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Meeting abstract

1131 Robust semi-automatic computer-aided segmentation of the left ventricle

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Introduction

Left ventricular assessment with CMR calls for extensive delineation from increasingly large datasets, especially for serial examinations. In these cases, manual segmentation is tedious and also involves significant inter- and intra-operator variability. Computer-aided approaches that help automate the delineation are fallible to a range of problems that affect automatic image segmentation and those that are unique to CMR. With trueFISP imaging, the quality of the images has been improved significantly but the automatic segmentation of the epi-cardial border remains difficult due to the poor contrast of the myocardium in relation to the surrounding anatomical structures. This purpose of this study is to present a new statistical modelling scheme based on an outlier detection mechanism [1] for robust, semi-automatic LV analysis.

Methods

The automatic segmentation technique is based on the use of a statistical shape model which can capture the geometrical complexity and natural variability found across subjects and time. The core of the technique is an outlier handling mechanism which allows the detection and the correction of boundary localisation errors throughout the automatic segmentation procedure. The method uses a tolerance model that is constructed from training samples to identify inconsistencies between the segmentation under investigation and the reference model. Therefore, errors due to noise, artefacts and poor signal contrast can be efficiently identified and rectified, thus allowing the overall delineation to be improved. To ensure the robustness of the technique, an initialisation step for the definition of valve and apical landmarks is incorporated. The long-axis epi-cardial contours are then extracted using the robust segmentation technique and used for initialisation of the final left-ventricular segmentation using the entire short axis image stack. A reviewing and correction tool was incorporated to allow the correction of inaccuracies from the automatic stage in a fast and interactive manner.

Validation

LV datasets were collected using a 1.5 T MR scanner (Sonata, Siemens, Erlangen Germany) and a TrueFISP sequence (TE = 1.5 ms, TR = 3 ms, slice thickness = 10 mm, pixel size of 1.5 to 2 mm) within a single breath-hold. A total 40 subjects were used to train the statistical and tolerance models for the automatic segmentation. The semi-automatic computer tool was tested on an additional 18 subjects. The epi-cardial boundaries of the left ventricle were first delineated manually by two expert observers and the corresponding volumes were calculated. The inter-observer variability error between the two clinicians was found equal to 13.24 ± 5.60%. Segmentation of the 18 subjects using the proposed computer-aided tool was carried out by two additional observers and the inter-operator variability in this case was found equal to 3.42 ± 3.75%. Figure 1.

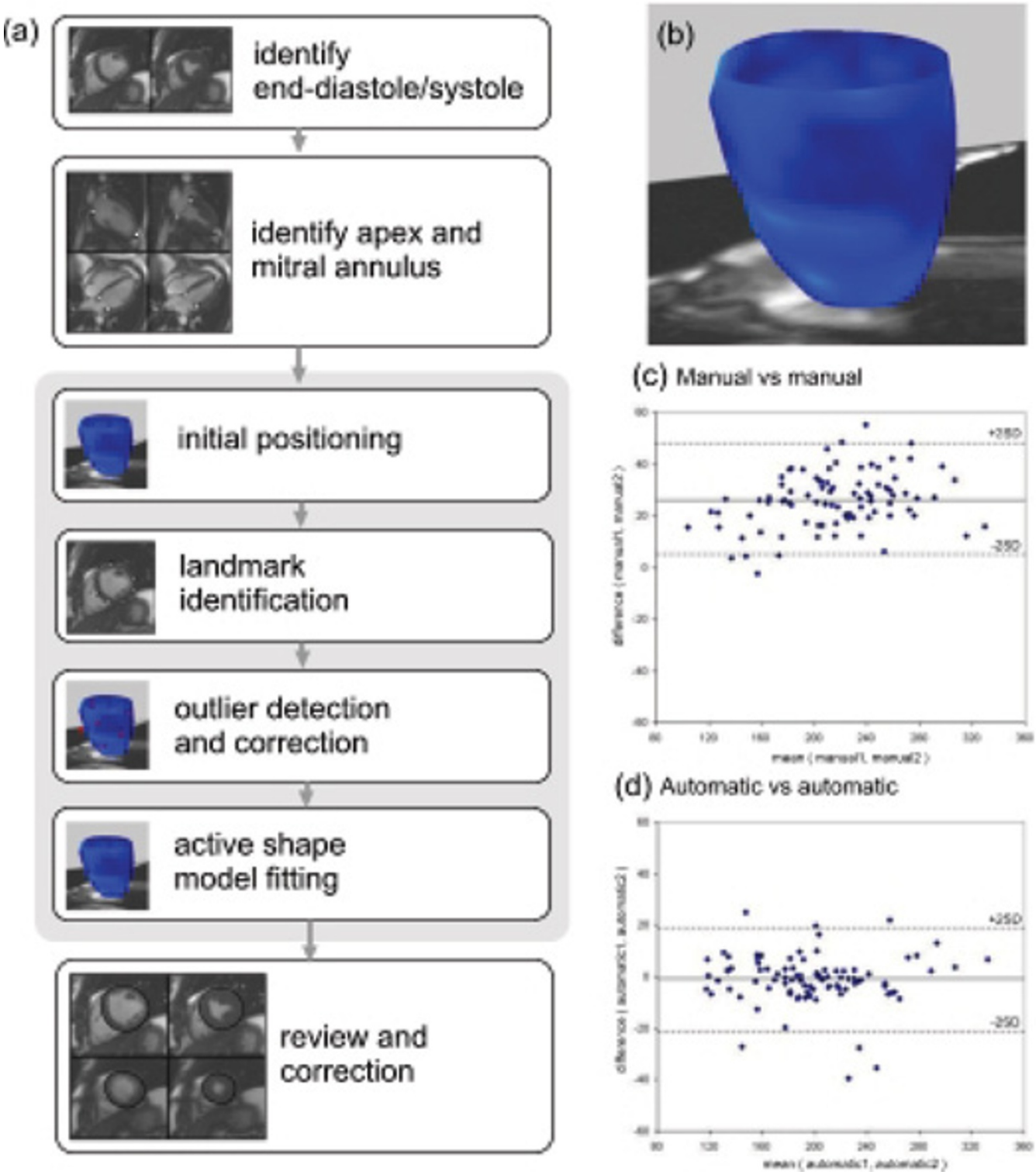

Figure 1
(a) is a schematic of the segmentation mechanism used for semi-automated delineation of the epi-cardial border (b). Figures (c) and (d) are Bland-Altman plots showing the variability between two manual observers and the variability between two computer-assisted observers respectively.

Conclusion

Manual delineation of the left ventricle boundaries is a labour-intensive task which may introduce significant operator bias and therefore confuse the analysis of the results, especially for monitoring of changes as response to therapeutic measures. The proposed method for left-ventricular delineation incorporates a fast and robust automatic segmentation technique based on statistical shape modelling combined with outlier detection. The results show significantly lower variability achieved as compared to manual delineation, demonstrating the potential clinical value of the technique.

References

1. Lekadir K, Merrifield R, Yang G-Z: **"Outlier detection and handling for robust 3D active shape models search".** *IEEE Transactions on Medical Imaging* 2007, **26:**212-222.