Brain MR Segmentation using Deep Neural Network

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Abstract: Brain MR images show soft tissue of the brain. Doctors can analyze the brain disease and design the treatment plan through brain MR images. Therefore, image segmentation for gray matter, white matter and cerebrospinal fluid is crucial for diagnosis. With the development of deep learning, people proposed the convolutional neural network and applied it in all kinds of fields such as image fuse, image coloring and super-resolution, etc. Besides, the convolutional neural network is also applied in image segmentation. In this paper, we use 'U-Net' which is Deep Neural Network (DNN) to segment the brain MR image automatically dividing image into 6 parts: gray matter, white mater, cerebrospinal fluid, brain stem, cerebellum and background. In experiment, the challenge provide MR image with 3 modalities, but we only use the T1 weighted MR as DNN input in order to make the model applied to practice easily.

Keywords: MR images; U-Net; DNN; Image segmentation

1.Introduction

Brain gray matter, white matter and cerebrospinal segmentation is the foundation of the image segmentation and three-dimensional reconstruction. Besides, it has important implications for normal brain development studies. Segmenting MR image manually is tedious, time consuming and lacks of reproducibility. Therefore, we need to propose an automatic method to segment the MR brain image. DNN learns image features and classifies object automatically. When we applied DNN to classify pixels, it will achieve automatic image segmentation. At present, DNN has been applied in all kinds of medical image segmentations. Hu P [1] applied 3D DNN to liver CT image segmentation achieving automatic and accurate segmentation. Pim Moeskops [2] proposed multi-ways DNN for brain MR image segmentation with 2 modalities.

In this paper, we use 'U-Net' to segment brain T1 weighted MR image. Deep neural network extracts MR image features automatically by training the DNN model and obtain optimized parameters of the DNN. In the testing stage, DNN automatically segments the brain MR images through optimized parameters. In next section, we will introduce my method in section 2 and shows the experiment results in section 3.

2.Methods

In order to obtain the segmentation results automatically, we used 'U-Net' segment the brain MR image, the 'U-Net' structure is showed as Figure1. U-Net has applied in liver segmentation for binary classification and generate a satisfied results. Therefore, we modified the 'U-Net' for multi-classification in brain MR image segmenting image into gray matter, white matter and cerebrospinal.

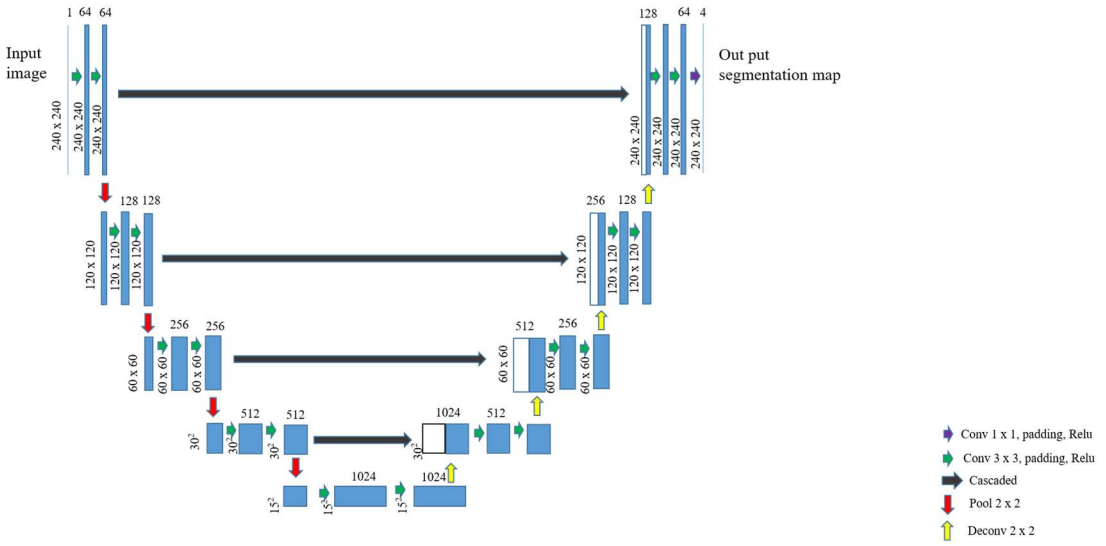

Figure1 U-Net applied to brain MR segmentation，T1 weighted MR images that has been corrected bias field and registered with T2-Flair are input to DNN on the left, and obtain the segmentation result with 4 classifications on the right through convolution and deconvolution layers that looks like a 'U'.

3. Results

In this paper, we classify pixels on MR image into 4 parts: gray matter (1), white matter (2), cerebrospinal fluid (3) and back ground (0). So we use soft-max at the end of the DNN for multi-classify the image pixels. In the training data, there are 7 patients, so we use 6 patients for training DNN and test the image with 7th patient. The test results are showed in figure2.

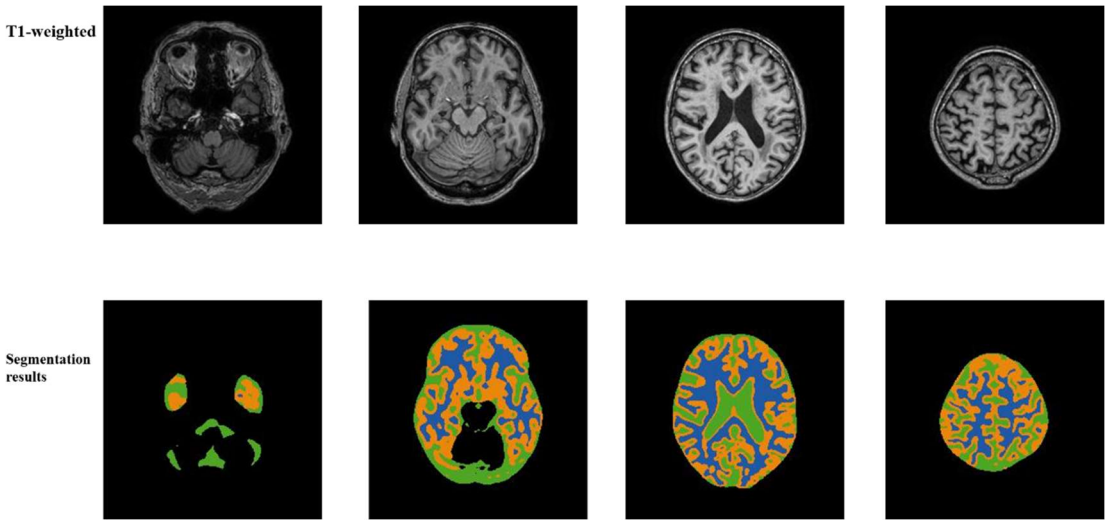

Figure2. The brain segmentation results. Different parts are colorized in different colors, blue represents white matter, orange represents gray matter, green represents cerebrospinal.

Reference

[1] Hu P, Wu F, Peng J, et al. Automatic 3D liver segmentation based on deep learning and globally optimized surface evolution.[J]. Physics in Medicine and Biology, 2016, 61(24): 8676-8698.
[2] Moeskops P, Viergever M A, Mendrik A M, et al. Automatic Segmentation of MR Brain Images With a Convolutional Neural Network[J]. IEEE Transactions on Medical Imaging, 2016, 35(5): 1252-1261.