

Ultrasound Imaging Technique for the Identification of Kidney Stones using Gsd Platform

N.Nithyavathy¹, Basil .M. Kuriakose², S.Arunkumar¹, P. Deepasundar², S.Amirthamani²

¹Faculty, Department of Mechatronics Engineering, Kongu Engineering College, Erode, Tamil Nadu, India

²Scholar, Department of Mechatronics Engineering, Kongu Engineering College, Erode, Tamil Nadu, India

Email id: nithyavathy11@gmail.com

Abstract: Nephrolithiasis (kidney stone formation) is one of the major threats faced by the human being. Correct identification of the stone plays an important role in identifying and curing it. On developing an advanced and precise technique for this purpose, the graphical processing software is involved. Graphics processing software is used today in a wide range of inspection applications in medical field. This software eases the way of understanding and performs parallel computing. This work gives a clear vision about the identification of kidney stones using Image processing techniques in LabVIEW. This technique uses the images of the kidney obtained from the ultrasound imaging technique. The main idea is based on the binary conversion using threshold range and the morphological filtration of the ultrasound image. The aforementioned process provides information about the location and dimension of the stones in the kidney. In future, this work could be used for identifying kidney stone in laboratories and in hospitals to identify the presence of kidney stones in a precise and cost effective way.

Keywords: LabVIEW, Image Processing, Threshold, Morphology, Kidney Stone.

I. INTRODUCTION

Kidney Stones: Kidney stone has the possibility of occurring in 50% of men and women and in about half of them gets clinically significant symptoms, which includes blocking easy flow of urine, swellings within the kidney, pain in back or flank side of the low back, even nausea, vomiting, and sweating. The medical name of the formation of kidney stone is Nephrolithiasis. [1] The five common types of stones are calcium oxalate, calcium phosphate, uric acid, struvite, and cystine. Calcium oxalate and calcium phosphate is the mostly occurred type of kidney stones. Computerized Tomography (CT scan), Intravenous Pyelogram, Magnetic Resonance Imaging, Ultrasound imaging and Urine test was the method of identification of kidney stones. The intravenous Pyelogram method uses dye which is injected into the human body and scanning process is carried to identify the stone but it is not mostly used now. Urine test is used to identify the chemical composition of kidney stone which less accurate and less used now. Computerized Tomography scan and Ultrasound imaging technique have been the mostly used latest techniques to identify the stone presence. The Ultrasound Imaging technique is the cheaper technique than the CT scan.

Image Processing Technique: Image processing technique in the Graphics Processing Software like LabVIEW has become

quite popular in recent. [2] Since this technology makes it possible to create and apply more advanced algorithms, it performs computationally demanding tasks quickly. Image processing is a kind of signal processing for which the input is an image, (a photograph or video frame), the output of image processing may be either an image or a set of characteristics or parameters related to the image.

Most image processing techniques involve images as a two-dimensional signal. It is used in various types of industries to perform the inspection tasks. Research papers on Kidney Stone Identification using image processing in Graphical Processing Software is rare. [3] In 2006, focused ultrasound has been proposed and it was successfully proved to treat soft tissue tumors deep in the body. In 2007, Rabinovici et al provided an effective treatment to uterine fibroids by heat ablation of magnetic resonance guided focused ultrasound surgery. [4] In 2008, CT scan was used to differentiate the uric acid stones and the non-uric acid stones. In 2010, Sonograms was used to determine the locations, number of the stones and the echogenicity of the stone was used to categorize the stones as low, intermediate, or high. [5] During the same period, William et al provided some information on individual urinary risk factors responsible for abnormalities. In 2013, the majority of past, present and current work on the GPU accelerated medical image processing. [6]



Fig 1: Breaks down the different steps which need to be accomplished

This present work uses images of kidney obtained from the ultrasound imaging technique for identifying kidney stone in a simple, precise and cost effective way. The main idea is based on the binary conversion using threshold range and the morphological filtration of the ultrasound image. [7,8] The aforementioned process provides information about the location and dimension of the stones in the kidney.

Generally a computer (DELL INSPIRON 4010) and software (LabVIEW 2011, Vision Assistant) to analysis the kidney image is utilized. [9,10] Algorithm is developed in LabVIEW vision assistant for the analysis of multiple ultra sound images. [11,12] The IPT uses prefixed procedures or methods to analyze the ultra sound images. The flowchart is shown in the

Fig.3. The figure discusses the procedures to be followed to process the ultrasound image of the kidney. It includes color plane extraction, Thresholding, Basic morphology, Advance morphology, Particle analysis and Particle area finder.



