Kidney Stone Detection Using Neural Networks

M.Akshaya
Department of Electronics and Instrumentation Engineering,
St.Joseph's College of Engineering,
Chennai,India.
akshayamathivanan1@gmail.com

R.Nithushaa
Department of Electronics and Instrumentation Engineering,
St.Joseph's College of Engineering,
Chennai,India.
nithushaa14@gmail.com

N.Sri Madhava Raja
Department of Electronics and Instrumentation Engineering,
St.Joseph's College of Engineering,
Chennai,India.
nsrimadhavaraja@stjosephs.ac.in

S.Padmapriya
Department of Electronics and Communication Engineering,
Manakula Vinayagar Institute of Technology,
Madagadipet, Puducherry, India.
padmapriyaece@gmail.com

***Abstract*—Back Propagation Network is the most commonly used algorithm in training neural networks. It is employed in processing the image and data to implement an automated kidney stone classification. The conventional technique for medical resonance kidney images classification and stone detection is by human examination. This method is not accurate since it is impractical to handle large amount of data. Magnetic Resonance (MR) Images may inherently possess noise caused by operator errors. This causes earnest inaccuracies in classification features/ diseases in image processing. However, usage of artificial intelligent based methods along with neural networks and feature extraction has shown great potential in extracting the region of interest using back propagation network algorithm in this field. In this work, the Back Propagation Network was applied for the objective of kidney stone detection. Decision making is carried out in two stages: 1.Feature extraction 2.Image classification. The feature extraction is done using the principal component analysis and the image classification is done using Back Propagation Network (BPN). This work presents segmentation method using Fuzzy C-Mean (FCM) clustering algorithm. The performance of the BPN classifier was estimated in terms of training execution and classification accuracies. Back Propagation Network gives precise classification when compared to other methods based on neural networks.**

Keywords— Kidney Stone, Back Propagation, MRI, Neural Networks.

I. INTRODUCTION

The objects in the given image are processed with common image processing strategies such as removal of noise, feature extraction by which specific areas in the image with certain textures are identified.

In order to process an image using a computer the image is first converted into numerical form so that the computer can process it. Each number in the picture represents a specific brightness value at a specific place, it is called as pixel. Digital image considered for analysis will have 512 × 512 / approximately 250,000 pixels. Recently larger size images are also used using advanced computing systems. After the image has been digitized, there are three fundamental operations that should be performed on it in the computer. In this operation, a single pixel of input image is responsible for generating pixel value in output image. Secondly, for local operation the value of output image depends on many pixels of input image. Finally, for global operation each pixel of input image is responsible for producing a pixel in output image. The given operations may take place separately or combined to enhance and compress the image. An image is said to be enhanced when the information in the image is clearer.

Identifying object groups in real-time images is a milestone in image processing. It is considered as a milestone because of more variations in similarity of object of same class. In addition to that, distortions due to clutter background, scale and variations in viewpoint may cause a different look of the same object. Other problems may be due to the appearance of the image which looks similar despite classification. These are some of the odds which are found in classification problems. Henceforth, the models for object classes should be adjusting to accommodate class variability. It should also be discriminative enough to filter the true object occurrences in a disorderly images. Thus the recognition of an object class model classification is difficult. This paper explains two approaches to recognize an object and classifying the same. The aim of image classification is to persuade the region of Interest in the considered image. An approach for object class recognition that employs edge information only is mainly focused in this work. Moreover, matching between primary images can be efficiently computed (e.g., with geometric properties), unlike divided fragments, which require analyses between each every edge pixels. The back propagation network algorithm

 ISBN 978-1-7281-6202-7

has shown best result for the above explained image processing for the kidney stone detection. The phrase back propagation states the backward propagation of error as an error determined at the outer layer is distributed backwards throughout the network's layers. Geometric properties can be fixed easily, they solve similarities across scales. But, contour fragments are not scale invariant. It must be rescaled by introducing aliasing effects (for e.g., placement of edge pixels apart), or to remodel the imaging sizing before extracting fragments from the image. This may further reduce image resolution.

In literature, it is shown that the standard nature of line segments and definite shapes meet the requirements of the ability to portrait intricate shapes and structures.

As individual structures, it appears to be less unique. When the same features are combined, their features are enhances and thereby appears to be adequately discriminative. A bi-level basic abstraction is being performed. Initially, at the first layer it is performed with pairs of primitives. Later, a learned number of shape indications. No constraint is imposed to have a standard values of shape-tokens. But it also allow it to be repeated and adaptable to an object class. This value influences a combination's ability to represent shapes, where simple shapes favor fewer shape- tokens than challenging ones. Continuously, discriminative combinations of varying complexity can be exploited to represent an object class. We study this combination by exploiting, demarcating the shape, geometric, and fundamental restrictions. The shapes inhibit, describes the visual approach of shape tokens, while geometric constraints describe its spatial outline (configurations). Structural constraints establish possible structures of an object by the relationships between shape-tokens.

