [2].

Riedmiller, H. Braun has proposed high intensity focused ultrasound (HIFU) technique for terminating tumors and stones [3].

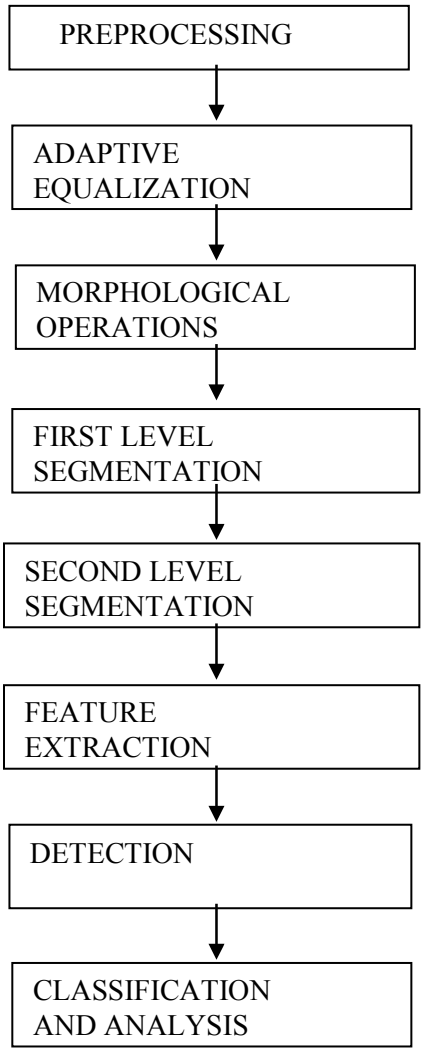
S.Sudha, G.R.Suresh and R.Sukanesh, had proposed wavelet thresholding methods to reduce speckle Noise Reduction in Ultrasound Images [6].

Otsu's method is one of the thresholding methods used in segmentation [8].

Hyun Wook Park and T. Schoepflin proposed an active contour model with gradient directional information [9].

.

III. PROPOSED METHODOLOGY



A. PREPROCESSING

Preprocessing methods are used to improve the quality of the images, especially in Ultrasound images which have speckle noise and low contrast present in them. Speckle noise can be reduced using filters like median, wiener, etc. The best filter is chosen based on parameters like high PSNR, low MSE and SSIM. In this paper, the wiener filter gave the best results.

B. ADAPTIVE EQUALIZATION

Contrast enhancement is done to clearly depict finer details like edges and boundaries, so that the desired stone region is detected easily. Spatial and frequency domain methods are available for this purpose and for this particular case. Adaptive equalization gave the best results in terms of visual appearance clarity.

C. MORPHOLOGICAL OPERATIONS

Morphological operations are done to detect the required stone region using operations like opening, closing and reconstruction. Major functions like erosion and dilation are carried out in this process. Basically a structuring element is used which is combined with the input image using a set operator (union, complement, intersection). The structuring element used here is disk of size 20. This helps in capturing the region of interest.

D. SEGMENTATION

Segmentation is the process of dividing the image into smaller segments. This aids in easier representation of the image which can be further analyzed. Different methods like thresholding, watershed segmentation, Otsu's threshold, image subtraction, etc. are present. Image subtraction is most efficient in this project since it discards all other unwanted regions that may be present even after morphological operations.

E. FEATURE EXTRACTION

The segmented image may contain irrelevant or redundant information. When such kind of large redundant input data is obtained, then it can be transformed into a reduced set of desirable features. The new image will still contain accurate and complete description of the input image. Feature extraction thus reduces the complexity of the system since large information generally requires a large amount of memory and computation power.

F.BOUNDARY OUTLINE

This step performs the boundary outlining of the detected regions (in case of one or more stones) and the regions of interest are depicted clearly for ease of visual appearance as well as for further location and size measurements. Contours are used here for this purpose. This is done using a two level segmentation.

G. DETECTION

In some cases edge detection may not give successful results in the case of area and location measurements. Therefore, in addition to edge detection, contour detection methods are also used for detection. Contours are often obtained from edges, but they are used only on closed curves. For example, if you put in white filled square on black background, the algorithm returns white empty square, just the borders. For efficient calculation of location and size, contour algorithms are the best option. Another advantage of contour detection is that it actually returns a set of points. This is very helpful because these points can be used for further processing.

