

# Fully-Automated Segmentation of Cartilage from the MR Images of Knee using a Multi-Atlas and Local Structural Analysis Method

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## ABSTRACT

**Purpose:** To develop a fully-automated method to segment cartilage from the magnetic resonance (MR) images of knee and to evaluate the performance of the method on a public, open dataset.

**Methods:** The segmentation scheme consisted of three procedures: multiple-atlas building, applying a locally-weighted vote (LWV), and region adjustment. In the atlas building procedure, all training cases were registered to a target image by a non-rigid registration scheme and the best matched atlases selected. An LWV algorithm was applied to merge the information from these atlases and generate the initial segmentation result. Subsequently, for the region adjustment procedure, the statistical information of bone, cartilage and surrounding regions was computed from the initial segmentation result. The statistical information directed the automated determination of the seed points inside and outside bone regions for the graph-cut based method. Finally, the region adjustment was conducted by the revision of outliers and the inclusion of abnormal bone regions.

**Results:** A total of 150 knee MR images from a public, open dataset (available at [www.ski10.org](http://www.ski10.org)) were used for the development and evaluation of this approach. The 150 cases were divided into the training set (100 cases) and the test set (50 cases). The cartilages were segmented successfully in all test cases in an average of 40 minute computation time. The average dice similarity coefficient was  $71.9 \pm 4.1\%$  for femoral and  $67.7 \pm 8.0\%$  for tibial cartilage.

**Conclusions:** We have developed a fully-automated segmentation program for knee cartilage from MR images. The performance of the program based on 50 test cases was highly promising.

Keywords: osteoarthritis, cartilage, multi-atlas segmentation, knee magnetic resonance imaging.

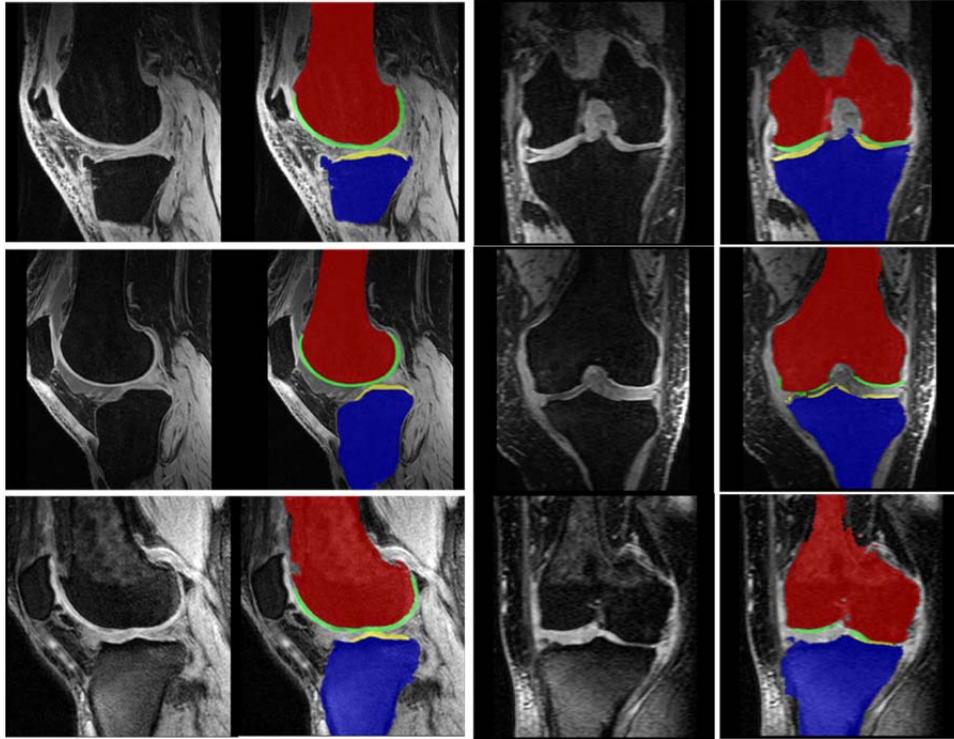


Figure 1. Examples from test cases showing segmentation results. Each row represents one of the three examples showing the original MR and segmented images in the sagittal and coronal planes. The segmented regions are color coded: red for the femur bone, blue for the tibia bone, green for femur cartilage and yellow for tibia cartilage.