An automated approach based on a convolutional neural network for left atrium segmentation from late gadolinium enhanced magnetic resonance imaging

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The assessment of viable left atrial (LA) tissue is a relevant information to support catheter ablation in atrial fibrillation. Late Gadolinium Enhanced (LGE) cardiac magnetic resonance imaging (MRI) is a new emerging non-invasive technique which might be employed for the quantification of LA myocardial fibrotic tissue in patients affected by atrial fibrillation. Even if studies on atrial structure segmentation applied to LGE MRI have shown promising results, most of them were based on manual tracing of LA wall. This procedure is time-consuming and prone to high inter-observer variability given the different degrees of observers experience, LA wall thickness and data resolution. Therefore, an automated segmentation approach of the atrial cavity for the LA wall quantification of scar tissue would be highly desirable.

This work focuses on the design of a fully automated LA segmentation pipeline exploiting a convolutional neural network (CNN) based on the successful architecture U-Net. The CNN was trained with the LGE MRI data available from the STACOM 2018 Atrial Segmentation Challenge (100 cardiac data) with two different approaches: using stacks of 2-D axial slices (2-D pipeline) and using 3-D data (3-D pipeline). Once the training was completed using 80 cardiac data, a post-processing step based on the 3-D morphology obtained was applied on 20 predicted segmentations belonging to the test set. Mean Dice coefficients on the test set were 0.896 and 0.914 by using the 2-D and 3-D approaches, respectively.

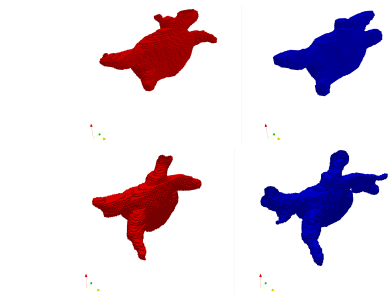

Figure 1. Meshes obtained with the proposed CNN in the 3-D pipeline (red) and the ground truth (blue) of the best prediction (top panels) and worst prediction (bottom panels).

Despite the high LA anatomy variability, both 2-D and 3-D CNNs provide accurate test predictions that could be useful for ablation therapy planning. Furthermore, even though the number of trainable parameters increases, the proposed 3-D neural network learns better features leading to slightly higher performance.