KIDNEY STONE DETECTION USING IMAGE PROCESSING TECHNIQUE

CH RAMBABU[1], NUNNA YAMINI GEETHA[2], MAREEDU VENKATA PAVAN[3], PALAKURTHY VINAY[4], PANGULURI MANIKANTA [5].

[1] SENIOR GRADE ASSISTANT PROFESSOR IN DEPARTMENT OF ECE IN SESHADRI RAO GUDLAVALLERU ENGINEERING COLLEGE, SESHADRI RAO KNOWLEDGE VILLAGE GUDLAVALLERU - 521356 ANDHRA PRADESH.

[2,3,4,5] UG STUDENTS IN DEPARTMENT OF ECE IN SESHADRI RAO GUDLAVALLERU ENGINEERING COLLEGE, SESHADRI RAO KNOWLEDGE VILLAGE GUDLAVALLERU - 521356 ANDHRA PRADESH.

ABSTRACT

It is possible to diagnose kidney problems using ultrasound imaging. Ultrasound imaging of kidney stones is a difficult undertaking due to their poor contrast and speckle noise. By utilising appropriate image processing methods, this difficulty may be addressed This research demonstrates an image processing method for detecting kidney stones. The picture pre-processing is the initial stage. Preprocessing includes techniques for improving the picture via the use of image enhancement. Afterward, the picture segmentation is carried out. The stone's position is then determined by analysing the segmented photos. Increased contrast in the stone makes it stand out more in the preprocessed photograph.

INTRODUCTION

A global epidemic of kidney stone disease is a leading cause of death. The early stages of kidney stone disease go undiagnosed, resulting in damage to the kidney. Diabetic kidney disease, hypertension, glomerulonephritis, and other conditions affect the majority of individuals. Because kidney dysfunction may be dangerous, it is best to have an early diagnosis of the condition. When it comes to kidney illness, ultrasound (US) images are a relatively low-cost, non-invasive, and extensively utilised imaging technology. It is possible to test urine using shock wave lithotripsy (SWL), percutaneous renal nephrolithotomy (PCNL), or relative super saturation (RSS). For laparoscopic surgery, the Robertson Risk Factor Algorithms (RRFA) are open and are given to extraordinary [2] unique circumstances. Glucuronic acid (GlcUA) and Nacetyl glucosamine (GlcNAc) disaccharides make up the linear glycosaminoglycan hyaluronan [3]. Urine concentration, uric acid, salt formation crystal, crystallisation inhibition, and crystal retention are all mechanisms that may contribute to renal stone disease. Magnesium ammonium phosphate and amino acid are also important.

The most important addition of this paper is a detailed explanation of how an ultrasound image might be used to locate a kidney stone. This research also examines the many methods for detecting kidney stones that are presently described in the literature, as well as the advantages and disadvantages of each.

This stone may be detected with a high degree of accuracy by image processing, which has a tendency to push for accurate findings and so is an automated method for doing so. To identify the stone from the X-Ray radiation picture, doctors often use a manual approach but our technology is entirely automated, which means that the time is decreased and the chances of mistake are also reduced.

LITERATURE REVIEW

This section provides an in-depth review of the various kidney stone screening methods that use various pictures.. Due to the dangers of failing to identify kidney stones in the human body, kidney stone identification is a challenging task. This section provides an in-depth review of the various kidney stone screening methods that use various pictures.. An inaccurate diagnosis of kidney stones in the human body might put a person's life at risk. Additionally, this might help save the lives of those who are afflicted by it. To put it another way, it has a direct effect on society.

In their study, Mallala et al. [3] used a c-arm tomographic technique to determine the kidney's three-dimensional structure. For kidney stone detection, their studies found that computed Tomography (C.T.) scans expose patients to more radiation than regular X-ray scans, particularly in individuals who need recurrent screening and youngsters with a lower bone density.

Because of this, sadhegi et al. [4] addressed the radiographic technique, which employs x-ray images to swiftly and accurately locate stone. Over 90% of urethral stones, according to their research, are black and opaque.

First suggested by [5], the Seeded Area Growing (SRG) methodology is a fast, robust, parameter-free method for segmenting intensity pictures given seed locations for each region among various image segmentation techniques. if, for example, the intensity or texture of their differences can be adequately contrasted, those pixels that fall inside a predefined neighbourhood are merged in SRG.