II. CLASSIFICATION OF IMAGES

Majorly, the images are classified based their pixel color in a perspective. Based on the efficacy of the output required any of the following type of images can be considered in their original form or can be converted to a different form. This reduces computational complexity and increases the processing time of the system to provide an output. The following list provides the various types as explained below.

A. Binary Image

It has two desirable outcomes when considered at a pixel level. Generally, the variations black and white are the two colors used to represent a binary image. But any two colors can be used in place of black and white. Foreground color is the color used for objects. The remaining image correspond to as background part of the considered image.

Binary images are commonly known to be bi-level or two-level. This indicates every pixel is placed in the memory as a single bit (0 or 1).This name black and white, monochrome or monochromatic are often used for this approach, nevertheless it may also represent any images which one sample for each pixel.

B. Gray Scale Image

In a gray scale image, value of each pixel is a single sample, it has only information based on intensity. These images possess exclusive shades of gray which ranges from the value 0-255. The variations persists from black (0) which can be represented to be the week shade and white (255) represents the highest. .

Gray scale images are incisive from one-bit black- and-white images. These stays the underlying concept of computer imaging. These images are with two colors, black, and white (also called bi-level or binary images). Multiple shades of gray are there in Gray scale images. Gray scale images have the properties such as monochromatic, which indicates the absence of the color based changes.

Gray scale images indicate the intensity of light at every pixel in an ensemble of electromagnetic spectrum. I captured in a single frequency, they are monochromatic.

C. Color Image

A color image has the knowledge about color for each and every pixel. Every pixel has a specific value which is determined by 3 numbers. It gives the decomposition of the color in the three primitive colors red, blue, and green. In other words, an image is an extensive two-dimensional array. It is characterized by the properties of colors and pixels. Each of them is coded in 3 bytes. This characterizes the three primary colors. In total 256x256x256 = 16.8 million different colors are created based on the combination of these three colors, known as RGB encoding and adjustable to human vision.

III. METHODOLOGY

Back Propagation Network (BPN) is employed in the detection of kidney stone. Propagation network is determined in terms of performance and classification measures. Back Propagation network gives quick and precise classification. It also serves as a satisfactory tool for identification of kidney stone. BPN is also used for classifying the pattern of malignant and benign Cancer. The back-propagation understanding is usually used to alter the weights and biases of networks. It also helps to reduce the squared error in a network.

Figure 1 shows the block diagram of kidney stone extraction. Two stage process helps to obtain the normal and abnormal kidney images. Initially the training mechanism with a known data set helps to train. Further, when a subjecting a sample image, based on feature extraction using GLCM method initial level classification is possible. The classification accuracy is improved when it is subjected pre-processing before extraction of features. Image pre-processing is a commonly used term to operate the images at the lowest level of abstraction.

Its input and output are intensity images. The objective of preprocessing is to improve the image data that reduce the unwanted distortions or enhances few image features which are mandatory for future processing. After the back propagation network classification of input image, the result shows whether the input images is a normal or abnormal image.

If the image normal the deducted image is not the kidney stone. Similarly, if the image abnormal the deducted image is the kidney stone.

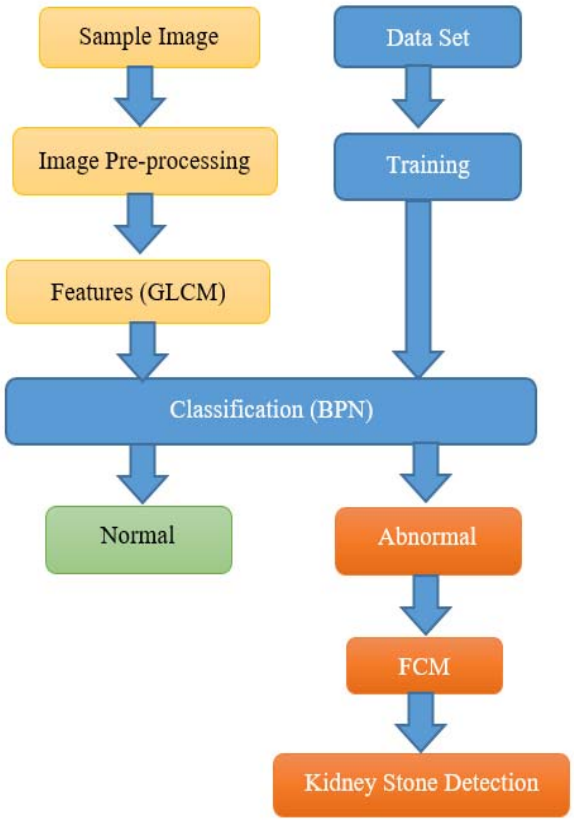

Fig 1 Block Diagram for Kidney stone Detection

IV. RESULTS AND DISCUSSIONS

Figure 2 shows the input image subjected as the sample image to the training system. The image is subjected to preprocessing and thereby with the help of GLCM feature based detection is performed. The preprocessed image is depicted in fig. 3. The edges of the original image is clearly obtained which helps to enhance the region of interest in the image. This provides the initial stage classification of image detection as normal and abnormal. Fig. 4 shows the feature extracted image and fig. 5 illustrated the stones segmented from the image.

