Evaluation of an Atlas-Based Segmentation Method for Prostate MRI

Nelson AS, Brockway J, Liu M, Javorek A, Pirozzi S, Piper JW

MIM Software Inc., Cleveland, OH

Purpose & Objective

Accurate definition of the prostate boundary is important in radiation therapy planning, brachytherapy, and for providing volumetric measurements of prostate size. T2 MRI provides an image with good soft tissue contrast for boundary definition. Manual segmentation of the prostate on MRI, however, can be tedious and have significant inter-observer variability. Our goal in this study is evaluate an automatic atlas-based segmentation method for prostate MRI.

Methods & Materials

Sixty subjects with expert defined prostate volumes of interest (VOI) were downloaded from the NCI-ISBI 2013 prostate segmentation challenge[1]. Thirty of the subjects had 1.5T T2 MRI scans with endorectal coils while the other thirty had 3T T2 MRI scans with no endorectal coil. Fifteen subjects were taken from each group (1.5T and 3T) to make a 30 subject atlas and a 30 subject test set.

The atlas method involved automatically finding the atlas subject that best matched the test subject followed by a normalized intensity-based free-form deformable registration of the atlas subject to the test subject. The prostate VOI was transformed to the test subject using the same deformation. Keywords (1.5T, 3T, Endorectal coil, No endorectal coil) were used to refine the atlas matching. For each test subject the seven best matches were used and the final VOI was combined using STAPLE[2]. The atlas-segmentation process was fully automatic. Dice similarity coefficients (DSC) were calculated comparing the atlas generated VOIs to the expert defined VOIs for each test subject.

Figure 1
Manual and Atlas Based Segmentation Results

3T   1.5T
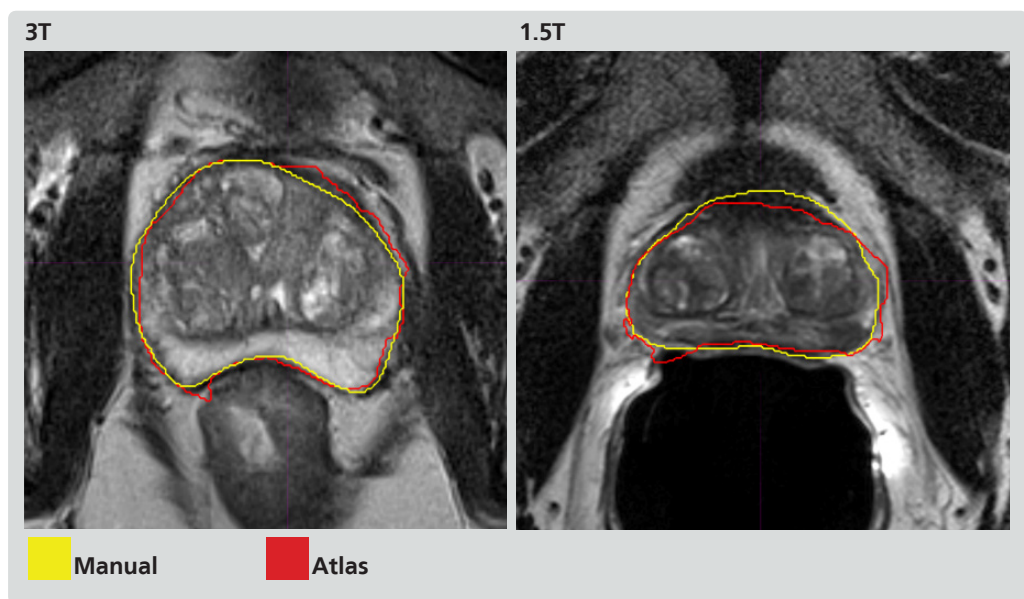
■ Manual   ■ Atlas

Comparison of manual and atlas-based segmentation results for 3T T2 MRI and 1.5T T2 MRI.

Results

The atlas-based segmentation method resulted in an average DSC of 0.79 +/- 0.11 and a median DSC of 0.82. The number of patients (#) in DSC ranges are as follows: <0.60 (1), 0.60-0.69 (4), 0.70-0.79 (5), 0.80-0.89 (19), >0.89 (1). There was one outlier data point with a DSC of 0.33 that was included in the overall mean and median statistics.

Conclusion

The prostate MRI atlas-based segmentation method achieved good results compared to expert defined VOIs and has the potential to provide significant time savings for prostate VOI definition.

Table 1
Dice Similarity Coefficient

DSC Range	Number of Patients
<0.60	1
0.60-0.69	4
0.80-0.79	5
0.80-0.89	19
>0.89	1

References

1. NCI-ISBI 2013 Challenge - Automated Segmentation of Prostate Structures. https://wiki.cancerimagingarchive.net/display/Public/NCI-ISBI+2013+Challenge+-+Automated+Segmentation+of+Prostate+Structures. Accessed June 27, 2013.
2. Warfield SK, Zou KH, Wells WM. Simultaneous truth and performance level (STAPLE): an algorithm for the validation of image segmentation. IEEE Trans Med Imaging 20104; 23(7):903-21.