NOVEL APPROACH FOR KIDNEY STONE DETECTION THROUGH ULTRASOUND IMAGES USING AGGREGATION FILTER MECHANISMS

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Abstract:

The Kidney Stone issue can be seeing rising dramatically throughout the world. Filtration of the blood is the primary function of kidneys. They maintain balance of bodily fluids by removing waste materials from it. When blood comes into kidney the work of kidney starts like removing waste and adjusting level of salt, water and minerals if it is needed. It's difficult to obtain results for large dataset using human inspection, this is where an automated kidney stone classification is implemented. The automated system uses image processing and deep learning method. The MIR and CT scan images of the proposed methodology of nephrolithiasis is preprocessed. A commendable contribution of various researcher in the discipline of nephrolithiasis detection via means of occurring numerous algorithms to locate the kidney stone is seen. Use of neural network for the classification of urinary calculus has shown great potential.

Keywords: Introduction, Deep learning-Based Approaches, CNN-Based Classification, Feature Extraction

I. INTRODUCTION

Ultrasound imaging is one of the imaging techniques used for diagnosis of kidney abnormalities. The kidney abnormalities such as formation of stones. During surgery it is very hard to recognize the precise location of the kidney stone. Kidney stone disease is one of the most life-threatening diseases in the world wide. The main function of the kidney is to regulate the balance of electrolytes in the blood. Kidney is a bean shaped organ and present on each side of the spine.The main application of detection is used in brain tumor detection and thyroid segmentation.

In existing work The applications of image processing are used in Image sharpening and restoration, Medical field, Color Processing, Pattern Recognition. The disadvantage of ultrasound images is that they have low contrast and speckle noise. It is a challenging task for detection of kidney stones. In proposed work the detection of kidney stones is a highly challenging task as they have low contrast and speckle noise. This challenge is overcome by using suitable imaging techniques and filters. Ultrasound images normally consist of speckle noise which cannot be removed by normal filters. So the median filtering algorithm is proposed, the median filter removes the speckle noise. The preprocessed image is achieved with a median filter to remove noise and to detect the stone region. Majority of people with kidney stone disease do not notice the disease as it damages organs slowly before showing symptoms. Different types of kidney stones namely renal calculi, struvite stones, staghorn stones were analyzed.(Hafizah and Supriyanto 2011). In order to get rid of the painful disorder the kidney stone is diagnosed through ultrasound images and then removed through a surgical process like breaking up of stone into smaller pieces which then pass through the urinary tract. Study setting of proposed work is done in our university. The number of groups identified for the study is 2. The group 1 is median filter and group 2 is rank filter. Matlab 2014a tool kit will be used to write the code and simulate. Using matlab accuracy and sensitivity has been calculated for the required algorithm and then results have been compared.

II. LITERATURE SURVEY

1. Malathy Chidambaranathan and Gayathri Mani "kidney stone detection with CT images using neural network" Research gate May 2020 DOI:10.37200/IJPR/V24I8/PR280269 Conference: iciot2020

Back Propagation Network (BPN) with image and data processing techniques are employed to implement an automated kidney stone classification. By human inspection and operators, it is impossible to produce result for large amount of dataset. CT scan and MRI produces a lot of noise and hence leads to inaccuracies. Artificial intelligent techniques through neural networks techniques have shown great importance in this field. Hence, in this project we are applying the Back-Propagation Network (BPN) for the purposes. Features are extracted using GLCM and are then classified using BPN. This project presents a segmentation method, Fuzzy C-Mean (FCM) clustering algorithm, for segmenting computed tomography images to detect the kidney stones in its early stages.

2. T. Vineela, R. V. G. L. Akhila, T. Anusha, Y. Nandini, S. Bindu "Kidney Stone Analysis Using Digital Image Processing" International Journal of Research in Engineering, Science and Management Volume-3, Issue-3, March-2020 www.ijresm.com | ISSN (Online): 2581-5792

Kidney stones are hard collection of salt and minerals often made up ofcalci um and uric acid. Majority of people with stones in kidney at initial stage do not notice and it damages the organs slowly. It is very important to detect the exact and accurate position of kidney stone for surgical operations. Ultrasoun d images normally consists of Speckle noise which cannot be removed by ma n kind. Hence we preferred automated techniques in detection of kidney stone s in ultrasound images using median filter instead of gabor filter.

