Introduction

Stress echocardiography is a common clinical procedure for diagnosing heart disease, especially myocardial ischemia. Stress echocardiography analysis is a challenging area because of poor image quality. In clinics, the diagnosis of the heart wall motion depends mostly on visual assessment, which is highly subjective and operator-dependent. It has become very important to introduce automated methods for heart function assessment. Automated wall motion analysis consists of two main steps. The first step is segmentation of heart wall borders and the second one is classification of heart function as either normal or abnormal based on the performed segmentation. The aim of this work is to perform automated classification of rest and stress echocardiography given myocardial contours extracted from contraction phase of cardiac cycle.

In clinical practice, cardiologists make a visual side-by-side comparison of rest and stress echocardiographic image sequences of the heart for more accurate clinical diagnosis, Fig. 1. This inspires us to perform the analysis of heart motion based on combined rest and stress sequences.

Automated wall motion analysis

An additional step for extraction of potentially useful features is introduced. These features form the candidate features vector. It is then investigated which of these features correspond to the highest classification accuracy to form the final set of optimal features.

Pre-processing and Candidate Features Extraction

- Interpolate 7 frames from each sequence
- Extract the cavity area features and normalize it with respect to the cavity area in the first frame

Selection of Optimal Features Using Relevance Vector Machines

Selection of the Best Set of 19 Features

• The mean error: decreasing from N = 4 until N = 19, minimum at N = 19, increasing from N = 19 until N = 30

Results and Conclusions

• Overall accuracy with the new method for global wall motion classification is 93.02%, for local wall motion classification is 88.60%, showing that the proposed method outperforms the current state-of-the-art HMM-based approach (for which global and local classification accuracy is 82.15% and 78.33%, respectively).
• The general approach can further be extended to 3D echocardiography.
• The methodology is not modality specific and could be equally applied to stress MRI.

The database contains contrast B-mode echocardiography loops from 173 patients between ages 55 – 80. The images from two planes (2C and 4C) were recorded at rest and stress phases. The myocardial contours were extracted using QuanTra, a semi-automated segmentation software and validated by two experienced cardiologists.

The mean error: decreasing from N = 4 until N = 19, minimum at N = 19, increasing from N = 19 until N = 30

The increase in the mean error is due to

**ONLY 19 FEATURES THAT ARE USEFUL**

**THE “CURSE” OF DIMENSIONALITY**

Insufficient data to accurately characterise the difference between classes in a high dimensional space

TO CHECK IF IT IS THE "CURSE" OF DIMENSIONALITY:

• reduce the dimensionality of N=19 and N=30 sets of features to 12 by applying PCA
• compare the performance of (i) the RVM using the principal components of N=19 features with (ii) the RVM trained using the principal components of N=30 features.

TO APPLY PCA ON N=19 FEATURES, NEED TO FIND THE BEST SET OF 19 FEATURES THAT RESULTS IN THE MINIMUM CLASSIFICATION ERROR

It is about 3 x 10^9 different selections of 19 features out of 30 candidate features

Exhaustive search is computationally impractical

The RVM trained using the principal components of the best set of 9 features

vs.

The RVM trained using the principal components of N=30 features

It is ONLY 19 FEATURES that contain important classification information

These 19 features are already found

Input to the RVM