DETECTION OF NON-VITAL TISSUES IN MEDICAL IMAGING USING NEURAL NETWORKS

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ABSTRACT

In the present scenario of the world, the medical imaging plays a major role in the medical imaging science. If we get the information about the dead tissues which are not visible by naked eyes or by machines, well in the time then we can easily prevent the further spreading of disease on the other parts of the body.

One of the major problems coming in the medical field is that doctors are not able to detect that infected part which is not visible bye naked eyes and therefore they only operate the visible infected part of the skin and this may cause a major problem like cancer or any dangerous disease in the future.

This paper is mainly concerned to overcome this problem by using the techniques of MATLAB using image processing toolbox, in which the property of ANN (artificial neural network) and FCC (false color composition) are used for detection of dead tissues which are visible as well as which are not visible. Up till now the training of such images were done which have sharp variation in the RGB values. Through this project we have trained the images that do not have very sharp variations in the RGB values. For training various techniques such as FCM, ANN and Neuro- Fuzzy models are used.

Keywords: Medical Imaging, Neural Networks, Fuzzy C-Means Clustering, Back Propagation Algorithm, Neuro-Fuzzy Logic

I. INTRODUCTION

India, with the growing population is presently the second most populated country of the world. Even with the advancement in medical field and technology, the healthcare situation in India (overall) is of course bad. This proves itself true when we consider key points like maternal mortality rate and infant mortality rate which are amongst the worst in the world. Unfortunately this situation continues despite the government coming out with large scale initiatives, probably due to corruption and lack of effective implementation.

Unfortunately, it's not just the public healthcare that is in trouble. What is equally disheartening is the situation in the urban areas. We have a rapidly progressing private healthcare sector in the towns and cities, most of which now have very big specialized hospitals with state-of-the-art equipment and skilled doctors.

Unfortunately, we seem to be failing to achieve patient satisfaction even at this end of the spectrum. There appears to be widespread dissatisfaction, unhappiness and frustration amongst public about the healthcare they are getting even in the larger city hospitals.

We cannot dream to become a developed country while we continue to fail in the improvement of one of the most important sectors.

II. MEDICAL IMAGING

Medical imaging is the process used for the creation of visual representations of different parts of the body (interior and exterior of a body) for the purpose of analysis of various diseases for medical interventions. It comprises different imaging modalities (such as radiography, MRI, Nuclear Medicine, Thermography, Tomography, Ultrasound, Elastography, etc.) and it plays an important role in the improvement of public health. It is a complex process and hence, requires supplementary activities of doctors, biomedical engineers, medical physicists, technicians, etc. It can reveal internal structure that is usually hidden by bones and skin, diagnose. It is used to find the abnormalities as well. Medical imaging helps in:

- Better interpretations of the symptoms and their effects.
- Less complications during the treatment.
- Personalized medical treatment based on the information present in the central repository.
- Evidence based decision making.

III. ARTIFICIAL INTELLIGENCE SYSTEMS

3.1. Ann (Artificial Neural Network)

Artificial neural networks are the computational models that behaves in a similar manner as that of animals' central nervous systems (particularly the brain) and are capable of machine learning and pattern recognition. They are usually a system of interconnected "neurons" that can compute values from inputs by feeding information through the network. The term "neural network" usually refers to the models employed in statistics, cognitive psychology and artificial intelligence.

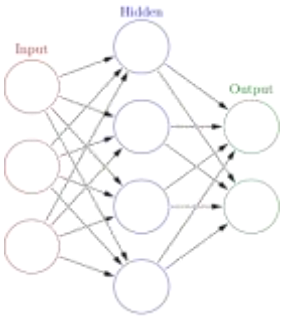

Figure 1. Artificial Neural Network

Commonly, a class of statistical models may be called "neural" if they consist of sets of adaptive weights, i.e. numerical parameters that are tuned by a learning algorithm, and are capable of approximating non-linear functions of their inputs. The adaptive weights are conceptually connection strengths between neurons, which are activated during training and prediction.

3.2. Fuzzy Logic

Initiated by Lotfi A. Zadeh in 1965 at the University of California in Berkeley, is a multivalued logic that allows intermediate values to be defined between conventional limits like true/false, yes/no, high/low, 0/1, etc. It is essential to realize that fuzzy logic uses truth degrees as a mathematical model of the ambiguity phenomenon.

Image processing using fuzzy logic can be done in three stages. Initially image fuzzification is used to modify the membership values of a specific data set or image. After the image data are transformed, appropriate fuzzy techniques modify the membership values. These can be a fuzzy clustering, a fuzzy rule-based approach, or a fuzzy integration approach. Decoding of the results, called de-fuzzification, then results in an output image.

The algorithm for the proposed work is as follows:

Step 1. Read a noisy image as input.

Step 2. Identify the Region of Interests of the image with different thresholding values.

Step 3. Extract the image information in terms of pixel qualities and threshold values for future use.

