KIDNEY STONE DETECTION USING NEURAL NETWORK


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ABSTRACT

Due to the presence of noise, there are inaccuracies in the classification of kidney stone. Kidney stone has become common nowadays due to various factors. In the proposed methodology nephrolithiasis in the MRI (Magnetic Resonance Image) image is preprocessed using DWT (Discrete Wavelet Transform). Key features are extracted using Gray level co-occurrence matrix (GLCM). A data set of 20 test data containing normal and abnormal kidney MRI images are classified using Back Propagation Method of Neural Network (BPNN). The output of BPN classification is displayed in LCD board which is interfaced with an Arduino board. A Fuzzy Clustering Mean Algorithm (FCM) is used for successful segmentation of kidney stone.

Keywords: Magnetic Resonance Image, Back Propagation Neural Network, Fuzzy Clustering Means, Discrete Wavelet Transform, Gray Level Co-occurrence Matrix.

INTRODUCTION

Kidney stone is the accumulation of salts and certain minerals mainly made up of calcium and uric acid in urine. It is caused due to inadequate intake of water. Kidney stone mainly occurs when our body lacks fluid but accumulates a lot of waste. Diabetes, high blood pressure and obesity may increase the risk of kidney stone in an individual.

There are various methods for the diagnosis of kidney stone such as urine test, blood test, CT scan, MRI scan etc. Operator-assisted kidney stone detection is impractical in the case of large amounts of data. In this paper an automated kidney stone classification using image and data processing with back propagation neural network is being done.

Use of neural network for the classification of kidney stone has shown great potential. In this paper feature extraction is done using the Gray level co-occurrence matrix and Fuzzy c-mean clustering algorithm for segmentation of the test image to detect the kidney stone. BPN classifier performance is evaluated in terms of training performance and the accuracy of classification.

LITERATURE REVIEW

Rahman, Tanzila & Uddin, Mohammad (2013) has reduced speckle noise using gabor filter and the image enhancement is done using the histogram equalization. Two segmentation techniques were used, cell segmentation and region based segmentation to extract the kidney regions [1]. Hafizah, Wan & Supriyanto, Eko & Yunus, Jasmy (2012) classified kidney ultrasound images into different groups creating a database based on the features extracted.

Feature extraction was based on nineteen gray level co-occurrence matrix (GLCM) features and five intensity histogram features [2]. P. Gladis Pushpa Rathi, V & Palani, S. (2011) proposed a method for segmenting the human brain for tumor detection. Image segmentation is done using Hierarchical Self Organizing Map (HSOM). Abnormal spectra and type of abnormality were determined using Artificial Neural Network and Wavelet packets [3].

Bommanna Raja, K & Muthusamy, Madheswaran & Thyagarajah, K. (2007) identified significant content descriptive feature parameters and classified the kidney disorders with ultrasound scan [4]. Stevenson, Mary Helen & Winter, Rodney & Widrow, Bernard made an analysis to determine the sensitivity of feedforward neural network to weight errors [5].

In this paper feature extraction is done using GLCM feature extraction and segmentation of kidney stone is done using Fuzzy C-means algorithm. Finally, classification of kidney stone is done using Back Propagation Neural Network.

OVERVIEW OF THE PROPOSED SYSTEM

The block diagram for automated kidney stone detection using back propagation method is shown in figure 1. The proposed method is implemented using the MRI kidney images. The process involves preprocessing using DWT, GLCM feature extraction, dataset training, BPN classification and segmentation of kidney stone using Fuzzy C-means algorithm. The tool used for simulation is MATLAB.
The input test image is preprocessed using Discrete Wavelet Transform. Image enhancement or pre-processing is done to remove noise and brighten the image making it easier to identify the key features. The purpose of wavelets is to convert an input image into a series of wavelets, which can be stored more efficiently compared to pixel blocks.

Applying discrete wavelet transform decomposes the input image into high pass and low pass components using the high pass and low pass filters. The image is now decomposed into four sub bands as LL, LH, HL, HH. The LL sub band contains most of the information while the other higher order bands contain the edges in the vertical, diagonal and horizontal direction.

The Gray level co-occurrence matrix determines the texture features of an image by calculating how often the pixel pairs with specific values and in a specified spatial relationship occur in an image. First, it creates a GLCM and then extracts the significant texture features from this matrix. Here in this paper we are going to consider five important features mainly as listed in the table below.

