

**AUTOMATED KIDNEY STONE DETECTION SYSTEM**

**A PROJECT REPORT**

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**BONAFIDE CERTIFICATE**

Certified that this project report “**AUTOMATED KIDNEY STONE DETECTION SYSTEM**” is the bona-fide work of **“MD. MAHABUB RAHMAN”** and **“ASMA UL MOWA”** who carried out the Image Processing LAB under my supervision.

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**Abstract**

Renal calculi, another name for **kidney stones**, are crystal-based solid masses. For surgical procedures, it's essential to locate the urinary calculus precisely and accurately. It is necessary to employ automated algorithms in order to detect kidney stones in ultrasound pictures because it is difficult to do so manually due to the speckle noise present in the images. Some mathematical and analytical methods are used to diagnose kidney abnormalities is ultrasound image. Kidney abnormalities can include changes in shape and position as well as swelling in the limbs. Other kidney abnormalities include the development of stones, cysts, blocked urine, congenital anomalies, and cancerous cells. Using the right image processing methods, this problem may be solved. This **Automated** **Kidney Stone Detection System** project is developed an image processing technique to identify kidney stones automatically without human interruption.

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**Abbreviations**

**ROI** **R**egion **O**f **I**nterest

**rgb2gray RGB T**o **Gray**

**IDE** **I**ntegrated **D**evelopment **E**nvironment

**Chapter 1**

**Introduction**

* 1. **Introduction**

In most cases, kidney stone illness goes unnoticed since it progressively affects the organs before symptoms appear, which is why kidney stone disease is on the increase globally. The kidney, an organ with the form of a bean, is located on either side of the spine. The major job of the kidney is to maintain the proper balance of electrolytes in the blood. Kidney stones develop as a result of cysts and congenital defects obstructing urine flow. A variety of kidney stones, including struvite, stag horn, and renal calculi stones, were examined. A kidney stone is a solid crystal or concretion that develops in the kidneys as a result of dietary minerals in urine. The kidney stone is identified using ultrasound scans, and it is then removed by surgical procedures including breaking the stone up into tiny fragments, which are then passed down the urinary tract. The ureter can get blocked if the stone's size increases to at least 3 millimeters. This hurts a lot, mainly in the lower back, and it might spread to the groin. The location of urinary stones in the kidney (nephrolithiasis), ureter (ureterolithiasis), or bladder (cystolithiasis), as well as their chemical make-up, are used to categorize them.

* 1. **Motivation**

Now a days ultrasound scanning is the most common method of examining a patient for the existing of kidney stones. Due to the varied texture and existence of speckle noise, detecting regions of interest in ultrasound pictures is a difficult process. But we think, we can design or develop a system that helps the medical practitioner by selecting the region to be evaluated for the existence of stone without any speckle noise and produce a very high enhance crystal clear image of stone. The main motive of this project is to develop an elementary and straightforward technique to find the stone in the kidney.

* 1. **Aims and Objectives**

The objective of this project is to detect a stone into the kidney using image processing technique by inputting the ultrasound image without human interruption.

1. To detect stone into the kidney.
2. To help the medical practitioner by detecting the stone.
3. To generate a very high enhanced crystal-clear image of stone without any speckle noise.
   1. **Project Scope & Features**

Our project aims at medical process automation. It also helps in current all works relative to Kidney stone detection system.

1. This project is going to be a medical analysis and detection tool, it will be able to detect a stone into the kidney using the ultrasound image.
2. The limitation of this projectis it doesn’t work if the give ultrasound image is 180° or 90° rotated. To overcome this limitation, we are concurrently working on developing better technologies.
3. Be easy to understand by the user or medical practitioner.
4. Be easy to operate.
5. Have a good user interface.
6. Be expandable.
   1. **Project Outline**

This project report will be structured as follows:

**Chapter 2** introduces the Literature Review containing background knowledge and related works in this field.

In **Chapter 3**, we present an overall interpretation of the methodology and design of the project work.

In **Chapter 4**, we discussed about the results and how we implemented the Automated Kidney Stone Detection System.

Finally, **Chapter 5**, we conclude this project report.

**Chapter 2**

**Literature Review**

This section offers a thorough overview of several kidney stone detection methods that have been developed throughout the years utilizing different types of imaging.