3. Kalannagari Viswanath and Ramalingam Gunasundari "Analysis and Implementation of Kidney Stone Detection by Reaction Diffusion Level Set Segmentation Using Xilinx System Generator on FPGA", Hindawi Publishing Corporation VLSI Design, Volume 2015, Article ID 581961,

Ultrasound imaging is one of the available imaging techniques used for diagnosis of kidney abnormalities, which may be like change in shape and position and swelling of limb; there are also other Kidney abnormalities such as formation of stones, cysts, blockage of urine, congenital anomalies, and cancerous cells. During surgical processes it is vital to recognize the true and precise location of kidney stone. The detection of kidney stones using ultrasound imaging is a highly challenging task as they are of low contrast and contain speckle noise. This challenge is overcome by employing suitable image processing techniques. The ultrasound image is first preprocessed to get rid of speckle noise using the image restoration process. The restored image is smoothened using Gabor filter and the subsequent image is enhanced by histogram equalization. The preprocessed image is achieved with level set segmentation to detect the stone region. Segmentation process is employed twice

for getting better results; first to segment kidney portion and then to segment the stone portion, respectively. In this work, the level set segmentation uses two terms, namely, momentum and resilient propagation () to detect the stone portion. After segmentation, the extracted region of the kidney stone is given to Symlets, Biorthogonal (bio3.7, bio3.9, and bio4.4), and Daubechies lifting scheme wavelet subbands to extract energy levels. These energy levels provide evidence about presence of stone, by comparing them with that of the normal energy levels. They are trained by multilayer perceptron (MLP) and back propagation (BP) ANN to classify and its type of stone with an accuracy of 98.8%. The prosed work is designed and real time is implemented on both Filed Programmable Gate Array Vertex-2Pro FPGA using Xilinx System Generator (XSG) Verilog and Matlab 2012a.

4. Anushri Parakh, Hyun Kwang Lee, Jeong Hyun Lee, Brian H. Eisner, Dushyant V. Sahani and Synho Do "Urinary Stone Detection on CT Images Using Deep Convolutional Neural Networks: Evaluation of Model Performance and Generalization" Radiol Artif Intell. 2019 Jul; 1(4): e180066.Published online 2019 Jul 24. DOI: 10.1148/ryai.2019180066.

To investigate the diagnostic accuracy of cascading convolutional neural network (CNN) for urinary stone detection on unenhanced CT images and to evaluate the performance of pretrained models enriched with labeled CT images across different scanners.

5. Venkatasubramani.K, K. Chaitanya Nagu, P. Karthik, A. Lalith Vikas, "Kidney Stone Detection Using Image Processing and Neural Networks", Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021

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This paper likely explores the application of image processing techniques and neural networks for the detection of kidney stones, which is a significant health issue affecting many individuals worldwide. The use of computational methods such as neural networks in medical image analysis has become increasingly common due to their potential to assist healthcare professionals in accurate diagnosis and treatment planning.If you need further information or assistance regarding the content or findings of this research paper, please feel free to ask.

III. PROPOSED ALGORITHM

Proposing novel algorithms and techniques for kidney stone detection involves leveraging advancements in imaging technology, computational methods, and machine learning. Such approaches aim to improve the accuracy, efficiency, and reliability of kidney stone detection across various imaging modalities, including ultrasound, computed tomography (CT), and X-ray. In this section, we'll explore proposed algorithms and techniques for kidney stone detection:

1. Deep Learning-Based Approaches: Deep learning has shown significant promise in various medical imaging applications, including kidney stone detection. Convolutional neural networks (CNNs), in particular, have demonstrated remarkable capabilities in learning complex patterns and features from imaging data. Proposed deep learning-based approaches for kidney stone detection include:

CNN-Based Classification: Designing CNN architectures tailored for kidney stone detection, where the network learns to differentiate between kidney stones and normal renal tissue based on input ultrasound, CT, or X-ray images.

Multi-Modal Fusion Networks: Developing networks that fuse information from multiple imaging modalities, such as combining ultrasound and CT images, to enhance the accuracy and robustness of kidney stone detection algorithms.