There is thus a limit to the degree of precision and accuracy that may be detected. It was unable to see any uric acid stones or smaller stones since they were buried. It was discovered by Cunitz et al. [6] that a Doppler imaging sequence was an improved method for finding kidney stones. According to this study, ultrasound is superior to computed tomography in most cases (C.T).

For the first time, researchers have developed a rotating sono probe that can capture photos from four evenly spaced angles in reference to a fixed and rotating axis. Calculating renal volume by hand takes a long time and is inaccurate. Their plan calls for cutting down on a number of energy-related activities. Thus, their automated technique of determining renal stones is more exact and precise than human approaches.

Extracorporeal shock wave lithotripsy requires a precise determination of kidney stone location, as shown by Tsao et al (ESWL). Using shock waves to target kidney stones in real time may result in tissue damage or trauma if the shockwave misses. According to their results, speckle noise must be reduced from ultrasonic pictures.

Ultrasonic renal pictures proposed by Rahman et al. [9] not only increase the identification of kidney stones, but also improve the quality of the images. It has been reported before that Vishwanath et al. [10] employed multilayer perception (MP) and back propagation (BP) to increase their accuracy in determining the kind of kidney stone identified to 98%.

The practice of restoring a damaged or noisy picture to its original, clean state is known as image restoration. Motion blur and noise are two examples of corruption that may appear in a number of ways. A picture may be restored by using the Point Spread Function (PSF) to reverse the blurring process, which can be done by taking an image of a specific location and then using the PSF to recover lost information.

To minimise noise or produce a less pixelated picture, smoothing is used. In addition to low-pass filters, you can also smooth a picture by determining the average or median value of a set of moving pixels.

MEDICAL IMAGING MODALITIES

The field of image technology has advanced dramatically since the turn of the 20th century. Many imaging methods were developed for medical use. Imaging modalities are the term used to describe these imaging procedures. Anatomical modalities and functional modalities are two types of imaging modalities.

When X-Rays were discovered, radiography was the first medical imaging technique. Radiography is an imaging method that uses X-Rays, which were employed in diagnostic treatments before the negative effects of ionising radiation were identified. X-ray penetration and radiation absorption into the body are influenced by the density of the tissue. The varying densities of tissues in the body generate the X-Ray picture on the fluorescent screen or photographic film. Fluoroscopy and creating by moving radiography are the two types of radiography. Because of their lower cost, higher resolution, and lower radiation exposure, these 2D tomography methods remain popular despite the advancements in 3D technology.

Magnetic Resonance Imaging (MRI)

In magnetic resonance imaging, the relaxation characteristics of water molecules' hydrogen nuclei are exploited. Nuclear Magnetic Resonance (NMR) tomography is another name for this technique. Polarized strong magnets leave the hydrogen nuclei of water molecules in human tissues to generate a detectable signal that is stored in spatial coordinates. MRI is favoured over CT because of the non-ionizing radiation used in MRI. Nuclei are increased in the presence of a magnetic field when radio frequency radiation is applied to the patient. Normal microscopic tumbling causes molecules to lose energy. Relaxation is the term used to describe this action. The pictures are created by comparing the relaxation times of various tissues. MRI makes use of radio frequency non-ionizing radiation and strong magnetic fields. An MRI needs a magnetic field that is both powerful and consistent. The gadolinium-based contrast agents used in MRI are called chalets. MRI is a tomographic imaging technology because it produces a two-dimensional picture of a slice of the body. Modern MRI machines are capable of producing 3D pictures.

Nuclear medicine

When it comes to diagnosing and treating illness, nuclear medicine is a unique branch of medicine that utilises radioactive chemicals. Radiation from radioactive materials is utiliZed in nuclear medicine for the diagnosis of a variety of diseases. Nuclear medicine, on the other hand, relies on physiologic evaluation rather than anatomic imaging. Nuclear medicine imaging investigations are more organ or tissue specific (lung scan, brain scan) than traditional radiology imaging studies, which concentrate on a specific portion of the body (for example: chest X-ray, CT scan). Diagnostic nuclear medicine has a wide range of procedures to choose from.