IV MATLAB SIMULATED RESULTS

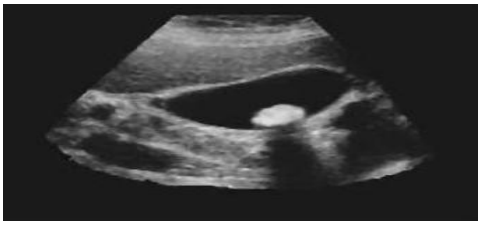


Fig 1. Input Image

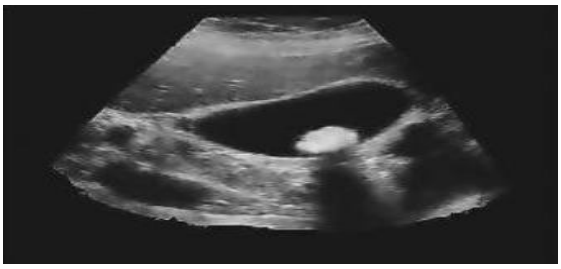


Fig 2. Contrast enhanced Image

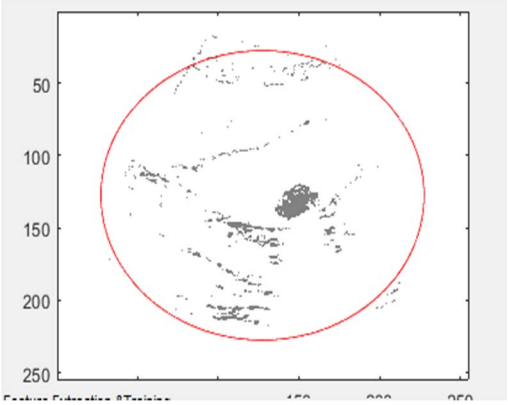


Fig 3. Initial Contour Image

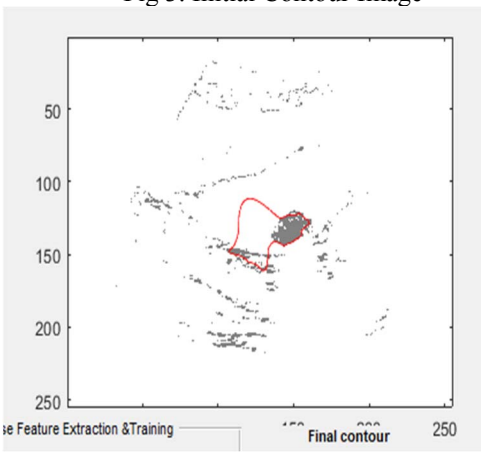


Fig 4. Final Contour Image

V.CONCLUSION

The proposed work is implemented with morphological operations, segmentation and for further classification. It is found to be capable in identifying the stones in the ultrasound kidney image. The algorithm performance is optimal with short runtime. The proposed system is done on several kidney images from the database and the results have higher efficiency. In the future work, classification using neural networks will be researched and the corresponding efficiency will be calculated.

VI.. REFERENCES

[1]T. Anzila Rahman, Mohammad Shorifuddin, "Speckle Noise Reduction and Segmentation of Kidney Regions from Ultrasound Image", *978–1– 4799–0400-6/132013 IEEE*.

[2] Wan Mahani Hafizah, "Feature Extraction of Kidney Ultrasound Images based on Intensity Histogram and Gray Level Co-occurrence Matrix", *2012 sixth Asia ModelingSymposium 978–0–7695–4730–5/12*, 2012.

[3]M. Riedmiller, H. Braun, "A direct adaptive method for faster backpropagationlearning: The RPROP algorithm", *Proc. IEEE Int. Conf. Neural Netw.*, vol. 1, pp. 586-591, Jun. 1993.

[4]T .Ratha Jeyalakshmi and K.Ramar," A Modified Method for Speckle Noise Removal in Ultrasound Medical Images", International Journal of Computer and Electrical Engineering, Vol. 2, No. 1, February, 2010.

[5]Shin, H.S., Chung, B. H., Lee, S.E., Kim, W.J.,Ha, H.I., Yang, C.W.,"Measurement of Kidney Volume with Multi-Detector Computed Tomography Scanning in Young Korea" ,Original Article, volume 50(2), 2009.

[6]S.Sudha, G.R.Suresh and R.Sukanesh, "Speckle Noise Reduction in Ultrasound Images by Wavelet Thresholding based on Weighted Variance", International Journal of Computer Theory and Engineering, Volume 1, April 2009.

[7]J.N. Otsu, "A threshold selection method from gray-level histograms," IEEE Trans. SMC **9**, 62–66 (1979).

[8]G. Pfurtscheller, et al., "Graz-BCI: state of the art and clinical applications," IEEE Trans. Neural Syst. Rehabil. Eng. **11** (2), 177–180 (2003).

[9]Hyun Wook Park and T. Schoepflin, "Active contour model with gradient directional information: directional snake," IEEE Trans. Circuits Syst. Video Technol. **11**(2) (2001)

[10]M. W. K. Law and A. C. S. Chung, "Segmentation of intracranial vessel and aneurysms in phase contrast magnetic resonance angiography using multirange filters and local variances," IEEE Trans. Image Processing **22**(3) (2013).