

Segmentation of the Full Myocardium in Echocardiography using Constrained Level-Sets

Martino Alessandrini*, Thomas Dietenbeck, Daniel Barbosa, Jan D'Hooge, Olivier Basset, Nicolo Speciale, Denis Friboulet and Olivier Bernard

ARCES, University of Bologna, Bologna, Italy

In echocardiography, left ventricle detection is a common practice in order to retrieve indexes of myocardial health. Although a great attention has been given to the segmentation of the endocardium, a very limited literature addresses the detection of both endo- and epicardial contours. Nevertheless, a trustful detection of both boundaries is fundamental in order to estimate clinical parameters like the ventricular mass.

Hereto, the aim of this work is to propose an original active contour model based on level-set technique specifically designed for the detection of the whole myocardium in short-axis ultrasound scans.

The proposed segmentation flow proceeds by seeking the maximal statistical separation between target, i.e. the myocardium, and background. In order to deal with low-contrast or missing boundaries, a localized version of standard region-based methods is adopted. Moreover, shape prior information is efficiently embedded in the evolution equation, forcing the active contour to be approximately annular. This prevents the detection of undesired small structures, like papillary muscles. With the resulting formalism the detection of both endo- and epicardium is addressed efficiently with a single level-set function.

Forty B-mode short-axis images were acquired from 5 different patients. Both endo- and epicardium were manually segmented by two expert physicians. We assessed the performances of the algorithm by measuring Mean Absolute Deviation (MAD) and Hausdorff Distance (HD) between automatic and manual contours, as well as the correlation coefficient (R) between the areas they enclose. Six points were placed by the user for initialization.

We obtained $MAD = 3.1 \pm 0.5$ pixels and $HD = 9.2 \pm 2$ pixels. These values fall within the intra-observer variability between the two experts, given by $MAD = 3.7 \pm 1.2$ and $HD = 10.6 \pm 3.7$. The correlation coefficient was $R = 0.98$.

The presented method is shown to be a reliable and accurate tool for full myocardium segmentation on ultrasound images.