Elastography

Elastography is the medical imaging technique used to depict soft tissue's elastic properties. The disease's existence or condition is determined by the hardness or softness of the tissue. Cancerous tumors, for example, are stiffer than healthy tissue because they are more densely packed. There are a variety of electrographic methods that may be used in a variety of settings, from therapeutic application to research. Electrographic techniques include Quasistatic Elastography/Strain Imaging, Shear Wave Elasticity Imaging (SWEI), Acoustic Radiation Force Impulse Imaging (ARFI), Supersonic Shear Imaging (SSI), and Transient Elastography.

Tactile imaging

Touch is used to create digital images in the tactile imaging modality. Tactile imaging uses stress pattern data to rebuild a tissue's interior mechanical structure. As the pressure sensor array put on the device's face simulates human fingers during inspection, Tactile Imaging replicates manual palpation The elastic characteristics of the myofascial trigger sites may be visually and tactilely assessed using a tactile imaging probe with a tactile imaging equipment. The photos and signal data may be saved for future inspection or data analysis. Tactile imagers will aid in educating pregnant women about the hazards of childbirth and in deciding on delivery management options.. Tactile imaging may be used to image the prostate, breasts, vaginal and pelvic floors, as well as muscular myofascial trigger points.

Photo acoustic imaging

'Photo acoustic imaging,' a hybrid biomedical imaging technique based on the photo acoustic effect, is one example of this technology. Photo acoustic imaging devices come in two varieties. Using an unfocused ultrasound detector, photo acoustic signals are acquired and the picture is reconstructed by inverting the photo acoustic equations. Another method is thermo acoustic computed tomography (TAT). Two further types of microscopy are available, the first of which is photo acoustic microscopy (PAM), which uses a spherically focused ultrasonic detector with 2-D point scanning.

Thermography

It is common to see thermal pictures or thermograms, which are images of the infrared radiation that an item emits, reflects back to itself, and transmits. Thermography is used by firefighters to see through smoke, by maintenance workers to find overheating joints, and by building construction professionals to observe thermal signatures that signal heat leakage. A snapshot isn't required since the live thermogram captures temperature changes at such a granular level. Neither the United States nor Canada have authorised thermography for breast cancer screening, nor both nations have issued cautions about thermography. The discrepancies in detecting temperature changes come as a result of the tumor/circulatory lesion's network changing to support its development. Passive thermography and active thermography are two types of thermography.

Tomography

Rather than cutting an item in half, a tomographic optical system is utilized to create virtual slices of a particular cross section of the subject under study. A technique known as "tomography reconstruction software" processes this data, which includes projection data from several directions, into a 3D model. Different forms of tomograms may be generated using a variety of physical phenomena.

A few examples of this include CT from X-ray, SPECT from gamma rays, and PET from electron-positron annihilation: Both filtered back projection (FBP) and iterative reconstruction are types of reconstruction methods. Traditional tomography and computer-aided tomography are used to provide a single, clear picture of the body.

Ultrasound

It is a diagnostic imaging procedure that uses ultrasound to see the internal body structures, such as the arteries and veins. Ultrasound refers to sound waves with frequencies greater than those of audio. With the use of probes, ultrasonic pulses are sent into tissues to create sonograms, or pictures of ultrasound. With a variety of monographic equipment, multiple imaging modalities may be achieved. The most common is the B-mode picture, which shows the acoustic impedance of tissue's 2-D cross section. When using ultrasound, the benefits include a live picture that can be taken with you anywhere, a reduced cost, and no ionising radiation utilised. For both diagnostic and therapeutic purposes, solography is commonly employed.

SOFTWARE IMPLEMENTATION

High-performance technical computer language MATLAB. An easy-to-use environment where problems and answers are presented in familiar mathematical language is provided by this tool. The MATLAB acronym stands for matrix laboratory, and it was created to make the matrix software produced by the LINPACK and EISPACK programmes more accessible. As a result, many technical computer problems, particularly those involving matrix and vector formulations, may be solved in a fraction of the time using MATLAB's advanced matrix tools.

Toolboxes are MATLAB's collection of application-specific solutions. Toolboxes are essential for the majority of MATLAB users since they enable them to learn and use specific technologies. Compendiums of MATLAB functions (M-files) that expand the MATLAB environment to tackle certain types of issues are included. Toolkits are available in a wide range of fields, including as signal processing, control systems, neural networks, fuzzy logic, wavelets, and simulation, among many other things.

