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A Neural Network Based Kidney Segmentation from MRI Images

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Abstract: Automated and robust kidney segmentation from medical image sequences is very difficult task particularly because of the gray level similarities of adjacent organs, partial volume effects and injections of contrast media. In addition to these difficulties, variations in kidney shapes, positions and gray levels make automated identification and segmentation of the kidney harder. Also, different image characteristics with different scanners much more increase the difficulty of the segmentation task. Therefore, in this work, we present an automated kidney segmentation method by using a multi-layers perception based approach that adapts all parameters according to images to handle all these challenging problems. The efficiency in terms of the segmentation performance is achieved by using the information from the previously segmented kidney image. The proposed approach is also efficient in terms of required processing time since it does not include pre-processing and training stages, which are very time consuming. Moreover, the unsupervised segmentation approach eliminates the common problem of most neural network based approaches that is dependency of results to the chosen data in the training stages.

Keywords: Image processing, segmentation, neural network.

I. INTRODUCTION

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business.

With increasing use of Computed topography (CT) and Magnetic resonance (MR) imaging for diagnosis, treatment planning and clinical studies, it has become almost compulsory to use computers to assist radiological experts in clinical diagnosis, treatment planning. Reliable algorithms are required for the delineation of anatomical structures and other regions of interest (ROI). The goals of computer-aided diagnosis (CAD) are:

To automate the process so that large number of cases can be handled with the same accuracy i.e. the results are not affected as a result of fatigue, data overload or missing manual steps.

To achieve fast and accurate results. Very high-speed computers are, now, available at modest costs, speeding up computer-based processing in the medical field.

To support faster communication, wherein patient care can be extended to remote areas using information technology.

II. LITERATURE SURVEY

Evgin Goceri et al [1]. They proposed an automatic kidney segmentation approach using Gaussian mixture model (GMM) that adapts all parameters according to each MR image dataset to handle all these challenging problems. The efficiency in terms of the segmentation performance is achieved by the estimation of the GMM parameters using the Expectation Maximization (EM) method. The segmentation approach is compared to k-means method. The results show that the model based probabilistic segmentation technique gives better performance for both low contrast images and atypical kidney shapes where several algorithms fail on abdominal MR images. An advantage of the Gaussian model based clustering is to provide a rigorous approach to assess the cluster numbers and the role of each variable in the clustering process. Experiments on different abdominal MR images showed that this GMM approach is less affected by noise, more appropriate than k-means clustering and gives better classification results.

Dibyendu Goshal et al [2]. This paper presents a robust procedure for segmentation and edge detection of MRI images based on marker controlled watershed algorithm. The efficiency and accuracy of the algorithm is demonstrated by the experiments on the MRI brain images. Experimental results presented in this paper are obtained by using MATLAB. An image segmentation approach based on Marker Controlled Watershed Transform has been discussed. This approach

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for segmentation of medical images can help in the proper detection of the region of interest and also can be very helpful for doctor's diagnoses, medical teaching, learning and research. They have tried to propose a robust approach for 3D medical image segmentation with human brain images by using marker-based watershed segmentation. With this approach we can reduce user interaction and speeds up the entire segmentation process. In this paper this approach has been applied successfully on medical images where we have chosen MRI brain images.

III. PROBLEM DESCRIPTION

The medical diagnosis by nature is a complex 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.
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

IV. METHODOLOGY

Purpose of Image processing
The purpose of image processing is divided into 5 groups. They are:
1. Visualization - Observe the objects that are not visible.
2. Image sharpening and restoration - To create a better image.
3. Image retrieval - Seek for the image of interest.
4. Measurement of pattern – Measures various objects in an image.

The two types of **methods used for Image Processing** are **Analog and Digital** Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing. Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction.

The various steps required for any digital image processing applications are listed below:
1. Image grabbing or acquisition
2. Preprocessing
3. Segmentation
4. Representation and feature extraction
5. Recognition and interpretation.

It is more appropriate to explain the various steps in digital image processing with an application like mechanical components classification system. Let us consider an industrial application where the production department is involved in the manufacturing of certain mechanical components like bolts, nuts, and washers. Periodically, each one of these components must be sent to the stores via a conveyor belt and these components are dropped in the respective bins in the store room. The sequence of operations performed is illustrated.

Kidney Image Database
Kidney image database consists of nearly 500 US kidney images collected from different individuals of various hospitals. It consists of both normal and abnormal images stored in the database. One of the images is selected from the database and subjected to stone detection process.

