KIDNEY STONE DETECTION USING IMAGE PROCESSING AND DEEP LEARNING

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Abstract— *The detection of kidney stones is an important task in medical imaging. In recent years, image processing and deep learning techniques have shown great potential in medical image analysis. This paper presents an approach for kidney stone detection using image processing and deep learning. The proposed method consists of two main stages: image pre-processing and deep learning-based detection. In the pre-processing stage, images are pre-processed to enhance the features that are important for kidney stone detection. In the detection stage, a deep learning model is trained on the pre-processed images to detect the presence of kidney stones. The performance of the proposed method is evaluated using a dataset of kidney stone images. Experimental results show that the proposed method achieves high accuracy in kidney stone detection and outperforms traditional image processing techniques. The proposed method has the potential to be used in clinical settings for early detection and diagnosis of kidney stones.*

I. INTRODUCTION

The kidney issue can be seeing rising dramatically throughout the world. Shape of kidney are like been shaped. They are located on both side of spines behind the bellies. Size of kidney is around size of largest fist. Filtration of the blood is the primary function of kidney. They maintain balance of fleshly fluids by removing waste accoutrements from it. Also, they keep electrolytes in their sufficient situations. When blood comes into order the work of order starts like removing waste and conforming position of swab, water and minerals if it's demanded also this filtered blood goes into body back and the waste goes into pelvis and also removed from body in the form of urine channel shaped structure that drains down a tube known as ureter to the bladder.

Each and every order gravestone having around ten percent bitsy pollutants. They're known as nephrons. If blood stops flowing through order part it could be die and that can lead to order failure. Conformation of a gravestone in order to leads to blockage of urine natural anomalies excrescencies. Colorful types of order monuments videlicet viz renal math gravestone, struvite monuments, stage cornucopia was analyzed. An estimable donation of colorful experimenter in the discipline of nephrolithiasis discovery via means of being multitudinous algorithms to detect the order gravestone is seen. Use of neural network for the bracket of urinary math has shown great eventually.

II. LITERATURE SURVEY

For this content, numerous exploration papers have been published and numerous experimenters have work upon it, in order to design order gravestone discovery using image processing and deep learning many of the following are bandied then. Literature check is an information review which will help us in understanding and exploring conception of base literacy So it will help us in better understanding the motifs grounded on early information available. Literature check is frequently done to connect our work with the relation of being data. Various surveys were conducted on the different methods used for kidney stone detection in ultrasound images. The main focus was to find an accurate and efficient method for detecting the exact position of kidney stones in order to facilitate surgical operations. We found that automated techniques are preferred over manual inspection, and that ultrasound images often contain Speckle noise which can be challenging to remove.

The survey focused on the development of an automated system for kidney stone detection using CT images and neural network techniques. The study aimed to explore the effectiveness of GLCM feature extraction and Fuzzy C-Means method for segmentation, and BPN classifier for classification. The study revealed that the proposed system achieved promising results in accurately detecting different types of kidney stones. Comparing with other methods such as Gabor filters and Canny Edge Detection lifting schemes, GLCM feature extraction demonstrated notable potential for accurately categorizing kidney stones.

The proposed system was evaluated for training and accuracy of classification, and the results showed that BPN classifier performed well. The study employed MATLAB R2016a for pre-processing with the use of GLCM feature extraction, dataset education, BPN, and watershed set of rules. Overall, the survey provides insights into the development of an automated system for kidney stone detection using CT images and neural network techniques. The study highlights the effectiveness of GLCM feature extraction and BPN neural network techniques in detecting different types of kidney stones.

After evaluating various existing techniques, we discovered that the proposed methodology of using a median filter instead of a Gabor filter for ultrasound image preprocessing, followed by segmentation and morphological analysis of the resulting image, was a promising method for detecting kidney stones. The resulting image allowed for the exact location and shape of the stones to be identified. The combination of these techniques resulted in an accuracy of 92.57%, which is competitive compared to previous algorithms.