It is used for math and computing, algorithm creation; data collecting; model building, prototype construction; data analysis; and display of scientific and engineering data. MATLAB is also used for application development and graphical user interface building.

FLOW CHART

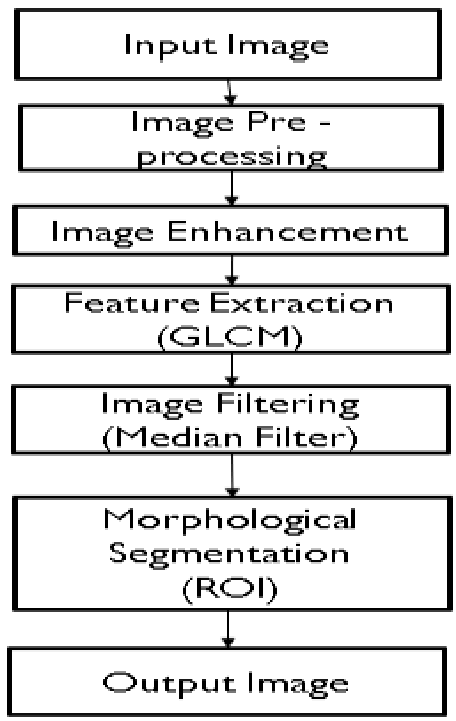

Fig. Flowchart of kidney stone detection using image processing technique

RESULTS

OUTPUT 1:

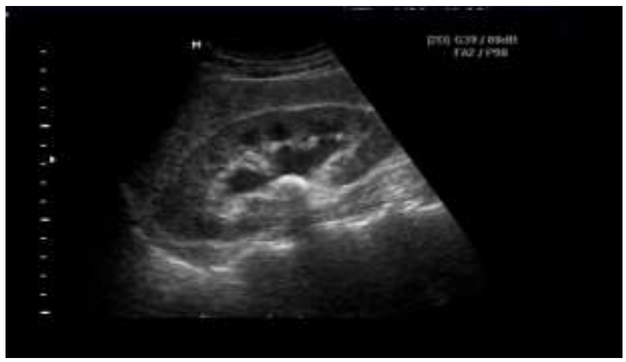

Fig: Input image

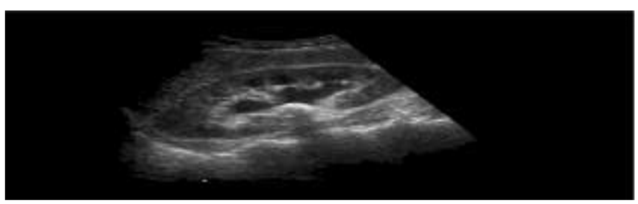

Fig: Pre-processed image

Fig: Filtered and contrasted

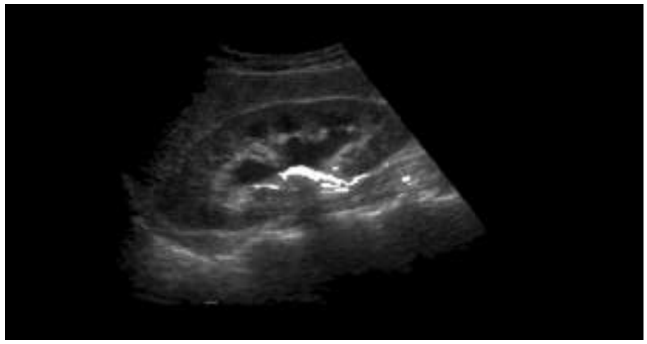

Fig : Final output 1

OUTPUT 2:

Output 2 shows the absence of stone in the kidney

Fig:Region of interest

- In the above image, there is no indication mark which shows absence of stone.

Fig :Final output 2

CONCLUSION

The suggested technique for identifying kidney stones includes pre-processing the ultrasound image, segmenting it, and then conducting morphological analysis on the resultant image.

By analyzing the resulting picture, we were able to pinpoint exactly where the stone was located, as well as its form and structure. The combination of these three methods proved to be an effective method of identifying kidney stones. Compared to previous methods, the proposed algorithm's accuracy is 92.57 percent.

Multi-scale wavelet-based features were shown to be the most effective in classifying images. In comparison to comparable neural network classifiers, a 97% accurate classification rate was attained.

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