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ECG Images Classification Using Feature Extraction Based On Wavelet Transformation And Neural Network

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Abstract

This paper, presents an intelligent diagnosis system using artificial neural network. Features are extracted from wavelet decomposition of the ECG images intensity. An introduced artificial neural network used as a classifier based on feed forward back propagation with momentum , Due to large amount of input data to the classifier, Images are grouped in batches that introduced to artificial neural network. The classification accuracy of the introduced classifier up to 92%.

Key-words: *Batches, feature, variance, wavelet decomposition, classifier*

1. Introduction

Image is a visual impression of something, so the images are a vital and integral part of every day life. On an individual, or person-to-person basis, images are used to reason, interpret, illustrate, represent, memorise, educate, communicate, evaluate, navigate, survey, entertain, etc[1].

Image processing seeks to modify and reaper pixel values of a digitized ECG image to produce a form that is more suitable for subsequent diagnosis application. Therefore, the image processing may be succinctly summarized as being concerned with "a process, which takes an image (input) and generates a modified image output" The objective of this process is to preparing the ECG image for transformation using the wavelet transform. However, wavelet features may contain richer and more discriminative information for expression classification. The theory of wavelet analysis has been well studied in [2], where images are represented by wavelet reconstructing toolbox. Daniell et al was one of the first to perform object recognition by applying wavelet to the images[3]. Hennings et al have successfully used wavelet transforms to significantly improve identification and classification rates on fingerprints. They showed that wavelet contains features that are more pronounced for higher accuracy in recognizing fingerprints [4]. Then using the output of wavelet transformation to obtain some features, which used as an input to the artificial neural network (ANN) classifier, classification using pattern recognition have a direct relationship[5,6]

2. Test material

The ECG images used in this research are different 63- ECG cases for diagnosis [7], These 63-ECGs diagnosis cases including normal and up normal heart diseases, that has been used to evaluate the algorithm, are diagnosed by experience cardiologist. Each ECG image dimenation consists of 512 by 496 pixel.

3. Method

The preprocessing of the 63-ECG image, wavelet decomposition (WD), and classification process are described in the following steps:

Step1*:* Reading the 63-ECG image using image processing under matlab toolbox, which converts the 63-ECG image into numerical data. Figure 1 shows one example from the 63 ECG image, its diagnosis is" Sinus Rhythm - Right Bundle Branch Block - Left Anterior Hemiblock -Bifascicular Block". The basic measurements for this diesis is "Vent Rate 76 BPM, PR Interval 154 ms, QRS Duration 140 ms, QT/QTc 396/445 ms, and P-R-T axes 42 -45 22'.

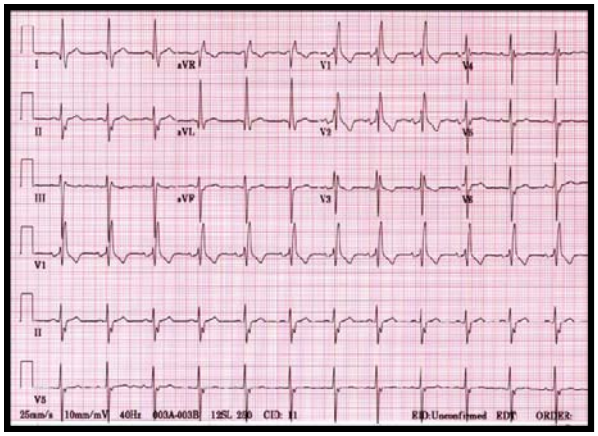

Figure 1. The Sinus Rhythm - Right Bundle Branch Block - Left Anterior Hemiblock -Bifascicular Block.

Step2: determine the best level of decomposition using wavelet packet toolbox, the 63-ECG image decomposed into one step decomposition using biorthogonal wavelet of order 3.7. Figure 2 shows the biorthogonal wavelet of the order 3.7. The output of transformation is the coefficient matrices of the level one approximation, horizontal, vertical, and diagonal details respectively.

