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Network Conditioning and Transfer Learning for Peripheral Nerve Segmentation in Ultrasound Images

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Abstract : Precise identification of the nerves is a crucial task performed by anesthesiologists for an effective Peripheral Nerve Blocking (PNB). Now, anesthesiologists use ultrasound imaging equipment to guide the PNB and detect nervous structures. However, visual identification of the nerves from ultrasound images is difficult, even for trained specialists, due to artifacts and low contrast. The recent advances in deep learning make neural networks a potential tool for accurate nerve segmentation systems, so addressing the above issues from raw data. The most widely spread U-Net network yields pixel-by-pixel segmentation by encoding the input image and decoding the attained feature vector into a semantic image. This work proposes a conditioning approach and encoder pre-training to enhance the nerve segmentation of traditional U-Nets. Conditioning is achieved by the one-hot encoding of the kind of target nerve a the network input, while the pre-training considers five well-known deep networks for image classification. The proposed approach is tested in a collection of 619 US images, where the best C-UNet architecture yields an 81% Dice coefficient, outperforming the 74% of the best traditional U-Net. Results prove that pre-trained models with the conditional approach outperform their equivalent baseline by supporting learning new features and enriching the discriminant capability of the tested networks.

Keywords : nerve segmentation, U-Net, deep learning, ultrasound imaging, peripheral nerve blocking
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