DESIGN AND ANALYSIS PERFORMANCE OF KIDNEY STONE DETECTION FROM ULTRASOUND IMAGE BY MORPHOLOGICAL SEGMENTATION

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A Project Report
Submitted in partial fulfillment of the
Requirements for the award of the degree of

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in

Electronics and Communication Engineering

by

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DECLARATION

We certify that

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b. The work has not been submitted to any other Institute for any degree or diploma.
c. We have followed the guidelines provided by the Institute in preparing the report.
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Mr. B. Santhosh Kumar	Dr. P. Munaswamy
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Date:

APPROVAL SHEET

This project report entitled **DESIGN AND ANALYSIS PERFORMANCE OF KIDNEY STONE DETECTION FROM ULTRASOUND IMAGE BY MORPHOLOGICAL SEGMENTATION** by **P. Saikiran, CH. Saiteja and B.Shivadeep** is approved for the award of the Degree Bachelor of Technology in Department of **Electronics and Communication Engineering.**

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ABSTRACT

Nowadays, the majority of people suffer from kidney stones. There will be a chance of complications if we are unable to detect the stones in early stages. Sometimes, due to misjudgment, there will be a chance of surgery to remove stones from our kidneys. With the help of image processing, it is easy to detect the stones in the kidney with better results and the exact location of the stones in kidney. To detect the stones in the ultrasound image, it is a difficult task because of the low discrepancy and speckle noise present in the input image. Specific image processing techniques are used to overcome these kinds of challenges. To remove the speckle noise present in the ultrasound image, we will first use the image pre-processing method. The output of pre-processed image is smoothen with the help of different filtering methods. The next step is to detect the stones present in the kidney with image segmentation. Further, the segmented image is reused with morphological segmentation.

Key Words: Kidney stone detection, ultrasound images, Median filter, morphological segmentation.

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MRI	-	Magnetic Resonance Imaging
DIP	-	Digital Imaging Processing
CT	-	Computed Tomography
CAD	-	Computer-Aided Design
MLP	-	Medical Legal Partnership
SVM	-	Support Vector Machine
GLCM	-	Gray Level Co-occurrence Matrix
GLRLM	-	Gray Level Run Length Matrix

CHAPTER 1
INTRODUCTION

1.1 Introduction to kidney stone detection

The process of reusing digital images on a computer is called digital image processing. By using the different algorithms in the computer, we can highlight the key features or get information from the image. On the computer, we can edit the images using digital image processing. Image processing is the subject developed from the signals and systems. The basic purpose of the DIP is to reuse the image in the computer system. To produce the final output image with the desired results, we are going to reuse the computer input, which is digital images.

It is the basic method used in image processing.

1. Importing the image via image accession tools.
2. Assaying and manipulating the image.
3. Affair in which the result can be an altered image or a report which is grounded on assaying that image.

A kidney stone, referred as renal math, because of urine minerals a solid mass formed in the kidneys. Kidney stones are generally removed from the body in the form of urine sluices. Without causing symptoms, a small stone leaves the kidney in the form of urine. The stone conditions remain unnoticed at the initials level, which causes damage to the kidney as they increase in size. The people are suffering from diabetes mellitus, hypertension, and glomerulonephritis, which is caused by kidney failure.

Symptoms kidney stones:

The stones present in your kidney or that move into your ureter will not cause any symptoms for the tube connecting the kidney and bladder. Sometimes you will come across these signs and symptoms.

1. Below the caricatures, severe pain in the side and back.
2. The lower breadbasket and groin will radiate the pain.
3. Because of the pain, there will be swelling and fluctuations in intensity.
4. Urinating will be painful.
5. The colour of urine will be pink, red, or brown.
6. The urine will be foul-smelling or cloudy.

7. You will come across vomits and nausea.
8. The patient needs to urinate.
9. Frequent urination.
10. The infection will be present if you are suffering from a fever.
11. The urination will be in less quantity.

When you change the location of the stone or while it moves to the urinary tract, if you increase the intensity, it will cause pain.

Causes of kidney stones:

In the urinary tract, or kidneys, unwanted minerals are stored, which is why they form stones in the kidney. The stones are removed from the kidneys because they cause discomfort and pain. The causes of kidney stones can vary depending on individual factors, such as diet, hydration, and medical history. Some common causes of kidney stones include dehydration, a diet high in salt, sugar, and animal protein, family history, obesity, certain medical conditions, medications, and urinary tract blockages. However, it's essential to understand that not everyone who has one or more of these risk factors will develop kidney stones, and some people may develop them without any known risk factors. Understanding the underlying causes of kidney stones can help individuals take preventative measures and seek medical attention if necessary.

1.2 Types of kidney stones

1.Calcium stones:

In the various kidney stones, the most common one is a calcium stone, accounting for around 80% of all cases. These stones are formed from a combination of calcium and oxalate, a natural substance found in many foods. In people with a genetic predisposition to calcium stones, the kidneys may excrete too much calcium into the urine, which can combine with oxalate to form stones. Because of the unhealthy food habits, there are high chances of calcium stones forming. The formation of calcium stones also increases because of food items like sugar, animal protein, and sodium.

Calcium stones are also formed because of dehydration. When the urine becomes more concentrated, this is a symptom of dehydration in the body, which eventually leads to the formation of calcium stones in the kidney. Additionally, certain medical conditions, such as hyperparathyroidism, can cause calcium levels in the urine to increase, leading to the formation of stones. The location and size of kidney stones vary, which also leads to different kinds of symptoms.

Sometimes you experience no symptoms in your body because smaller stones easily pass through the urinary tract. However, larger stones will create problems for your health conditions, and the symptoms include blood in the urine, pain in the lower abdomen, vomiting, and nausea. Treatment for calcium stones may include medication to help break up the stones or surgery to remove them. In some cases, dietary changes and increased hydration may be enough to prevent future stone formation. If you suspect that you may have calcium stones or are at risk for developing them, it's essential to talk to your doctor about preventative measures and treatment options.

2.Struvite stones:

Struvite stones, also known as infection stones, are a type of kidney stone that is formed in the presence of an infection in the urinary tract. The stones become large if we do not treat them at an early stage, and they are composed of ammonium, phosphate, and magnesium. Struvite stones typically form when bacteria in the urinary tract produce urease, ammonia and carbon dioxide are obtained from the urea. The ammonia raises the pH of the urine, which creates an environment that is conducive to the formation of struvite crystals. As the crystals grow and combine, they can form large stones that can cause pain and discomfort.

Women are more likely than men to develop struvite stones, and people with a history of recurrent urinary tract infections are also at increased risk. Other risk factors for struvite stones include underlying medical conditions such as kidney or bladder infections, urinary tract abnormalities, or a history of urinary tract surgeries. Symptoms of struvite stones can include pain in the back or side, fever, chills, and frequent urination. In severe cases, struvite stones can cause a blockage in the urinary tract, which can lead to kidney damage and other complications.

Treatment for struvite stones typically involves antibiotics to treat the underlying infection and surgery to remove the stones. After the stones are removed, a patient may need to take steps to prevent future stone formation, such as staying well-hydrated and taking antibiotics to prevent recurrent infections. It's important to talk to a doctor if you suspect you have struvite stones or are at risk for developing them.

3.Uric acid stones:

Uric acid stones are formed from the buildup of uric acid in the urine. Sometimes the kidneys will excrete the unwanted material, known as uric acid. The crystals are formed when the kidneys excrete too much uric acid, which leads to the formation of kidney stones. They often occur in people with a history of gout, a condition characterized by high levels of uric acid in the blood. Other risk factors for uric acid stones include dehydration, a diet high in purines (found in foods like red meat, organ meats, and shellfish), and certain medical conditions, such as metabolic disorders or chemotherapy.

Symptoms of uric acid stones can include pain in the back or side, frequent urination, and blood in the urine. Uric acid stones may be smaller than other types of kidney stones, making them easier to pass through the urinary tract, but they can also be very painful. Treatment for uric acid stones may involve medication to help dissolve the stones, such as allopurinol or potassium citrate. Drinking plenty of fluids and making dietary changes, such as reducing the intake of purine-rich foods, can also help prevent the formation of uric acid stones. In some cases, surgery or other medical procedures may be necessary to remove the stones.

4. Cystine stones:

Because of the inherited disorder cystine stones are formed in kidney and it is called cystinuria. Cystinuria is a genetic condition that affects the way the body processes certain amino acids, leading to an excess buildup of cystine in the urine. Over time, the excess cystine can form crystals that grow into stones. Other risk factors for cystine stones include a diet high in protein, dehydration, and certain medical conditions, such as inflammatory bowel disease.

Symptoms of cystine stones can involve pain in the back or side, frequent urination, and blood in the urine. Cystine stones can be larger than other types of kidney stones and may require medical intervention to remove.

Treatment for cystine stones typically involves a combination of medication and lifestyle changes. Medications like alpha-mercaptopropionyl glycine (MPG) or tiopronin can help reduce the levels of cystine in the urine and prevent stone formation. Drinking plenty of fluids and making dietary changes, such as reducing the intake of high-protein foods, can also help prevent the formation of cystine stones.

1.3 Types of kidney stone detection

These may include:

1.Blood testing:

Blood testing is not typically used as a primary method for detecting kidney stones, as imaging tests like CT scans and ultrasounds are generally more effective. However, blood testing can provide valuable information about the underlying causes of kidney stones and help guide treatment decisions. One blood test that may be used in the diagnosis and management of kidney stones is a serum creatinine test. The waste product produced by muscles in the blood is used to identify the risk of creatinine.

High levels of creatinine can indicate kidney damage or impairment, which may be caused by a large or obstructive kidney stone. Another blood test that may be used to evaluate kidney stone risk is a uric acid test. Uric acid stones are formed when the uric acid found in the blood, so measuring uric acid levels can help identify individuals who are at risk for developing these types of stones. In addition, blood tests can be used to observe the correctness of treatments for kidney stones. For example, if a patient is taking medication to dissolve a kidney stone, regular blood tests can be used to monitor changes in creatinine levels and ensure that the medication is not causing further kidney damage.