It takes time to discover kidney stones in a human body since if done incorrectly, it might endanger life. As a result, several researchers have contributed to the effort to remove or minimize erroneous kidney stone diagnosis by developing effective algorithms. Kidney stone detection may be automated, which can help to decrease or even completely remove manual error. This can aid in a more effective and precise treatment of the issue and ultimately save lives. Consequently, it directly affects society.

Mallala et al. [1] investigated a c-arm tomographic technique in their paper to develop three-dimensional structure of kidney. The result of their experiments showed the ability to develop volume information for kidney stone detection but computerized Tomography (C.T) scans of the kidney have greater exposure to radiations than the regular X-ray radiations, particularly in the people who need repeated scanning and children who have less bones. Therefore, sadhegi et al. [2] discussed the radiographic method, which use x-ray films to diagnose stone faster and more accurately. The result of their paper shows almost 90% of urethral stones as dark and obscure.

Therefore, the disadvantage is that precise and accurate detection is limited. Furthermore, uric acid stones could not be observed and smaller stones are out of the field of view. Hence kidney stone detection is done in an improved method by using Doppler imaging sequence by Cunitz et al. [3]. This paper quotes that ultrasound is much better than computed Tomography (C.T).

Sun et al. [4] designed a rotational sono-probe that could take sonographic images of four equally separated angles with respect to an axis that is fixed and rotating. Calculation of renal volume manually is time consuming and unreliable. Their method is performed by minimizing some energy functions. Therefore, their automated method of calculating renal stone is precise and accurate as compared to that done manually. This three-dimensional analysis is further used by Marsousi et al. [5] to improve kidney stone detection using automated methods. Their method automatically diagnoses and segment kidneys in “three-dimensional abdominal ultrasound images”.

Works of Tsao et al. [6] shows that detection of accurate position of kidney stone is very important for extracorporeal shock waves lithotripsy (ESWL). Since it uses shock waves to focus on renal stone in real time, the miss-hit of shockwave can cause damage or trauma to the tissues. Their research shows that ultrasonic images contain speckle noise which needs to be removed.

Rahman et al. [7] proposed reduction of speckle noise and segmentation of ultrasonic kidney images not only improves kidney stone detection but also enhances the quality of image. Furthermore, Vishwanath et al. [8] extracted some energy levels that give a hint of the presence of kidney stone in a specific location and then their paper applies multilayer perception (MP) and back propagation (BP) to increase the accuracy of type of stone detected to 98.9%.

**Chapter 3**

**Analysis and Implementation**

The ultrasound pictures are gathered in the first stage, which creates a dataset. The next phase is image pre-processing, which comes after gathering the dataset. The ultrasound image is given as an input into the system. After some process, the system will prompt a message. If any stone is found the prompt will be show **“Detected”** otherwise **“Not Detected”**.

**3.1 Proposed System**

My proposed system is an **Automated Kidney Stone Detection System**. The automation of the system reduces the complexity and efforts, improves of the existing voting system, save our time and transportation cost. My proposed system will have the following advantages:

1. User friendly interface.
2. Generate a high enhanced crystal-clear image of stone.
3. Prevent any speckle noise into the ultrasound image.
4. Detecting process is easy and faster.
5. No error in detecting stone.
6. More efficient speed.

**3.2 Methodology**

**3.2.1 Image pre-processing:**

Pre-processing is done to make the picture data better by reducing undesirable distortions and enhancing specific visual attributes. By enhancing or minimizing certain visual elements through the use of filter operations, noise reduction facilitates a quicker and easier assessment of the image. It includes edge filtering, image enhancement, and customized filtering. There is a lot of speckle noise in ultrasound pictures. The ultrasonic picture is distorted when speckle noise is present. This problem results in erroneous stone identification, which might injure kidney tissues during surgery. In order to improve the quality of the image and increase the information of the essential content, de-speckling of noise is a very important stage in the image pre-processing process.

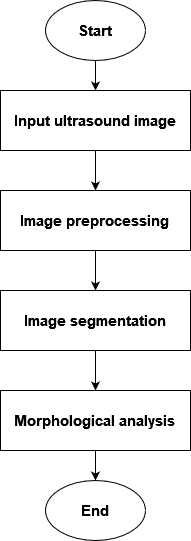
**3.2.2 Image segmentation:**

A digital image is divided into groups of pixels, often referred to as super pixels, in a process called image segmentation. The ROI approach is typically used to identify aberrant regions based on clusters and centroids. The current phase uses a clustering algorithm to divide the input data points into groups based on how far apart they actually are from one another. It is employed to find the area of interest.

