Kidney Stone Analysis Using Digital Image Processing

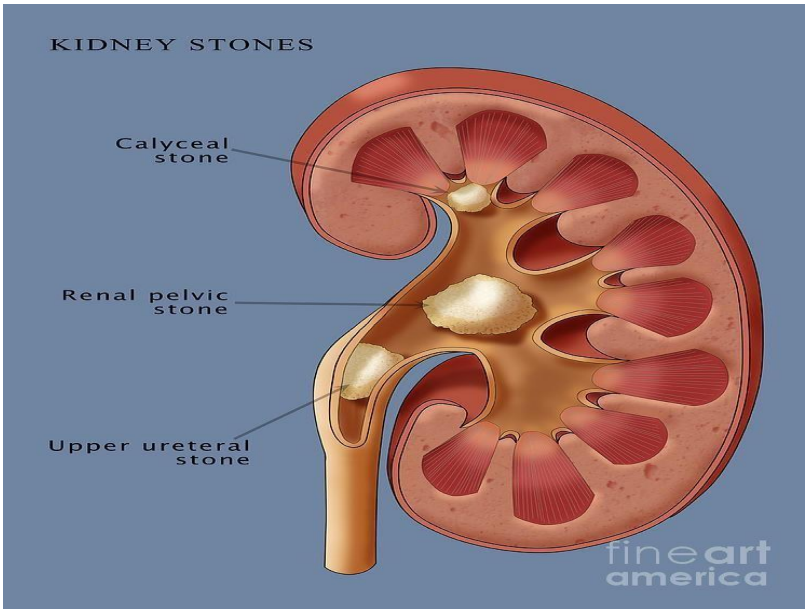
Abstract: Kidney stones are hard collection of salt and minerals often made up of calcium and uric acid. Majority of people with stones in kidney at initial stage do not notice and it damages the organs slowly. It is very important to detect the exact and accurate position of kidney stone for surgical operations. Ultrasound images normally consists of Speckle noise which cannot be removed by mankind.

1.Introduction

Kidney stones are on rise throughout the world and majority of people with kidney stone disease do not notice the disease as it damages the organs slowly before showing symptoms. Kidney is a bean shaped organ and present on each side of the spine. The main function of kidney is to regulate the balance of electrolytes in the blood. Formation of stones in kidneys is due to blockage of urine congenital anomalies, cysts.

Different types of kidney stones namely struvite stones, stag horn stones and renal calculi stones were analyzed. Kidney stone is a solid concretion or crystal formed in kidneys from dietary minerals in urine. In order to get rid of this painful disorder the kidney stone is diagnosed through ultrasound images and then removed through surgical processes like breaking up of stone into smaller pieces, which then pass-through urinary tract. If the size of the stone grows to at least 3 millimeters, then they can block the ureter. This causes a lot of pain mostly in the back lower and it may radiate to groin. Classification of urinary stone is done based upon their location in the kidney (nephrolithiasis), ureter (ureterolithiasis), or bladder (cystolithiasis), or by their chemical composition.

The stone may be present inside minor and major calyces of the kidney or in the ureter. In medical imagining modalities, ultrasonography is used because it is versatile, portable, does not use ionizing radiations and is relatively of low cost. The major disadvantage of ultrasound image is that it consists of poor quality of images that has low contrast and multiplicative speckle noise thus making it a challenging task for detection of kidney stones. speckle noise present in the image degrades its quality which there by affects the interpretation and diagnosis.



The kidney malfunctioning can be life intimidating. Hence early detection of kidney stone is essential. Precise identification of kidney stone is vital in order to ensure surgical operations success. The ultrasound images of kidney comprise speckle noise and are low contrast which makes the identification of kidney abnormalities a difficult task.

2.Aim

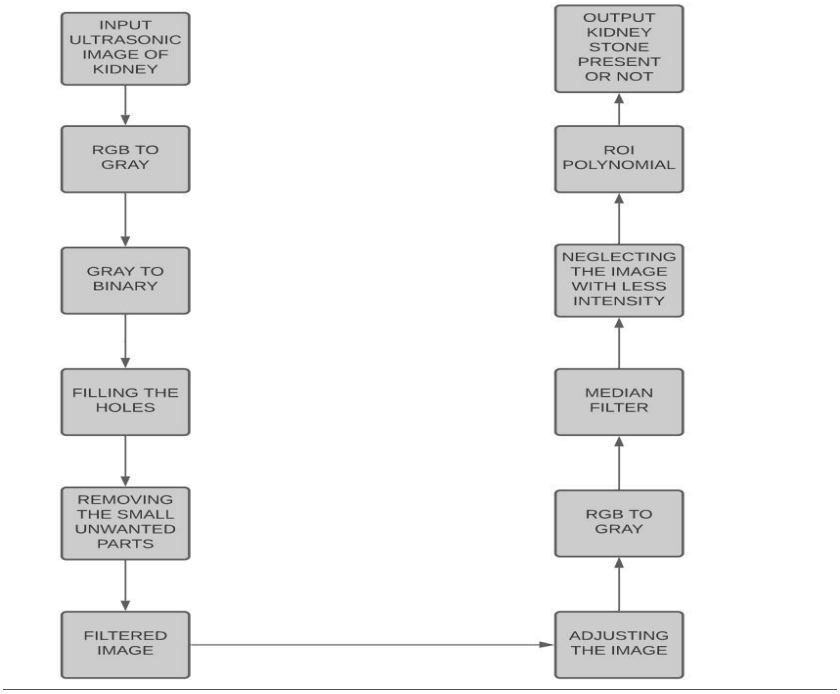
To detect the kidney stones in ultrasound images using median filters to improve the detection rate in terms of accuracy and sensitivity. Materials and Methods: The accuracy and sensitivity of median filter (n=114) was compared with rank filter (n=114). The median filter is used to detect the kidney stone in ultrasound images. 114 is the sample size taken with the p-value 0.8 and has been used to improve detection rate of kidney stones in terms of accuracy and sensitivity using Matlab simulation tool.