2. Urine testing:

Urine testing is an important tool in the diagnosis and management of kidney stones. Urine testing can provide valuable information about the composition of kidney stones, as well as the underlying causes of stone formation. One type of urine test commonly used in the diagnosis of kidney stones is a urinalysis. This test involves examining a sample of urine for the presence of red blood cells, white blood cells, and other substances that may indicate the presence of a kidney stone.

A urinalysis can also help identify other underlying conditions that may contribute to stone formation, such as urinary tract infections or metabolic disorders.Another type of urine test that may be used in the diagnosis of kidney stones is a 24-hour urine collection. In the 24-hour period, urine is collected, and after analyzing it, we observe that substances like uric acid and calcium are present in the urine, which leads to the formation of kidney stones. We can classify the people who are in danger of the formation of stones in their kidneys with the help of 24-hour urine collection and guide treatment decisions. In addition, urine testing can be used to observe the correctness of treatments for kidney stones. For example, if a patient is taking medication to dissolve a kidney stone, regular urine testing can be used to monitor changes in stone composition and ensure that the medication is effective.

3.Imaging:

The stones present in urinary tract identified by using imaging tests. Simple abdominal X-rays, which can miss small stones, are one option, while high-speed or binary energy computerised tomography (CT) may reveal bitty stones.

1.4 Medical imaging techniques

1.X-rays:

X-rays are used to take images of the inside of the body, which is one of the medical imaging techniques. To take a picture of part of your body, we are going to use some amount of ionizing radiation that is exposed to our body. The image produced can help diagnose and treat a wide range of medical abnormalities. Traditional X-ray imaging, also known as radiography, is used to create two-dimensional images of bones, teeth, and internal organs. This type of imaging is commonly used to diagnose fractures, dislocations, dental issues, and lung conditions. The process is quick and painless, and the patient is usually not required to prepare in any way.

To obtain real-time images of the body, we use fluoroscopy, which is one of the techniques that uses X-rays. The images of body parts that should be analysed are projected onto a monitor when the continuous X-ray beam is passed through the body. This process is observed during fluoroscopy. This technique is commonly used during medical procedures such as angiography, which involves imaging the blood vessels, and endoscopy, which involves imaging the digestive system.

While X-ray imaging has many benefits, but in young adults and children, we believe they are infected with cancer when they are exposed to ionizing radiation. As such, doctors must carefully weigh the risks and benefits of X-ray imaging before recommending it to their patients. It is also worth noting that modern X-ray machines are designed to minimize the amount of radiation exposure to the patient while still producing high-quality images.

2.Computed tomography (CT):

Computed tomography (CT) is a medical imaging technique that uses X-rays to create a detailed, three-dimensional image of the body. It is a powerful diagnostic tool that provides more detailed images than traditional X-ray imaging. The x-rays are emitted from the circular machine when the patient moves through it; this process is known as a CT scan. These circular machines take multiple images from different angles by moving around the patient's body. Next, we are going to examine the 3-D image body part that was processed by the computer.

CT scans are one of the major diagnostic techniques used to detect heart disease and cancer. They can give us informative images of bones, soft tissues, and blood vessels, making it an effective tool for detecting and monitoring tumors, fractures, and other abnormalities. In biopsies and surgeries, CT scans play a pivotal role in medical operations. The region of interest of images being treated, doctors can more accurately locate the area of concern and perform the procedure with greater precision.

In recent years, images with high quality are obtained with the help of lower dose CT scans which also provide the less radiation exposure on the body. Because of the advancements in technology CT scans are reduced the radiation exposure while still allowing doctors to make accurate diagnoses. Overall, CT scans are an important tool in modern medicine. They provide detailed images of the body that can help diagnose and monitor a wide range of medical conditions. However, the risks of radiation exposure must be carefully considered before undergoing a CT scan.

3.Magnetic resonance imaging (MRI):

Magnetic Resonance Imaging (MRI) is used to produce informative images of body parts with the help of radio waves, a magnetic field, and computer technology. The MRI is a powerful tool that can produce images of organs, soft tissues, and bones with exceptional clarity and detail. A strong magnet is placed in the large tube-like machine, and the patient who lies on the table will move through it during the entire MRI scan. In the above process itself, we are going to develop 3D images of body parts. The protons align in the body tissues with the help of a magnetic field, which is obtained by the magnet present in the MRI scan machine. The sensors are used in the machine to grab the signals that are emitted by the protons when they send radio waves through the body. Generally, signals contain information about the image, and 3D images are generated when computers process these signals.

While MRI scans are a powerful diagnostic tool, they do have some limitations. Additionally, MRI scans cannot be performed on patients with certain medical conditions, such as severe kidney disease. In recent years, advancements in MRI technology have led to the development of faster and more powerful machines, as well as new types of MRI scans that can provide even more detailed images of the body. These advancements have made MRI an increasingly important tool in modern medicine.

4.Ultrasound:

The generation of body part images happens when high-frequency sound waves are sent through the body; this process is also known as an ultrasound image. The ultrasound imaging technique is one of the safest methods because it does not have any side effects, and your medical condition will be absolutely fine. These methods are also used in many major areas, such as observing the growth of a baby during pregnancy, and also play a crucial role in identifying the abnormalities that will happen to the body parts. In the ultrasound test, a transducer is placed over the skin, and the physician observes the patient's medical conditions through the computer. To produce the images from the computer, we should send high-frequency sound waves that hit the body, and here we observe the pattern of echoes that are grabbed by the transducer. However, the ultrasound technique is safe, but somehow there is a rare risk attached to this technique.

In rare cases, the high-frequency sound waves can cause tissue damage, particularly in developing fetuses. Additionally, ultrasound may not be able to provide detailed images of certain parts of the body, such as bones and air-filled organs. While ultrasound is a powerful method in modern medicine that provides a safe and non-invasive way to diagnose and monitor a wide range of medical conditions. Its versatility and accessibility make it an important imaging technique in many medical settings.

5.Bone scan:

The images of the bones are produced when the radioactive material passes into your body; this process is known as a bone scan. The bone scan technique is the most widely used to treat people who are suffering from bone-related health issues such as infections, cancer, and fractures. The next step of the bone scan technique moves towards the bloodstream; we are going to inject the radioactive substance, also known as a radiotracer. The radiation is emitted by the radiotracer when it is absorbed by the bones, and it is detected by the special camera. The informative images are generated when they are processed by the computer.

Bone scans are particularly useful for detecting changes in the bones that may be indicative of disease or injury. They can be used to detect bone cancer, monitor the progression of osteoporosis, and identify fractures that may not be visible on X-rays. Bone scans are generally safe and non-invasive, and the amount of radiation exposure is typically low. However, they are not recommended for pregnant women, as the radiation may be harmful to the developing fetus.

CHAPTER 2
LITERATURE SURVEY

2.1 Level set segmentation

Viswanath and Dr. R. Gunasundari (2015) used level-set segmentation for the identification of kidney abnormalities similar to the conformation of stones, excrescences, blockages of urine, natural anomalies, and cancerous cells. At the time of medical operations, it's vital to determine the exact and precise position of the stone. Because of the patchy noise and low discrepancy, it is difficult to identify the kidney stone in the ultrasound image. Specific image processing methods are used to overcome these types of challenges. The image restoration process is used to get rid of the patch noise present in the ultrasound image by using image pre-processing. The Gabor filter is used to smooth the restored image, and the histogram equalisation is used to enhance the posterior image. The pre-processed image is obtained with level-set segmentation to delineate the kidney stone region.

To obtain the desired output the segmentation processes is applied at two levels. Once it is applied at stone region and another time is applied at Kidney region. The level set segmentation uses two words, videlicet, instigation, and flexible propagation (R mount), to describe the stone region. Following segmentation, the uprooted region of the kidney stone is given to the lifting scheme sea sub-bands of Symlets, Biorthogonal, and Daubechies to prize energy situations. When compared to normal energy situations, these energy levels substantiate the presence of a stone.

2.2 Seeded region growing based segmentation

P.R. Tamilselvi and P.Thangaraj (2011) proposed an ultrasound kidney image opinion scheme for stones based on increased quality of seeded regions, growing grounded segmentation, and bracketing of kidney images with stone sizes. From the image we can detect the early stone phases by adjusting the intensity threshold in region of interest. By these we can also classify different stages of the stones. Based on image quality characteristics, the enhanced robotic Seeded Region Growing (SRG) grounded image segmentation procedure for same regions uproots structures with bounds comparable to patch size.

The intensity threshold variation created from the image's segmented pieces, as well as the size of the portions in contrast to conventional stone sizes, influence the opinion process. A clinical laboratory trial of colorful ultrasound kidney picture samples is utilized to assess the parameters of texture values, intensity threshold variation, and stone sizes. To estimate the size and position of kidney stones, we use texture uprooted from the segmented portion of the kidney images, which wasn't done in the earlier studies. To conform to the early stage of stones, we are going to integrate improved SRG and mechanisms, as well as the presence and absence of stones in the kidney.

2.3 Entropy based segmentation

A kidney stone detection paper was published by Jyoti Verma, Madhawendra Nath, KK Saini, and Priyanshu Tripati (2017). There are some colourful issues with this content, such as the image's low resolution and the stone's similarity to the kidney's new image. Ultrasound images have a low degree of variation and are delicate in describing and valuing the region of interest. Thus, the next step will be image pre-processing, which typically contains image improvement. The purpose of this method is to identify the distinctive quality of the kidney to make identification easier.

To un-sharp mask the image, we are going to use the gaussian filter and median filter. In the morphological operations first we use the dilation and followed by the erosion. To classify regions of interest, we employ entropy-based grounded segmentation. The SVM and KNN methods are used to determine the stones present in the image.

2.4 Computer aided detection

The paper "Computer-aided detection of kidney stones in CT images using morphological segmentation and support vector machine" proposes a CAD system for kidney stone detection using morphological segmentation and support vector machine (SVM) classification. According to the scientists, the typical approach for finding kidney stones is manual segmentation, which takes time and is prone to mistakes. As a result, an automated approach for detecting kidney stones is required. Pre-processing, morphological segmentation, and feature extraction and classification are the three primary processes of the proposed CAD system.