Transfer Learning: Leveraging pre-trained CNN models on large-scale image datasets to perform kidney stone detection. Fine-tuning these models on smaller, annotated datasets specific to kidney stone detection tasks can expedite algorithm development and improve performance.

Generative Adversarial Networks (GANs): Exploring GANs to generate synthetic ultrasound, CT, or X-ray images of kidney stones. These synthetic images can be used to augment training data, improve algorithm generalization, and address data scarcity issues.

2. Hybrid Image Processing Techniques: Hybrid techniques combine traditional image processing methods with advanced computational algorithms to enhance kidney stone detection accuracy. Proposed hybrid approaches include:

Edge Enhancement and Segmentation: Employing edge detection algorithms to enhance kidney stone boundaries in ultrasound or X-ray images, followed by segmentation techniques to accurately delineate stone regions from surrounding tissues.

Feature Extraction and Classification: Extracting handcrafted features, such as texture patterns, shape characteristics, and intensity distributions, from kidney stone images. These features are then input to machine learning classifiers for accurate stone detection and classification.

3.Advanced Image Reconstruction Techniques: Advanced reconstruction techniques aim to improve image quality and enhance the visualization of kidney stones in medical images. Proposed approaches include:

Iterative Reconstruction: Iteratively refining image reconstruction algorithms to reduce noise, artifacts, and image degradation in ultrasound, CT, or X-ray images, thereby improving the clarity and visibility of kidney stones.

Super-Resolution Imaging: Employing super-resolution techniques to enhance image resolutionand detail, particularly in cases of low-quality or low-resolution ultrasound or X-ray images.

4. Real-Time Detection Systems: Real-time detection systems aim to provide instantaneous feedback to healthcare providers during imaging procedures, facilitating prompt diagnosis and treatment decisions. Proposed approaches include:

GPU-Accelerated Processing: Leveraging Graphics Processing Units (GPUs) for accelerated image processing and analysis, enabling real-time detection of kidney stones in ultrasound, CT, or X-ray images.

Parallel Computing Architectures: Exploiting parallel computing architectures, such as Field-Programmable Gate Arrays (FPGAs) or Application-Specific Integrated Circuits (ASICs), to implement high-performance, real-time detection algorithms for kidney stone imaging systems.

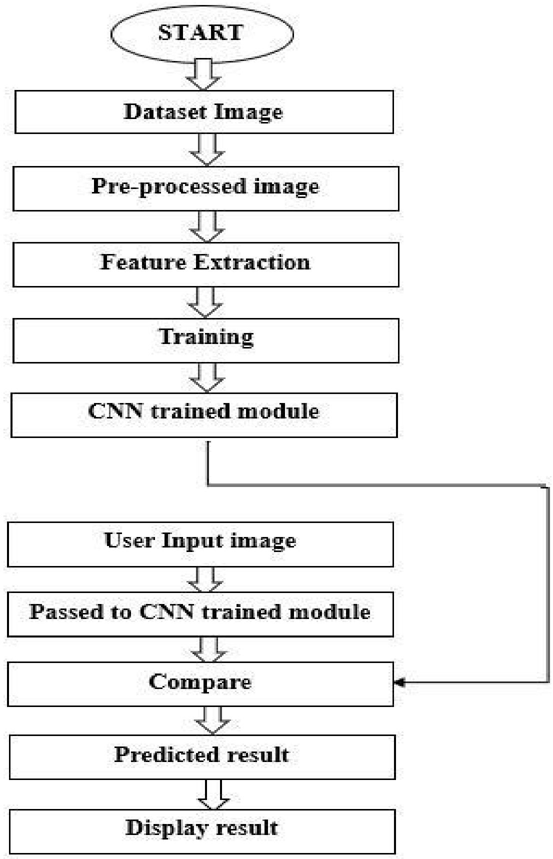
Embedded Systems Integration: Developing compact, embedded systems that integrate advanced detection algorithms with ultrasound, CT, or X-ray imaging devices, enabling point-of-care kidney stone detection in clinical settings

5.Multi-Modal Fusion Strategies: Multi-modal fusion strategies combine information from multiple imaging modalities or sources to improve kidney stone detection accuracy and reliability. Proposed fusion approaches include:

Feature-Level Fusion: Integrating complementary features extracted from ultrasound, CT, or X-ray images using advanced fusion techniques, such as principal component analysis (PCA) or canonical correlation analysis (CCA), to enhance detection performance.