Step 4. Construct the different membership envelops of the input image.

Step 5. Generate fuzzy rules based on the numerical data obtained from the input image corrupted by noise.

3.3 Neuro-Fuzzy Logic

3.3.1 Introduction

In the field of artificial intelligence, Neuro-Fuzzy means combinations of Artificial Neural Networks and Fuzzy Logic. Neuro-Fuzzy hybridization results in a hybrid intelligent system that synergizes these two techniques by combining the human-like reasoning style of fuzzy systems with the knowledge and connectionist structure of neural networks. Neuro-Fuzzy system incorporates the human-like reasoning style of fuzzy systems through the use of fuzzy sets and a linguistic model consisting of a set of IF-THEN fuzzy rules.

3.3.2 Neuro-Fuzzy Systems

Neural networks can learn from data, but cannot be interpreted - they are black boxes to the user. Fuzzy Systems consist of interpretable linguistic rules, but they cannot learn from the information. The learning algorithms can learn both fuzzy sets, and fuzzy rules, and can also use prior knowledge. We usually use the term Neuro-Fuzzy system for this approach.

3.3.3 Neuro-Fuzzy Systems In Image Processing

There are neural-fuzzy models for multispectral image analysis and its processing. We consider both supervised and unsupervised categorization. The model for supervised classification comprises of six layers. The first three layers map the input variables to fuzzy set membership functions. The last three layers implement the decision rules. This model learns decision rules by a supervised gradient descent procedure. The model for unsupervised classification consists of two layers. The algorithm is comparable to competitive learning. However, here, for each input sample, membership functions of output categories are used to update the weights.

Neural networks represent a powerful and reasonable alternative to conventional statistical classifiers. The combination of neural networks and fuzzy logic seems natural as the two approaches attack the design of “intelligent” systems from different angles. Neural networks provide algorithms for learning, classification, and optimization, whereas fuzzy logic often deals with issues such as reasoning on a high (semantic or linguistic) level. Therefore the two technologies complement each other.

IV. MATERIALS AND METHODS

This image is taken from the internet. The image is of the disease named Hives, also known as urticarial. It is a common allergic reaction and appears as an outbreak of pale red swollen welts. Hives are often itchy, and sometimes burning and may vary in sizes and usually join together to form larger areas. They can appear anywhere, including tongue, face, throat or ears and may last for few minutes to a few hours, or up to several days. Medications, foods, temperature extremes, and infections are some causes of hives. Antihistamines can provide relief.

4.1 Analysis Using Artificial Intelligence Systems

4.1.1 Methods of Analysis

For the analysis of the multi spectral images of skin, various Image Processing algorithms like Artificial Neural Networks (ANN) and fuzzy k-mean clustering (FCM) is used either for the generation of a False Colour Composite of the multi spectral image or for emphasis on few of the features of the image that might be the particular regions or pixels of the image.

To analyze multi spectral images using ANN, Back propagation algorithm is used. Through this algorithm, a neural network is defined that specifies the mapping relationship between the input and the target. After generating FCC image we worked for FCM image and values are obtained accordingly.

But the color differentiating situations are more difficult, as we vary the epochs value of the ANN tool box then the entire image color may vary. So we need certain corrections.

It can be done by employing sharp variations in RGB data and changing the number of epoch's values taken and also the target values.

Step 1 Assembling the Training Data

For the given image (Fig. 5.1.), we have obtained the RGB components of the pixels using Data Cursor Tool in MATLAB. RGB Components are taken in such a way that they best signify the different features of the image like non-vital tissues. Hence, a table is created.

Table 1. Various RGB values of sampled image.

R	G	B
215	133	121
195	123	108
160	092	073
151	084	065
133	092	042
220	084	122
225	062	125
197	142	091
207	144	100
213	110	108
221	120	122
242	128	137
222	145	127

The obtained RGB values of 100 pixels are then arranged in the form of 3 **X** 100 matrix:

R: 215 195 160 151 133 220 225 197 207 213.....
G: 133 123 092 084 062 142 144 110 120 128.....
B: 121 108 073 065 042 122 125 091 100 108.....

Step 2: Create the Network Object

Now we define the network and identify its features. In target matrix, there is a particular color for the particular characteristic to generate the FCC:

R: 0.0 0.0 0.0 0.0 0.6 0.6 0.6 0.6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0....
G: 0.7 0.7 0.7 0.7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0....
B: 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.8 0.8 0.8 0.8 0.0 0.0 0.0 0.0....

Now begins the training of the network and the weights are assigned automatically. Thus, the step 2 makes it to get the obligation of the mapping relationship between the input and the target.

Step 3: Simulate the Network Response for Whole the Image

As we have obtained the function representing the relation between the input and the target, we, now generate a resulting matrix corresponding to the final FCC of the given image.

