Journal of Advanced Engineering Research
ISSN: 2393-8447
Volume 10, Issue 1, 2023, pp.59-64

Detection of Urolithiasis Using Image Processing Techniques

Fathimath Fayiza*, Amita Dessai

Department of Electronic & Telecommunication Engineering, GEC, Farmagudi-403401, India

*Corresponding author email: fayizafathimath@gmail.com Tel. : 7066763062

ABSTRACT

The abstract should summarize the content of the paper. Try to keep the abstract below 200 words. Do not make references nor display equations in the abstract. The journal will be printed from the same-sized copy prepared by you. Your manuscript should be printed on A4 paper (21.0 cm x 29.7 cm). It is imperative that the margins and style described below be adhered to carefully. This will enable us to keep uniformity in the final printed copies of the Journal. Please keep in mind that the manuscript you prepare will be photographed and printed as it is received. Readability of copy is of paramount importance. This paper proposes a methodology for Urolithiasis detection from medical image of patients using image processing techniques. Urolithiasis known as kidney stone in common terms, a disease where minerals in urine crystalize and form stones which is detected using lab results, medical imaging techniques and patient's symptoms. It is one of the common diseases across the globe. The proposed method must be able to detect presence or absence of Urolithiasis from the medial image report thus eliminating manual examination done by radiologist or nephrologist. For this purpose, the input image is initially preprocessed to eliminate unnecessary details, noise, reconstruct and enhance image after which it undergoes segmentation using thresholding techniques. Finally, detection of presence or absence of Urolithiasis from ROI will be done using edge detection methods and ORB.

Keywords - ORB, Otsu's thresholding, segmentation, Urolithiasis, threshold

1. INTRODUCTION

Urolithiasis also known as kidney stone in common words is a common disease, because of the living nature of people. Its occurrence is usually believed to be due to crystallization of minerals inside urine, which on more sedimentation form a stone within the kidney due to abnormal collection of certain chemicals. Presence of these stones can be in kidney, urethra or in urinary bladder. Urolithiasis has an estimated prevalence of 13% for men and 7% for women. Diagnosis of kidney stones is based on information obtained from the history, physical examination, urinalysis, and radiographic studies of patient. Medical imaging techniques commonly used for studying the patient are X-ray, Ultrasound, CT scan and MRI. The radiologist or nephrologist manually examine the image to find presence or absence of Urolithiasis which consumes time. Medication varies depending on the health condition of patient, size of stone, type of stone formed and many more. Over past few years technology and medical science go hand in hand to improve health facility system. The main motivation of this study is to contribute to developing medical technology in healthcare industry and to aid in better and faster analysis of medical images for detection of Urolithiasis.

This study proposes a methodology to detect presence or absence of Urolithiasis using dataset obtained from Kaggle. Ultrasound image is non-invasive, low-cost imaging and flexible but due to presence of speckle noise and low contrast, detection of Urolithiasis is a difficult as well as challenging task thus initially image is pre-processed in which we remove noise and unwanted details, followed by segmentation and detection of Urolithiasis from which we will know if the patient of suffering from Urolithiasis or not using image processing techniques.

2. LITERATURE REVIEW

This section discusses some of papers published on techniques used for image processing techniques used on kidney images acquired from ultrasound. Various study and work have been done in related field for detection of Urolithiasis from medical image results. In order to detect and analysis of Urolithiasis different methods can be used. Some authors use wiener filter to remove speckle noise and performs two level segmentation followed by feature extraction and detection using watershed segmentation and contour detection. Different approaches give different results.

In [1] author work on the design and significance of a CAD-CT image model for cancer diagnosis using image preprocessing, segmentation nodule detection and feature extraction. For the removal of noise from the CT image. In [2] author conducts a comparative study of size-based thresholding, shape-based thresholding and hybrid thresholding algorithm for preprocessing and best results were archieved using shape and size based thresholding. In [3] author study various imaging methods and conclude that ultrasound is safer method with disadvantage of not detecting minor stone. Author proposes an artificial intelligence-based approach with aim to aid the medical practitioner to provide faster, accurate detection of Urolithiasis and a technique to reduce the exposure of radiation in Computed Tomography Imaging. Different methodologies are developed over the years for kidney segmentation, in [4] author presents a systematic review, comparing methods used in selected 95 articles. Distinct image processing classes used to segment the kidney in different imaging modalities gave accurate results. Author concluded that to overcome the current drawbacks of the state of-the-art methods more research work should be conducted.