Then another paper proposes a method for detecting kidney stones using ultrasound images and Reaction Diffusion Level Set Segmentation on FPGA. The ultrasound image is pre-processed to remove noise, smoothed with a Gabor filter, and enhanced with histogram equalization. Level set segmentation is employed twice to detect the kidney and stone portions. The proposed method is implemented on FPGA with satisfactory results and low resource utilization. An ANN is trained with wavelets filters to classify normal or abnormal conditions with an accuracy of 98.8%.

Overall, survey highlights the importance of automated techniques and the need for accurate and efficient methods for detecting kidney stones in ultrasound images. The proposed methodology shows promise in this regard and can potentially be further improved upon in future studies.
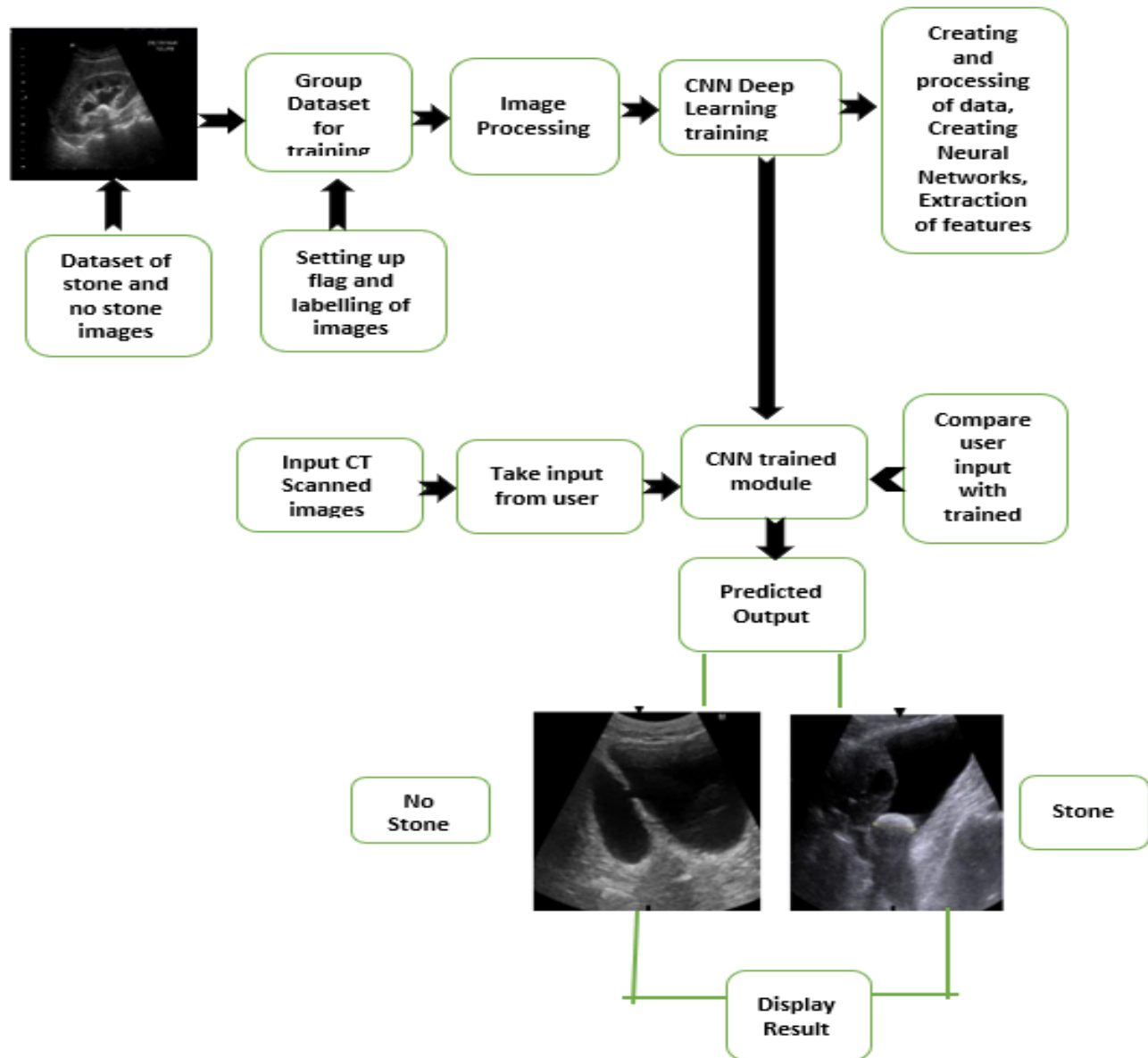
III. DESIGN AND DRAWING

