Classification of Kidney Stone Using GLCM

Dr.Punal M Arabi, Surekha Nigudgi, Rohith N Reddy, Dhatri
Department of Biomedical Engineering, ACSCE, Bangalore-74 arabi.punal@gmail.com, sursanju@gmail.com, rohithnreddy12345@gmail.com, monanatraj10@gmail.com

ABSTRACT : Kidney stone disease is one of the risks for life throughout the world and majority of people with stone formation in kidney at the initial stage do not notice it as disease and it damages the organ slowly. Current estimation is that there are 30 million people suffering by this disease. The currently available widely used low cost imaging techniques for diagnosing kidney diseases include X-ray imaging and Ultrasound imaging. This paper proposes an approach for the classification of different types of Kidney stones using gray level co-occurrence matrix (GLCM) features namely contrast, co-relation, energy and homogeneity. Different types of Kidney stones namely Struvite stones, Stag horn stones and Renal Calculi stones were analyzed and the results obtained show that the proposed GLCM feature analysis method could be used to classify kidney stones. The results obtained further show that there is a possibility of developing CAD and computer aided classification of kidney stones by the proposed texture analysis method.

Keywords – Classification, GLCM, Renal Calculi, Stag horn, Struvite, texture analysis.

I Introduction

Kidney diseases are on rise throughout the world and majority people with kidney disease do not notice the disease as it damages the organ slowly before showing symptoms. The increasing number of patients with kidney diseases leads to a high demand of early detection and prevention of kidney diseases. It is well known that ultrasound (US) can be used as an initial evaluation to estimate kidney size and position, and help to diagnose structural abnormalities as well as presence of cysts and stones. However, diagnosis of kidney diseases and abnormalities using ultrasound demands decision from experts as US images suffer from speckle noise. Speckle has variation of gray level intensities. Therefore, to enhance quality of these images, some image processing techniques are usually applied for better understanding of hidden information as well as for extracting some parameters or features that will be useful for diagnosis of the images. Current estimates are that 30 million (1 in 11) Americans will experience a kidney stone within their lifetime, and up to 50% of new stone formers will have a recurrence, within as early as 5 years . The data suggest the incidence of kidney stones will continue to grow with our increasing obesity and diabetes rate, and even climate change. When dietary minerals in the urine become supersaturated, crystals of Urinary stones are formed. Stones almost always start in the kidneys which may cause problems or may not be noticed until they move into the urethra (the tube that connects each kidney to the urinary bladder). Once stones pass down the urethra into the bladder, they usually then are passed with the urine, but sometimes they can get into the bladder and grow larger there. The most common symptom of kidney stones is pain in upper back. When the pain is severe there is possibility of getting nausea as well. There can be blood in the urine and also a urinary tract infection. Stones are diagnosed with CT scans, X-rays, or ultrasound. A kidney stone may not cause symptoms until they move within your kidney or until it passes into urethra — the tube connecting the kidney and bladder. Severe pain in the side and back, below the ribs pain may spread to lower abdomen and Pain that comes in waves and fluctuates in intensity, Pain on urination, Cloudy or foul-smelling urine, Nausea and vomiting, Persistent need to urinate, Urinating more often than usual Fever and chills if an infection is present.

II Literature Survey

Farid.G.Mitri et.al proposed vibroacoustography technique for imaging and detecting kidney stones within the kidney and also to show the local anatomical features while differentiating stones from surrounding tissue structures [1]. P.R.Tamiselvi et.al developed a semiautomatic region growing algorithm for ultrasound kidney images to detect calculi from renal calculi images [2]. K.Viswanath et.al proposed kidney stone detection from ultrasound images by level set segmentation and ANN classification [3]. K.Bommanna Raja et.al proposed a fuzzy neural system to offer classification efficiency and to identify the category of kidney stones [4]. K.Dhanalakshmi et.al developed and implemented a computer aided decision support system for an automated diagnosis and classification of ultrasound kidney images [5]. Mahdi Marsousi et.al proposed a new automated kidney detection approach using three **dimensionalămorisons‘săpouchăultrasoundăimagesăalongăwithă** a shape based method to segment detected kidneys [6]. K.Divya Krishna et.al presented a computer aided automatic detection of abnormality in kidney on IOT enabled portable ultrasound systems [7].

III METHODOLOGY

In the proposed method, the acquired images undergo a pre-processing stage which is of two folds namely-

1) Image enhancement for removal of blur.
2) Filtering by low pass filter.

Region of interest is then selected. The selected region of interest is an RGB image which is then converted to gray image.

For this work a set of different types of kidney stone images (three images for each set) are taken for experimentation. The images are analyzed using GLCM parameters.

GLCM ANALYSIS

From every image, the stone is cropped which is the region of interest and the GLCM parameters of the cropped portion are then found.

