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A Robust and Efficient Segmentation Method Applied for Cardiac Left Ventricle with Abnormal Shapes

Authors : Peifei Zhu, Zisheng Li, Yasuki Kakishita, Mayumi Suzuki, Tomoaki Chono

Abstract : Segmentation of left ventricle (LV) from cardiac ultrasound images provides a quantitative functional analysis of the heart to diagnose disease. Active Shape Model (ASM) is a widely used approach for LV segmentation but suffers from the drawback that initialization of the shape model is not sufficiently close to the target, especially when dealing with abnormal shapes in disease. In this work, a two-step framework is proposed to improve the accuracy and speed of the model-based segmentation. Firstly, a robust and efficient detector based on Hough forest is proposed to localize cardiac feature points, and such points are used to predict the initial fitting of the LV shape model. Secondly, to achieve more accurate and detailed segmentation, ASM is applied to further fit the LV shape model to the cardiac ultrasound image. The performance of the proposed method is evaluated on a dataset of 800 cardiac ultrasound images that are mostly of abnormal shapes. The proposed method is compared to several combinations of ASM and existing initialization methods. The experiment results demonstrate that the accuracy of feature point detection for initialization was improved by 40% compared to the existing methods. Moreover, the proposed method significantly reduces the number of necessary ASM fitting loops, thus speeding up the whole segmentation process. Therefore, the proposed method is able to achieve more accurate and efficient segmentation results and is applicable to unusual shapes of heart with cardiac diseases, such as left atrial enlargement.

Keywords : hough forest, active shape model, segmentation, cardiac left ventricle
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