The CT images are pre-processed in the pre-processing stage to reduce noise and improve contrast. The kidney stones are segmented utilising morphological procedures such as erosion, dilation, opening, and closure during the morphological segmentation process. Features such as area, perimeter, compactness, and eccentricity are retrieved in the feature extraction and classification stage, and SVM classification is utilised to categorise the stones as kidney stones or non-stones. The authors tested their CAD system on a collection of 150 CT scans labelled manually by a radiologist. They compared their results to those obtained using a deep learning-based system and found that their method was 94.91% accurate in identifying kidney stones. The authors also performed a sensitivity study to assess the resilience of their CAD system to changes in the morphological segmentation step parameters.

Finally, the CAD system proposed by Akhand is a promising approach for detecting kidney stones utilising morphological segmentation and SVM classification. However, the suggested approach's accuracy is somewhat lower than that of the deep learning-based method utilised for comparison. More study is required to compare the suggested technique to other deep learning-based methods and to assess its efficacy on a bigger data set.

2.5 KNN classification

The paper titled "Kidney stone detection using morphological segmentation and feature extraction" by Khedkar and Dhabe proposes a method for kidney stone detection using morphological segmentation and feature extraction. According to the scientists, manual segmentation of kidney stones in CT images is time-consuming and prone to mistakes, hence an automated technique for kidney stone identification is required. Pre-processing, morphological segmentation, and feature extraction and classification are the three primary processes in their suggested technique.

The CT images are pre-processed in the pre-processing stage to reduce noise and improve contrast. The kidney stones are segmented utilising morphological procedures such as erosion, dilation, opening, and closure during the morphological segmentation process. Features such as area, perimeter, compactness, and eccentricity are retrieved in the feature extraction and classification stage, and k-nearest neighbour (KNN) classification is utilised to categorise the stones as kidney stones or non-stones. The researchers tested their approach on a batch of 25 CT scans that had been manually labelled by a radiologist.

Using their proposed strategy, they attained an accuracy of 92% in identifying kidney stones. The authors also compared their suggested technique to two existing methods based on texture analysis and contourlet transform, and discovered that it outperformed these methods. Finally, the approach described by Khedkar and Dhabe is a promising method for detecting kidney stones utilising morphological segmentation and feature extraction. However, the assessment was performed on a limited data set, and more study is required to test the suggested method's effectiveness on a bigger data set and compare it to other approaches, including deep learning-based methods.

2.6 Multilayer perceptron neural network.

The paper titled "Kidney stone detection using morphological segmentation and multilayer perceptron neural network" by Gharehchopogh et al. proposes a method for automated detection of kidney stones in CT images. The authors use a combination of morphological segmentation and multilayer perceptron (MLP) neural network classification to detect the presence of kidney stones. The manual segmentation of kidney stones in CT images is time-consuming and error-prone, hence an automated approach for kidney stone identification is required. The suggested technique is divided into two steps: morphological segmentation and MLP neural network classification.

The kidney stones are segmented utilising morphological procedures such as erosion, dilation, opening, and closure during the morphological segmentation process. The segmented areas are sent into an MLP neural network for categorization as kidney stones or non-stones in the MLP neural network classification stage. The MLP network contains three layers: an input layer, a hidden layer, and an output layer.The authors test their suggested approach using a dataset of 120 CT scans labelled manually by a radiologist. Using their proposed approach, they identify kidney stones with an accuracy of 94.2%. The authors compare their technique to another morphological segmentation and fuzzy logic-based method and discover that their suggested method beats the other method. The proposed method for detecting kidney stones in CT images is promising. This study, however, has drawbacks. The dataset employed was tiny, and more research is needed to validate the approach on bigger datasets.

The authors advise that future research should focus on evaluating the approach on other forms of kidney stones and developing a larger dataset. Furthermore, it would be interesting to compare the suggested strategy to deep learning-based methods to discover how these approaches compare.

2.7 Morphological segmentation and texture analysis

The paper titled "Kidney stone detection using morphological segmentation and texture analysis" by Harikumar proposes a method for kidney stone detection using morphological segmentation and texture analysis. According to the scientists, manual segmentation of kidney stones in CT images is time-consuming and prone to mistakes, hence an automated technique for kidney stone identification is needed. Pre-processing, morphological segmentation, and texture analysis are the three primary processes in their suggested technique.

The CT images are pre-processed in the pre-processing stage to reduce noise and improve contrast. The kidney stones are segmented utilising morphological procedures such as erosion, dilation, opening, and closure during the morphological segmentation process. Using the gray-level co-occurrence matrix (GLCM) and gray-level run-length matrix (GLRLM), characteristics such as energy, entropy, contrast, and homogeneity are recovered from the segmented areas during the texture analysis process. The researchers tested their approach on a batch of 20 CT scans that had been manually labelled by a radiologist. Using their proposed approach, they attained an accuracy of 90% in identifying kidney stones. The authors also compared their suggested technique to another method based on thresholding and region growth, and discovered that it outperformed this method.

In conclusion, Harikumar suggested approach for kidney stone identification utilizing morphological segmentation and texture analysis is a promising strategy. However, the assessment was performed on a limited data set, and more study is required to test the suggested method's effectiveness on a bigger data set and compare it to other approaches, including deep learning-based methods.

2.8 Problem statement

A malfunctioning kidney can be fatal. By using image processing techniques, we are going to detect the early stones in the kidney. Firstly, an ultrasound image is taken as an input, and kidney stones are identified from it.

The disturbance present in the ultrasound image is called speckle noise. We smooth the image with a filter, and morphological segmentation is used for precise kidney stone identification results.

2.9 Existing system

In the existing system, they have used the Gabor filter and level-set segmentation to detect the stone in the kidney. Because of the continuous construction of the appropriate velocities for the advancement of the level set function, sometimes it is difficult to provide continuous operation for the system. Sometimes, the accuracy may reduce because more data is available for analysis to get the results.

CHAPTER 3

METHODOLOGY

3.1 Block diagram

Median filter is used to remove the speckle noise from the Ultra Sound Image. Rank filter algorithm is use to detect the stone in the kidney.

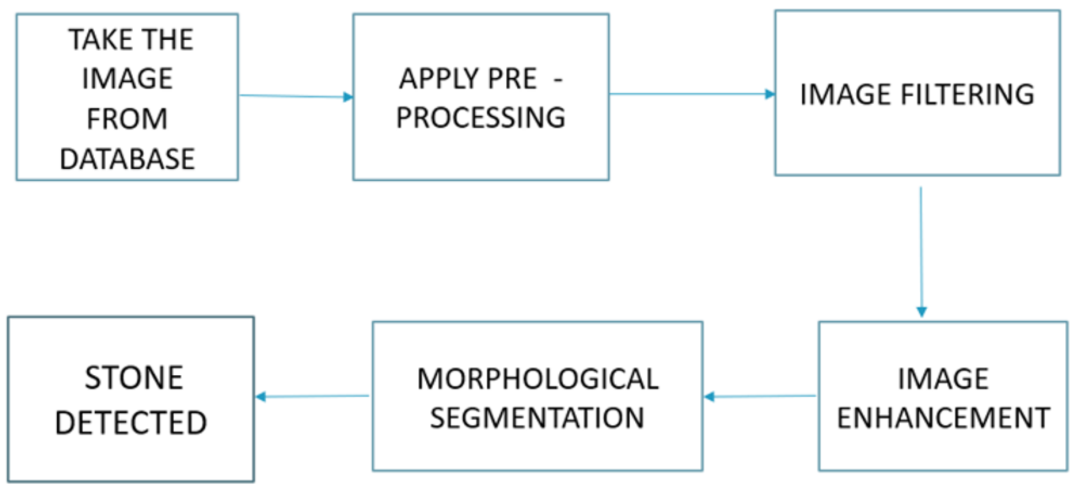

Fig:3.1 Block diagram for kidney stone detection

3.2 Image pre-processing

Image pre-processing is an important step in kidney stone detection, which involves manipulating raw medical images to improve the quality and usability of the image. Kidney stones are a common condition that affects millions of people worldwide and can cause severe pain and discomfort. Medical imaging, such as X-rays or CT scans, are commonly used to detect and diagnose kidney stones. Image pre-processing plays a crucial role in kidney stone detection, as it can help to improve the accuracy and efficiency of subsequent analysis or processing. The process of image pre-processing for kidney stone detection includes several stages, such as image cleaning, enhancement, feature extraction, and segmentation.

In the image cleaning stage, the medical image is cleaned to remove any noise or artifacts that may affect the accuracy of the subsequent analysis. Techniques such as median filtering, morphological filtering, or noise reduction may be used to remove noise or unwanted information from the image.

There are few pre-processing requirements because the ultrasound is composed of speckle noise and has a low discrepancy. Image restoration, smoothing, and sharpening are methods used in image pre-processing to improve the quality of the image. The smallest position of abstraction for both output and input intensity images is extracted by the common name image pre-processing. The information collected from the detector represents the intensity of the image with respect to that pixel value. These pixel values are represented in a form matrix, and they are also known as the brightness of that image.

After the image pre-processing, the next step is image enhancement, where the visual quality of the medical image is improved by adjusting the brightness and contrast or by removing blurriness or distortion from the image. Techniques such as contrast stretching, histogram equalization, or deblurring may be used to enhance the image. By using, the image filtering you can remove unwanted information and extract the useful features.

3.3 Image filtering

Image filtering is a technique used to enhance or modify digital images by applying a certain mathematical algorithm or kernel to each pixel of the image. It can be used to reduce noise, sharpen images, blur images, or detect edges in images. Convolution is used to produce the result when it perform operation on the two functions shows how one of the original functions is modified by the other. In image filtering, convolution is used to apply a kernel or filter to each pixel of the image.

