A Neural Network Approach for Contrast Enhancement Image

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Abstract

Tuberculosis infection is a serious disease which could be controlled by early diagnosis. A commonly used technique for detecting the TB bacilli is by analyzing sputum smear. Now days, image recognition systems have several applications in enormous fields. This paper uses an artificial neural network to enhance color images of Ziehl-Neelsen stained smear for the purpose of detecting TB bacilli. The first necessary step is the captured images are converted into usable format (RGB values) and pass the RGB values to neural network for training to emulate the contrast enhancement technique. The training is based on back-propagation algorithm. It is found that the proposed neural network approach could emulate contrast enhancement technique quite well.

1. INTRODUCTION

Image processing is a matured area which has successfully solved many problems in difference areas, such as Medicine, Astronomy and Engineering [1]. Image contrast enhancement is important in medical applications [2] [3]. This is due to the fact that visual examination of medical images is essential in the diagnosis of many diseases. These medical imaging have their own weakness, such as blurred and low contrast.

Artificial Neural Network (ANN) is closely related to image processing task. Nowadays researches in the field of image processing are actively used neural networks. One advantage of using ANN is the ability of ANN to adapt, which appear in form of internal characteristics changing of ANN to perform particular task. This paper presents an ANN approach to contrast enhancement to improve the quality of Zielh-Neelsen stained slide images.

2. I MAGE ENHANCEMENT AND ARTIFICIAL NEURAL NETWORK

Image enhancement procedures are technique used to achieve a subjective improvement in image "quality" for a specific application [4]. The goal of image enhancement is to improve the image quality so that the processed image is better than the original image for a specific application or set of objectives [5]. Actuality of image enhancement problem conditioned by necessity of it's solving in medical diagnostics, mine searching, patterns recognition, enhancement amateur photography, etc.

Contrast enhancement based on artificial neural networks has many important advantages in solving problems that are too complex for conventional technologies [6]. Problems that do not have an algorithmic solution or for which an algorithmic solution is too complex to be found can be easily solved. The approach has successfully been applied to various areas of medical application, such as image analysis, diagnosis and computer added inspection.

From the very beginning Artificial Neural Network (ANN) are closely related to image processing task [7]. One of the first tasks for ANN was pattern recognition. Nowadays researchers in field of image processing are actively used neural networks [8].

A neural network is a powerful data modeling tool that is able to capture and represent complex input/output relationships. The motivation for the development of neural network technology stemmed from the desire to develop an artificial system that could perform "intelligent" tasks similar to those

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performed by the human brain. Figure 1 shows a fundamental representation the basic unit of neural networks is an artificial neuron.

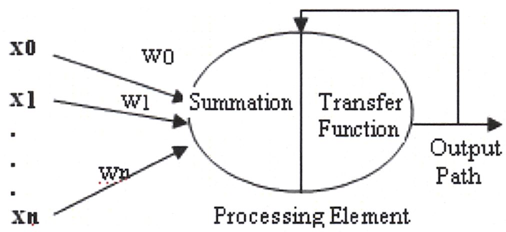

Figure 1. A Basic Artificial Neuron.

Where x's and w's are the inputs and weights for the neuron.

In Figure 1, various inputs to the network are represented by the mathematical symbol, x(n).These inputs are multiplied by connection weights. These weights are represented by w(n). In the simplest case, these products are simply summed, fed through a transfer function to generate an output. This process lends itself to physical implementation on a large scale in a small package. This electronic implementation is still possible with other network structures which utilize different summing functions as well as different transfer functions.

3. NEURAL NETWORK APPROACH TO CONTRAST ENHANCEMENT

The process of image contrast enhancement based on neural network is shown in following figure.

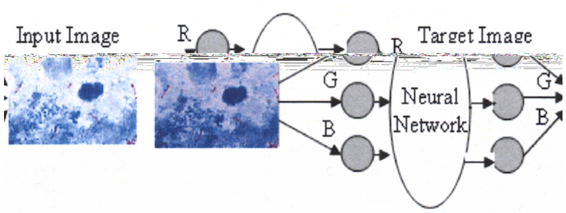

Figure 2. Neural Network Approach for Contrast Enhancement

The captured original images are containing the Red, Green, and Blue (RGB) color space values. In the learning process, the original TB Ziehl-Neelsen slide images were taken as input images for neural network and contrast images were treated as the target images. Partial contrast techniques were used to produce the contrast images and this technique is an auto scaling method that demonstrated the strong influence of contrast ratio on resolving power and detection capability of images.

Based on the Figure 2, each pixel of input and target image will be separated to Red, Green and Blue color space (RGB data). The RGB data of input and target image will be converted into usable format (RGB value) [9]. The R, G, B values will be passed to neural network for the learning process to emulate the contrast enhancement technique.

During the neural network process, each color component (R, G, and B) will be processed separately. Actually neural network learn from experience (learning process). In the learning process, neural network will learn how to map the R, G, B data, pixel by pixel between input and target image. During the learning process, about 50 of TB slide images were used to train the neural network.

4. BACK PROPAGATION ALGORITHM

A back propagation neural network is a multilayer, feedforward neural network with an input layer, an output layer and a hidden layer. The neurons in the hidden and output layers have biases (similar to weights) which are connections from units whose output is always 1.