Fig 2: Typical Ultra sound Image
 a) Normal Kidney b) Calculus

II. MATERIALS & METHODS

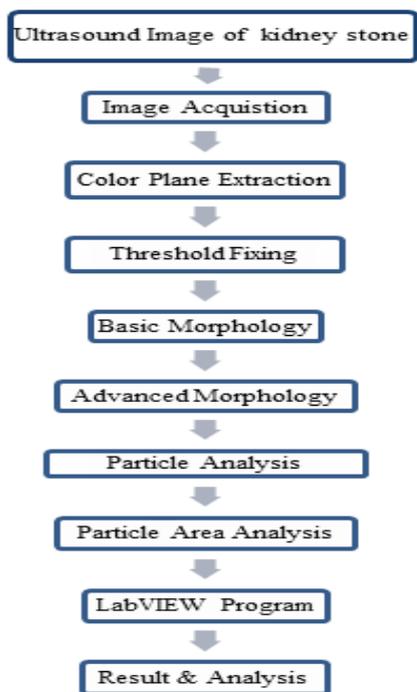


Fig: Kidney stone identification process flow diagram

In color plane extraction, the human visual system can distinguish hundreds of thousands of different color shades and intensities, but only around 100 shades of grey. Therefore, in an image, a great deal of extra information may be contained in the color, and this extra information can then be used to simplify image analysis. In thresholding, the gray-scaled image is converted into binary images thresholding task. Generally, thresholding have three types of process: Manual, Auto, Local. The default value of the thresholding is fixed as 128. Generally, morphology operations change the structure of objects (often called particles) of a (usually binary) image.^[13] In image processing the major concern is appearance of images, which use pixels as their smallest element with certain properties. The shape or structure of an object can be changed if pixels are added to or removed from the border (the area where pixel values change) of the object. Basic morphology have many

operations like erosion, dilation, open, close, proper open, proper close, auto median, thick, thin. Erosion is a function that basically removes (sets the value to 0) pixels from the border of particles or objects. If particles are very small, they may be removed totally. In advance morphology processing has many operations like remove small objects, remove large objects, remove border objects, fill holes, convex hull, skeleton, etc., Particle analysis and Particle area finder technique helps to find the number of particles in an image. This process is used to identify the number of individual stones in the kidney.

III. IMAGE PROCESSING METHODOLOGY

A. Color plane extraction

In the Fig.4, the ultra sound image of kidney is a gray scale image and it contains color shades other than gray also. So it is very essential to extract the color shades in that image. The color plane extraction has many types: RGB (Red, Green, Blue planes extraction), HSL (Saturation, Luminance, Hue), HSI (intensity), HSV (Value), the extraction the color shade from the gray scale using HSL - Luminance is as shown in Fig.4



Fig 3: Color plane extraction- Luminance

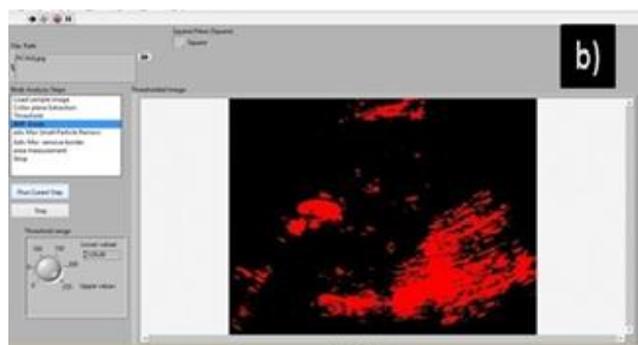


Fig 4: Thresholding – default value 128

B. Thresholding

In the Fig.5 thresholding is applied to convert it as binary image; the gray objects (stone and minerals deposit) in the ultra sound image are of value 1 whereas background of the images is of value 0. Here thresholding is the variable parameter

C. Morphology

In basic morphological erosion of a binary image f by a structuring element s (denoted $f \ominus s$) produces a new binary image $g = f \ominus s$ with ones in all locations (x,y) of a structuring element's origin at which that structuring element s fits the input image f , i.e. $g(x,y) = 1$ if s fits f and 0 otherwise,

repeating for all pixel coordinates (x,y). The erosion operation is performed to remove the particles (discontinuous pixels) bordering the objects of continuous pixels as shown in Fig 5.