Decision-Level Fusion: Combining detection decisions from individual imaging modalities using fusion rules, such as majority voting or weighted averaging, to achieve consensus-based kidney stone detection outcomes.

IV. SYSTEM ARCHITECTURE



V. FIGURES

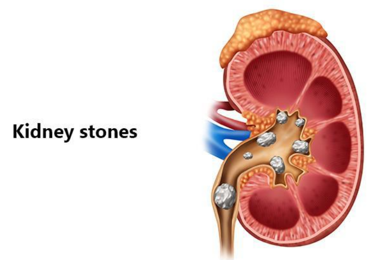


FIG1.KIDNEY STONE

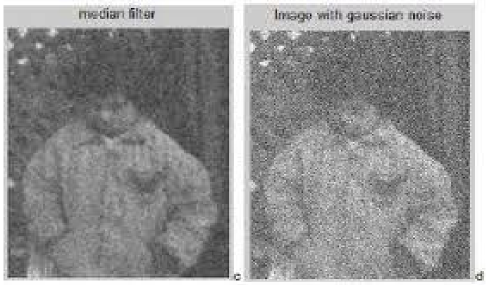


FIG2.MEDIAN FILTER

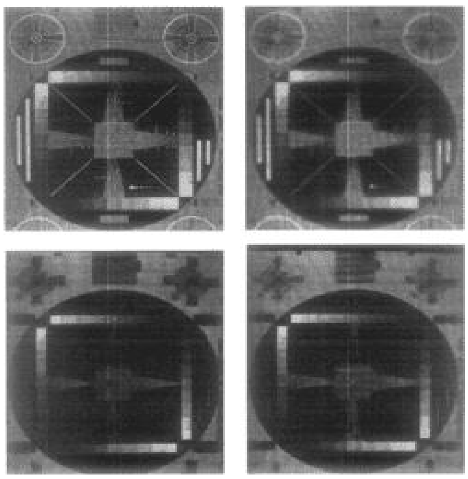


Fig3. Rank Filter

