

Computerised Detection and Classification of Five Cardiac Conditions

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Abstract

An electrocardiogram (ECG) is a bioelectrical signal which records the heart's electrical activity versus time. It is an important diagnostic tool for assessing heart functions. The interpretation of ECG signal is an application of pattern recognition. The techniques used in this pattern recognition comprise: signal pre-processing, QRS detection, feature extraction and neural network for signal classification. In this project, signal processing and neural network toolbox will be used in Matlab environment. The processed signal source came from the Massachusetts Institute of Technology Beth Israel Hospital (MIT-BIH) arrhythmia database which was developed for research in cardiac electrophysiology.

Five conditions of ECG waveform were selected from MIT-BIH database in this research. The ECG samples were processed and normalised to produce a set of features that can be used in different structures of neural network and subsequent recognition rates were recorded. Backpropagation algorithm will be considered for different structures of neural network and the performance in each case will be measured. This research is focused on finding the best neural network structure for ECG signal classification and a number of signal pre-processing and QRS detection algorithms were also tested. The feature extraction is based on an existing algorithm.

The results of recognition rates are compared to find a better structure for ECG classification. Different ECG feature inputs were used in the experiments to compare and find a desirable features input for ECG classification. Among different structures, it was found that a three layer network structure with 25 inputs, 5 neurons in the output layer and 5 neurons in its hidden layers possessed the best performance with highest recognition rate of 91.8% for five cardiac conditions. The average accuracy rate for this kind of structure with different structures was 84.93%. It was also tested that 25 feature input is suitable for training and testing in ECG classification. Based on this result, the method of using important ECG features plus a suitable number of compressed ECG signals can dramatically decrease the complexity of the neural network structure, which can increase the testing speed and the accuracy rate of the network verification.

It also gives further suggestions to plan the experiments for the future work.

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NOTATIONS

A	Atrial premature beat
A/D	Analogy to digital
ANN	Artificial Neural network
AV	Atrio Ventricular
BP	Backpropagation
DBNN	Decision based neural network
DCT	Discrete Cosine Transform
DSP	Digital signal processing
ECG	Electrocardiogram
F	Fusion of paced and normal beats
FFT	Fast Fourier transform
FIR	Finite impulse response
GUI	Graphical user interface
HBR	Heart beat rate
I/O	Input/Output
IIR	Infinite impulse response
ISO	Isoelectric line
LMS	Least Mean Square
LVQ	Linear vector quantisation
MART	Multi-channel adaptive resonance theory
MIT-BIH	Massachusetts Institute of Technology Beth Israel Hospital database
MSE	Mean Squared Error
N	Normal
NLMS	Normalised LMS algorithms

P	Paced beats
PSD	Power spectral density
R	Right bundle branch block
RBBB	Right bundle branch block
SA	Sino Atrial
SNR	Signal to noise ratio
SOM	Self organization map
STD	Standard deviation