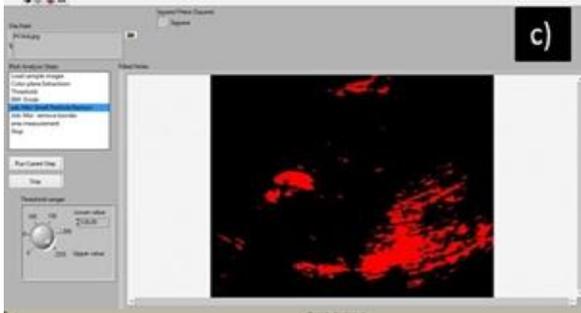


Fig 5: Basic Morphology – Erosion

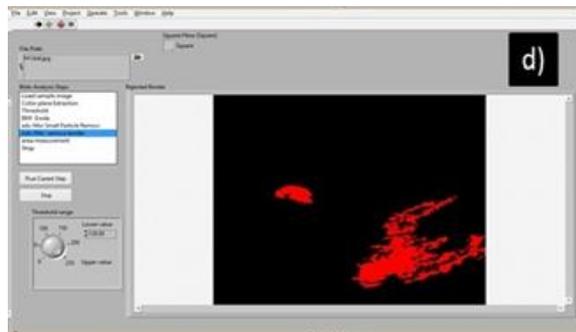


Fig 6: Removal of small object

D. Advance morphology

In the Fig.7 removes small objects operations is performed and in Fig.8 remove border object operation is performed. When advance morphology is done, the entire small object (discontinuous pixels) and pixels bordering the particles are removed. The calculus in image has high intensity when compared to other area in the image. This makes the calculus not to get disappeared when Basic and advance morphology is applied.

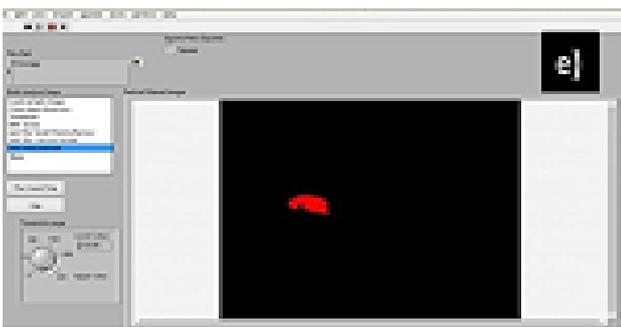


Fig 7: Removal of border object

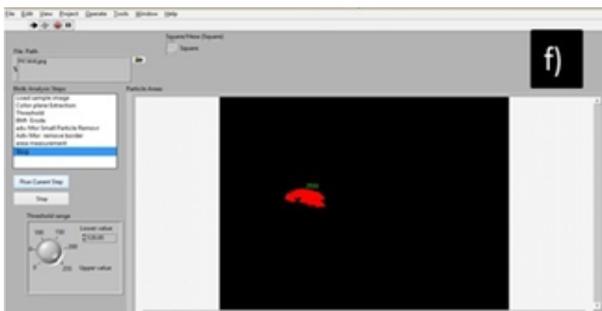


Fig 8: Area analysis

E. Particle finder and area

In Fig.9 Particles in the processed image has been analyzed and using Particle area finder, area of the calculus has been identified and then converted to real word measurement from pixel value. In the Fig.6 erosion operation is performed to remove the particles (discontinuous pixels) bordering the objects in the image. This algorithm can identify the stones from 3mm and above. Less than 3mm is difficult to identify in ultrasound scan and even manually. In block diagram window a case structure program is developed to create a user interface in the front panel window. In each case structure labview image processing block is used.

IV. RESULT AND DISCUSSION

After the program algorithm is executed the ultrasound image is first color plane extracted and then converted to binary image by thresholding and then the sequences of filter operation is performed continuously to get the desired output. As mentioned earlier the thresholding is the variable parameter. The calculus is found with the maximum degree of accuracy and the area of the calculus is also found. In LabVIEW front panel separate window is created to have understandable and easy human interaction. When the Laboratory scanned image is loaded in the file path user can run the program in the front panel itself. The steps involved are clearly explained in the Front panel sections. Fig.11 shows the picture of the identification of location and dimensions of the kidney stone using the image processing technique. The text box in the left side of the front panel shows the program execution has stopped by the case structure and while loop used in the block diagram window. When error message arises user can stop the program by pressing stop in the front panel.