A kernel is a small matrix of numbers that is used to modify each pixel of an image. The values in the kernel determine how the image is modified. For example, a kernel that is used for blurring an image might have values that are evenly distributed and low. A kernel that is used for sharpening an image might have values that are higher in the center and lower around the edges. To apply a kernel to an image, the kernel is placed over each pixel of the image, and the values of the kernel are multiplied by the corresponding pixel values in the image. The resulting values are then added together, and the sum is used as the new value for the center pixel. In the image, each pixel follows the same process recursively.Image enhancement or image compression can also be obtained from image filtering.

For example, in image compression, filters are used to reduce the amount of data required to represent an image. To enhance and edit the digital images, we are going to use the most widely used technique, which is image filtering.

3.4 Median filter

In the field of digital signal processing, the median filter is most widely used for a signal or image to get rid of noise from it. The median value is produced by the neighboring pixels and replaced at each pixel in the image with the help of setting a kernel size or window. The median filter is particularly useful in applications where saving the edges and sharp features of the image is important. The median value is taken from the given window, and each pixel value is replaced with the median value in the image. This is how the median filter operates throughout the image. The size of the window or kernel used by the filter is an important parameter that determines the degree of smoothing applied to the image. A larger window size results in more smoothing of the image, but at the cost of reduced sharpness and loss of detail. The median filter that it does not depend on the linear relationship between the output and input values. This property makes it particularly useful in applications where there is a lot of noise in the signal or image.

The main advantages of the median filter is its ability to preserve edges and sharp features in the image. This is because the median filter only considers the values of the neighbouring pixels and does not take into account the intensity values of distant pixels. As a result, the filter is less likely to smooth over sharp edges and fine details in the image. However, the median filter is not perfect and has some limitations. One major limitation is its inability to remove all types of noise from the image.

For example, if the noise is highly correlated with the signal, the median filter may not be effective in removing it. In addition, the filter may introduce some artifacts or distortions in the image, especially if the window size is too large. Its ability to sharpen image and save edges in the image makes it particularly useful in applications where preserving detail is important. However, the choice of the window size and the nature of the noise in the signal can affect the effectiveness of the filter in removing noise.

There are two ways to apply median filter technique on image f(x,y) which represented in nxn matrix form.

Pixel replication for padding:

Pixel replication is a padding method used in image processing, computer vision, and deep learning. The purpose of padding is to add extra pixels around the edge of an image to increase its size, which is useful for applying convolutional filters or pooling operations. Pixel replication padding involves replicating the pixels at the edge of the image to create a border around it.

To understand pixel replication, consider a simple example of a 4x4 grayscale image:

4	3	2	1
3	1	2	4
5	1	6	2
2	3	5	6

Fig:3.4.1 Pixel values in image

If we want to add a 1-pixel border around the image, we would need to add an extra row and column on each side:

4	4	3	2	1	1
4	4	3	2	1	1
3	3	1	2	4	4
5	5	1	6	2	2
2	2	3	5	6	6
2	2	3	5	6	6

Fig:3.4.2 Pixel replication for padding

The pixels in the new border are filled by replicating the values of the edge pixels of the original image.

2.Zero padding:

Zero padding is a popular padding method used in image processing, computer vision, and deep learning. The purpose of padding is to add extra pixels around the edge of an image to increase its size, which is useful for applying convolutional filters or pooling operations. To the edges of an image zeros are added to the rows and columns this process is known as zero padding

To understand zero padding, consider a simple example of a 4x4 grayscale image:

4	3	2	1
3	1	2	4
5	1	6	2
2	3	5	6

Fig:3.4.3 Pixel values in image

If we want to add a 1-pixel border around the image, we would need to add an extra row and column on each side:

0	0	0	0	0	0
0	4	3	2	1	0
0	3	1	2	4	0
0	5	1	6	2	0
0	2	3	5	6	0
0	0	0	0	0	0

Fig:3.4.4 Zero padding

In zero padding, the pixels in the new border are filled with zeros. In this case, the top-left pixel of the border is zero, as are all the other pixels in the new border.

Zero padding is a useful method of padding an image because it preserves the values of the original pixels while adding extra space for operations like convolution and pooling. It is also computationally efficient, since the added pixels have a value of zero and do not contribute to the final output.

Steps to find the median value in the image:

1. Arrange a nxn empty mask.
2. Place this mask for convolution.
3. Arranage the nxn pixels intensity in ascending or descending order.
4. Select the median value from these nxn intensity values.
5. Place this value at candidate pixel.
6. Move the mask to the next pixel value in the image.

3.5 Image enhancement

The improvement of the quality of an image deals with image enhancement. By using image enhancement, it will be easy to analyse a good image without any disturbance in the image, and more useful for a particular task. Image enhancement techniques can be applied to both photographs and digital images obtained from other sources, such as satellites, telescopes, or medical imaging devices. There are several different techniques used in image enhancement, including contrast enhancement, colour correction, sharpening, noise reduction, and edge enhancement.

Contrast enhancement is used identify the darkest and brightest parts in the image. This can be achieved by adjusting the brightness and contrast settings of an image or by applying filters such as histogram equalization. Contrast enhancement can help to reveal more detail in an image and make it easier to interpret. Sharpening is the process of increasing the edge contrast of an image. This can be achieved by applying filters such as unsharp masking or high-pass filtering. Sharpening can help to make an image appear more detailed and can be used to highlight important features in an image.

In addition to these techniques, there are also more advanced image enhancement techniques such as image deblurring, super-resolution, and image fusion. Image deblurring is the process of removing blur caused by camera motion or other factors. Super-resolution is the process of increasing the resolution of an image beyond its original size. By combining multiple enhancement techniques, it is possible to achieve dramatic improvements in image quality and to reveal features that would otherwise be difficult or impossible to see.

3.6 Image segmentation

Image segmentation is a key technique used in medical imaging. It is used in the visualisation of medical data and the diagnosis of colourful conditions. The dividing of a digital image into small parts is also known as image segmentation. Some groups of pixels are called image objects. By dividing the image into small parts, we get useful information from it for the next step. Image segmentation is generally used to detect objects and boundaries (lines, angles, etc.) in images. With the help of image segmentation, we can classify the group of pixels that share the same characteristics. Colour, intensity, or texture are some of the properties of the pixel that are available in that region.

Image segmentation is a challenging task in kidney stone detection, as the kidney and the kidney stones may have similar intensity values or textures. Thresholding is a simple and widely used image segmentation technique in kidney stone detection, which involves setting a threshold value to separate the kidney and the kidney stones based on their intensity values. A global threshold value may be used for images with uniform intensity values, while adaptive thresholding may be used for images with non-uniform intensity values.

3.7 Rank filter

A rank filter is a type of digital signal processing filter used to process digital images or signals. It works by replacing the value of each pixel in an image with a statistic that is derived from the neighbouring pixels within a certain window or kernel size. The rank filter is particularly useful in applications where the image or signal contains non-Gaussian noise or outliers. Rank filters operate by sliding a window over the image and calculating a statistic for the pixels within the window. The type of statistic used depends on the specific rank filter being applied.

From the image, we have arranged M pixels and Kth values of grayscale levels will assigned by using rank filter from given window. The median filter is (min+max)/2 that means min value consider as 1 and max value equals to M. Rank filters are non-linear filters, which means that they do not depend on the linear relationship between the output and input values.

One of the main advantages of rank filters is their ability to remove noise or outliers from an image or signal while preserving the important features such as edges and fine details.

In summary, the rank filter is a useful technique for processing digital images or signals with non-Gaussian noise or outliers. Its ability to preserve important features while removing noise or outliers makes it a powerful tool for image processing and computer vision applications. However, the choice of window size and the specific statistic used must be carefully considered in order to achieve the desired results.

CHAPTER 4

IMPLEMENTATION

4.1 Software requirement:

MATLAB is commonly used for kidney stone detection using morphological segmentation because of its user-friendly interface, powerful image processing toolboxes, and ability to perform complex mathematical calculations and algorithms. The morphological segmentation techniques used to detect kidney stones can be easily implemented in MATLAB using functions such as dilation, erosion, opening, and closing. Additionally, MATLAB allows for the visual representation of results, making it easier to interpret and validate the results.

The process of putting a strategy or concept into action is referred to as implementation. Implementation in the context of a project entails carrying out the numerous tasks and activities necessary to meet the project's goals and objectives. Implementation is a vital step of every project since it entails carrying out the strategy and achieving the project's goals. This necessitates careful planning, coordination, and execution of diverse tasks and operations, as well as good resource management.

History of MATLAB:

MATLAB (short for Matrix Laboratory) is a multi-paradigm numerical computing environment and proprietary programming language developed by MathWorks. It was first released in 1984 and has since become one of the most popular software tools for scientific computing and data analysis. The development of MATLAB can be traced back to the late 1970s, when Cleve Moler, a mathematician and computer scientist, was working on his PhD thesis at the University of New Mexico. Moler was working on a project that required him to solve complex mathematical problems using a computer. At the time, most computers used programming languages such as FORTRAN or C, which required a lot of coding and were not well-suited for complex mathematical operations.

To address this problem, Moler and his colleagues developed a new programming language that was specifically designed for numerical computation. They called it MATLAB, and the first version was released in 1984.Initially, MATLAB was only available on Unix-based systems.

Sometimes it was ported to other platforms, including Windows and macOS. MATLAB quickly gained popularity among scientists, engineers, and researchers, who found that it made it easy to perform complex mathematical operations and visualize data.

Over the years, MATLAB has been continuously improved and expanded, with new features and tools being added to the software. Today, MATLAB is widely used in many fields, including engineering, science, economics, finance, and medicine. It has become a key tool for researchers and professionals who need to analyse and manipulate large amounts of data.

The important tools we have used in our projects to achieve the desired output.