**3.2.3 Morphological analysis:**

Changing an object's shape from one form to another is known as morphing. Smoothing the area of interest involves applying morphological techniques. Morphological processes that structure elements based on shapes on the pictures. During processing, it eliminates the pixels unwanted data from the region of interest's border. It comprises erosion and dilution.

Flow chart for steps involved in kidney stone detection,



**Fig 3.1: Flowchart**

**3.2.4 Evaluation parameters:**

An overview of the criteria used to gauge the effectiveness and accuracy of the kidney stone detection algorithm that was developed.

Peak Signal to Noise Ratio (PSNR): It is the ratio of maximum possible value (power) and distortion noise power. It identifies the losses and lossy compression after reconstruction.

Signal to Noise Ratio (SNR): An overview of the criteria used to gauge the effectiveness and accuracy of the kidney stone detection algorithm that was developed.

Mean Square Error (MSE): An overview of the criteria used to gauge the effectiveness and accuracy of the kidney stone detection algorithm that was developed.

Mean Absolute Error (MAE): An overview of the criteria used to gauge the effectiveness and accuracy of the kidney stone detection algorithm that was developed.

By evaluating all the above-mentioned parameters, we are going to find stones present in kidneys.

**Chapter 4**

**Experimental Results and Discussion**

The stage of the project where the theoretical design is translated into a working system is known as implementation. The new system is built, installed, and operated during the implementation phase. The most important aspect in establishing a new successful system is ensuring that it functions efficiently and effectively.

**4.1 Project Implementation**

In this system we use MATLAB for development of project. In this phase a system is built based on the design in the design phase.

**4.2 Implementing System Program**

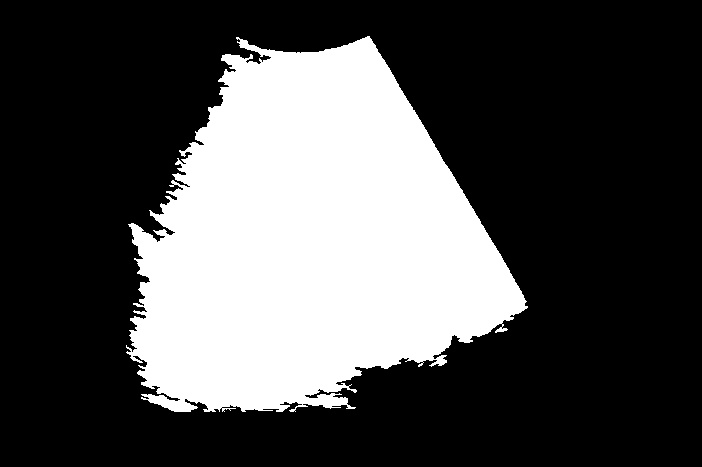
The first step involves converting RGB image to grayscale image. Here in below the grayscale image is shown.

A threshold of 20 is applied to the grayscale image using the ‘>’ operator, resulting in a binary image where pixels above the threshold are set to true (white) and below the threshold are set to false (black)



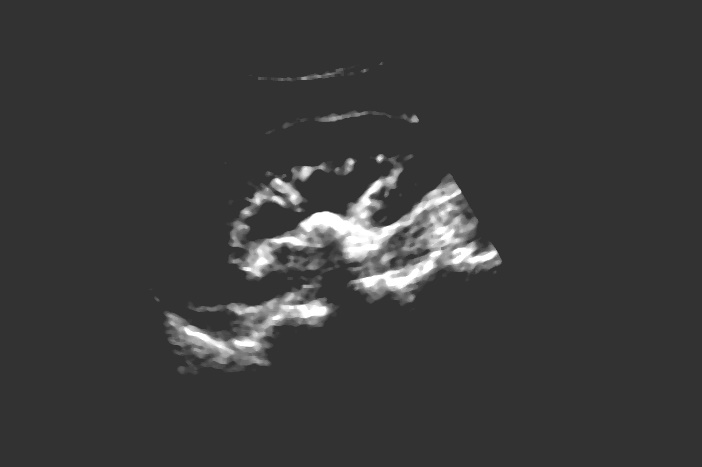
**Fig 4.2: Binary Image**

A function is used to fill holes in the binary image and the result is stored in another variable. The **‘bwareaopen”** function is applied to the filled binary image to remove small objects with the fewer than 1000 pixels.