Fig.4 Original image

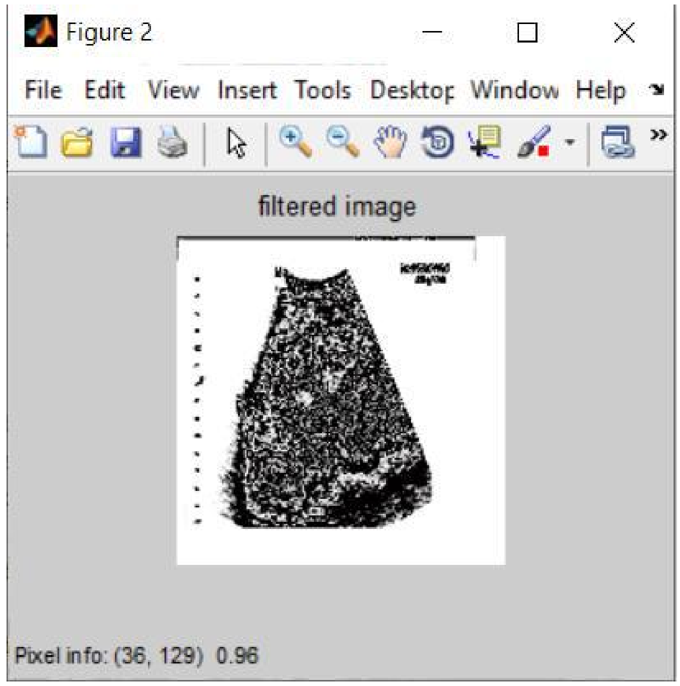
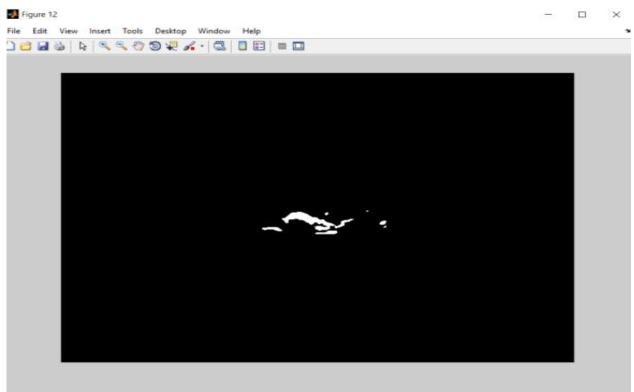
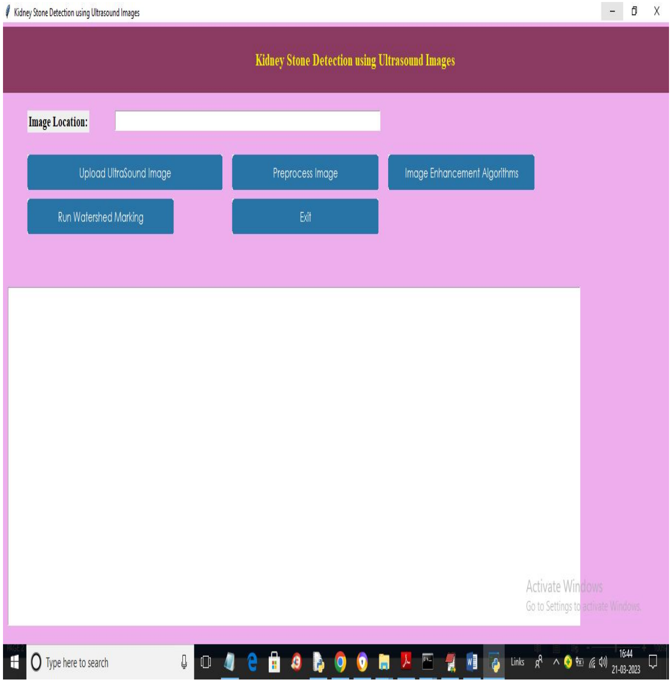


Fig5.Removal of noise using Median Filter



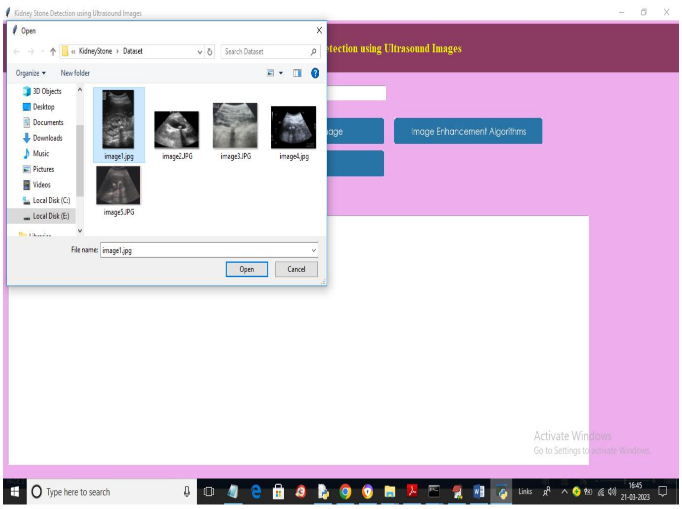
VI. SCREEN SHORTS

1.To run project double click on 'run.bat' file to get below screen



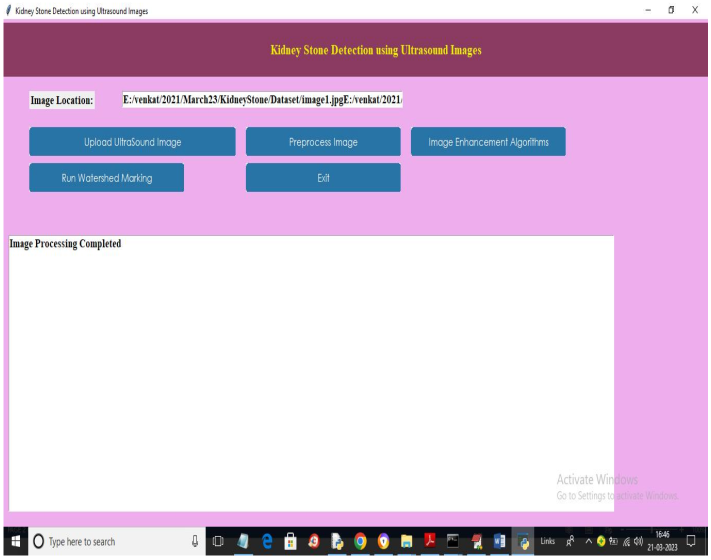
In above screen click on ‘Upload Ultrasound Image’ button to upload image and get below output.