GLCM matrix has been found using the formulae shown below:

Contrastă=ă$\sum_{(i,j)}[i-j]^2$**P(i,j)ă…………………………..(1)**

Correlation = $\sum_{(i,j)} P(i,j) \left[\frac{(i-\mu)(i-\mu)}{\sqrt{(\sigma)2(\sigma)2}}\right]$ ………………..(2)

Energy = $\sum_{(i,j)} P(i,j)^2$ ……………………………..…..(3)

Homogeneityă=ă$\sum$**ă**$_{(i,j)}\frac{P(i,j)2}{[illegible]}$**……………………..….(4)**

Where p=image

i,j=coordinates

p(i.j)=Intensity value at i,j

The average values of all the parameters are found and using these average values the texture analysis is done.

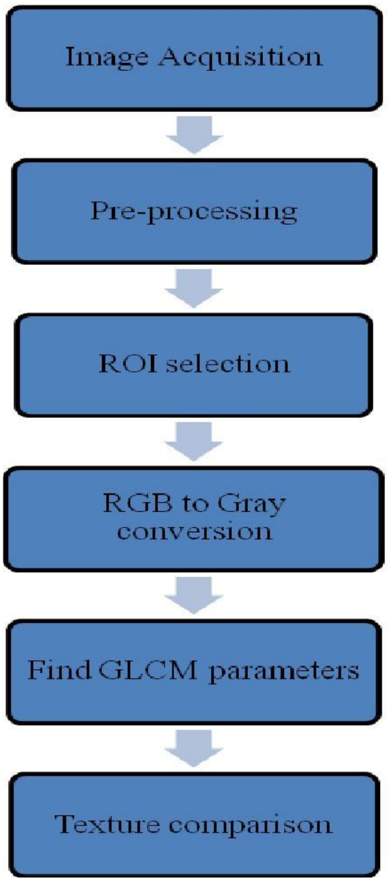

Fig (1) Flow diagram

IV RESULTS

Fig (2) b: Shows the set of Stag horn images

Fig (2) c: Shows the set of Renal Calculi images

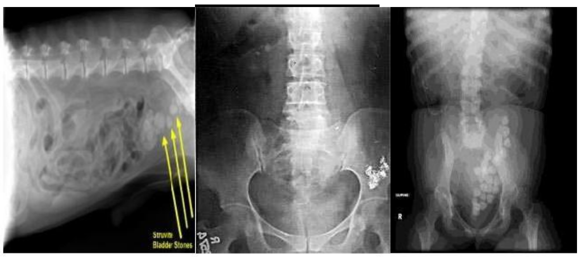

Table1. GLCM parameters for Struvite images

Images	Contrast	correlation	energy	homogeneity
1	383.295	0.0165	5.2177	0.1278
2	421.455	-0.0021	4.3463	0.1225
3	444.461	0.0200	5.4641	0.1190
Average	416.403	0.3314	5.0093	0.1231

Table2. GLCM parameters for Stag horn images

Images	contrast	correlation	energy	homogeneity
1	77.5444	-0.0018	0.0022	0.2197
2	89.8888	-0.0013	0.0019	0.2054
3	98.0452	0.0176	0.0019	0.1969
Average	88.4928	0.0048	0.0020	0.2073

Table3. GLCM parameters for Renal Calculi images

Images	contrast	correlation	energy	homogeneity
1	77.5444	-0.0018	0.0022	0.3665
2	89.8888	-0.0013	0.0019	0.2769
3	98.0452	0.0176	0.0019	0.1782
Average	88.4928	0.0048	0.0020	0.2738

Fig (2) a: Shows a set of Struvite images, Fig (2) b: Shows a set of Stag horn images, Fig (3) c: Shows a set of Renal calculi images, Table(1) GLCM parameters for Struvite images, Table(2) GLCM parameters for Stag horn images, Table(3) GLCM parameters for Renal Calculi images.

IV DISCUSSION

A set of three images of Struvite, Stag horn and Renal Calculi Kidney stone X-ray images taken for analysis by the proposed method. These stone images area first pre processed and the regions of interest are then selected. The selected region of interest is an RGB image which is converted to gray image. The average values of GLCM parameters Contrast, correlation, energy, homogeneity are found and tabulated.

The tabulated results show that the Struvite stones have highest contrast, correlation and energy where as its homogeneity is low; Stag horn stones have medium contrast, homogeneity where as its correlation and energy are low. Renal Calculi stones have highest homogeneity where as the contrast is low. Correlation of Renal Calculi stones is of medium value and their energy is though slightly higher than Stag horn stones but much lower in value compared to Struvite stones.

After analyzing about 50 images the average values can be found and from which reference values be fixed. Based on the reference values a scouring system may be developed for computer aided diagnosis and classification of Kidney stones.

V Conclusion

The results obtained show that the texture features could be used to classify kidney stones. The results obtained further show that there is a possibility of developing CAD and computer aided classification of kidney stones by texture analysis method and framing a suitable decision rule. By analyzing many more images by GLCM and other statistical methods a suitable decision rule can be found in future.

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