Fig 1 - Detection of Kidney Stone Using Deep Learning and Image Processing

A. *SPECIFICATIONS*: The specifications described above are related to the software platform Python. Python is a programming language that is interpreted, object-oriented, and high-level, meaning it provides an abstracted way of writing programs that is closer to human language. Python's dynamic semantics make it well-suited for Rapid Application Development and for scripting or gluing together existing components. Python's syntax is easy to learn and read, which can help reduce the cost of program maintenance. Python also supports modules and packages for program modularity and code reuse. The language is free and open-source, and has a vast library support. Finally, Python is portable, meaning that it can be used on different operating systems without modification.

B. *CNN ALGORITHM* - A Convolutional Neural Network (CNN) is a type of Deep Learning algorithm that is particularly useful for analysing visual images. The network consists of multiple hidden layers that are designed to extract important features from an image. The four main layers in a CNN are the convolution layer, the Relu layer, the pooling layer, and the fully connected layer. The first layer in a CNN is the convolution layer, which applies multiple filters to the input image to extract important features. Each filter performs the convolution operation by sliding over the image and computing the dot product to get the convolved feature matrix.

The output of the convolution layer is passed through a Relu layer, which applies an element-wise operation to the output and sets all negative pixels to zero. This introduces non-linearity to the network and generates a rectified feature map. The next layer in the CNN is the pooling layer, which reduces the dimensionality of the feature map by performing a down-sampling operation. The pooling layer uses different filters to identify different parts of the image, such as edges, corners, and other features.

The flattened matrix is then fed to the fully connected layer to classify the image. The fully connected layer uses the output from the previous layers to generate the final output, which indicates the presence or absence of a particular object in the image. Overall, a CNN is an effective way to extract important features from an image and classify it based on those features. It is widely used in image recognition and classification tasks, such as detecting kidney stones in medical images.

C. MACHINE LEARNING - Kidney stone detection can also benefit from machine learning algorithms. The identification of kidney stones through imaging techniques can sometimes be challenging and require expert radiologist interpretation. Machine learning algorithms can be trained using a large dataset of kidney stone images and their corresponding clinical data to develop accurate predictive models. For instance, supervised machine learning algorithms can be trained using a dataset of labeled images of kidney stones and their corresponding clinical data, such as size, location, and type. The algorithm can then be used to predict the likelihood of a new image containing a kidney stone based on these features.

Unsupervised learning algorithms can also be useful in identifying patterns in the data that may be indicative of kidney stones, even if they are not explicitly labeled as such. The algorithm can restructure the data into new features that may help identify previously unseen patterns. Moreover, reinforcement learning algorithms can be used to optimize the detection and diagnosis of kidney stones by allowing the algorithm to learn from feedback provided by expert radiologists. This can lead to improved accuracy and efficiency in the diagnosis of kidney stones.

In conclusion, machine learning algorithms can be a valuable tool in the detection and diagnosis of kidney stones, providing accurate and efficient results that can help clinicians provide the best possible care for their patients.

