COMPUTER AIDED SYSTEM FOR DIAGNOSIS OF KIDNEY STONES USING NEURAL NETWORKS

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Abstract
Human body works as a synchronized system based on functions of various organs which have prominent role to play individually but are interrelated with different functioning properties. In the present work we have taken upon such organ called as kidney which performs the job of filtering the chemical compositions, taken as an input to the human body. In the present literature much work as not been done to understand the diss functioning of kidney using signals as a parameter, hence we have considered ultrasound signal for recognition of different forms of stones which are the major obstacles for kidney functioning
Keywords: ANN, Kidney Stone, Level Set Segmentation, Ultrasound Imaging.

I. INTRODUCTION

Every human being as to take either solid or liquid indifferent propositions for his existence, during this process their might be certain ingredients which may not play a major in development of the human system, hence there must be certain organs in a human body which play a role of filtering (separating required ingredients), It also quite evident that segregation of unwanted ingredients will spoil the functioning of human body. In the present work we have taken up kidney one such organ which separates the liquid content of human intake.

Further, it also bring us to the point what happens to this ingredients which are in liquid form when solidified, which is a basic property in chemical engineering. In human body they become stones since the ingredients are nothing but chemicals different compositions in different propositions. The effect of these solidified materials on the functioning of human body is drastic that the entire human body functioning collapses to a desynchronizing effect on the other organs leading to the death of human being

II. PROBLEM STATEMENT

The medical diagnosis by nature is a complex and fuzzy cognitive process hence soft computing methods, such as neural networks, have shown great potential to be applied in the development of medical diagnosis. In disease diagnosis the learning and detection of partial disease can be helpful when time and information constraints are present. Thus artificial neural networks provide a good means to partial diagnosis. Data mining technology helps in classifying kidney stone patients and this technique helps to identify potential kidney stone patients by simply analyzing the data set from scanned image. The need is to automate this process to make the kidney stone diagnosis efficient and fast with the use of state of the art technology.

III. RELATED WORK

A. LEVEL SET SEGMENTATION

The ultrasound images are low contrast and contains speckle. As a result the doctors may have problem to identify the small kidney stones and their type properly. To address this issue a modified level set segmentation to identify location of the stone, Wavelets sub-bands to

extract the energy levels of the stone and Multilayer Perceptron with Back Propagation (MLP-BP) ANN algorithms for classification is proposed and analyzed [5].
Speckle noise is removed by preprocessing of ultrasound images. In modified level set segmentation, Wavelets subbands to extract the energy levels of the stone using Daubechies (Db12), Symlets (symI2) and Biorthogonal filterers (bi03.7, bi03.9 & bi04.4), and a MLP - BP ANN algorithms for classification.

The ANN trained with normal kidney image and classified image input into normal or abnormal by considering extracted energy levels from wavelets filters. The different kidney images from database are tested and has classified successfully with the accuracy of 98.8%. So the system can be readily deployed in the hospitals for detecting abnormality of individuals' using ultrasound kidney image. Thus it is proved that the combination of level set segmentation, wavelet filters, and MLP - BP technique provides the better approach for the detection of stones in the kidney [6].

B. Artificial Neural Networks

Diagnosis of kidney stones is done by using three different neural network algorithms which have different architecture and characteristic. Performance of all the three neural networks is compared based on its accuracy, time taken to build model, and training data set size. Performance comparison of different algorithms is done to propose the best algorithm for kidney stone diagnosis.
The three Radial basis functions (RBF), Learning Vector Quantization (LVQ) and a Multilayer perceptron with back propagation algorithm The attributes are actually symptoms of kidney stone on the basis of which neural networks are trained. The attributes taken for diagnosis are Lymphoctyes, Monocytes, Eosinophis, Neutrophil, S. Creatinine, Blood Sugar, and U.Acid.

The multilayer perceptron with two hidden layers and back propagation algorithm has accuracy of 92% in diagnosis the kidney stone disease. It correctly classified the 977 instances from 1000 instances. Thus finally we come to conclusion that multilayer perceptron trained with back propagation is best algorithm for kidney stones diagnosis [8].

C. MULTILAYER PERCEPTRON

Back propagation is a supervised learning network. It requires a dataset of the desired output for many inputs, for creating the training set. The back propagation is the best model for kidney stone disease. Its accuracy is 81% to diagnosis the kidney stone disease Back propagation is a supervised learning network. It requires a dataset of the desired output for many inputs, for creating the training set. There are two type of transfer function can be used by the back propagation algorithm is sigmoid and log sigmoid [16]. Back propagation algorithm is also known as multilayered feed forward network.
Error data at the output layer is "back propagated" to earlier ones, allowing incoming weights to these layers to be updated**.** It is most often used as training algorithm in current neural network applications. The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units. The architecture of a back propagation network [1].