The methodology proposed in this paper and its results will be shown in further sections.

3. METHEDOLODY

The proposed methodology's objective is to detect urolithiasis using some of the image processing techniques. Steps used for proposed methodology are Image acquisition, Image preprocessing, Image segmentation, ROI and Detection as shown below in Fig. 1. Image acquisition involves selecting or acquiring raw images using any of the imaging modalities. Medical images used in this research work is acquired from Kaggle consisting of both CT and ultrasound images. Image is preprocessed thereafter to enhance the image quality some preprocessing steps. Image segmentation is performed before selection of ROI. The ROI might or might not contain stone. The final step of proposed methodology must be able to detect presence or absence of stone.

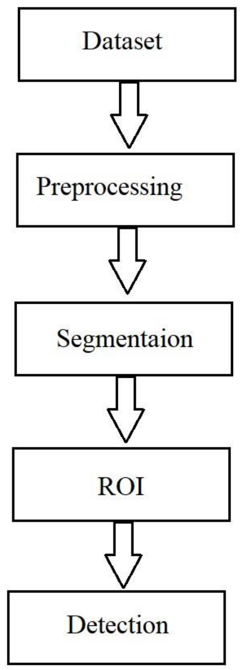


Fig 1. Steps included for proposed methodology to detect presence or absence of urolithiasis.

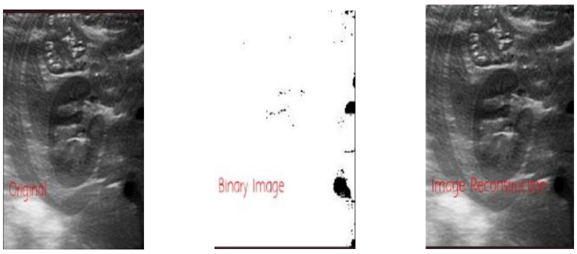
3.1 Dataset

The dataset used is obtained from Kaggle which consists of CT scan and Ultrasound scan images having both images with and without urolithiasis. From total of 4586 images 500 were selected. 400 images of patient suffering from urolithiasis and 100 images of patients without urolithiasis.

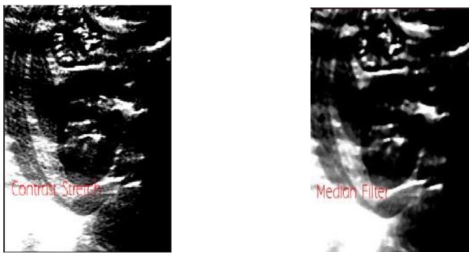
3.2 Image Preprocessing

It is necessary to preprocess ultrasound image or any medical image to remove noise, enhance and reconstruct image to get proper results. Thus, in preprocessing following steps are done and its respective results are displayed in Fig. 2

- Image conversion: - The input image is converted to grayscale then to binary image.
- Image reconstruction: - binary image consists of holes which need to be filled to get better results.
- Image enhancement: - ultrasound images are low contrast images thus we need to apply contrast stretching.
- Filtering: - median filter is used to remove noise from image.



2(a) 2(b) 2(c)



2(d) 2(e)

Fig 2(a), (b), (c)(d)(e): Original image, binary image, reconstruction, enhancement, median filter

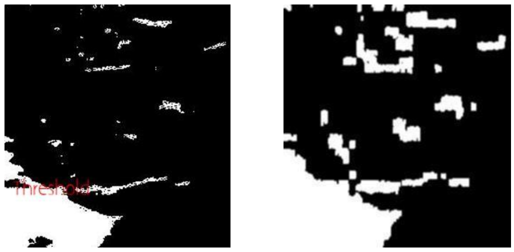
3.3 Segmentation

The preprocessed image is broken into subgroups by segmentation. Initially thresholding is done followed by Gaussian blur, Otsu's thresholding and finally watershed is done to obtain segmented image in Fig.3 respective results are shown.