3. Materials and Methods

Study setting of proposed work is done in our university. The number of groups identified for the study is 2. The group 1 is median filter and group 2 is rank filter. Matlab 2014a tool kit will be used to write the code and simulate. Using matlab accuracy and sensitivity has been calculated for the required algorithm and then results have been compared. Sample size per group is 114 (Kane, Phar, and BCPS n.d.). Median filter and rank filter are explained below. SPSS software has been used to compare the results and to find the graph. The pre-test analysis has done with p-value with 0.8 (gpower 80%).

4.Steps for detection of kidney stone :

The first step is to collect the ultrasound images and forms a dataset.



Input ultrasonic image of kidney : We take an ultrasonic image from device as the input image.

Original Picture

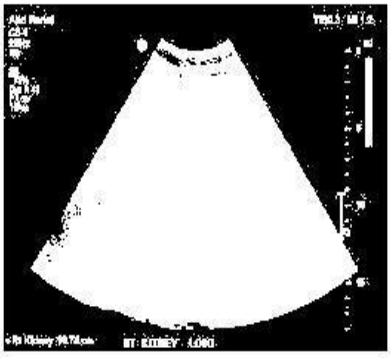
RGB TO GRAY: the aim of rgb to gray filter is an improvement of the image data that suppresses unwanted distortions and enhances some image features. This filter converts the specified true color image RGB to a grayscale intensity

image. The function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

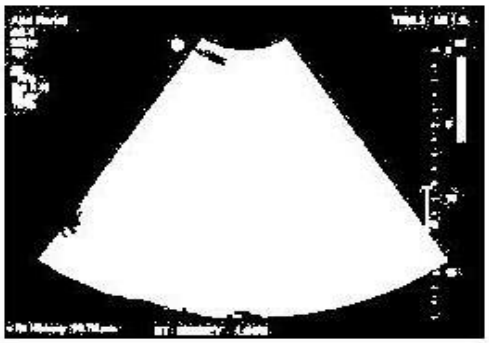
Pixel info: (X, Y) Intensity

GRAY TO BINARY: This filter converts the grayscale image to binary image BW, by replacing all pixels in the input image with luminance greater than level with the value 1 (white) and replacing all other pixels with the value 0 (black).

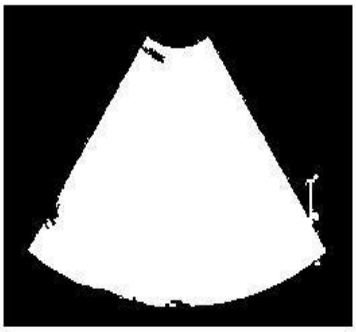
This range is relative to the signal levels possible for the image's class. Therefore, a level value of 0.5 corresponds to an intensity value halfway between the minimum and maximum value of the class.



Filling the holes: performs a flood-fill operation on background pixels of the input binary image BW, starting from the points specified in locations.



Removing the small unwanted part: The function bwareaopen(BW,P) removes all connected components (objects) that have fewer than P pixels from the binary image BW, producing another binary image, BW2. This operation is known as an area opening.



Filtered image: Image preprocessing prepares data for a target workflow. The main goals of medical image preprocessing are to reduce image acquisition artifacts and to standardize images across a data set. Your exact preprocessing requirements depend on the modality and procedure used to acquire data, as well as your target workflow.

Adjusting the image: The function imadjust(I) maps the intensity values in grayscale image I to new values in J. By default, imadjust saturates the bottom 1% and the top 1% of all pixel values. This operation increases the contrast of the output image J.

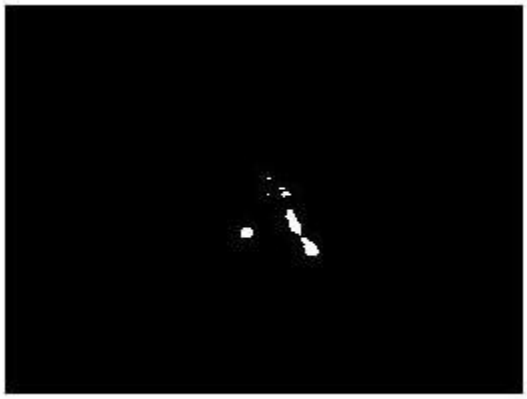
RGB to GRAY : This filter converts the specified true color image RGB to a grayscale intensity image. The function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

Median filter : This function medfilt2(I,[m n]) performs median filtering, where each output pixel contains the median value in the m-byn neighborhood around the corresponding pixel in the input image.

Neglecting the image with less intensity : We use po=mo>250 this function to neglect the less intensity pixels under 250.

ROI Polynomial : Roipoly creates an interactive polygon tool associated with the image displayed in the current figure.

Masking the kidney stone area: We use the bwareaopen function to mask the stone area. The function bwareaopen(BW,P) removes all connected components (objects) that have fewer than P pixels from the binary image BW, producing another binary image, BW2. This operation is known as an area opening.



5. Result

Kidney stone detection using median filter in Matlab simulation tool and the output obtained for stone detection. These results were obtained by simulating the images in Matlab.

6.Conclusion

With the help of present algorithms doctors can look forward to appropriate treatment methods which can result in the removal of stone from kidneys in an appropriate manner.