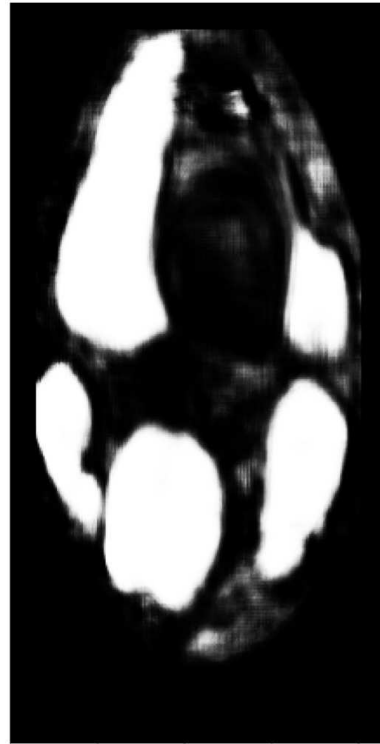
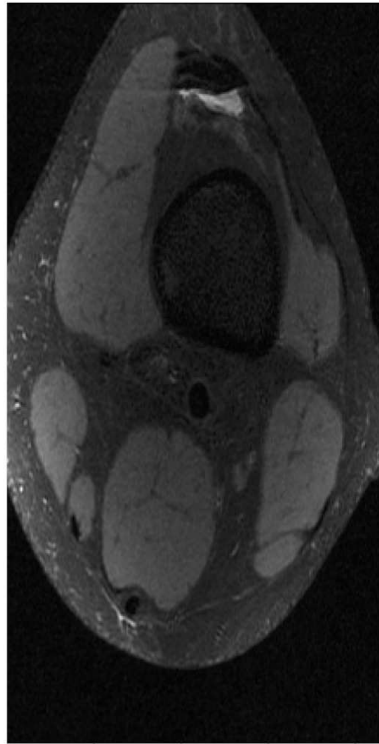




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Automatic segmentation of knee muscles in MRI data using deep learning convolutional neural network

Master's thesis in Biomedical Engineering, MPBME

KOKCHUN GIANG

MASTER'S THESIS 2018:NN

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Department of Electrical Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
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Cover: An example slice of test data (**left**) and its segmentation (**right**) by the 3D convolutional neural network.

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Abstract

Total knee arthroplasty (TKA) is a common surgical intervention for severe knee osteoarthritis. The demand for TKA has been increasing tremendously all over the world. Higher accuracy of this intervention can be achieved through image guided surgery, which requires image segmentation of anatomical structures around the knee, in particularly the muscles. In recent years, convolutional neural networks (CNN) has excelled in image segmentation in different disciplines. This thesis aims at developing an automatic segmentation algorithm based on 3D CNN for knee muscles and evaluate its performance.

The dataset is composed of 18 knee 3D fast spin echo, proton density (PD) weighted images with volume dimension 512x512x256, voxel spacing 0.3125x0.3125x0.6mm (GE Medical Systems 3T Discovery MR750 scanner). 3D patches are extracted from the volumes to train a 3D CNN to segment muscle using a sliding window approach. This results in a likelihood map in which a global thresholding is performed on it, followed by morphological operations to obtain the final segmentation. The segmentation algorithm is validated using k-folded ($k=8$) cross validation and Dice similarity coefficient (DSC).

The final segmentation has a DSC of 0.869 ± 0.047 for muscle voxels and 0.972 ± 0.010 for non-muscle voxels. This segmentation result indicates that 3D CNN based segmentation is feasible for image guided surgery. However, to further develop the proposed segmentation method, a larger dataset should be used for training and more postprocessing methods should be tested, which leaves room for improvements.

Keywords: deep learning, convolutional neural network, CNN, 3D CNN, knee MRI, segmentation