Einblicke in die
Forschungsarbeit

MASTERARBEIT

„Deep Convolutional Neural Networks for Medical Image Segmentation and Classification“

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Fight against most common causes of death

Cardiovascular disease and liver cancer are among the most common causes of death in both Europe and North America. Medical images play a critical role in the diagnosis and treatment planning of both diseases.

However, manually performed medical image analysis is costly, time-consuming, susceptible to human error and exhibits inter- and intra-operator variability. This work presents various deep learning-based image processing methods to provide fully automatic solutions to the common problems of image classification and segmentation.

The methods are applied to three different medical imaging data sets, namely a Late Gadolinium Enhanced Cardiac Magnetic Resonance data set for left ventricular (LV) wall and scar segmentation, an abdominal T2 MRI data set for plaque classification, aortic wall and plaque segmentation as well as an abdominal CT data set for liver and tumor segmentation. A state-of-the-art residual U-Net architecture is used as a base method to tackle the segmentation problems.

Various enhancements such as a cascaded networks architecture, a three-dimensional convolutional neural network (CNN), the usage of class weighting and different loss functions, label region merging and advanced transfer learning were implemented and compared to the residual U-Net in their image segmentation performance. A residual CNN, a residual U-Net and a capsule network were analyzed as plaque classification methods.

Beneficial results of a more complex network architecture

The results show an overall beneficial effect of a deeper, more complex network architecture, a larger number of different regions in the ground truth segmentation mask and class weighting. The usage of data augmentation and the Dice loss function achieved mixed results. The cascaded architecture improved performance for LV wall, LV scar and plaque segmentation, while marginally worsening performance for aortic wall segmentation. 3D CNNs applied to aortic wall and plaque segmentation obtained slightly worse results than their 2D counterparts. The cascaded CNN with class weighting achieved the highest Dice scores for LV wall and LV scar segmentation with about 0.95 and 0.59 respectively. The base CNN architecture achieved the highest Dice scores for aortic wall segmentation with about 0.8 while the cascaded CNN with transfer learning finished first in plaque segmentation with a Dice score of 0.3. Capsule networks performed best in plaque classification reaching accuracy scores of 0.68, while the base residual U-Net obtained comparable results to other state-of-the-art methods in liver lesion segmentation.