1. The Command Window
2. The Workspace
3. The Command History
4. The Run Button
5. The Current Directory
6. The Help Browser
7. Editor Window
8. Plotting Lines

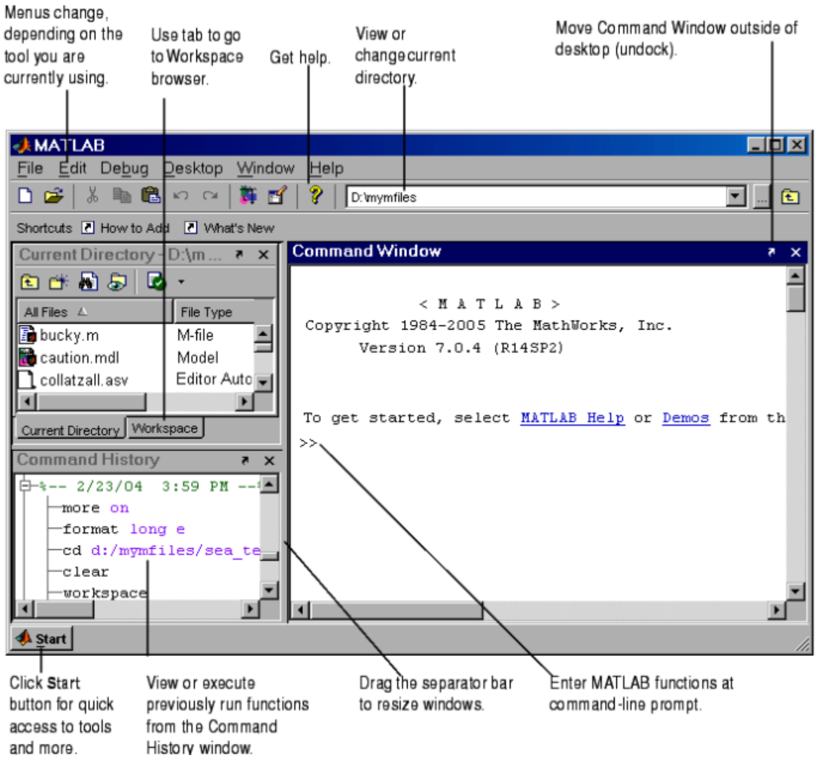

Fig:4.1.1 The graphical interface of MATLAB workspace

Current Folder:

The current folder in MATLAB refers to the location in which MATLAB is now running. This is the location where MATLAB looks for files to utilise in your code or to store your code to. The current folder is usually set to the MATLAB root folder when you start MATLAB. The Current Folder browser, on the other hand, allows you to change the current folder to any folder on your computer. The current folder browser is a graphical user interface (GUI) feature that allows you to easily traverse and manage your MATLAB environment's files and folders. It's accessible from the MATLAB desktop by clicking the Current Folder button in the toolbar or entering "cd" into the MATLAB command window.

You may access your data or files immediately from MATLAB by moving the current folder to the location where they are kept, without having to give their complete path. The Current Folder browser, in addition to exploring directories, has capabilities for managing files and folders. For example, you may use the browser to create new directories, rename files and folders, copy and move data, and remove files and folders.

MATLAB looks for files and data in the current folder as well as any directories on the MATLAB path by default. MATLAB may be unable to identify a file or data if it is not located in the current folder or on the MATLAB path. In summary, the MATLAB Current Folder is a critical component of the MATLAB environment that allows you to explore and manage files and folders. Understanding how to utilise the Current Folder browser allows you to work more efficiently and successfully in MATLAB, as well as more conveniently access your files and data.

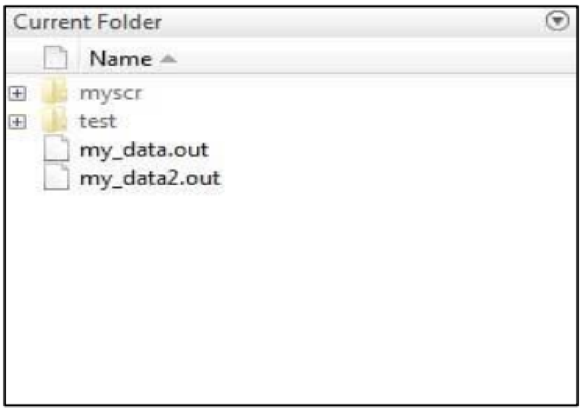

Fig:4.1.2 Current folder

Command Window:

The Command Window is an important part of the MATLAB desktop experience since it allows users to communicate with the software. It has a command-line interface via which users may enter commands, run scripts and functions, and display results. The Command Window is generally the first window that opens when you launch MATLAB. It shows a command prompt where you may input MATLAB instructions and execute them by pressing the input key. The Command Window has several fundamental editing functions, such as copy, paste, and undo, as well as features to help you create MATLAB code more effectively, such as command history, command completion, and syntax highlighting.

The Command Window is a vital tool for learning MATLAB since it allows you to experiment with code and quickly see the results. In the Command Window, you may input any MATLAB command, including fundamental arithmetic operations, function calls, and variable assignments. For example, you may execute a simple command like x = 2 + 3 to give the variable x the value 5. More complicated commands, such as plot(x, y), can be used to construct a plot of a set of data points contained in arrays x and y.

You may launch MATLAB scripts and functions from the Command Window in addition to inputting commands directly into it. To execute a script, just type its filename (without the.m suffix) into the command prompt. To run a function, enter its name followed by the required input parameters. The Command Window also includes a number of tools to help you operate more effectively with MATLAB. The command history capability, for example, allows you to access previously performed commands and re-execute them as needed. By using the Tab key, you may use the command completion tool to assist you complete commands and function names. Debugging features like as breakpoints, stepping, and variable inspection are now available in the Command Window to assist you in debugging your code.

Overall, the Command Window is an important tool in the MATLAB environment because it provides a command-line interface via which you may interact with MATLAB software and input instructions to perform functions and scripts. You may improve your MATLAB skills and get better results from your code and data by learning how to utilise the Command Window efficiently.

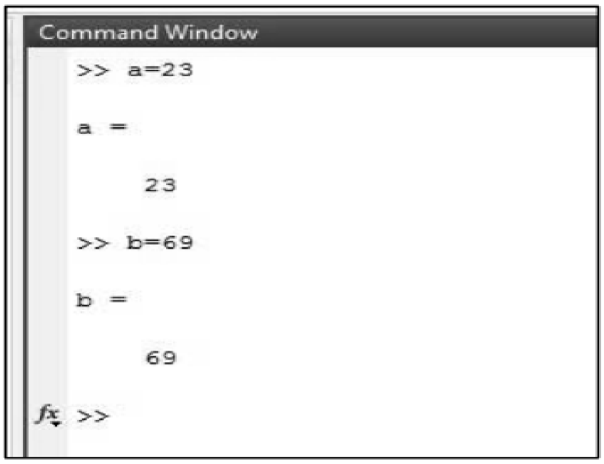

Fig:4.1.3 Command window

Workspace:

The Workspace is an important component of the MATLAB desktop environment that displays a graphical representation of the current state of variables in memory. It lets you to examine and change variables in your MATLAB workspace, as well as study and analyse data. Variables are produced and saved in memory when you run MATLAB commands and functions. The Workspace pane provides variable information such as names, values, and data types. The Workspace pane allows you to review the variables in your workspace, change their values, and delete them if required.

The Workspace pane is accessible from the MATLAB desktop and dynamically updated as you perform MATLAB commands. You may also change the appearance of the Workspace window by modifying the column widths, sorting the variables by various criteria, and choosing which columns to display. The Workspace window includes tools for dealing with variables in addition to a graphical depiction of variables in memory. For example, in the Command Window, you may use the 'who' and 'whos' commands to display a list of variables and their attributes, respectively. To delete variables from memory, use the 'clear' command, and to save variables to a file, use the 'save' command.

The Workspace window also includes a number of visualization tools for exploring and analysing data. You may use the plot function, for example, to generate line graphs, scatter plots, and other sorts of plots based on data contained in variables.

We may also use the image function to display variables' pictures, or the surf function to generate surface plots based on variables' data. Overall, the Workspace is a critical component of the MATLAB desktop environment, allowing you to interact with variables in your workspace as well as explore and analyse data. You may improve your MATLAB skills and get better results from your code and data by learning how to utilize the Workspace efficiently.

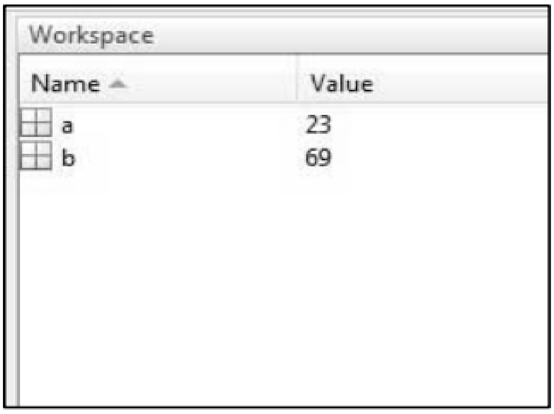

Fig:4.1.4 Workspace

Command History:

The Command History is an important element of the MATLAB desktop environment that keeps track of previously run commands. It allows you to access and re-execute past instructions, as well as remember and alter code. The Command History window provides a list of all commands executed in the MATLAB Command Window since the session began. Each command has a line number and a timestamp to indicate when it was run. To view past commands, use the arrow keys or the mouse scroll wheel to go through the Command History window.

By choosing prior commands and clicking the Enter key, you may utilise the Command History box to recall and re-execute them. This can be handy when you need to repeat a previously run command with minor changes, or when you need to refer to a previously executed command. The Command History pane, in addition to storing past commands, includes tools for finding and filtering commands. You may, for example, use the search field to look for instructions that contain certain keywords or phrases, or you can use the filter buttons to show just commands that meet specified criteria, such as those that contain errors or warnings.

The Command History pane may also be used to amend and change previously run commands. Simply pick the command to be edited, amend it in the Command History pane, and then press Enter to re-execute the modified command. This might be beneficial when making small changes to a previously run command or when reusing code from a prior session. Overall, the Command History is an important element of the MATLAB desktop environment since it keeps track of previously run commands and makes it easy to access and re-execute them. You may improve your MATLAB skills and get better results from your code and data by learning how to use the Command History efficiently.

