Automatic Bone Segmentation using Voxel Classification

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**INTRODUCTION**

This experiment applies a Voxel Classification approach [1] to automatically segment the Tibia as a first step to develop quantitative methods for analysis of bone morphometry and structure. The dataset is composed of 14 MRI scans selected from a population of 139 test subjects knees. The original population has approximately equal distribution between healthy and diseased, laterality, sex and age.

**POSITION ADJUSTMENT**

Regarding the variations in the knee placement, in some cases it is necessary an adjustment on the scan coordinates. The method consists of two steps:
1. Shift the coordinates so that the object center of mass, found from the segmentation, is positioned at the location of the center of mass of the object points in the training set;
2. Re-classify the voxels. The outcome is combined and the largest connected component is selected as the object segmentation.

**FEATURE SELECTION**

The method uses a voxel classifier to select a subset of features by sequential floating selection. At each time, it iteratively adds one feature and might excludes the least significant feature according to the volume overlap with the manual segmentation. The candidate features are the intensity, the position, the three-jet, eigenvalues, and eigenvectors of both the Hessian and the structure tensor. All features except the position are calculated in different scales (0.5, 1.1, and 2.4 mm).

The resulting features are the first-order derivative on the three scales, the position, the structure tensor with outer scale of 0.5mm and derivative scale of 2.4mm, the Hessian on all three scales, the gradient on 0.5mm and 2.4mm and the third-order derivative on scale 1.1mm. The final feature vector has 27 dimensions.

**RESULTS AND DISCUSSION**

Before applying the position adjustment scheme, the automatic segmentation method yields an average sensitivity of 88.6% and DSC of 93.8% in comparison with manual segmentations. After applying the automatic position normalization, the average sensitivity increases to 90% and DSC to 94.5%.

The results show that the method has a good accuracy in the dataset evaluated. But in order to do a better analysis, we plan to apply the method in the whole dataset with 139 test subjects knees.

Also as a future work, considering the improvement of the position adjustment, a shape model of the bone could be applied to better adjust the segmented object to the scan coordinates.

In addition, it is possible to evaluate the features with different scales regarding the size of the anatomical structure being analyzed.

**REFERENCES**


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