Importance of MR vendor specific optimization of automated left ventricular contour detection

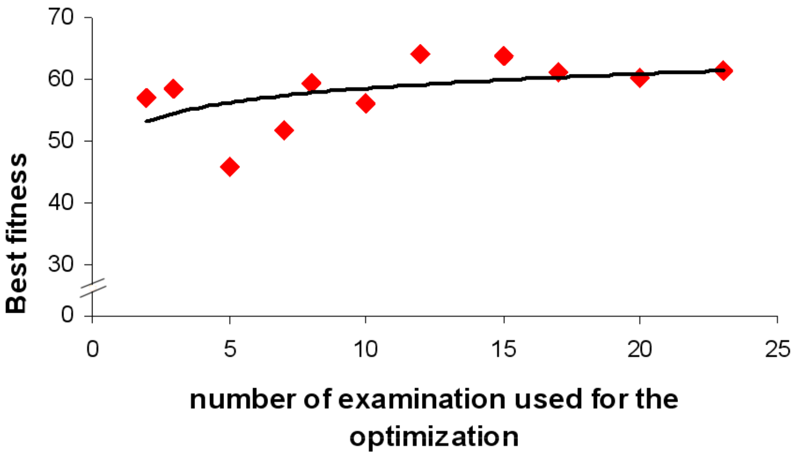
E. Angelié[1], R. J. van der Geest[1], P. J. de Koning[1], J. H. Reiber[1]
[1]Radiology/Image Processing, Leiden University Medical Center, Leiden, Netherlands

Synopsis : In previous work we demonstrated the importance of optimizing the settings of the automated left ventricular contour detection parameters of the MASS software package for images obtained with specific pulse sequences such as Gradient Echo and Steady State Free Precession (SSFP) sequences (1). In this work we studied whether specific optimization of the contour detection parameters is needed for SSFP images obtained from MR systems of three different vendors. The results of this study indicate that optimization for a specific MR system results in improved automated contour detection performance.

Introduction: The use of automatic contour detection techniques facilitates quantitative assessment of left ventricular myocardial function. Since image characteristics vary due to the use of different pulse-sequences or the use of MR systems from different vendors, the various parameters of the segmentation algorithm need to be optimized for a specific situation. In this study two different questions were addressed: the first deals with the number of examinations needed to perform the optimization procedure. The second question was to study the ability and the need of an optimization of the segmentation algorithm when considering examinations acquired with a similar Steady State Free Precession (SSFP) pulse sequence implemented on MR systems from different MR vendors (A, B, C).

Methods: The contour detection optimization approach used a Genetic Algorithm (GA) as an intelligent self-adaptive method to tune the segmentation algorithm (1,3). Based on the degree of similarity between the automatically detected and the manually drawn contours (2), the GA will generate a new set of parameters that will replace the previous setting. As the search process continues, the population converges to a better set of parameters. The tuning was realized for the automatic detection of endocardial contours in the end-systolic and end-diastolic phases. We analyzed the accuracy of the segmentation process using different sizes of the training set (2, 3, 5, 7, 8, 10, 12, 15, 17, 20, and 23 examinations). The optimal setting found after tuning was evaluated on the set of 28 exams. On one hand the image characteristic is dependent on the pulse sequence used to acquire the examination and on the other hand may depends on the system used to acquire the examination. To verify this last hypothesis, the automatic segmentation algorithm was optimized on three different populations of ten SSFP examinations acquired with MR systems from three different vendors (A, B and C). The "after-tuning" performances of the segmentation found for each manufacturer set were compared with inter-observer variability. The three different optimal parameter settings found were used for the automatic segmentation of the three sets of SSFP examinations indifferently and the resulting accuracies of segmentation were compared between each other.

Results: The variation of the degree of similarity (graph 1) found on a set of 28 SSFP examinations using the automatic segmentation algorithm with different optimal parameter settings (found on 2, 3, 5, 7, 8, 10, 12, 15, 17, 20, and 23 examinations sets) shows that the optimization should be realized on a set of 10 to 15 examinations.



Parameters /tested on	Vendor A	Vendor B	Vendor C
Parameters A	71.38	73.78	65.27
Parameters B	65.91	74.94	64.60
Parameters C	68.30	72.50	68.73
Inter-observer variability for manual drawing	77.13	73.67	74.45

Graph 1: Variation of the best degree of similarity found as a function of the number of examination used for the optimization. Table 1: Degree of similarity found when performing the automatic segmentation on a set of examination using the optimal parameter setting found with the same or a different set of examination.

Table 1 shows that for each set of examinations from a specific vendor, the optimal degree of similarity is found when using the parameter set corresponding to this set of examinations (Segmentation using parameter B set on set B of examinations provides highest result). It also shows that for an optimal parameter set, the degree of similarity found on the same set of examinations can be smaller than the one found on another set of examinations (parameter C tested on A, B, C set of examination).

Discussion and Conclusion: A set of 10-15 examinations seems to be sufficient to tune the automatic segmentation algorithm used in MASS analytical software package. The importance of using the optimization process for examinations acquired with different system was strengthened by the difference found between the accuracy of the segmentation of the three sets of examinations. When comparing the performance of the automatic segmentation after optimization and the corresponding inter-observer variability, it appears that the automatic segmentation after tuning is comparable with the manual segmentation.

References: 1) E. Angelié et al. Proc. Intl. Soc. Mag Reson Med. 2003 11:2596; 2) E. Angelié et al. Proc. EuroCMR 2002. 1: 9-10. 3) DE Goldberg. Genetic algorithms in search, optimization, and machine learning. 1989.