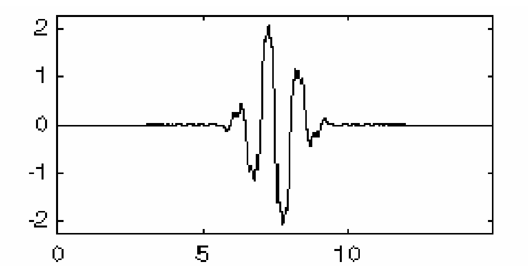

Figure 2. The biorthogonal wavelet of order 3.7

Step3: Using the approximation , horizontal, vertical, and diagonal details coefficients in reconstructing or synthesizing the original image

Step4: create a vector that contains eight features from the original image, first approximation, horizontal, vertical, diagonal details, and the reconstructing image . The features are: mean, median, maximum, minimum, range, standard deviation, variance, and mean absolute deviation.

Step5: The features vector of each original image, approximation, horizontal, vertical, diagonal details, and the reconstructing image is a matrix of (48×1). Since The total number of the different used diseases is 63 ECG images, Then the total features for the whole diseases are a matrix of (48×63).

Step6: Using the total features for the whole 63-ECG image as input to the artificial neural network (ANN). In order to simplify the architecture of the ANN, the large amount of input data is divided into 9 batches (each batch forms a matrix of (48×7)), and the empirical evaluation factor

$$EV = \frac{10^6}{\text{Total Number of neurons} * \text{Total Numbe of epochs}}$$

(1)

is used to obtain the best architecture of the ANN[8].

It is found that the best architecture of the ANN consists of three layers (an input layer, one hidden layer, and output layer) using feedforward backpropagation computation with momentum term, 48 neurons in the input layer, 25 neurons in the hidden layer, and 7 neurons in the output layer. The learning rate is 0.01, and the error goal is 0.0001. Figure. 3 shows the training of the ANN. Figure. 4 shows the relation between total number of neurons and the evaluation factor for the trailed architectures.

The introduced ANN was trained by the main features of the 63 ECG image of different diseases. A testing set by another 60-ECG image, was used to check the classification performance and its accuracy, that is given by [9]:

$$accuracy = \frac{\text{correctly detected heart diseases}}{\text{total tested heart diseases (samples)}}$$

(2)

The classification result showed that the accuracy was 92 %

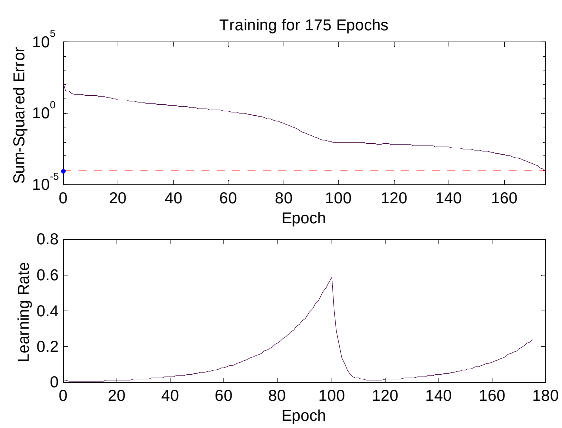

Figure 3. The training of the ANN.

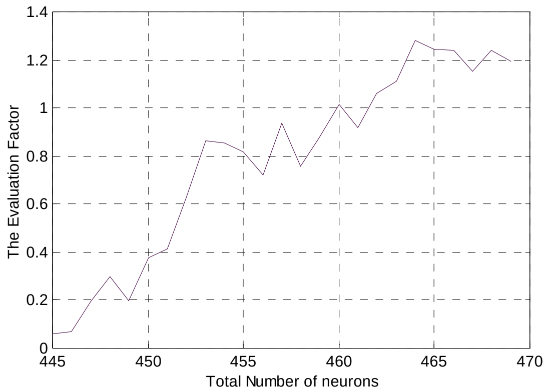

Figure 4. The Relation Between Total Number of Neurons and The Evaluation Factor.

4. Conclusions

Using the feature vectors obtained from the wavelet decomposition level and reconstructing as an input to the proposed classifier leads to about 92 % percent accuracy. This classifier can be used as computerized diagnosis of many heart diseases without depending on the experience of cardiologist, and before sending the patient to the cardiology.

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