Abstract

Automatic Heart Sound Analysis for Tele Cardiac Auscultation

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This thesis is concerned with the algorithm development for an automatic heart sound analysis system that is a part of a tele-auscultation project. The goal of tele-auscultation is to create a device that can automatically acquire and analyse the heart sound of a patient in order to determine if it shows any sign of cardiac disorder or not. This project is motivated by the apparent imbalance of cardiac medical capability between hospitals in Bangkok and those in other areas of Thailand.

Heart sound analysis process consists of segmentation, feature extraction and classification. Segmentation is the most difficult process due to heart sounds are non-stationary signal and interference from extra cardiac sounds. This research presents a novel method that does not require the segmentation of heart sound into individual cardiac cycles. It also proposed a classification method based on using multiple neural networks acting as committee.

The method consists of envelope detection using the energy of wavelet transform coefficients and calculation of the cardiac cycle length using the autocorrelation of the envelope signal. Features extraction is performed on a five cardiac cycle segment of both the envelope signal and the heart sound signal itself. The raw feature space is normalized and then optimized using principal component analysis technique. The classifier is a committee of feedforward neural networks with ten members. Each of the ten neural networks was trained with training data sampled from the original feature space in a bootstrap process. Ten fold cross validation for each of the neural network showed average accuracy of 94 $\%$. The final performance of the classifier are 94.7 $\%$ accuracy, 93.3 $\%$ sensitivity and 100 $\%$ specificity.