Artificially generated training data-sets for supervised Machine Learning techniques in Magnetic Resonance Imaging: an example in myocardial segmentation

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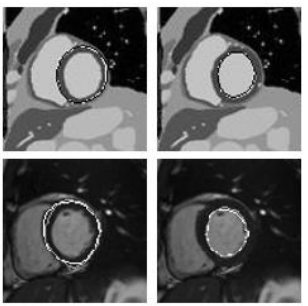
Aims: The study aimed to encounter the low-availability, the poor-relativeness and the small-size of the training data-sets that prevent the further development or delay the application of Machine learning techniques in radiology. This study proposes for the first time the development of artificially generated training data-sets for supervised learning techniques through the incorporation of a realistic simulation framework in Magnetic Resonance Imaging (MRI).

Methods: The 4D-XCAT anatomical model was utilized as the main computer model whereas the coreMRI simulation platform (www.coremri.org) was utilized for the generation of artificial MR images. The 4D-XCAT model was modified to be incorporated into coreMRI but also to be adapted to MR applications. 91 artificial end-diastolic, short-axis, cardiac MR images were generated in coreMRI and the corresponding maps of the myocardium of the left-ventricle (LV) were extracted from the 4D-XCAT model. The artificial data-set was further augmented by geometric transformations and by adding synthetic white noise (546 images in total). A fully convolutional network (FCN) (Tran, 2016) for LV segmentation was utilized. The performance of the FCN was evaluated on true cardiac MR data that were acquired from one healthy volunteer using a similar MR protocol. The number of training epochs used was 20 and the evaluation metrics used were accuracy and Dice index.



Indicative predictions (dark contours) of the LV contours (epi and endo) for both synthetic (top) and real (bottom) MR-images. White contours indicate ground truth.

Results: The application of the FCN (trained on the simulated data-set) on the cardiac MR data of the healthy volunteer presented an accuracy of 0.96 and a DICE index of 0.83 for the prediction of epicardium and an accuracy of 0.99 and a DICE index of 0.90 for the prediction of endocardium.

Conclusion: This study presented an alternative solution to the limitations encountered today in collecting training data-sets in MR. The proposed solution is performed without the use of a true MRI scanner, without scanning patients and without having personnel.