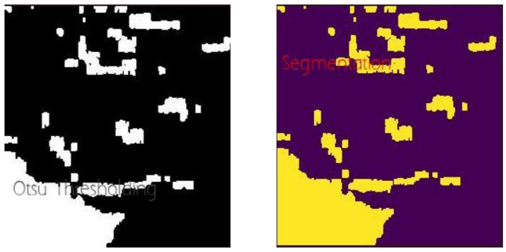
- Thresholding: - kidney stone will exhibit highest pixel value thus we set threshold as more than 250.
- Gaussian blur: - to remove maximum amount of noise by softening the image, we use Gaussian blur.
- Otsu's threshold: - this method automatically sets a threshold value from the values present in the image. It will consider certain values as foreground and certain values as background and select the threshold.
- Watershed: - in case of any touching or overlapping object to obtain proper boundaries we use watershed segmentation which draws borders by extracting the sure background and foreground.

The preprocessed image is broken into subgroups by segmentation. Initially thresholding is done followed by Gaussian blur, Otsu's thresholding and finally watershed is done to obtain segmented image in Fig.3 respective results are shown.

- Thresholding: - kidney stone will exhibit highest pixel value thus we set threshold as more than 250.
- Gaussian blur: - to remove maximum amount of noise by softening the image, we use Gaussian blur.
- Otsu's threshold: - this method automatically sets a threshold value from the values present in the image. It will consider certain values as foreground and certain values as background and select the threshold.
- Watershed: - in case of any touching or overlapping object to obtain proper boundaries we use watershed segmentation which draws borders by extracting the sure background and foreground.



3(a) 3(b)



3(c) 3(d)

Fig 3(a)(b)(c)(d) threshold image, gaussian blur, Otsu's threshold, segmentation

3.4 ROI

The segmented image will have the stone properly visible if patient is suffering from urolithiasis as shown in Fig. 4. For the system to detect the stone we need to select the ROI by simply cropping the segmented image from which detection of stone will be done.

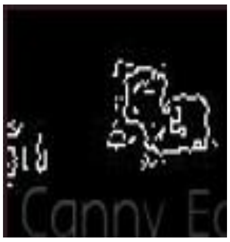
Fig 4. ROI

3.5 Detection

From ROI final step is to perform detection of presence or absence of urolithiasis. In case patient is suffering from urolithiasis the system show display present else absent. For this following step are done:

- Canny edge detection: this is applied to detect the edges from the ROI since the shape and size of crystal varies from patient to patient.
- ORB: This is used to detect the stone if stone is detected.

At the end of entire image processing procedure result will be displayed along with the stone key points highlighted from the medical image report of the patient as shown in Fig 5.



5(a)

5(b)

5(c)

Fig 5(a),(b),(c): canny image, ORB with keypoints, Output image

4. RESULT

Proposed methodology for detection of urolithiasis using image processing techniques results on implementation using python are shown in this section. Detection of urolithiasis has two possible results, either patient suffers from urolithiasis else patient is not suffering from urolithiasis. The result will either display present or absent after using the above-mentioned image processing techniques. Results for both the cases are shown below.

4.1 Detection of Urolithiasis as present

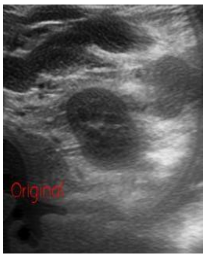
The original image which is pre-processed to enhance and remove noise present in it. Then after segmentation the image was cropped to obtain ROI followed by detection using canny edge and ORB. The grayscale of original image, and results of proposed methodology is shown below in Fig. 6.

6(a) 6(d)

Fig.6(a),(b): original image, output image

4.2 Detection of urolithaisis absent

In case the patient is not suffering from urolithiasis after pre-processing and segmentation, the ROI will not contain any stone thus with absence of stone no key points will be detected on applying ORB. The output displays absence of kidney stone as shown in Fig. 7.



7(a) 7(b)

7(c)

Fig. 7(a),(b),(c): input image, ORB-NO keypoint, output image

4.3 Observation

Out of total of 4586 images in dataset 500 were used for implementation of proposed methodology 400 images were of patient suffering from urolithiasis while remaining 100 were of patients without urolithiasis.

Of the 400 ultrasound images tested 29 gave error in results while in rest of 371 ultrasound images presence of urolithiasis was detected successfully. Error in results were due to negligible size of stone which got filtered with salt pepper noise.