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Dataset

The dataset is collected from several medical labs, centres and hospitals. From this the synthetic kidney function test (KFT) dataset have been created for analysis of kidney disease. This dataset contains five hundred and eighty four instances and six attributes are used in this comparative analysis. The attributes in this KFT dataset are Age, Gender, Urea, Creatinine and Glomerular Filtration Rate (GFR). This dataset consists of renal affected disease information.

NEURAL NETWORK CLASSIFICATION

A. Neural Network Topology Design

Using "NeuralBuilder" module in "NeuroSolutions" software provided by "NeuroDimension", Inc., a multilayer neural network as shown in Fig. 8, with two hidden layers with 10 nodes each was designed. Five output nodes were used to produce the following output encoding for the five kidney image classes- „10000" for „Normal", „01000" for „Failure", „00100" for „Stone", „00010" for „Tumor" and „00001" for „Cyst". A Sanger´s rule and sigmoidal activation function were found suitable for the classification purpose. A mean square error value of 0.05 was used to stop the learning process.

B. Building and Training ANN

Network characteristics like number of hidden layers, processing elements in each layers, optimization method and learning rule are customizable and could be adjusted for getting better learning rate and less mean square error (MSE) which is an important measure of network performance. Different topologies of neural networks were used to reach the best results.

Optimal results were obtained when the number of processing elements the first hidden layer is 3 nodes and in the second hidden layer are 6 nodes.

Training was performed using the hold-out method where 50% of the data were used for training the classifier and 50% for testing. Each set of features was used separately and the results were compared. A correct classification rate was obtained using statistical features; on the other hand of the images were correctly classified when trained with wavelet features.

V. ALGORITHM USED

Neural Network

ANN is a mathematical or computational model and consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation.A single input neuron is shown in figure. The scalar input 'p' is multiplied by the scalar weight 'w' to form' wp' , one of the terms that is sent to the summer. The other input 'l' is multiplied by a bias 'b' and then passed to the summer. The summer output n, often referred to as the net input, goes into a transfer function f, which produces the scalar neuron output 'a'.

If we relate this simple model to the biological neuron, the weight 'w' corresponds to the strength of a synapse, the cell body is represented by the summation and the transfer function, and the neuron output 'a' represents the signal on the axon.

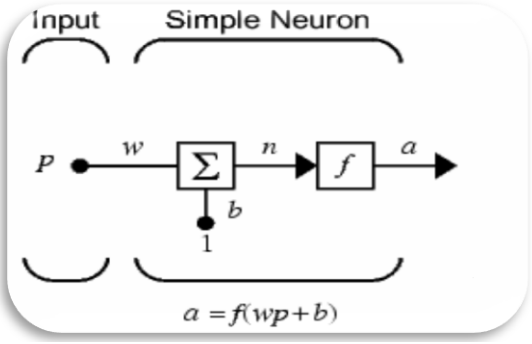

Figure 7.1: Single input neuron

The neuron output is calculated as

$$a = f(wp + b)$$

if , for instance, w=3 , p=2 and b= -1.5, then

$$a = f(3(2) - 1.5) = f(4.5)$$

the actual output depends on the particular transfer function that is chosen.

The bias is much like a weight, except that it has a constant input of 1. However, if you

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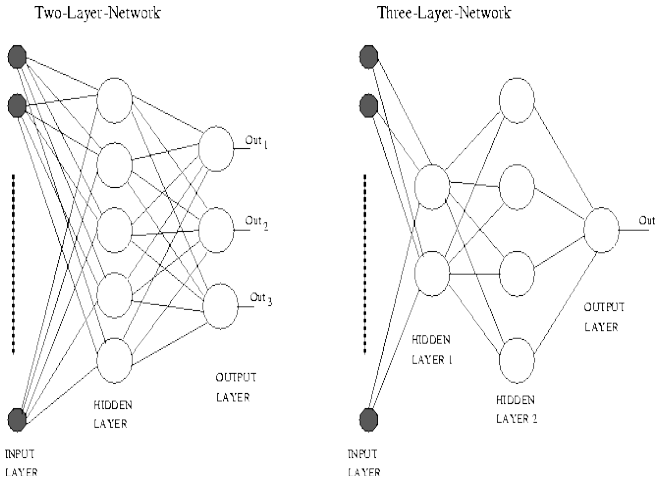