D. IMAGE PROCESSING - Image processing, specifically morphological image processing, can be applied in the detection and analysis of kidney stones. In medical imaging, such as CT scans or X-rays, morphological operations can be used to extract the shape and size of the kidney stones from the images. By applying dilation and erosion operations, the boundaries of the kidney stones can be enhanced, and the size and shape of the stones can be accurately measured. This information can be used by medical professionals to determine the appropriate treatment for the patient, such as the size and location of the stone, and whether it can be treated with medication or if surgical intervention is necessary. Morphological image processing can also be used to analyse the composition of the stone, providing valuable information for the development of personalized treatment plans.
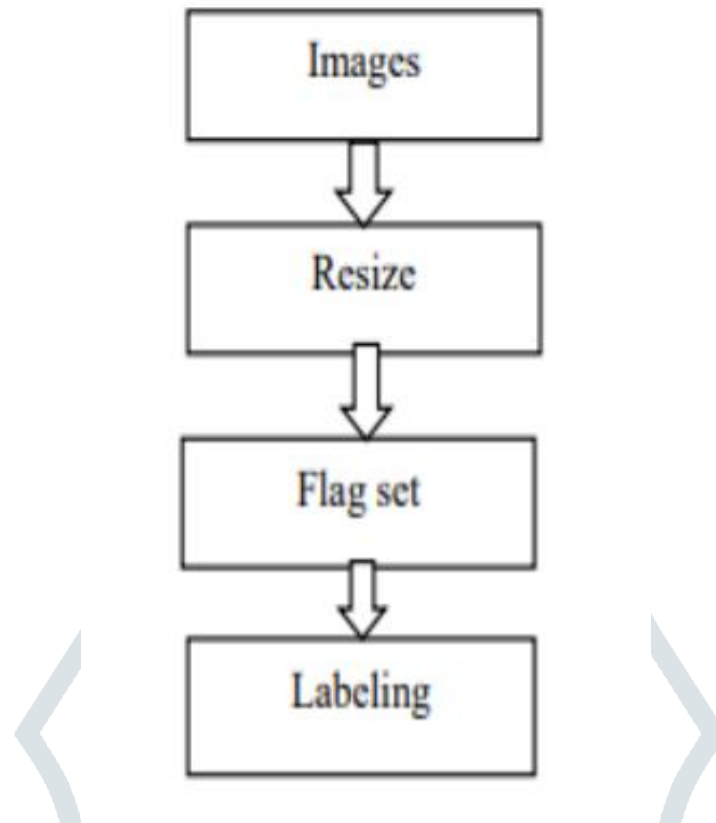
Fig 2 – Image Processing

E. GUI- The use of GUI in software development is common, as it provides an intuitive and user-friendly way for users to interact with the software. GUIs utilize visual elements such as buttons, dialog boxes, menus, and toolbars to enable users to navigate and execute commands with ease. In addition, GUIs provide a platform for the display of data in a visually appealing and understandable way. Although GUI systems are primarily navigated using a mouse, a keyboard can also be used via keyboard shortcuts or the arrow keys. In contrast, command-line interfaces require users to have knowledge of commands to navigate directories, list files, and execute commands.

IV. EXPERIMENTATION

1. Dataset Preparation: A dataset of ultrasound images is prepared, which consists of images containing kidney stones and images without kidney stones. This dataset is used to train the deep learning model.

2. Data Processing: The dataset is processed by resizing the images, setting flags to images, and labeling the images. This is done to make sure that the data is uniform and can be used for training.

3. CNN Training: Convolutional Neural Network (CNN) is trained using the processed dataset. In the training process, the CNN algorithm is used, and three layers of CNN are employed to extract features of the images.

4. Trained Module: The trained module stores all the information extracted from the dataset, and it acts as a reference point for the kidney stone detection system.

5. User Input: When a user inputs an image, it is sent to the trained module for analysis.

6. Image Comparison: The input image is compared with the training done on the dataset. This comparison generates a predicted result of whether the stone is present or not.

7. Output: Finally, the output is displayed on the screen, indicating whether the kidney stone is present or not.
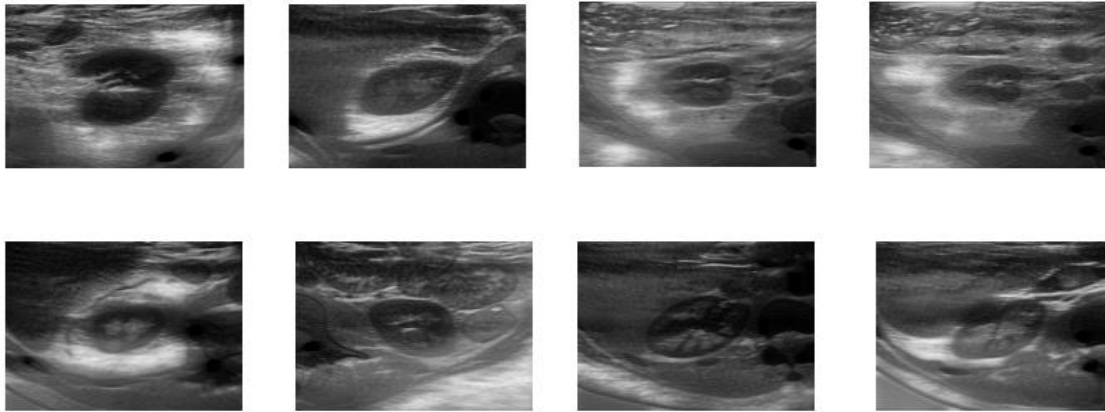
VI. Result / Output

INPUT

Fig 3 – Input images

The above figure shows that we gave some input images which may or may not contain kidney stone.

