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Poster presentation

Left ventricle segmentation in cardiac MRI using data-driven priors and temporal correlations

Xiao Jia*[1], Ying Sun[1], Ashraf A Kassim[1], Yijen L Wu[2], Kevin Hitchens[2] and Chien Ho[2]

Address: [1]National University of Singapore, Singapore, Singapore and [2]Pittsburgh NMR Center for Biomedical Research, Carnegie Mellon University, Pittsburgh, PA, USA

* Corresponding author

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Introduction

Cardiac MRI has been widely adopted in the study of heart transplant rejection using small animal models. Due to limited image quality, quantitative assessments of such studies are generally performed through manual segmentation. Therefore, it is desirable to develop a reliable and accurate segmentation algorithm.

Purpose

The goal of this study is to develop an automated algorithm for the segmentation of the left ventricle (LV) of both native and transplanted rat hearts in cardiac MR images of rats.

Methods

Our level set based method combines data-driven priors, temporal correlation, as well as texture and intensity information for segmentation.

1. Prior extraction

We first generate priors for the LV endocardium and epicardium respectively by extracting corner points inside the LV cavity (Fig. 1b) and the scale-invariant edges (Fig. 1d). For endocardium, the probabilistic map is obtained by kernel density estimation (Fig. 1c); for epicardium, the probabilistic map is obtained by measuring the likelihood of the extracted edges being on the true epicardial boundary (Fig. 1f).

2. Temporal correlation

Instead of segmenting each image independently, we incorporate the temporal correlation among frames. Given one reference frame with reliable segmentation, the myocardial contours in the reference frame are propagated to other frames in the same sequence by non-rigid registration. Based on registration error, we then generate a confidence map for each frame, indicating the reliability of the propagated contours.

Results

We have tested the proposed method on 120 MR images of both native and transplanted rat hearts. All MRI scans were performed by a Brucker AVANCE DRX 4.7 T system with the following imaging parameters: FOV = 4 cm; image resolution = 256 × 256 pixels; TR = a cardiac cycle; TE = 5.5 msec.

To quantitatively evaluate the segmentation accuracy, we measure the area similarity between myocardial masks obtained by the proposed method and their manual counterparts. The area similarities have mean value of 0.88 with standard deviation 0.05, which indicates very good match between the ground truth and our segmentation results.

Interestingly, in Fig. 2 we find automated segmentations (Fig. 2a&2c) are more reasonable than their manual counterparts (Fig. 2b&2d) in terms of temporal consistency.

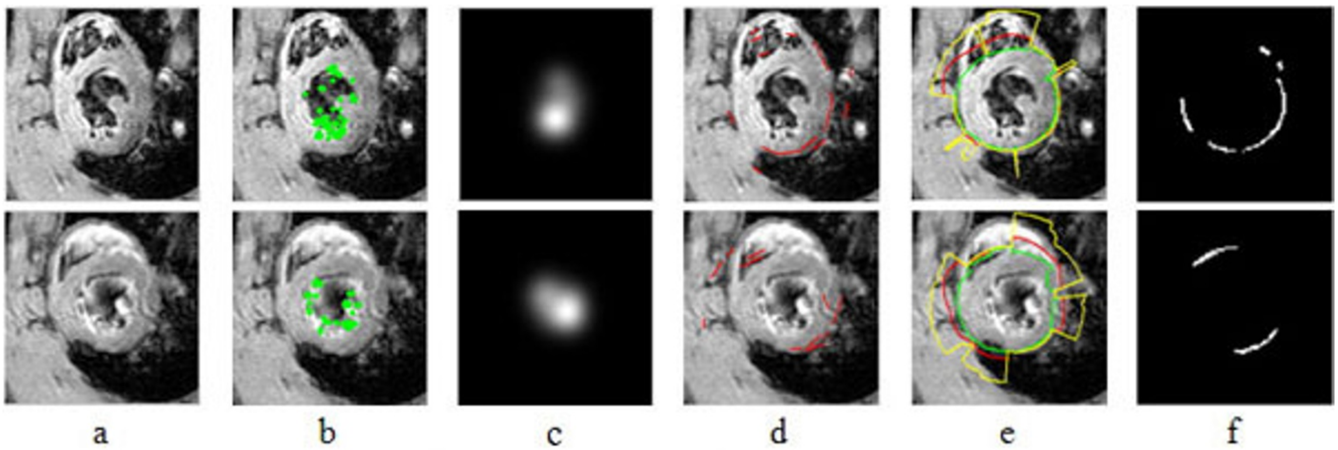

Figure 1
Feature extraction & Prior generation. a) Original image; b) Detected corner points; c) Prior map for endocardium segmentation; d) Detected scale-invariant edges; e) Edge filtering; f) Prior map for epicardium segmentation

The underlying reason is that the proposed algorithm integrates temporal correlation among frames in the segmentation while humans can only segment images one by one.