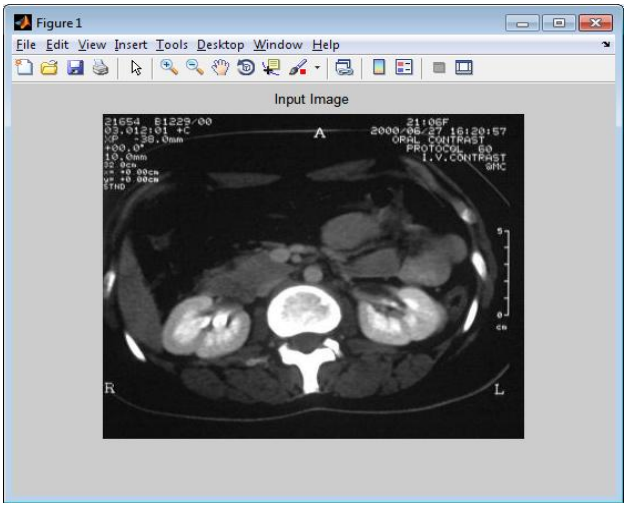
VI. EXPERIMENTAL RESULTS

NEURAL NETWORK CLASSIFICATION

Neural Network Topology Design Using "NeuralBuilder" module in "NeuroSolutions" software provided by "NeuroDimension", Inc., a multilayer neural network as shown in Fig. 8, with two hidden layers with 10 nodes each was designed. Five output nodes were used to produce the following output encoding for the five kidney image classes- „10000" for „Normal", „01000" for „Failure", „00100" for „Stone", „00010" for „Tumor" and „00001" for „Cyst". A Sanger´s rule and sigmoidal activation function were found suitable for the classification purpose. A mean square error value of 0.05 was used to stop the learning process.

Input image

The main concern of this paper is the extraction of kidney from the CT images using various techniques in image processing. In the current scenario CT images provide a good overall view of the abdomen, but it fails to provide an accurate view of the kidney, so in an attempt to find out the exact position of the kidney the image needs to be preprocessed and various image processing technique like image segmentation, template formation, morphological operations, subtraction etc. are applied. This helps us to obtain better insight of kidney in CT images.



Morphological image

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest. The segmentation experiments and performance evaluation were carried on three groups of abdominal CT images. The parameters of abdominal CT images for scanning. The pixel spacing was 0.683594 mm, the slice thickness was 1.0 mm and the spacing between slices was 0.5 mm. The number of slices ranged. Each slice of

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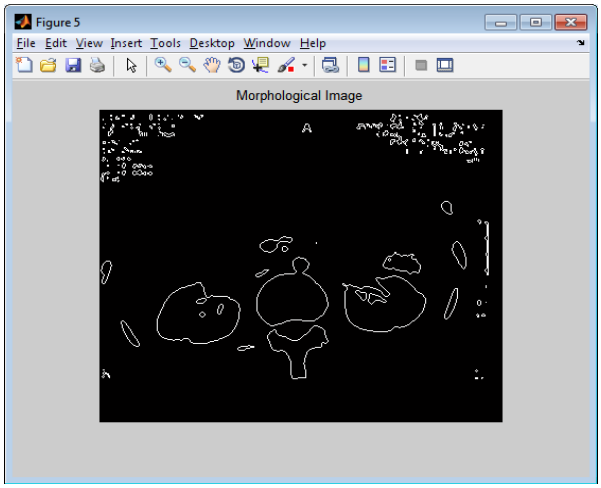
these three datasets had a spatial resolution of 512 × 512 pixels. Both SKFCM and IGC algorithm were implemented on MATLAB R2010b. All experiments were implemsented on the computer with Pentium Dual – Core

Segmentation kidney using DCT

(DCT) is widely used in image segmentation/classification and image compression. There are many features about the content of image which are contained in the DCT coefficients, reflecting the same features as those used at pixel level. Thus, the DC coefficient represents the average intensity value in a block of pixels/ voxels, while the AC coefficients reflect the variance of luminance changes in pixels/voxels within the same block.

Image segmentation can be done on pixel/voxel level considering the local color and texture information, but also at block level in the reduced feature space formed by the ordered quantized DCT coefficients described by the intensity values in the spatial locations (x, y, z) in the block (f(x, y, z) – the intensity value) is defined as:



VII.CONCLUSION

new intrusion detection system that improves the detection accuracy and time efficiency for building the intrusion detection systems. For this purpose, we proposed a LAICRF model which is developed by combining an ICRFFSA and LA based classification algorithm for effective intrusion detection. In this work, rule and LA based classification methods have been used that significantly reduce the detection time and hence it increases the detection accuracy. A intrusion detection system is proposed in this paper for detecting novel internet attacks. Moreover, a new Incremental Feature Selection Algorithm (IFSA) is also proposed and implemented for effective feature selection. The proposed feature selection algorithm is the combination of Cuttle Fish Feature Selection algorithm and the Extended Chi-square algorithm. The experimental result shows the performance of the proposed system which is achieved detection accuracy in all types of attacks.

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