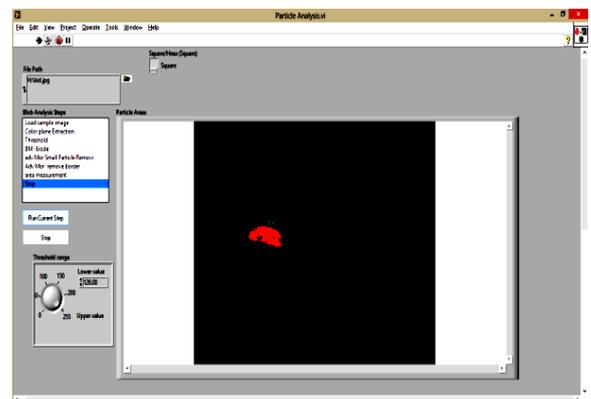


Fig 9: Kidney Stone

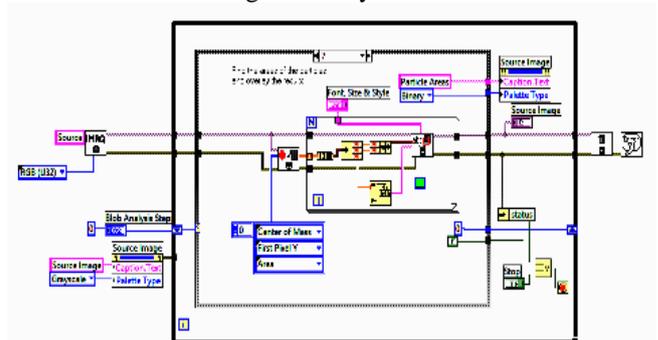


Fig 10: Overall LabVIEW block diagram of identification of kidney stone

A. Discussion

Here in the discussion we have the statistical data. Response time of the proposed image processing algorithm is 8 seconds. Percentage of error reduction when compared to the available image processing techniques like water marking is slightly more. Percentage of error reduction is approximately 0.3%. The cost analysis gives the following data. The estimated cost analysis would be just the operating and System cost. When a LabVIEW program is saved as .exe file it does not need a full version of LabVIEW to run the program. Another advantage of storing the program in .exe is we can run it many times.

V. CONCLUSION

The aim and objectives that were set at the beginning of this project were successfully achieved. By this technique, identification of any type of kidney stones with the maximum speed, accuracy and repeatability for all pixels of ultrasound image of the kidney stones. This project provides the desired output that is identification of exact locations and dimensions of the stones formed in the kidney. In this project, it only identifies length and breadth of the kidney stones. There is no provision to identify the depth of the kidney stone. So the future work would be developing a three dimensional image processing technique for measuring depth also. The final result and analysis can be web published as .html file using web publish tool in LabVIEW. This published file can be viewed in Hot Spot browser in mobile phones and computers.

References

- [1] Andrew N. Primak And Joel G. Fletcher, Non-invasive Differentiation Of Uric Acid Versus Non-Uric Acid Kidney Stones Using Dual-Energy CT. *Journal ACRA*, 2007, 27,1441 -1448
- [2] Anders Eklund and Paul Dufort, Medical image processing on the GPU – Past, present and future, *Journal Elsevier B.V.*, 2013,17, 1073–1094.
- [3] Barnard R.W. and Kellogg C, “Applications of Convolution operators to Problems in univalent function theory”, *Journal Michigan Mach*, 2013, 27,81-94
- [4] JeongYeon Cho and SeungHyup Kim, MD, “Efficacy and Safety of Daily Repeated Sonographically Guided High-Intensity Focused Ultrasound Treatment of Uterine Fibroids”, *Journal Ultrasound Med.*, 2013, 32, 397–406.
- [5] Jiaranai et al, “Automated Expert System for Urolithiasis Classification from Infrared Spectrogram”, *The 10th International PSU Engineering Conference*, 2012, 22-28.
- [6] Oleg A. Sapozhnikov And Neil R. Owen, “Use Of Scattering Of Ultrasound Pulses And Shock Waves By Kidney Stones For Imaging In Lithotripsy”. *Journal of ICSV14*, 2007, 2, 8-16
- [7] William G. Robertson, “Methods for diagnosing the risk factors of stone formation”. *Journal of Arab Association of Urology*, 2007, 67, 250 – 257
- [8] Libor Hargaš, et al, “Tissue Analysis by Virtual Instrumentation”. *Journal of sensors and instrumentation.*, 2007, 75,914-919
- [9] Nagarkar V et al, “Ultrafast multi pinhole single photon emission computed tomography iterative reconstruction using CUDA”. *Journal IEEE Nuclear Science Symposium and Medical Imaging Conference*, 2011, 2558–2559.
- [10] Andersen, A., Kak, A, “Simultaneous algebraic reconstruction technique (SART): a superior implementation of the ART algorithm” *Journal Ultrasonic Imaging*, 1984, 6, 81–94.
- [11] Andersson, M., Wiklund, J., Knutsson, H, “Sequential Filter Trees for Efficient 2D, 3D and 4D Orientation Estimation. Report LiTH-ISY-R-2070”, *Journal Linkoping University, Sweden*, 1998.
- [12] Sharma H, Gupta A, Shekhawat NS, Memon B, Memon MA. Amyand’s hernia, “A report of 18 consecutive patients over a 15-year period”, *Journal Hernia* 2007, 11, 31–35.
- [13] Sanghvi N T, Hawes R H, “High-intensity focused ultrasound”, *GastrointestEndoscClin N Am*1994, 4, 383–395