Back propagation training involves three stages consists feedforward of the input training pattern, backpropagation of the associated error and weight adjustment. The architecture of backpropagation network is shown in Figure 3.

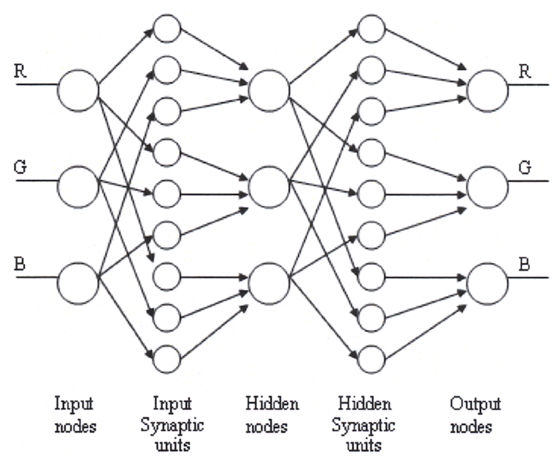

Figure 3. The architecture of Backpropagation Network

The feedforward stage consists:

1. The input node receives the input signal (R, G, B values) and passes it to the input synaptic unit.
2. The input synaptic unit multiplies the signal with the weight. On this stage the signals is summed up and send to the hidden node.
3. The signal from hidden node will send to the hidden synaptic unit.
4. The activation function is applied to the signal and is then multiplied by the weight.
5. The signal is then summed up and the activation function is applied, and passed to the output node.

Backpropagation of the associated error consists:

1. Calculate the error.
2. The derivative of the activation function is multiplied with the error.
3. In the input synaptic unit, weight correction is calculated and the error of output unit is multiplied by weight and the derivative of the activation function to get the error.
4. In the input synaptic unit, the weight correction is calculated based on the hidden synaptic unit.
5. The weights are finally updated.
6. Training is terminated.

5. RESULT

The difference of images such as good images, dark images and bright images were used to train the network to become familiar and clever to obtain the desired results. To test the performance of neural network approach, the news TB slides images (not used for training) have been used. Figure 3, 4 and 5 show the three difference resulted images after applying the updated weight of neural network. These resulted images show the proposed technique is capable to emulate the original images to the desire result. That means, the neural network resulted images can perform like the normal technique (Partial contrast technique).

Therefore, the neural network approach is capable to process new images and increases the images contrast level. Thus, TB bacilli will be easier to be detected.

6. CONCLUSION

A contrast enhancement procedure using neural network has been presented. The results in previous section show that the approach is adequate for image enhancement. The contrast of Zeihl-Neelsen stained slide images have been improved significantly and the TB bacilli become more visible, so that the resultant images would be more useful for further analysis by microbiologists.

ACKNOWLEDGMENT

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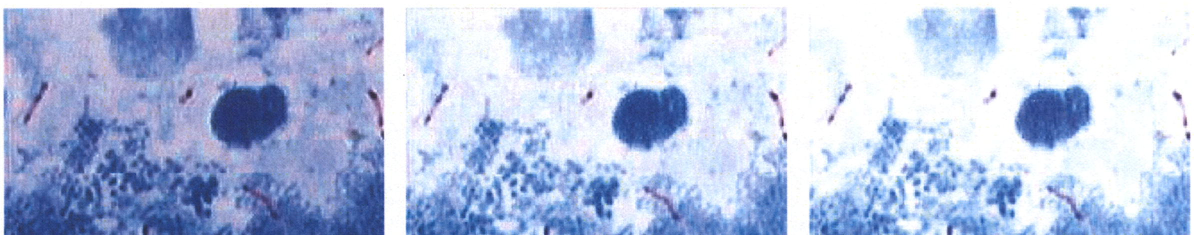
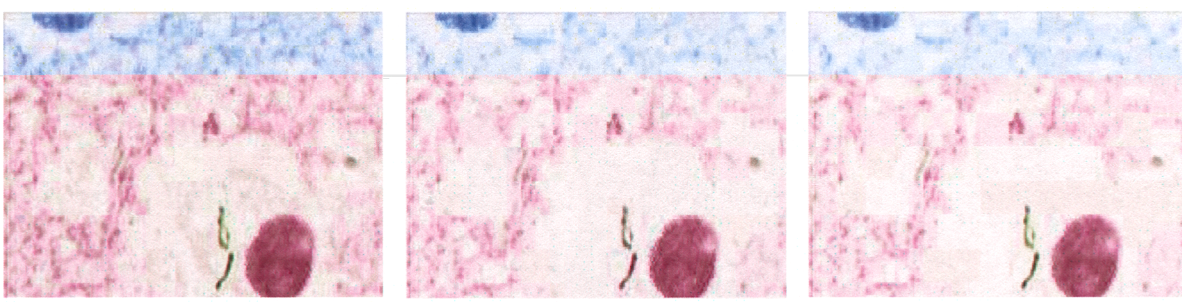
[redacted]

Figure 3. The result of contrast enhancement after applying the artificial neural network (ANN) for original TB image, smear 1.



[redacted]

Figure 4. The result of contrast enhancement after applying the artificial neural network (ANN) for original TB image, smear 2.



(a) Original image, smear 3

(b) Contrast enhancement image using partial contrast technique

(c) Resulted image using Neural Network

Figure 5. The result of contrast enhancement after applying the artificial neural network (ANN) for original TB image, smear 3.