**Fig 4.3: Filled binary image**

The original image is preprocessed by multiplying each pixel with the binary image using element-wise matrix multiplication and the result is stored in the variable. The **“imadjust”** function is used to adjust the contrast of the preprocessed image. The lower and upper limits of the input image intensities are set to 0.3 and 0.7, respectively, while the output intensity range is left empty. The adjusted image is then increased by 50 to brighten it, and the result is stored in the variable.



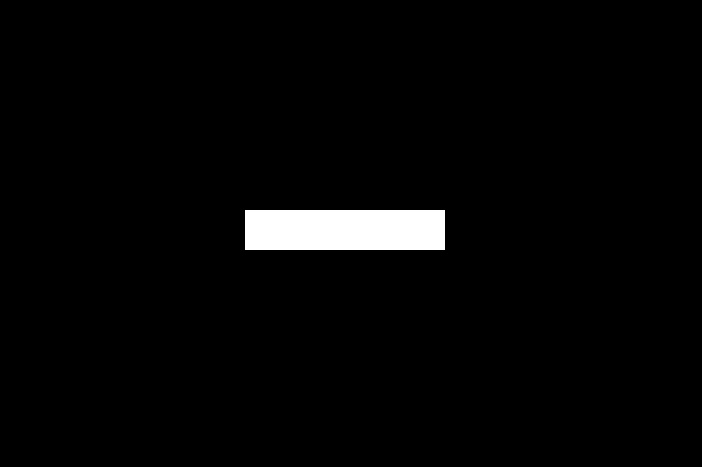
**Fig 4.4: Preprocessed Image**

The **“rgb2gray”** function is applied to the adjusted preprocessed image to convert it to grayscale, and the result is stored in the variable. The **“medfilt2”** function is used to apply median filtering with a 5\*5 neighborhood to the grayscale image and the result is stored into another variable. The median filtered image is displayed using the **“imshow”** function. Here in below given the median filtered image.



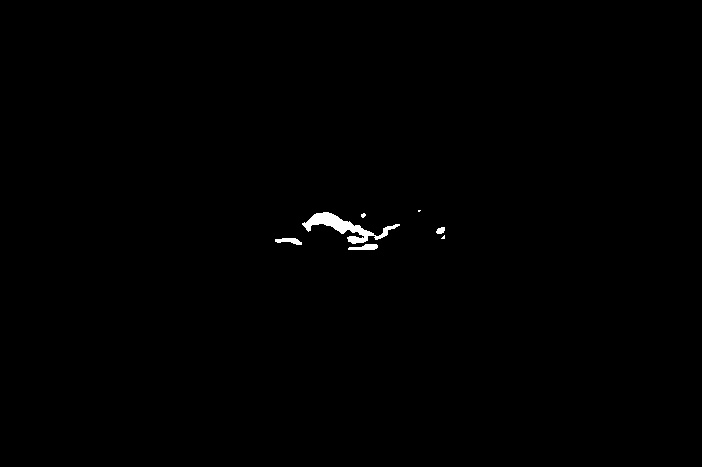
**Fig 4.5: Median Filtered Image**

The **“roipoly”** function is used to create a binary mask “BW” based on a region of interest (ROI) defined by the row and column vertices. In this case, the ROI id defined as a quadrilateral shape using four sets of coordinates. The binary mask “BW” is applied to the binary image using element-wise multiplication.

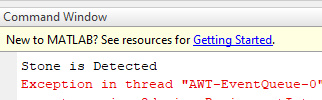


**Fig 4.6: Region of Interest (ROI)**

The **“bwareopen”** function is again applied to the masked image to remove small objects with fewer than 4 pixels. The **“bwlabel”** function is used to label the connected components in the binary image and the number of labeled objects is stored in the variable **“number”.** If **number** is greater than or equal to 1, it means at least one stone is detected. Otherwise, stone is not detected.



**Fig 4.7: The stone**

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**Fig 4.8: Final Output**

**Chapter 5**

**Conclusion**

The proposed methodology of detecting the presence of stones formed in kidneys has been done by pre-processing the ultrasound image followed by its segmentation and finally performing morphological analysis on the resulting image. The resulting image helped in detecting the exact location of stone and further the edge detection method was used to identify the shape and structure of the stones formed. The strategic combination of these three methods proved to be an accurate method that can be used in the process of detection of kidney stone. The accuracy of proposed algorithm is 92.57% which is competent enough as compared to previous algorithms.

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