But, first it is required to change the 3-dimensional matrix of dimensions '256 X 256 X 3' corresponding to the multi spectral image into a 3-dimensional matrix of dimensions '3 X 256 X 256'.

Now this transformed form of the multi spectral image is applied to neural network for the simulation. After the simulation, a 2-dimensional matrix of the same dimensions '3 X 256 X 256' is obtained, which is then, converted into the 3-dimensional matrix of dimensions which represents the FCC equivalent to the given multi spectral image.

4.1.2 Analysis Applied to Ann to Obtain Neuro-Fuzzy Result

Here we have used fuzzy c-means (FCM) algorithm that incorporates spatial information into the membership function for clustering since the conventional FCM algorithm does not fully utilize the spatial information in the image. The advantage of this new method is that, it yields regions more homogeneous than those of other methods and removes noisy spots.

Fuzzy c-means (FCM) algorithm has robust characteristics for ambiguity and can retain much more information than hard segmentation methods. Although the conventional FCM algorithm works well on most noise-free images, it does not incorporate any information about spatial context, which cause it to be sensitive to noise and imaging artifacts. To compensate this, the obvious way is to smooth the image before segmentation. However, the conventional smoothing filters can result in loss of important image details, especially image boundaries or edges.

The image that we have received as output in Artificial Intelligence System is given as input to the Neuro-Fuzzy system to obtain a hybrid output.

Figure 2(a) Original Image

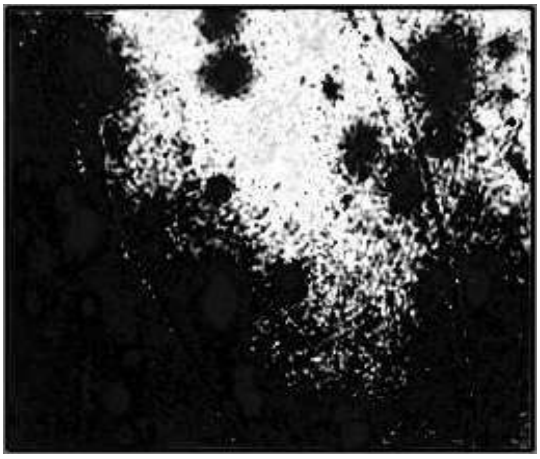

Figure 2(b) FCM Image

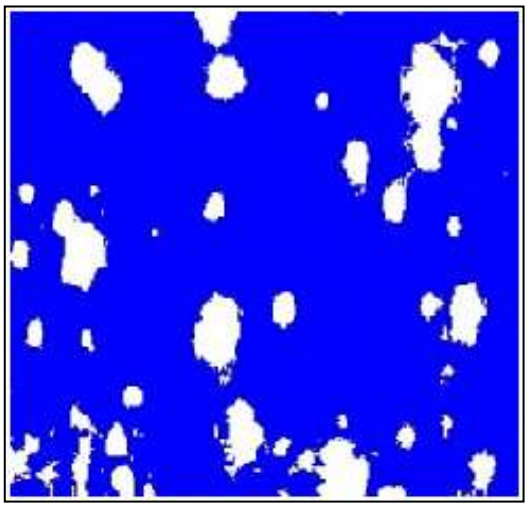

Figure 2(c) ANN Image Figure

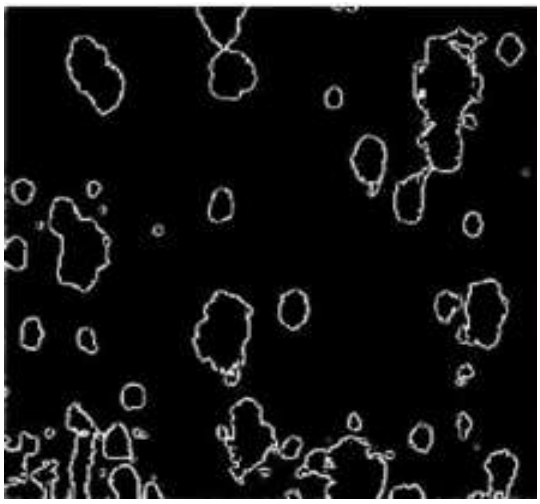

Figure 2(d) Neuro-Fuzzy Image

V. CONCLUSION

The analysis is done on the images with low variations in RGB values. Although it could be done with various segmentation techniques, but the results may not be satisfactory. Using Artificial Intelligence system called ANN (Artificial Neural Network) we could see a very clear improvement in results. For further improvement the hybrid Neuro fuzzy system was used. All live and non-vital tissues were clearly visible and the results were almost 80% improved clearly proving that Neuro Fuzzy is more efficient than any other technique. However, more hybrid techniques such as NDVI can be used for more improved and efficient results. Despite the challenges faced by these techniques presently, it will prove to be a tool of utmost importance in the medical field few years from now. The data collected by us will surely be helpful for doctors, researchers, analysts for the clear visualization of the infected area that is not visible by the naked eyes.

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