AUTOMATIC ANALYSIS OF M-MODE ECHOCARDIOGRAMS.

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ABSTRACT

A method for M-mode echocardiograms automatic analysis has been developed on images directly transferred from an echograph to a micro-computer. After image enhancement of a cardiac cycle, we use a new method for automatic extraction of myocardial borders based on dynamic programming to compute parameters for left ventricular function.

I-INTRODUCTION

Echography is a non-invasive method for monitoring ventricular function and evaluating myocardial hypertrophy in patients with heart disease. Although the information displayed in two-dimensional echocardiograms (2-D) is usually the most useful for qualitative diagnosis, estimation of wall thickness using 2-D remains relatively inaccurate and M-mode echocardiography (one-dimensional), due to its greater reliability, is widely accepted as the reference method for thickness measurements. Usually, these measurements are obtained on strip-chart recordings. To facilitate these determinations and to minimize potential errors, we have conceived an automatic analysis of M-mode echocardiograms based directly on the numerical image stored in the echocardiograph.

II-PREPROCESSING and TIME-WARPING

Because of intrinsic limitations in the measurement device, echocardiograms have a relatively high noise level. A preprocessing is performed to attempt a substantial noise reduction with minimal information loss by smoothing the data selectively along the time direction.

In order to reduce again noise and to enhance wall borders, we want to superpose successive cardiac cycles. However,we have to correct small variation in cardiac rhythm. We assume that this variation can be represented by only a time deformation of a reference cycle. The time-warping algorithm allow us to estimate this deformation.

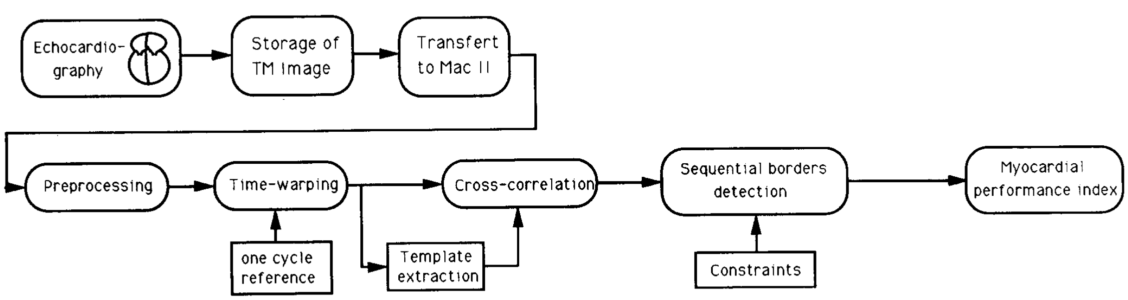
III-CARDIAC BORDERS DETECTION

The four cardiac borders extraction is based on template matching. Each of the borders is characterized by a one-dimensional reference profile or template in the spatial direction. Difficulties arise from the borders extraction: (i) observed time trajectories of cardiac borders sometimes present discontinuities and (ii) most echocardiograms contain a certain number of irrelevant high contrast edges, due to other moving structures, which are sometimes located in the close proximity to true cardiac borders. To overcome these difficulties we have introduced some continuity and physiological constraints: (i) when the ultrasonic beam is oriented correctly, the major property distinguishing cardiac boundary trajectories from those of other moving structures is a relative continuity along the global cycle and (ii) the linear relationship between wall thickness and ventricular diameter during systole. So it is possible to enumerate all allowable time trajectories in a specified search area and select the 'best' one based on some global cost function.

The successive time frames are cross-correlated with templates representing characteristic border profiles. The optimal trajectory is defined as the one that maximizes the sum of all elementary correlations with a template along this path. This problem is solved effectively through dynamic programming. The relationship between cardiac wall thickness and ventricular diameter is introduced here as a physiological constraint to ensure the borders detection.

IV-CONCLUSION

A method of automatic cardiac border extraction, based on template matching, is presented. This algorithm has been tested on certain cases and satisfactory results have almost always been obtained.



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