Subject Specific Bone Atlas: Segmentation Applications and Validation on OA Subjects

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Abstract. This work evaluates the performance of an atlas based segmentation method for segmenting bones from MRI data sets. We found that the atlas based method performed as good as an alternative supervised segmentation method on subjects with OA.

1 Communication

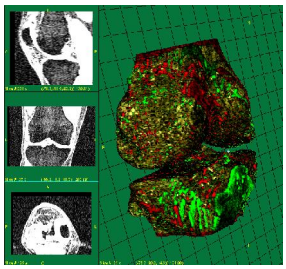
Osteoarthritis (OA) is a common disease that modifies the shapes of joint bones. The use of a segmentation function to evaluate the progression and change of bones shapes with MRI images can be a valuable, time saving tool in the understanding of OA progression. In this work, we evaluate the performance of a fully automated atlas based segmentation method applied to the segmentation of MRI images of the OA knee. The subject specific atlases are created using a supervised segmentation tool then these atlases are used to fully segment the new MRI acquisition of the same subject. The supervised segmentations and the fully automated atlas based segmentation of the OA knee are compared and presented in this work.

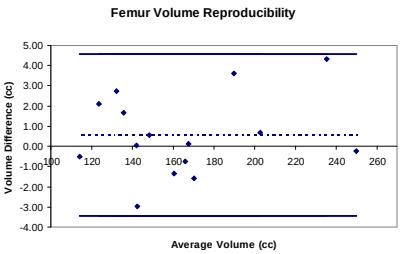
The marker knee of 15 subjects obtained in a pilot study for the Osteoarthritis Initiative (OAI) validation of MR protocol study was scanned twice in a scan-rescan fashion using a Siemens 3T scanner. Each scan consisted of a Coronal water excited 3D FLASH acquisition with 64 1.5mm thick slices and 0.3125 by 0.3125mm in plane resolution. All 30 scans were then randomized, and an hybrid segmentation algorithm, which combines an edge based segmentation approach with a pixel based classification technique, was used to extract all structures within each image series, after which, the tibia and femur were manually labeled by an expert user and then inspected by a musculoskeletal radiologist. Four random subjects were selected for re-analysis and a voxel to voxel comparison was used to estimate the volume re-classification variability per unit area. The evaluation of the atlas based approach consisted on mapping the initial scan's supervised segmentation to its rescan sequence using the ap-

proach outlined in Tamez-Pena *et. al*[1]. The difference in overlap between the atlas based and the supervised segmentations was assessed by measuring the commonly classified voxels. As a result, the femur and tibia average volumes difference and the classification disagreement between the two segmentation approaches was measured.

The supervised and the atlas based process resulted in similar segmentations. The difference in overlap between the two segmentations types is well within the calculated volume re-classification variability per unit area of 0.37mm as well as to the in-plane resolution of our images. The atlas based segmentation proved to be unbiased and reproducible and can be a valuable time saving technique in longitudinal studies, where the editing time could be reduced up to 75%.

2 Results





	Femur	Tibia
Non overlapping volume per unit	0.20 ± 0.04	0.31 ± 0.09
Classification Disagreement (%)	4.1 ± 0.9	4.3 ± 1.4
Volume CV (%)	1.0 ± 0.8	1.2 ± 0.9

Fig. 1. Top left, 3D rendering of the tibia and femur where the (*red*) and (*green*) regions show the supervised and the atlas based segmentation differences. Top right, Bland-Altman plot of the femur volume. Bottom, The table summarizes of differences between the supervised and the atlas based segmentations for the femur and tibia regions.

3 Acknowledgements

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References

1. Tamez-Pena, J.G., *et al.* The Integration of Automatic Segmentation and Motion Tracking for 4D Reconstruction and Visualization of Musculoskeletal Structure. IEEE Workshop on Biomedical Image Analysis. 1998. Santa Barbara, CA. pp. 154-163.