EXPERIMENTAL OUTPUT –

{array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([0, 1]), array([1, 0]), array([1, 0]), array([0, 1]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([0, 1]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([1, 0]), array([0, 1]), array([1, 0]), array([0, 1])}

Run id: Kidneyst-0.001-6conv-basic. Model

 Log directory: log/

Training samples: 4586

Validation samples: 0

 [0,1] = no stone
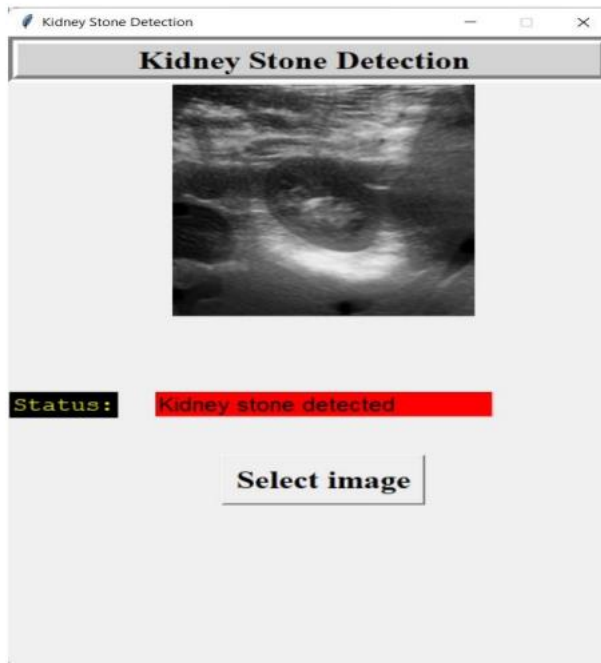
 [1,0] = stone

GUI OUTPUT –

Fig 4 – GUI Output of Kidney Stone Detection

The above fig 4 shows the information about output. We gave the input image which is a stone image and the result also shown correctly. So, as per output system is working correctly with proper accuracy

Fig 5 – GUI Output of no Kidney Stone Detection

The above fig 5 shows the information about output. We gave the input image which is not a stone image and the result also shown correctly. So, as per output system is working correctly with proper accuracy.

VII. APPLICATIONS

- Early detection: By analyzing medical images of the urinary system, deep learning algorithms can detect the presence of kidney stones at an early stage. This can help doctors diagnose and treat the condition before it worsens and causes complications.

- Quantitative analysis: Deep learning models can also be used to quantify the size, shape, and location of kidney stones. This information can help doctors plan the most effective treatment strategy, such as determining the best approach for surgical removal of the stones.

- Monitoring treatment progress: Deep learning algorithms can be used to monitor the progress of treatment by analyzing changes in the size, shape, and location of kidney stones over time. This can help doctors determine whether a treatment is effective or whether adjustments need to be made.

- Improving diagnosis accuracy: By using image processing techniques to enhance medical images, doctors can improve the accuracy of their diagnoses of kidney stones. This can lead to more effective treatment and better outcomes for patients.

- Automated diagnosis: In the future, deep learning models could be used to automatically diagnose kidney stones, reducing the need for human intervention and speeding up the diagnosis process. This could be particularly useful in areas with limited access to medical professionals.

VIII. CONCLUSIONS

Detecting the presence of stones in kidney using the proposed methodology has been done by preprocessing the ultrasound image. It was followed by segmentation and eventually morphological analysis of the performing image was performed. The final image helped in the discovery of the exact position of the kidney stone. Moving further the edge discovery system was performed which linked the shape and structure of the stones that get formed in the kidney.

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