Conclusion

Our experimental results suggest that the proposed method is robust and accurate in segmenting LV of both native and transplanted rat hearts in cardiac MR images.

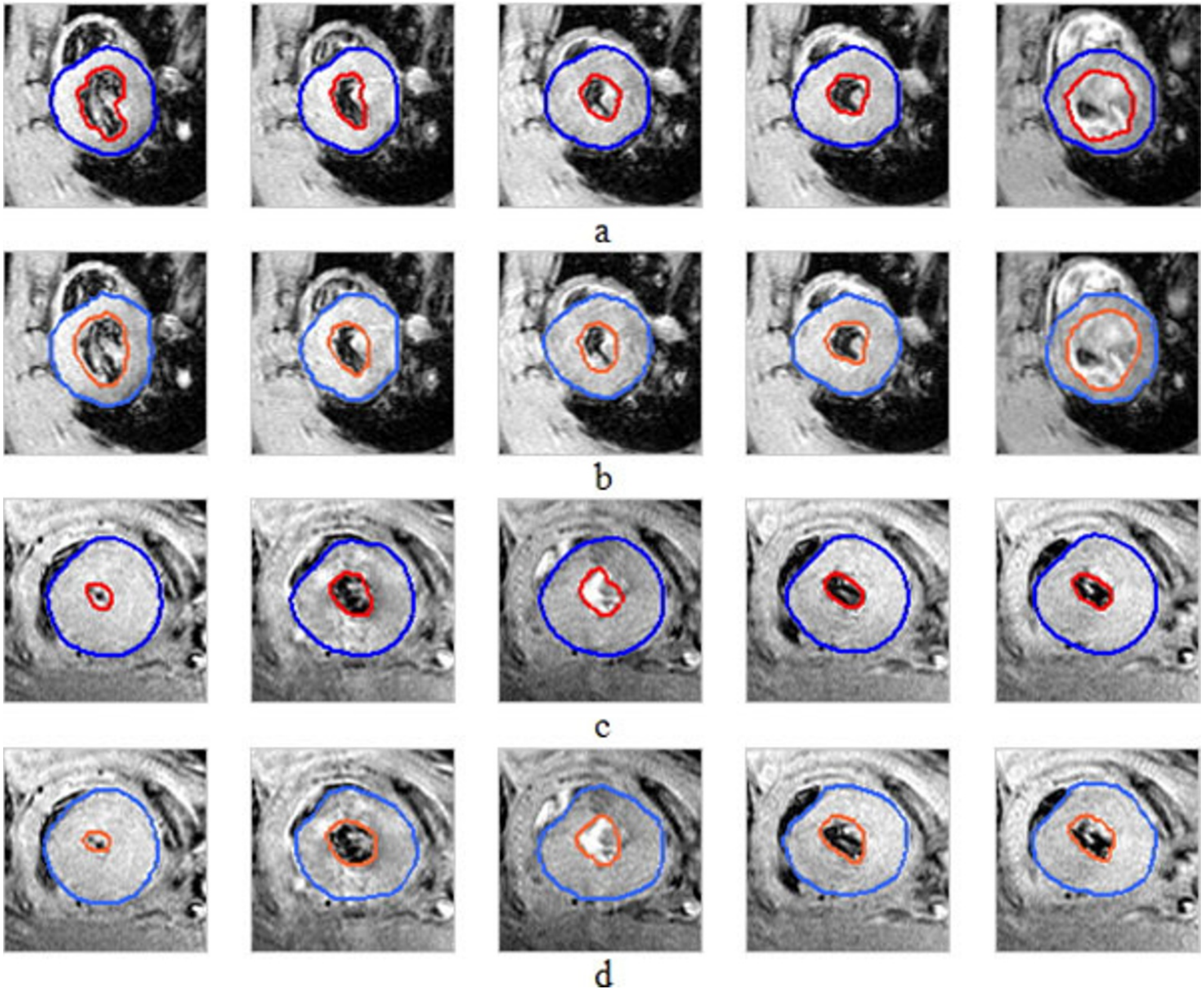

Figure 2
Comparison between automated segmentation and ground truth a), c) Automated segmentation; b), d) Manual segmentation (by experts).