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Kidney stones detection using Image proccesing technique

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Abstract

The main objective of this project is to detect the kidney stone from the digital ultrasound image of the kidney by performing various image processing techniques. Due to the varied texture and existence of speckle noise, detecting regions of interest in ultrasound pictures is a difficult process. Ultrasound scanning is the most common method of examining a patient for the presence of kidney stones. We created an application that aids the medical practitioner in selecting the region to be evaluated for the presence of stone using the suggested technology. The feature extraction is done on cropped portions that may have stones in them. The KNN classifier is used to categories images based on training data.

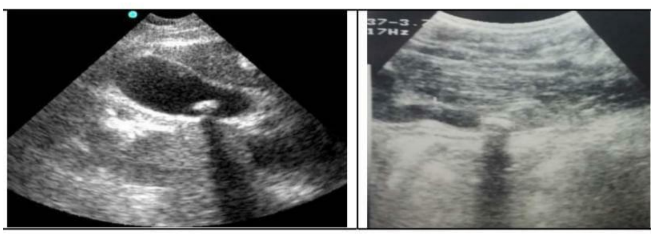
I. INTRODUCTION

The production of crystals in the urine induced by genetic predisposition distinguishes renal calculus, also known as kidney stone formation. Even though many people, including children, are impacted by kidney stones, the vast majority of cases go unnoticed unless there is severe abdominal pain or an irregular urine color. Furthermore, persons with kidney stones exhibit common symptoms such as fever, discomfort, and nausea, which might be mistaken for other illnesses. Kidney stone identification is critical, especially early on, in order to receive adequate medical treatment. The presence of stones in the kidney reduces renal functionality and can potentially cause dilatation[1].

People who have never been diagnosed with this ailment will be affected by the severity of chronic kidney disease (CKD) / chronic renal failure (CRF). Because of its asymptomatic character, it is frequently detected during medical examinations for other diseases such as cardiovascular disease (CVD), diabetes, and other medical problems that predispose to the urogenital apparatus. Days, computer-assisted tools like ultrasound imaging, computed tomography (CT), and X rays gives the most accurate diagnostic tools for kidney stone screening and diagnosis. The main objective of this project is to detect the kidney stone from a digital ultrasound image of the kidney by performing various image processing techniques. But the image produced by the ultrasound techniques is not suitable for further processing due to low contrast and the presence of speckle noise.[2] Hence, the study also examined the effectiveness of various diagnosis techniques on the ultrasound image to enhance the quality of the image. Further, enhanced ultrasound image will be used to locate the exact position of the stone. The main motive of this project was to develop an elementary and straightforward technique to find the stone in the kidney.[3] This detection can be done in any available PC's and hence any normal being can check an ultrasound for a kidney stone and dissolve it in the stone[4].

II. METHODOLOGY

The kidney stone produces an acoustic shadow in the ultrasound image. An acoustic shadow is like a mirage through which the sound waves fail to propagate. In this case, kidney stone is a barrier that disrupts sound waves. Once we detect the shadow, the stone can be located just above it in the image. The ultrasound images contain speckle noise. To process the image and detect the location of the stone in the image, we need to remove the noise. Thus, the first step is to enhance the image by using various sharpening and smoothing filters. After the image is enhanced, image segmentation is used to differentiate between the shadow and the stone by separating the foreground and the background



A. IMAGE ENHANCEMENT:

Image enhancement is a part of preprocessing which is used to **enhance** the **image** which is achieved with power law transformation.

1. he Frequency Domain + Gaussian Filter was the first method we used. We had to split the image into two plains, real plain and complex plain, and then apply the Gaussian Filter to each of them.
2. The second attempt was with Gaussian Blur + Laplacian Filter. We had to apply Gaussian Blur to make Laplacian filter less sensitive to noise.
3. Following up on our research, we discovered that ultrasounds produce speckle noise in several research articles. So, instead of Gaussian Blur, we used Median Blur, which is better for low-level noises like speckle noise, salt and pepper noise, and so on, before applying the Laplacian filter.
4. In application of the Gabor filter, the restored image is enriched with optimal resolution in both domains (as stated in one of the research papers, whose link is given below). 2-D Gabor filter is easy to regulate the direction and frequency bandwidth, and easy to adjust center frequency, so they get the best resolution in both domains.

B. HISTOGRAM EQUALIZATION:

It is a technique is used to adjust image intensities and to increase contrast. This imputes the intensity pixels values for the input image so that the output image will have a uniform intensity distributions and also improves contrast and obtains a uniform histogram. This process leads to an increase in contrast of the shadow of the stone and the stone itself. Thus, it became more visible.