All 100 ultrasound images showed absence of urolithiasis. Results of proposed methodology upon implementation is shown below in Table I.

TABLE I. IMPLEMENTATION RESULTS OF DATASET

Urolithiasis	**Total Cases**	**Stone Detected**	**Stone Absent**
Present	400	371	29
Absent	100	0	100

5. CONCLUSION

This paper presents a methodology for detection of urolithiasis using images processing techniques. During implementation of our proposed methodology, we found that the dataset for detection of urolithiasis varies from one patient to another thus obtaining correct ROI is challenging. Removal of speckle and salt and pepper noise completely was difficulty faced to obtain proper results. Also, the chemical composition of the stone is unknown. The methods applied can reduce noise and detect both presence and absence of urolithiasis with accuracy and speed.

ACKNOWLEDGEMENTS

We thank Mr. Sawad C. P. for sponsoring this research work. We also thank the principal of the college DR. R. B. Lohani for his immense support. Lastly we thank our families for motivating us.

REFERENCE

Proceedings Papers:

[1] Jeyaprakash Vasanth Wason & Ayyappan Nagarajan, “Image processing techniques for analyzing CT scan images towards the early detection of lung cancer,” *Volume 125, ISSN 1877-0509*, 2019

[2] N. Thein, K. Hamamoto, H. A. Nugroho and T. B. Adji, "A comparison of three preprocessing techniques for kidney stone segmentation in CT scan images," *2018 11th Biomedical Engineering International Conference (BMEiCON)*, pp. 1-5, 2018

[3] Smiti Tripathy1, Sivakumar R1, Simran Nair1, Inbamalar TM2, “Analysis and Detection of Nephrolithiasis using Imaging Techniques,” Volume 15, *ISSN: 1998-4510*, 2021

[4] Torres, Helena R et al. “Kidney segmentation in ultrasound, magnetic resonance and computed tomography images: A systematic review.” Computer methods and programs in biomedicine vol. 157: 49-67, 2018

[5] Mohit Pandey, Abhishek Gupta, “A systematic review of the automatic kidney segmentation methods in abdominal images,” *Biocybernetics and Biomedical Engineering, ISSN 0208-5216*, 2017

[6] P. T. Akkasaligar, S. Biradar and V. Kumbar, "Kidney stone detection in computed tomography images," *2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon)*, pp. 353-356, 2017

[7] W. Brisbane, M. R. Bailey, and M. D. Sorensen, “An overview of kidney stone imaging techniques,” *Nat. Rev. Urol., vol. 13, no. 11, pp. 654662*, 2016

[8] SamanEbrahimi and Vladimir Y. Mariano, “Image Quality Improvement in Kidney Stone Detection on

Computed Tomography Images, Journal of *Image and Graphics", Vol. 3, No. 1*, 2015

[9] S. M B and A. M R, "Kidney Stone Detection Using Digital Image Processing Techniques," *2021 Third International Conference on Inventive Research in Computing Applications (ICIRCA), pp. 556-561*, 2021

[10] S. Rajput, A. Singh and R. Gupta, "Automated Kidney Stone Detection Using Image Processing Techniques," *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), pp. 1-5*, 2021

[11] Raja Krishnamoorthi, Shubham Joshi, Hatim Z. Almarzouki, Piyush Kumar Shukla, Ali Rizwan, C. Kalpana, Basant Tiwari, "A Novel Diabetes Healthcare Disease Prediction Framework Using Machine Learning Techniques", *Journal of Healthcare Engineering, vol. 2022, Article ID 1684017,* 10 pages, 2022.

[12] Sundaramurthy, Sridhar, "Segmentation of Ureteric and Bladder Calculi in Ultrasound Images*," Journal of Computer Science. 8. 716-720. 10.3844/jcssp.2012.716.720*, 2012

[13] Joel, T. & S. R, "An extensive review on Despeckling of medical ultrasound images using various transformation techniques," *Applied Acoustics 138 (2018):18–27. doi: 10.1016/j.apacoust*, 2018

[14] T. Joel, R. Sivakumar, "An extensive review on Despeckling of medical ultrasound images using various transformation techniques,"Applied Acoustics, *ISSN 0003-682X, Volume 138,Pages 18-27*, 2018

[15] https://en.wikipedia.org/wiki/Kidney_stone_disease