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Automated Boundary Detection of Left Ventricle from Cardiac MR Images Using Pattern Recognition

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INTRODUCTION

Cardiac disease is the leading cause of death among males in the Korea. Recently, there has been a deluge of efforts in the use of noninvasive techanique for measuring the dyna mic behavior of the human heart, especially the left ventricle. This paper describes the de sign of an image processor for the total evaluation of cardiac function by the developme nt of a flexible knowledge-based system using pattern recognition for detection of the en docardial and epicardial boundaries of the left ventricle(LV) using computer vision techniq ue from time-varying cross-sectional images obtained by ECG-gated magnetic resonance i maging (MRI) efficiently and reliably.

Subsequently, this image data were 3-D reconstructed by volume rendering technique as ti me-varying (4-D).

METHOD

The automated boundary detection system is applied to cardiac short axial plane images which were acquired a 1.5T Siemens scanner using a fast gradient echo technique.

Preprocessing consists of data conversion procedures for reduction of both noise and data using either linear or nonlinear filter masks. For each slice, a gray level histogram is ge nerated by counting the number of pixels with same gray level so that the data are displ ayed on an (r,θ) coordinate system centered on the center of the LV blood pool. After th is procedure, it is selected threshold by the operator to extract line segments. The interme diate processing deals with the task of extracting and characterizing in an image resulting from a low level processing.

As the line segments are detected, spectral information about them is collected. This incl udes their average gray level, length, radial location, angular location from center, and th e gradient value. Five mass functions are then generated for each line segmentation. As e ach location case, it is fitted curve is determined from the distance between the epicardiu m, endocardium endpoint and the center each pattern group during end-diastole and end-d iastole.

RESULTS

We have implemented the knowledge-based left ventricular wall boundary detection syste m described in Visual C++ under IBM PC. We have applied the program to cardiac MRI data from normal and abnormal patient studies. We evaluated the performance of the sys tem by the success rate compared to semi-automatic system.

At result, automatic processing were satisfactory with success ratio is grater than 90% su ccess rate in many slices except papillary muscle compared to semi-automatic processing.

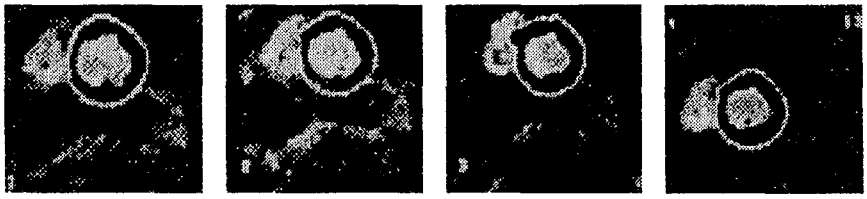

Fig 1. Example of epicardial and endocardial boundaries detection of left ventricular wall during several cardiac cycles

DISCUSSION

We have described a pattern recognition methodology which we applied to detection of e ndocardial and epicardial boundaryes from dynamic cardiac MR images. Although it was found that there is a good agreement between the result obtained by the semi-auto meth od and that by the automated method, future work increasing clinical cases for further fe asibility test on the improved method is needed.

CONCLUSION

This result shows that our boundary detection procedure can reduce time and detect accur ately. In addition, it is very useful to apply successfully in a variety of clinical applicatio ns: diagnosis of congential anomalies such as septal defects, abnormal great vessel orienta tion and position, chamber enlargement, diagnosis of ischemic heart disease, identifications of mass lessions and evaluation of cardiac functions by measuring attributes such as left ventricular end systolic volume and end systolic volume, stoke volume, ejection fraction, wall motion, wall thickening, etc.