D. WAVELET TRANSFORM

Ultrasound image enhancement algorithm is presented using wavelet transform for efficient speckle suppression. A wavelet is a mathematical function that is used to represent a continuous time signal into different scale components. A wavelet transform is representation of a function by wavelets. Wavelet decompositions are fast to compute and yield a small number of coefficients [3].
Daubechies - Discrete Wavelet Transform (DWT) provides an appropriate basis for separating the speckle noise from an image. Fuzzy C means clustering technique is used for unsupervised image segmentation. Area criteria is used to select the label that represents the stone region and to eliminate the unlikely tape artifacts and high intensity labels. The result of this step is multiplied with the original image to detect kidney stone. The statistical features are extracted by using wavelet decomposed image. The extracted features are the characteristics of the input type to the classifier. The extracted features are compared with the features of unknown sample image for classification. The ability of these features to classifying kidney stone is done using Back Propagation Neural Network.

The algorithm was tested and found to be effective for an exact matching of the signal and noise distributions at different scales and orientations. Computerized analysis of the US data objectifies the examination and makes easier and more accurate the early diagnosis of certain diseases which usually provide similar US images [2].

IV. METHODOLOGY

The overall block diagram of the proposed method is shown in Fig. 1. It consists the following modules, Ultrasound Images, Image preprocessing, Image Segmentation, Feature Extraction, Classification.

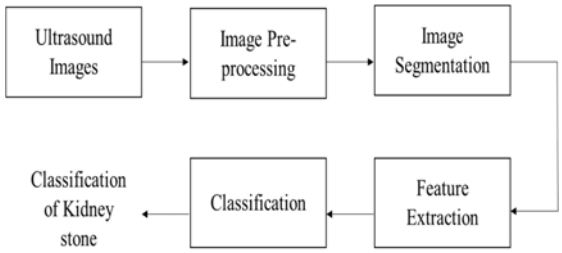

Fig1: System Architecture

A. Image Pre-processing

The low contrast nature of ultrasound images and presence of speckle noise reduce the image quality. This makes the detection of kidney difficult. To improve the quality of the ultrasound image preprocessing is performed. First, image restoration is performed on the image [12, 15]. The image preprocessing is performed by three steps as shown in Fig. 2.

- Image Restoration
- Smoothing and Sharpening
- Histogram Equalization

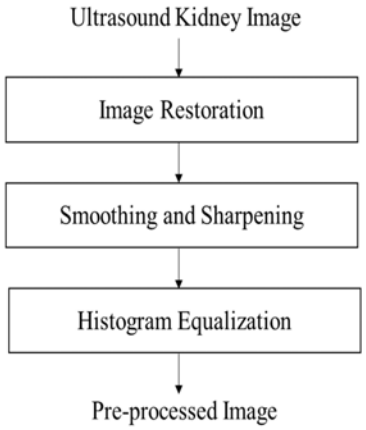

Fig2: Image Preprocessing

- *Image Restoration*

During the acquisition process of ultrasound imaging, the image obtained gets degraded. The image restoration is used to reduce the degradations that are caused [6, 15].

- *Smoothing and Sharpening*

Gabor filter is used to obtain optimal resolution in both spatial and frequency domains. By adjusting the degree of smoothing standard deviation of the Gaussian function can be varied [6, 15].

- *Histogram Equalization*

Histogram equalization is used to improve contrast and obtain uniform intensity. Contrast image is enhanced by transforming the value of intensity such that the histogram obtained approximately matches a specified histogram [6, 12].

B. Image Segmentation

To segment the location of kidney stone level set segmentation method is used. There are two modified gradient descent methods. One is momentum term and second one is based on resilient propagation term (R_{prop} term). Momentum term will adopt the machine learning community and choose a search vector. Resilient propagation provides a modification which uses individual adaptive step sizes and the signs of the gradient components. The level set segmentation with these two methods is very effective in identifying the regions of stones in the ultrasound kidney image [6, 12, 13, 14].

C. Feature Extraction

Function of one or more measurements, each of which specify some quantifiable property of an object and is computed such that it quantifies some significant characteristics of the object. General features: Application independent feature such as color, texture and shape. Domain specific features: Application dependent features such as human faces, fingerprints and conceptual features classified as low-level and high level features [13]. The features such as energy, mean, variance, entropy, correlation, skewness and kurtosis, are extracted from the segmented image. The features are used as an input data sets for the classification algorithms. With the help of these features the Neural Networks are trained and classified.

D. Classification

A different classification technique yields different results on the same data set. By comparing the accuracy and performance of different algorithms, the best classification

algorithm can be identified. In order to diagnose the kidney stones disease basically we consider the three Artificial Neural Network algorithms, these are Multilayer Perceptron (MLP), Radial Basis Function (RBF), and Linear Vector Quantization (LVQ).

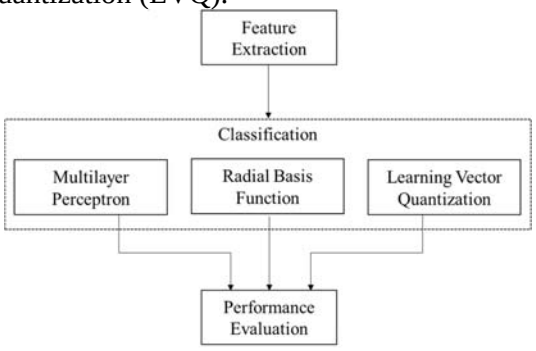

Fig3: Classification

V. TECHNIQUES

In ANN Classification three architectures are used namely, Multilayer Perceptron, Radial Basis Function and Learning Vector Quantization which are described in detail in the following sections.