Fig 2 Input Image

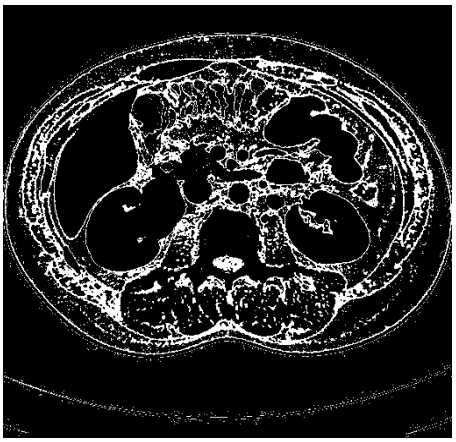

Fig 3 Processed Image

Fig 4 Feature Extracted Image

ISBN 978-1-7281-6202-7

Fig 5 Output Image

The extracted stone region aids in early detection of kidney stones. Further, patients subjected to medication can also monitored to record their response. The size of the stones can be precisely monitored compared to other methods. Since noise associated in other methods are high, early detection and continuous monitored is comparatively less efficient to analysis of MR images.

V. CONCLUSIONS

In this work, BPN is used to detect stones in MR images of a kidney. The two stage detection process namely the feature extraction and classification has eventually detected the stone in the kidney. This qualitative analysis helps to find the position of the stone in a kidney even as the size of the stone was small. Back Propagation Network gives precise classification when compared to other methods based on neural networks. The advantages of this methods are it can separate the stone regions from the image rightly, suitable to classify the kidney stone images for precise detection and early detection.

REFERENCES

[1] Saman Ebrahimi and Vladimir Y. Mariano, "Image Quality Improvement in Kidney Stone Detection on Computed Tomography", Journal of image and graphics, Vol.3, No. 1, June 2015.

[2] Prema T. Akkasaligar, Sunanda Biradar and Veena Kumbar, "Kidney stone detection in computed tomography images", IEEE, 2017.

[3] Aniket Gaikwad, Azharuddin Inamdar, Vikas Behera, "Lung cancer detection using digital Image processing On CT scan Images", International research journal of engineering and technology, 2016.

[4] Wayne Brisbane, Michael R. Bailey and Mathew D. Sorensen, "An overview of kidney stone imaging techniques", Nat Rev Urol, November 2016.

[5] S. Asadi, H. Hassanpour, and A. Pouyan, "Texture based image enhancement using gamma correction", Middle-East Journal of Scientific Research, vol. 6, no. 6, pp. 569-574, 2010.

[6] R. C. Gonzalez and R. E. Woods,"Digital Image Processing", 2nd ed., 1992, ch. 2, pp. 47-51 and ch.10, pp. 568-611.

[7] D. Y. Kim and J. W. Park, "Computer-Aided detection of kidney tumor on abdominal computed tomography scans", Acta Radiologica, vol. 45, no. 7, pp. 791-795, 2004.

[8] D. T. Lin, C. C. Lei, and S. W. Hung, "Computer-Aided kidney segmentation on abdominal CT images", IEEE Trans. on Information Technology in Biomedicine, vol. 10, no. 1, pp. 59-65, Jan. 2006.

[9] F. L. Coe, A. Evan, and E. Worcester, "Kidney stone disease", Journal of Clinical Investigation, vol. 115, no. 10, pp. 2598-2608, 2005.

[10] F. Grases, A. Costa-Bauza, and R. M. Prieto, "Renal lithiasis and nutrition", Nutrition Journal, vol. 5, no. 23, pp. 1-7, 2006.

[11] Sri Madhava Raja N.,Rajinikanth V., Latha K."Otsu based optimal multilevel image thresholding using firefly algorithm", Modelling and Simulation in Engineering, https://doi.org/10.1155/2014/794574, 2014.

[12] R Vishnupriya, N Sri Madhava Raja, V Rajinikanth". An efficient clustering technique and analysis of infrared thermograms" 2017 Third International Conference on Biosignals, Images and Instrumentation (ICBSII), Chennai, 2017, pp. 1-5, doi: 10.1109/ICBSII.2017.8082275.

[13] N Sri Madhava Raja, SL Fernandes, Nilanjan Dev, Suresh Chandra Satapathy, V.Rajinikanth. "Contrast enhanced medical MRI evaluation using Tsallis entropy and region growing segmentation" J Ambient Intell Human Comput (2018). https://doi.org/10.1007/s12652-018-0854-8.

[14] Raja N.S.M., Lakshmi P.R.V., Gunasekaran K.P. (2018) Firefly Algorithm-Assisted Segmentation of Brain Regions Using Tsallis Entropy and Markov Random Field. In: Saini H., Singh R., Reddy K. (eds) Innovations in Electronics and Communication Engineering. Lecture Notes in Networks and Systems, vol 7. Springer, Singapore. https://doi.org/10.1007/978-981-10-3812-9_24.