C. IMAGE SEGMENTATION:

It divides an image into discrete zones, each containing pixels with identical characteristics. The zones should be associated with graphical items for easier image analysis and exposition. Meaningful segmentation is the first stage in the transformation into one or more other pictures (grayscale or color) from low-level to high-level image processing explanation in terms of features, objects, and scenarios. By doing so, we were able to separate our stone from the rest of the image. Watersheds are the sort of image segmentation used here. The image is divided into peaks (high intensity) and valleys (low intensity) (low intensity). Water of various hues is poured into the valleys (points of minimum or backdrop) (labels). River from separate valleys, plainly of different colors, will start to blend as the water rises, depending on the neighboring peaks (gradients). To prevent this, we must construct barriers in the area where the water mixes. We also keep filling the reservoir with water until all of the peaks are submerged. Image segmentation is responsible for the barriers that are so produced. The stone's shadow is now separated from it, revealing a clear image of the stone.

D. MARKING

It provides to identify and label a spot within the processing pipeline. Adding a marker to the pipeline will refer to the image being processed at that point. It is also used to location other modules in the pipeline.

III. FEATURES EXTRACTION

The objectives of the feature’s extraction is to capture important characteristics of rigion in kidney images.The features of this are to identify kidney stones region and the space occupied by those stones.The following features are extracted from the GLCM and the ROI kidney images using spyder.

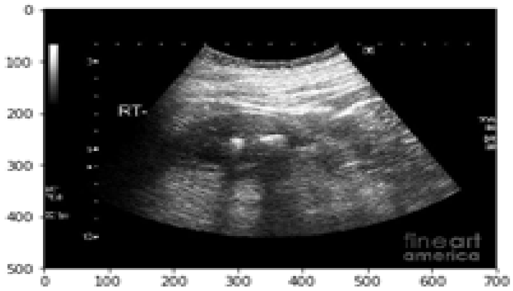
Table 1: Samples of features extracted from ultrasound kidney stones images

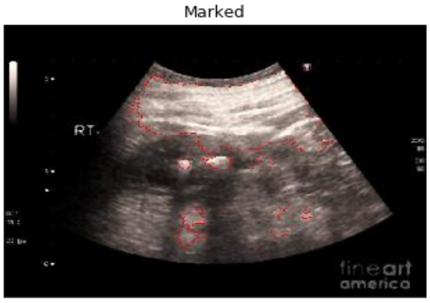
feature	Image1values		image 2 values	
	min	Max	min	max
contrast	0.8842	1.379	0.892	1.229
ASM,energy	0.1902	2.0127	0.276	2.763
entropy	2.374	2.54	1.923	2.403
correlation	0.543	0.712	0.391	4.138

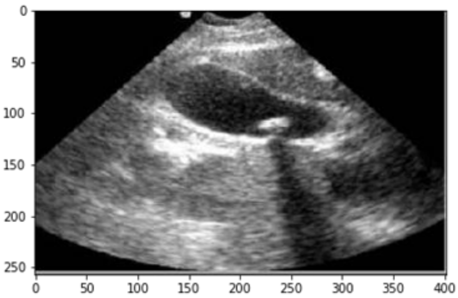
IV. RESULT

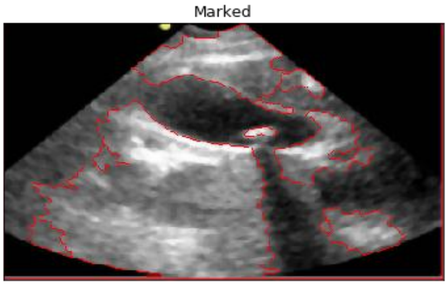
To improve the image's quality, four methods were used: Gabor Filter, Median blur + Laplacian Filter, Gaussian blur + Laplacian Filter, and Gaussian Filtering in Frequency Domain. Out of the 4, we have noticed that Gabor Filter was effective on a larger number of images though not all. Next Median blur + Laplacian Filter and Gaussian blur + Laplacian Filter worked perfectly with other of the few images which are lesser compared to Gabor Filter. Lastly, Gaussian Filtering in Frequency domain, which didn’t work as expected and hence this technique was not employed to enhance any of the other images. We also could generalize the effectiveness of the techniques due to lack of data samples.

Resulting images of ultrasound are given below:









V. CONCLUSION

The effectiveness of various enhancement techniques

Out of the 4 approaches, we conclude that Gabor filter is more effective because For texture analysis, a linear filter is utilized, which examines if the image contains any specific frequency content in specific directions in a localized region around the point or region of examination. Hence due to this, to locate a stone (i.e. we have to locate a region above the shadow formed by the stone) Gabor filter works more efficiently. Whereas in the case of median blur followed by Laplacian filter, it's a nonlinear digital filtering technique, used to remove noise from an image with retaining the edges. Hence it's an effective procedure when there are particulate noises such as salt and pepper. Next Gaussian blur followed by Laplacian filter is used to typically to reduce image noise and reduce detail. As details are also lost hence this technique doesn't give a clear image so it's followed by a Laplacian filter to increase the edges. Lastly, Gaussian in frequency domain failed because the real and imaginary plane were not separated and hence the inverse transformation did not take place properly. We had an image of an ultrasound of a kidney containing a stone. We applied the Gabor Filter for the Image Enhancement followed by Histogram Equalization. The restored image went under Image Segmentation, namely, Watersheds after which Marking was done and the final image was produced. The final image showed a distinct location of the stone in the kidney. Hence the stone was detected.

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