Semi-Automatic Segmentation and Scar Quantification of the Left Ventricle in 3-D Late Gadolinium Enhanced MRI

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Introduction: Late gadolinium enhanced (LGE) MRI is used to visualize regions of fibrosis and scaring in the left ventricle (LV). This is very important information for treatment planning and the success prognosis for the patient. Recently, high-resolution isotropic 3-D LGE-MRI methods were proposed to allow for a more precise quantification of healthy and scared tissue. The major challenge arises in the analysis of the resulting images to quantify scar tissue. In this work, we propose a novel approach for automatic LV segmentation for 3-D whole-heart LGE-MRI to address this limitation.

Subjects and Methods: We evaluated the automatic segmentation in 8 clinical MRI data sets (sparse GRE sequence, spatial resolution (1.3 x 1.3 x 1.3)mm^3)**.** A three step algorithm has been developed for LV segmentation: First, an initial seed-point within the LV cavity is selected by the user. A first approximation of the endocardium is achieved with active contour (AC) segmentation. Subsequently, a short-axis view is estimated by means of principal component analysis. In the second step, the endocardial contour is refined in polar space using the edge information from Canny detector. For the refinement, the contours found via AC are used to initialize a minimal cost path search to find the optimal contour. Finally, the epicardial contour is computed starting from the endocardium and using edges similar to the previous step. A threshold based approach was used for scar quantification as described in (2). The automatic segmentation of the LV endocardium, epicardium, and scar tissue was compared to a manual gold-standard annotation of a clinical expert.

Results: Four out of the eight clinical MRI scans contained scar tissue. The automatic segmentation resulted in an overlap to the gold-standard for the endocardium of 0.85±0.05 and for the epicardium of 0.84±0.06 using the Dice coefficient. For scar segmentation, we yielded an overlap of 0.59±0.2, respectively.

Discussion and Conclusion: The results indicate that our proposed segmentation approach is accurate and robust for segmenting the LV endocardium and epicardium as well as for scar quantification in 3-D LGE-MRI with only minimal user interaction. Future work will focus on elimination of the remaining user interaction as well as a clinical validation/evaluation.

Disclaimer: The methods and information presented in this paper are based on research and are not commercially available.

Keywords: Segmentation, Left Ventricle, 3-D Late-Gadolinium Enhanced MRI, Scar Quantification,

References:

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