

Interactive Systems to Enable Human-in-the-Loop Auto-Segmentation on Large Bio-Medical Image Database for Muscle Analysis

Situation

Muscle-volume analysis is becoming essential for the planning of pre-surgical interventions, pre- and rehabilitation and recovery protocols (e.g., joint replacements), as well as for the design of training programs for performance enhancement or injury prevention. A tool to receive automated analysis of skeletal muscles after every regular MRI-scan is missing. Yet, there are numerous auto-segmentation deep learning models emerging specifically for medical images and muscles. However, in practice, these auto-generated segmentation labels require often fine-tuning by a human expert, which then helps to fine-tune or customize publicly available segmentation models.

Goals / Methodology / Tasks

The goal of this project is to develop a human-in-the-loop auto-segmentation framework that allows a user to refine auto-generated labels using an open-source visualization tool.

- Explore MR images and select human body region from [UK-Biobank MRIs](#)
- Define benchmark data set
- Develop 3D segmentation label editing using open-source tools (e.g., [3D slicer](#), [MONAI Label](#), [ITK-SNAP](#))
- Generate and refine auto-segmentations from medical segmentation models (e.g., [MuscleMap](#), [TotalSegmentator](#), SAM/MedSAM) for muscle segmentation
- Analyze and study label refinement process of physicians using eye tracking
- Fine-tune a muscle segmentation model using weakly-annotated labels and the refined human-expert labels

Required Skills

Interest in medical imaging, data analysis (data wrangling, data exploration, visualization).

- GUI-programming using open-source tools
- Deep learning
- Image segmentation
- Human-computer-interaction analysis
- Python

Tasks for the Master Student

We see the following project phases:

P7: Develop tool in 3D to edit auto-generated segmentation labels from MR images of muscles

P8: Study label-editing of human experts using eye tracking and compare auto-generated labels vs. human-edited ones

P9: Fine-tune auto-segmentation tools based on edited human expert labels, use deep learning training strategies such as using weakly-generated labels

Full/Parttime: Full time study
 Part time study

Location: FHNW Brugg-Windisch

Advisor: Prof. Dr. Susanne Suter, Prof. Dr. Arzu Cöltekin

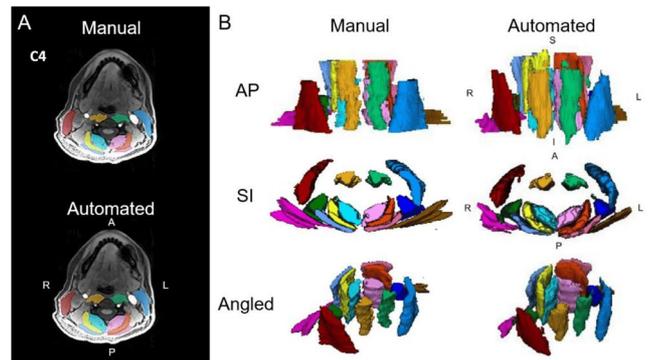


Figure 1: Cervical spine muscle segmentations from manual segmentation and an automated computer-vision model overlaid over MRI [MuscleMap].