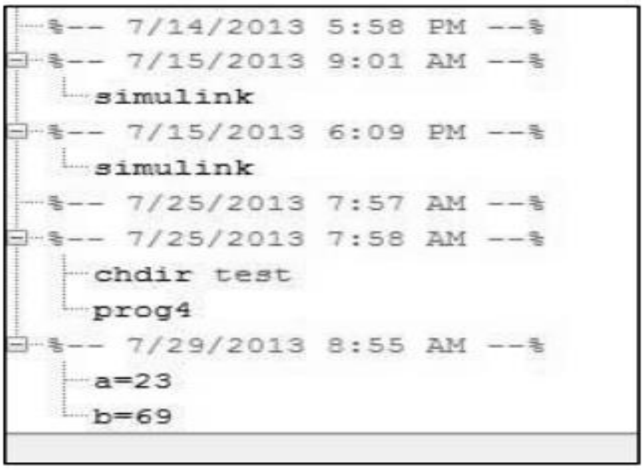

Fig:4.1.5 Command history

Run Button:

The Run button in the MATLAB desktop environment allows you to run the code in the current Editor Window. It is usually at the top of the Editor Window and is accessed by clicking on the green arrow symbol. When you press the Run button, MATLAB runs the code in the current Editor Window line by line. If there are mistakes or problems in the code, MATLAB will display error messages in the Command Window and indicate the line where the problem occurred in the Editor Window.

The Run button is an important feature for testing and debugging code since it allows you to rapidly execute code and find problems. You may monitor the output and behaviour of your code and spot faults or issues as they arise by executing code line by line. MATLAB has various different run-related features and capabilities, in addition to the usual Run button.

Such as the ability to execute chunks of code, run code in debug mode, and run code on remote workstations. These options are accessible via the Run menu or keyboard shortcuts.

Overall, the Run button is an important element of the MATLAB desktop environment that allows you to rapidly and effectively execute code and find errors. You may boost your productivity, test and debug code more efficiently, and obtain better outcomes from your MATLAB projects by understanding how to utilise the Run button effectively.

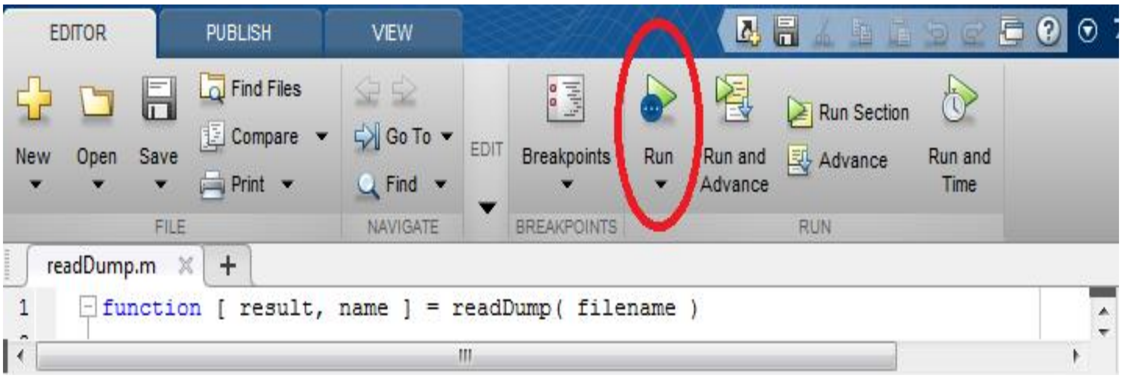

Fig:4.1.6 Run button

The Help Browser:

The Help Browser is an important part of the MATLAB desktop environment that serves as a comprehensive reference guide to MATLAB functions, instructions, and programming ideas. It gives access to thorough documentation on MATLAB functions and a handy approach to learn and explore MATLAB's capabilities. The Help Browser window contains a searchable index of all MATLAB functions and commands, as well as their syntax, explanations, and use examples. You may use the search bar to look for specific functions or ideas, or you can browse the index to learn about different types of functions and instructions.

The Help Browser not only provides documentation for particular functions and commands, but it also gives access to a variety of tutorials, examples, and videos that illustrate how to use MATLAB for various sorts of analytical and programming activities. These materials are accessible via the Help Browser window's 'Examples' and 'Tutorials' tabs, and they include a lot of information on how to use MATLAB efficiently. The Help Browser also includes options for customising the presentation of documentation, such as the ability to modify the font size, the window layout, and highlight certain areas of text.

When you need to focus on a specific portion of documentation, or when you need to print or share content with others, this might be handy. Overall, the Help Browser is an important component of the MATLAB desktop environment, serving as a complete reference guide to MATLAB capabilities and programming principles. You may improve your MATLAB skills and get better results from your code and data by learning how to utilise the Help Browser efficiently.

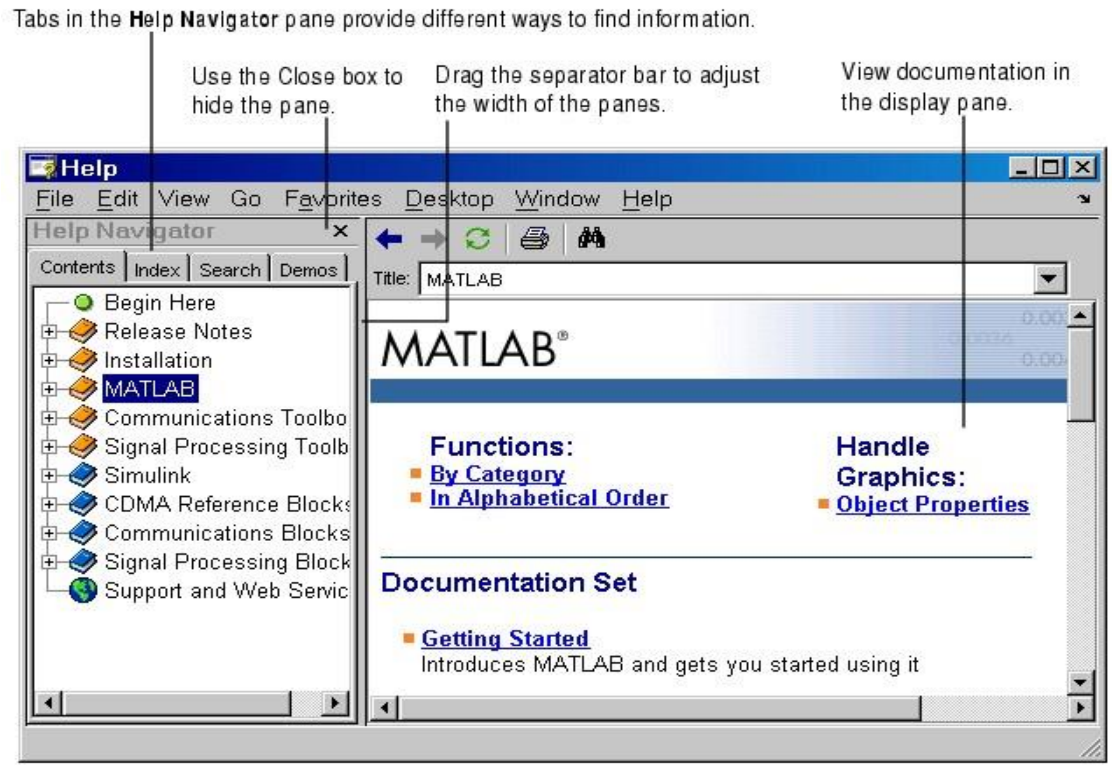

Fig:4.1.7 Help browser

Editor Window:

The Editor Window is a critical component of the MATLAB desktop environment that includes a text editor for developing and modifying MATLAB code. It lets you to create and edit code in an easy-to-use interface with tools and capabilities for organising and debugging your code. The Editor Window presents MATLAB code in an easy-to-read and comprehend style. It has syntax highlighting and other features to help you identify code components like variables, functions, and comments. It also includes tools for indenting code, formatting text, and file management.

The Editor Window provides tools for debugging your code, which is one of its main advantages. You may use breakpoints in your code to halt execution at certain places and analyse variable and other data values.

This is important for detecting flaws or bugs in your code and correcting them before they cause difficulties. The Editor Window also includes code management and organisation features.

The Editor Window, in addition to tools for editing and debugging code, gives access to a variety of additional features and tools, such as the MATLAB debugger, profiler, and code analyzer. These tools can assist you in optimising your code, identifying performance issues, and improving overall code quality. Overall, the Editor Window is a critical component of the MATLAB desktop environment, providing a user-friendly interface for authoring and modifying MATLAB code. You may enhance your productivity, create better code, and obtain better outcomes from your MATLAB projects by understanding how to utilise the Editor Window efficiently.

Fig 4.1.8 Editor window

Plotting Tools:

Plotting tools, which allow you to visualise data and produce plots, graphs, and charts, are a fundamental part of the MATLAB desktop environment. MATLAB has a plethora of charting tools and features that make it simple to generate high-quality data visualisations. The ability to construct a broad variety of plots and charts, such as line plots, scatter plots, bar charts, histograms, and more, is one of the primary characteristics of MATLAB's charting capabilities. MATLAB also includes a variety of customization options for these plots, allowing you to modify the plot's colours, labels, axes, and other visual aspects.

The capacity to deal with huge datasets and produce interactive graphs is another significant aspect of MATLAB's charting capabilities. MATLAB has capabilities for working with large amounts of data, such as data preparation, filtering, and segmentation. It also has interactive charting capabilities that allow you to zoom in and out of the plot, pan it, and choose individual data points or plot regions. Plotting tools in MATLAB include tools for making 3D charts, surface plots, and other complicated visualisations. These tools enable you to visualise complicated data in novel ways and obtain insights into your data that 2D charts may not reveal.

MATLAB includes capabilities for exporting and sharing charts in addition to a comprehensive range of plotting tools and features. Plots may be exported to a variety of file formats, including PNG, PDF, and SVG, and the size, quality, and other properties of the exported file can be customised. Plots may also be shared directly from MATLAB using tools such as the MATLAB Web App Server or the MATLAB Connector for Excel.