A. Multilayer Perceptron

A multilayer perceptron is a feed forward artificial neural network model. This maps sets of input onto a set of appropriate outputs. MLP can distinguish data that are not linearly separable MLP consists of multiple layers of nodes, with each node as a processing element. MLP make use of supervised learning technique called backpropagation for training the network [8, 12]. The architecture of MLP is as shown in Fig. 4.

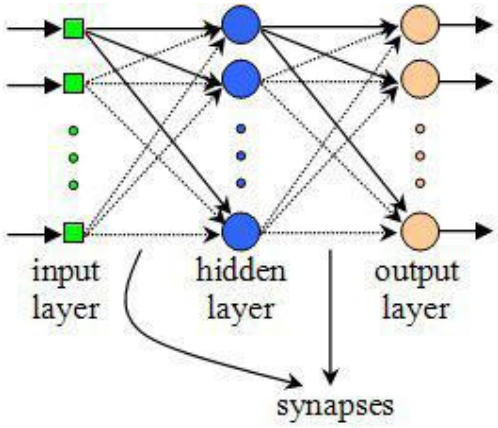

Fig4: Multilayer Perceptron

B. Radial Basis Function

Radial basis function network is a special type of artificial neural network that uses radial basis functions as activation function. There are three layers, out of which first layer is input layer, second one is hidden layer and the third one is output layer. The hidden layer implements a set of radial basis functions. The outputs from the hidden layer are inversely proportional to the distance from the center of the neuron. The output of the input layer is determined by calculating the distance between the network inputs and hidden layer centers. The output of the hidden layers is weighted forms of the input layer outputs [8, 9]. The architecture of RBF is as shown in Fig. 6.

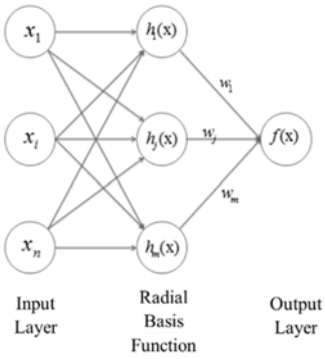

Fig6: Radial Basis Function

C. Linear Vector Quantization

A Linear Vector Quantization has two layers, first a competitive layer and a second linear layer. Competitive layer learns to classify input vectors. Function of linear layer is to transform the competitive layer's classes into target classifications defined by the user. The classes learned by the competitive layer are sub classes and the classes of linear layer are target classes. The output classes are known for each input pattern. Hence second layer needs no learning [8, 9].

VI. DATASETS

The 160 ultrasound kidney images of both normal and abnormal kidney were collected from hospitals. 120 images are trained and 40 images will be tested.

VII. EXPERIMENTAL RESULTS AND DISCUSSION

Medical diagnosis by neural network is the black- box approach. A network is chosen and trained with examples of all classes. After successful training, the system is able to

diagnose the unknown cases and to make predictions. In this experiment work we applied neural networks on kidney stones disease for classification and diagnosis of patients. The results of experiment are shown below in table. Table 1 shows neural networks are trained with 120 instances or data items and testing of neural networks is done with 40 data instances. The numbers of hidden layers used are 2 which are sufficient for any kind of classifications. Learning rate and momentum used for training and testing is 0.3 and 0.2 respectively, this particular value is chosen because of maximum accuracy is achieved with these parameters. Validation threshold has value 20 and value of error per epoch is 0.013.

Parameters	**Values**
Number of Training Data	120
Number of Testing Data	40
Number of Hidden layer	2
Learning Rate	0.3
Accuracy	98%

Table 1: MLP parameter with maximum accuracy

Table 1 shows the parameters we used for training and testing of different networks. Total numbers of instances are 120 instances used for testing are 40, number of hidden layers are two, learning rate of network is 0.3 and momentum is 0.2. Learning rate is defined as training parameter that controls the size of weight and bias changes during learning and momentum simply adds a fraction of the previous weight update to the current one. The momentum parameter is used to prevent the system from converging to a local minimum or saddle point. A high momentum parameter can also help to increase the speed of convergence of the system. However, setting the momentum parameter too high can create a risk of over fitting the minimum, which can cause the system to become unstable.

CONCLUSION

The investigation for the diagnosis of kidney stones is done by the usage of three artificial neural networks. It is proved that the, combination level set segmentation, multilayer perceptron with back propagation is the better approach for the detection of stones in the kidney. Thus from this work we are able to find the best fit model for the diagnosis of kidney stones. Different researchers are reported that the performance of radial basis function is better than the multilayer perceptron for their applications, some of them in their opposite way of results. In the future work the system can be designed to implement on Field Programmable Gate Array (FPGA) using hardware description language (HDL). So the display of kidney images and stone can be done with color for easy identification and visibility of stone. The work can extended for Magnetic Resonance Imaging (MRI), Computerized Tomography (CT) and better results can be observed.

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