### Table 1. Feature Description

<table>
<thead>
<tr>
<th>KEY FEATURE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Contrast</td>
<td>It is used to measure the local variations in the gray-level cooccurrence matrix.</td>
</tr>
<tr>
<td>Correlation</td>
<td>It calculates the joint probability occurrence of the specified pixel pairs.</td>
</tr>
<tr>
<td>Energy</td>
<td>It provides the sum of squared elements in the GLCM and is also known as uniformity or the angular second moment.</td>
</tr>
<tr>
<td>Homogeneity</td>
<td>It measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal.</td>
</tr>
<tr>
<td>Entropy</td>
<td>It refers to the intensity level that the individual pixels can adapt.</td>
</tr>
</tbody>
</table>

### Table 2. Extracted Features of Test Image

<table>
<thead>
<tr>
<th>Energy</th>
<th>Contrast</th>
<th>Correlation</th>
<th>Homogeneity</th>
<th>Entropy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.8315</td>
<td>0.0000</td>
<td>0.0001</td>
<td>0.0005</td>
</tr>
<tr>
<td>0.000</td>
<td>1.1791</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

### DATASET TRAINING

Training dataset consists of a set of 20 images consisting of normal and abnormal kidney. Training is a process of learning usually done to recognize features and shapes and even patterns in image processing. The training process is same as the processing of test image, which involves pre-processing, and feature extraction.

The features extracted from the trained set are used for comparison with the features extracted from the test image. The comparison of the trained data and test data is for accurate classification of kidney stone, which is done using Back Propagation method of neural network.
BACK PROPAGATION NEURAL NETWORK

In Artificial Neural Network Back Propagation method uses a technique called gradient descent to compute a gradient needed in the calculation of weights to be used in the network. The term back propagation means backward propagation of errors as an error computed at the output layer is distributed backwards throughout the network’s layers.

Back Propagation is a learning algorithm and the main aim of this algorithm is to minimize the error function by adjusting the weights. The algorithm trains a given feed-forward multilayer neural network for a given set of input patterns with known classifications of normal and abnormal kidney.

Once the sample set containing the input test image is presented to the network, the network examines its output response to the sample input pattern of the trained data set. The obtained output response is later compared with the known and desired output. The error value is computed. The sample patterns are presented continuously to the network until the error value is minimized.

Thus the back propagation neural network classifies whether the given input test image contains kidney stone or not. The following classification of normal or abnormal condition is displayed in a LCD board. The exact region of the kidney stone is later found by segmentation using fuzzy c-means algorithm.

WATERSHED ALGORITHM

The purpose of watershed algorithm is visualizing a gray level image into its topographic representation categorizing it into three basic notions as minima, catchment basins and watershed lines. Thus, in the input test image, the dark areas are assumed to have low altitudes and the bright areas are to have high altitudes making it look like a topographic surface. Therefore, watershed algorithm shows great potential in image segmentation and properly segments the identified abnormal regions.

FUZZY C-MEANS ALGORITHM

Fuzzy clustering is an unsupervised clustering technique which does not demand a human interaction to decide the clustering criteria. It performs on the basis of distance metrics between the data point and cluster center by assigning a membership function to each data point corresponding to each cluster center.

It groups large sets of data into smaller sets of similar data. Comparing to k-means clustering fuzzy-c means works well for overlapped data set thus enabling us to find the accurate location of the kidney stone.
RESULTS AND DISCUSSION

This method is implemented in MATLAB R2016a. Thus classification of kidney stone using GLCM feature extraction and BPN neural network is successfully achieved. Comparing with Gabor filters, Canny Edge Detection and Daubechies lifting schemes GLCM has shown great potential for recognizing the significant features for accurate classification of kidney stone.

Others lead to feature reduction which may probably remove some significant features. GLCM feature extraction is a statistical approach. GLCM together with DWT has shown great potential in feature extraction leading to higher accuracy of 98.8% of classification rate. Fuzzy C-means algorithm performs better than K-means clustering in case of overlapped data. In Fuzzy C-means data point may belong to more than one cluster center unlike k-means where data point must exclusively belong to one cluster center.

FUTURE WORK AND CONCLUSION

In future work, the proposed methodology will be designed for real time implementation by interfacing it with the scanning machines. The captured kidney image will be subjected to the proposed algorithm to identify the affected region and for an accurate classification of kidney stone. For achieving higher accuracy, we can compare the results of other neural networks besides Back Propagation algorithm.

REFERENCES