Overall, the plotting tools in MATLAB are a strong and versatile part of the MATLAB desktop environment that allows you to visualise data, develop sophisticated visualisations, and obtain insights into your data. You may enhance your productivity, generate more informative and interesting visualisations, and gain better outcomes from your MATLAB projects by learning how to utilise these tools successfully.

Fig:4.1.9 Plotting lines

CHAPTER 5

RESULTS

We are implementing our project using MATLAB software. The input image in Fig. 5.1 is obtained from an ultrasonic database. Convert the ultrasonic image into a grayscale image.

Fig:5.1 Ultrasound image

Check the pixel information to apply global thresholding; if not, go for adaptive thresholding. If the pixel intensity is greater than 20, consider the intensity to be 1, otherwise it will be 0. It produces a binary image, as shown in Figure 5.2.

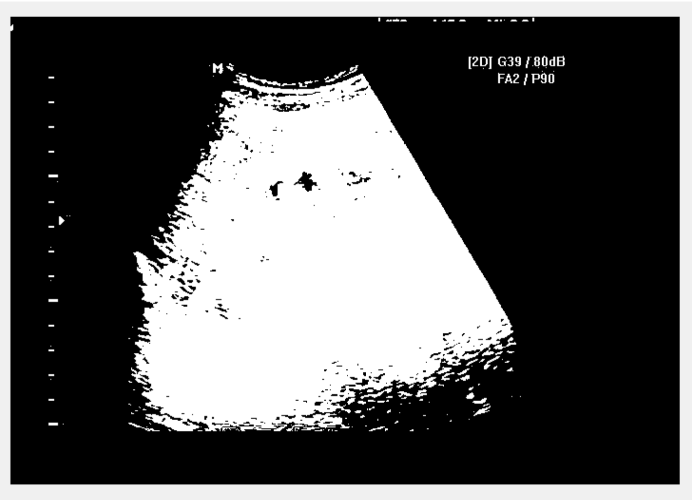

Fig:5.2 Binary image

Because of the above process, holes are formed in the binary image. To fill the holes, we should do region filling. By multiplying the binary image with an ultrasonic image, the result leads to the formation of a pre-processed image. The markings and scales in the grayscale image will be removed in the pre-processed image in Fig. 5.3.

Fig:5.3 Pre-processed image

Figure 5.4, "Image enhancement," refers to the process of improving the quality of an image by adjusting its visual appearance. This can be done through histogram equalisation, etc. By using image enhancement, it will be easy to analyse a good image that we have made by using the above process. This provide us to extract the information for image in an easy manner.

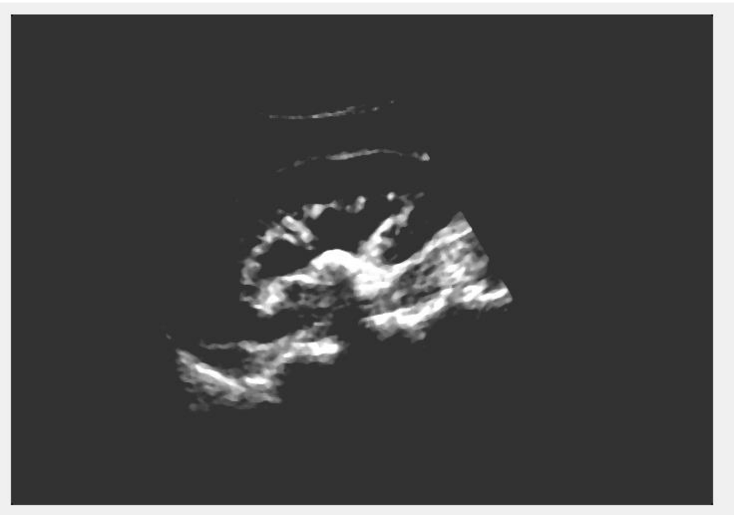

Fig :5.4 Image enhancement

Image filtering is a technique used to enhance or modify digital images by applying a certain mathematical algorithm or kernel to each pixel of the image. It can be used to reduce noise, sharpen images, blur images, or detect edges in images. Convolution is used to produce the result when it performs operation on the two functions shows how one of the original functions is modified by the other. In image filtering, convolution is used to apply a kernel or filter to each pixel of the image.

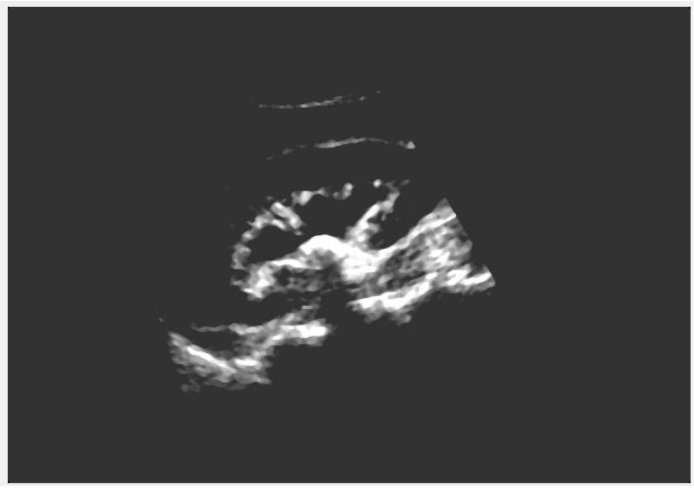

Fig:5.5 Image filtering

The division of an image into small segments, which represent the useful information in the whole image. This process is known as image segmentation (fig 5.6). Because of the image segmentation, it will be easier to analyse the small image that is required rather than the whole image. This way, we use the required parts of an image and discard the unwanted information in the image.

Fig:5.6 Segmentate image

The detected stone is displayed (Fig.5.7) on the monitor to make medical operations easier. The morphological segmentation approach for kidney stone detection may vary depending on the quality of the input image, the choice of thresholding method, and the morphological operations used.

Fig:5.7 Stone detected

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION:

In this project, to detect stones present in the ultrasound image, we have analysed the various methods and algorithms. In the existing system, we have to provide continuous velocities to get a perfect advanced level set function, which sometimes may not be possible for the system. Sometimes the accuracy will reduce because there is more data available to analyse to get the result. And they did not show the detected stone image on the monitor; they just gave the stone present as a statement on the screen. We have overcome the limitations present in the existing system by using morphological segmentation.

6.2 FUTURE WORK:

The future work is possible to estimate the size, colour and type of the stone present in the ultrasound image with the help of classify the kidney stone region. Kidney stone detection using morphological segmentation is an area of ongoing research that has the potential to significantly improve the accuracy and efficiency of diagnosing kidney stones. The future work in this area may involve further refinement of the algorithms used to detect kidney stones, as well as exploring new techniques to improve the accuracy of the segmentation process.

One area of potential improvement is in the use of machine learning and artificial intelligence techniques to assist in the detection and segmentation of kidney stones. By training algorithms on large datasets of medical images, these systems can learn to recognize patterns and features that are indicative of kidney stones, and can improve the accuracy and efficiency of the segmentation process.

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Design and Analysis Performance of Kidney Stone Detection from Ultrasound Image by Morphological Segmentation

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***Abstract*—** Nowadays, the majority of people suffer from kidney stones. There will be a chance of complications if we are unable to detect the early signs of stones in the kidney. Sometimes, due to misjudgment, there will be a chance of surgery to remove stones from our kidneys. With the help of image processing, it is easy to detect the stones in the kidney with better results and the exact location of the stones in kidney. To detect the stones in the ultrasound image, it is a difficult task because of the low discrepancy and speckle noise present in the input image. Specific image processing techniques are used to overcome these kinds of challenges. To remove the speckle noise present in the ultrasound image, we will first use the image pre-processing method. The pre-processed image is smoothed with the help of different filtering methods. The next step is to detect the stones present in the kidney with image segmentation. Further, the segmented image is reused with morphological segmentation.

Keywords: Kidney stone detection, Median filter, morphological segmentation

I.INTRODUCTION

The process of reusing digital images on a computer is called digital image processing. By using the different algorithms in the computer, we can highlight the key features or get information from the image. On the computer, we can edit the images using digital image processing. Image processing is the subject developed from the signals and systems. The basic purpose of the DIP is to reuse the image in the computer system. To produce the final output image with the desired results, we are going to reuse the computer input, which is digital images.

A kidney stone, referred as renal math, because of urine minerals a solid mass formed in the kidneys. Kidney stones are generally removed from the body in the form of urine sluices. Without causing symptoms, a small stone leaves the kidney in the form of urine. The stone conditions remain unnoticed at the initials level, which causes damage to the kidney as they increase in size. The people are suffering from diabetes mellitus, hypertension, and glomerulonephritis, which is caused by kidney failure.

In the urinary tract, or kidneys, unwanted minerals are stored, which is why they form stones in the kidney. The stones are removed from the kidneys because they cause discomfort and pain. The causes of kidney stones can vary depending on individual factors, such as diet, hydration, and medical history. Some common causes of kidney stones include dehydration, a diet high in salt, sugar, and animal protein, family history, obesity, certain medical conditions, medications, and urinary tract blockages. However, it's essential to understand that not everyone who has one or more of these risk factors will develop kidney stones, and some people may develop them without any known risk factors. Understanding the underlying causes of kidney stones can help individuals take preventative measures and seek medical attention if necessary.

II. LITERATURE REVIEW

Viswanath and Dr. R. Gunasundari (2015) used level-set segmentation for the identification of kidney abnormalities similar to the conformation of stones, excrescences, blockages of urine, natural anomalies, and cancerous cells. At the time of medical operations, it's vital to determine the exact and precise position of the stone. Because of the patchy noise and low discrepancy, it is difficult to detect the stone in the ultrasound image. Specific image processing methods are used to overcome these types of challenges. The image restoration process is used to remove the patch noise present in the ultrasound image by using image pre-processing. The Gabor filter is used to smooth the restored image, and the histogram equalisation is used to enhance the posterior image. The pre-processed image is obtained with level-set segmentation to delineate the kidney stone region. To obtain the desired output the segmentation processes is applied at two levels. Once it is applied at stone region and another time is applied at Kidney region..