2.



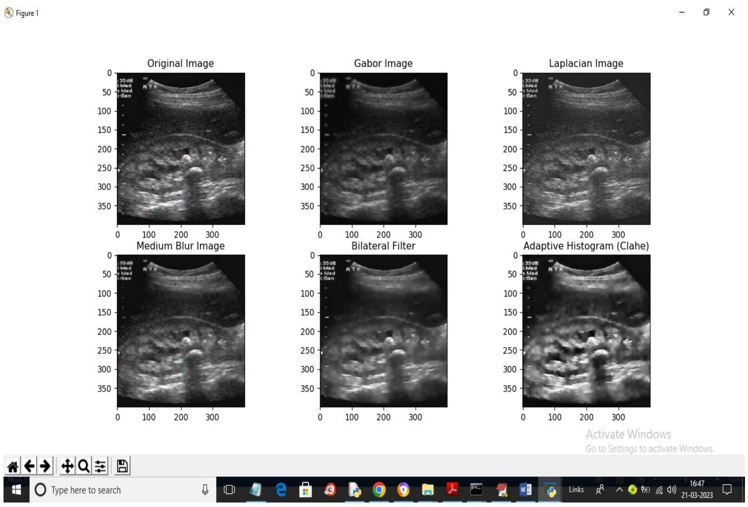
In above screen selecting and uploading image and then click on ‘Preprocess Image’ button to normalize and resize image and get below output.

3.



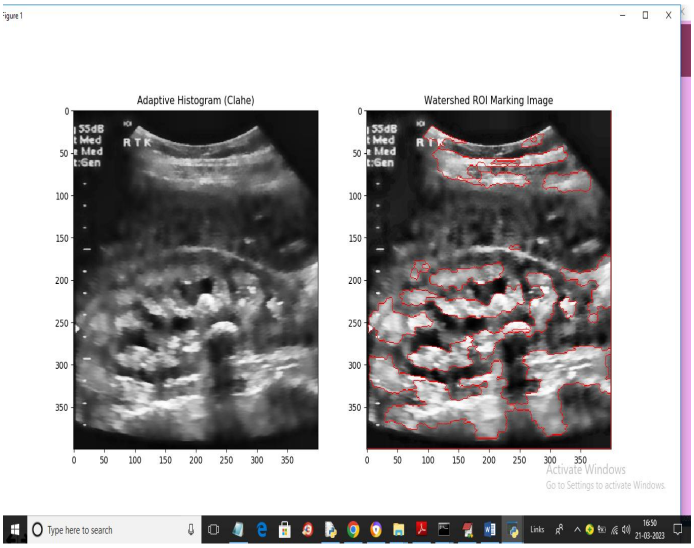
In above screen image processing task completed and now click on ‘Image Enhancement Algorithm’ button to apply filtration algorithms to enhance image and get below output.

4.



In above screen first image is original image and second image is Gabor image and 3r image is Laplacian Image and 4t image is Medium Blur and 5th image is Bilateral image and 6th is the adaptive histogram CLAHE image and in all images Bilateral and Adaptive histogram having more clarity. Now close above image and then click on ‘Run Watershed Marking’ algorithm button to get below output

5.



In above screen first image is adaptive histogram image and second image ROI marking image and this ROI region is showing in red colour marking. Similarly you can upload and test any other image

VII. CONCLUSIONS

Based on the results and tabulations, the detection rate of the kidney stones in ultrasound images using median filters is improved in terms of accuracy (86.4%) and sensitivity (87.7%) compared with the accuracy (82.2%) and Sensitivity (82.5%) of rank filter.

VIII. ACKNOWLEDGEMENT

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