P.R. Tamilselvi and P.Thangaraj (2011) proposed an ultrasound kidney image opinion scheme for stones based on increased quality of seeded regions, growing grounded segmentation, and bracketing of kidney images with stone sizes. By varying the intensity threshold in the segmented portions of the image, we can identify the normal stone and early stone stages. The improved robotic Seeded Region Growing (SRG) grounded image segmentation process for homogeneous regions is based on image granularity features, in which structures with confines similar to patch size are uprooted. These lookup table entries are used to classify the shape and size of the growing regions. The region that forms after the region grows suppresses the high-frequency vestiges as well.

A kidney stone detection paper was published by Jyoti Verma, Madhawendra Nath, KK Saini, and Priyanshu Tripati (2017). There are some colourful issues with this content, such as the image's low resolution and the stone's similarity to the kidney's new image. Ultrasound images have a low degree of variation and are delicate in describing and valuing the region of interest. Thus, the next step will be image pre-processing, which typically contains image improvement. The purpose of this method is to identify the distinctive quality of the kidney to make identification easier. Medical imaging is one type of abecedarian imaging because it is used in a more sensitive field, the medical field, and it must be accurate. To un-sharp mask the image, we are going to use the gaussian filter and median filter. In the morphological operations first we use the dilation and followed by the erosion. To classify regions of interest, we employ entropy-based grounded segmentation. The SVM and KNN methods are used to determine the stones present in the image

III.EXISTING METHODLOGY

In the existing system, they have used the Gabor filter and level-set segmentation to detect the stone in the kidney. Because of the continuous construction of the appropriate velocities for the advancement of the level set function, sometimes it is difficult to provide continuous operation for the system. Sometimes, the accuracy may reduce because more data is available for analysis to get the results.

IV.PROPOSED METHOD

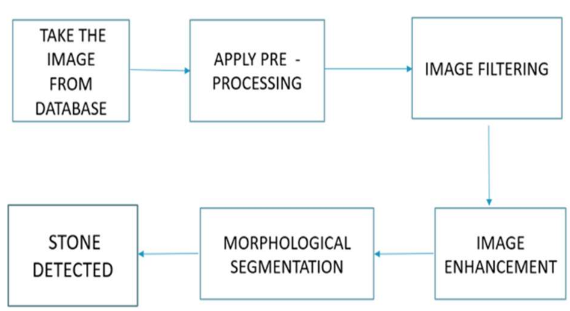

Fig:1 Block Diagram of Kidney Stone Detection

Image Pre-processing:

Image pre-processing is an important step in kidney stone detection, which involves manipulating raw medical images to improve the quality and usability of the image. Kidney stones are a common condition that affects millions of people worldwide and can cause severe pain and discomfort. Medical imaging, such as X-rays or CT scans, are commonly used to detect and diagnose kidney stones. Image pre-processing plays a crucial role in kidney stone detection, as it can help to improve the accuracy and efficiency of subsequent analysis or processing. The process of image pre-processing for kidney stone detection includes several stages, such as image cleaning, enhancement, feature extraction, and segmentation.

In the image cleaning stage, the medical image is cleaned to remove any noise or artifacts that may affect the accuracy of the subsequent analysis. Techniques such as median filtering, morphological filtering, or noise reduction may be used to remove noise or unwanted information from the image. There are few pre-processing requirements because the ultrasound is composed of speckle noise and has a low discrepancy. Image restoration, smoothing, and sharpening are methods used in image pre-processing to improve the quality of the image. The smallest position of abstraction for both input and output intensity images is extracted by the common name image pre-processing. The information collected from the detector represents the intensity of the image with respect to that pixel value. These pixel values are represented in a form matrix, and they are also known as the brightness of that image.

Median Filter:

In the field of digital signal processing, the median filter is most widely used for a signal or image to get rid of noise from it. The median value is produced by the neighbouring pixels and replaced at each pixel in the image with the help of setting a kernel size or window. The median filter is particularly useful in applications where preserving the edges and sharp features of the image is important. The median filter operates by sliding a window over the image and replacing the value of each pixel in the image with the median value of the pixels within the window. The size of the window or kernel used by the filter is an important parameter that determines the degree of smoothing applied to the image. A larger window size results in more smoothing of the image, but at the cost of reduced sharpness and loss of detail. The median filter is a non-linear filter, which means that it does not depend on the linear relationship between the input and output values. This property makes it particularly useful in applications where there is a lot of noise in the signal or image. In addition, the median filter is relatively simple to implement and computationally efficient.

Image Enhancement:

The improvement of the quality of an image deal with image enhancement. By using image enhancement, it will be easy to analyse a good image without any disturbance in the image, and more useful for a particular task. Image enhancement techniques can be applied to both photographs and digital images obtained from other sources, such as satellites, telescopes, or medical imaging devices. There are several different techniques used in image enhancement, including contrast enhancement, colour correction, sharpening, noise reduction, and edge enhancement. These techniques are often used together in order to achieve the desired effect.

Contrast enhancement is used identify the darkest and brightest parts in the image. This can be achieved by adjusting the brightness and contrast settings of an image or by applying filters such as histogram equalization. Contrast enhancement can help to reveal more detail in an image and make it easier to interpret. Sharpening is the process of increasing the edge contrast of an image. This can be achieved by applying filters such as unsharp masking or high-pass filtering. Sharpening can help to make an image appear more detailed and can be used to highlight important features in an image.

Image Segmentation:

Image segmentation is a key technique used in medical imaging. It is used in the visualisation of medical data and the diagnosis of colourful conditions. The dividing of a digital image into small parts is also known as image segmentation. Some groups of pixels are called image objects. By dividing the image into small parts, we get useful information from it for the next step. Image segmentation is generally used to detect objects and boundaries (lines, angles, etc.) in images. With the help of image segmentation, we can classify the group of pixels that share the same characteristics. Colour, intensity, or texture are some of the properties of the pixel that are available in that region.

Image segmentation is a challenging task in kidney stone detection, as the kidney and the kidney stones may have similar intensity values or textures. Thresholding is a simple and widely used image segmentation technique in kidney stone detection, which involves setting a threshold value to separate the kidney and the kidney stones based on their intensity values. A global threshold value may be used for images with uniform intensity values, while adaptive thresholding may be used for images with non-uniform intensity values.

VI.RESULTS AND DISCUSSIONS

We are implementing our project using MATLAB software. The input image in Fig.2 is obtained from an ultrasonic database. Convert the ultrasonic image into a grayscale image.

Fig 2: Ultrasound Image

Check the pixel information to apply global thresholding; if not, go for adaptive thresholding. If the pixel intensity is greater than 20, consider the intensity to be 1, otherwise it will be 0. It produces a binary image, as shown in Figure 3.

Fig 3: Binary Image

Because of the above process, holes are formed in the binary image. To fill the holes, we should do region filling. By multiplying the binary image with an ultrasonic image, the result leads to the formation of a pre-processed image. The markings and scales in the grayscale image will be removed in the pre-processed image in Fig.4.

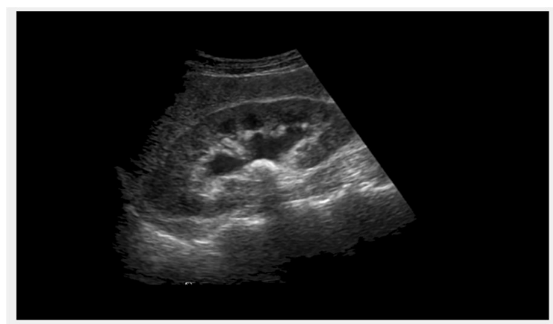

Fig 4: Pre-processed Image

Figure 5, "Image enhancement," refers to the process of improving the quality of an image by adjusting its visual appearance. This can be done through histogram equalisation, etc. The goal of image enhancement is to make the image more visually appealing or to make it easier to extract information from it.

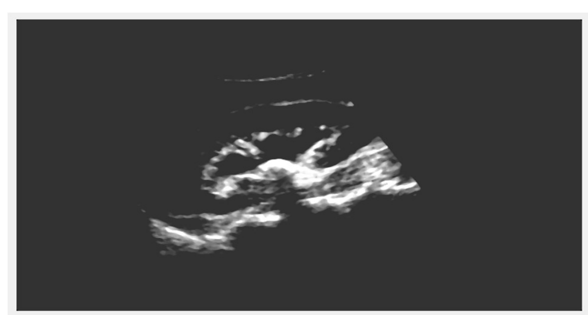

Fig 5: Image Enhancement

The division of an image into small segments, which represent the useful information in the whole image. This process is known as image segmentation (6). Because of the image segmentation, it will be easier to analyse the small image that is required rather than the whole image. This way, we use the required parts of an image and discard the unwanted information in the image.

Fig 6: Segmentate Image

The detected stone is displayed (Fig.7) on the monitor to make medical operations easier. The morphological segmentation approach for kidney stone detection may vary depending on the quality of the input image, the choice of thresholding method, and the morphological operations used.

Fig 7: Stone Detected

VI. CONCLUSION

In this project, to detect stones present in the ultrasound image, we have analysed the various methods and algorithms. In the existing system, we have to provide continuous velocities to get a perfect advanced level set function, which sometimes may not be possible for the system. Sometimes the accuracy will reduce because there is more data available to analyse to get the result. And they did not show the detected stone image on the monitor; they just gave the stone present as a statement on the screen. We have overcome the limitations present in the existing system by using morphological segmentation.

VII. FUTURE SCOPE

The future work is possible to estimate the size, colour and type of the stone present in the ultrasound image with the help of classify the kidney stone region. Kidney stone detection using morphological segmentation is an area of ongoing research that has the potential to significantly improve the accuracy and efficiency of diagnosing kidney stones. The future work in this area may involve further refinement of the algorithms used to detect kidney stones, as well as exploring new techniques to improve the accuracy of the segmentation process.

One area of potential improvement is in the use of machine learning and artificial intelligence techniques to assist in the detection and segmentation of kidney stones. By training algorithms on large datasets of medical images, these systems can learn to recognize patterns and features that are indicative of kidney stones, and can improve the accuracy and efficiency of the segmentation process.

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