Synthesis of CT images from MRI images based on nnU-Net

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Abstract. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are widely used in clinical practice due to their respective advantages. Synthesizing CT images through MRI is expected to become a means of reducing patient exposure to ionizing radiation. We developed a MRI-to-CT synthesis method based on nnU-Net.

Keywords: CT · MRI · Image synthesis.

1 Method

nnU-Net, an deep learning segmentation approach, exhibits the unique capacity to autonomously configure its operational parameters encompassing preprocessing, network architecture, training dynamics, and post-processing requisites, tailored to diverse novel tasks in a fully automated manner [1].

By effecting specific adaptations to the underlying nnU-Net, we have facilitated the accomplishment of the task involving the synthesis of CT images from MRI data. We trained two synthetic models, named Model-Brain and Model-Pelvis, both of which are based on the modified nnU-Net architecture.

1.1 Data preprocessing

We employed the inherent data preprocessing techniques encompassed within the nnU-Net. It is pertinent to underscore that we deactivated the foreground cropping operation and data augmentation operation within the nnU-Net.

1.2 Model architecture

The model architecture is based on 3D U-Net with minor changes, as shown in Fig. 1 and Fig. 2.

1.3 Loss function

We change Dice and Cross entropy loss in nnU-Net to MSE loss:

$$MSELoss = \frac{1}{N}\sum_{i=1}^{N}(\hat{y_i} - y_i)^2 \tag{1}$$

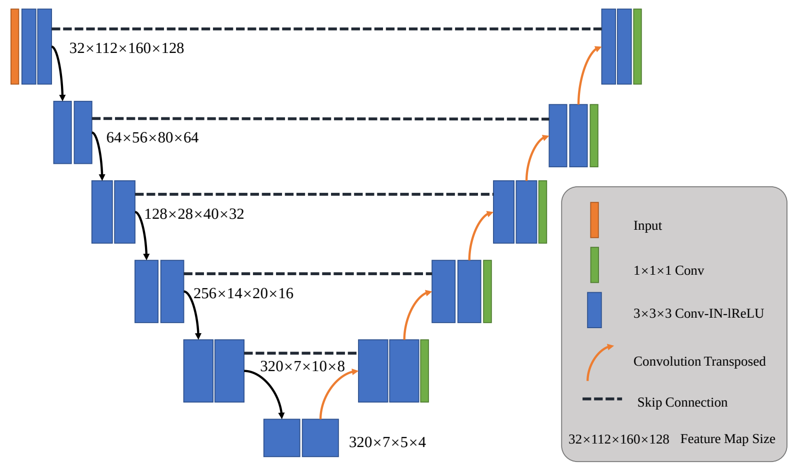

Fig. 1. Model architecture of Model-Brain.

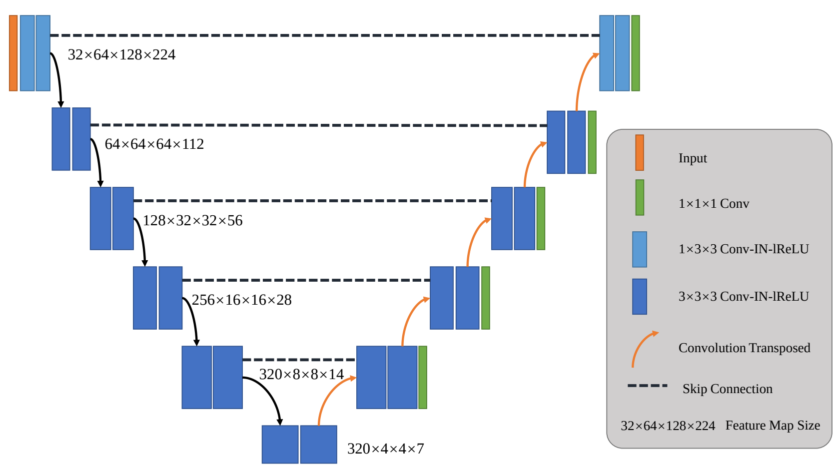

Fig. 2. Model architecture of Model-Pelvis.

1.4 Implementation details

Limited by the memory of the GPU, nnU-Net uses a patch-based method for training and testing. For Model-Brain, the patch size is 112×160×128. For Model-Pelvis, the patch size is 64×128×224.

The number of epochs, batch size, learning rate decay strategy, optimizer, and other parameters are set by nnU-Net.

2 Conclusion

We modified the data preprocessing, data augmentation, and loss function in nnU-Net. The image synthesis model based on nnU-Net has exhibited commendable success in effectuating the synthesis of CT images from MRI data. Indeed, the image synthesis model based on nnU-Net constitutes an apt foundational reference for the formulation and refinement of innovative models. Researchers can judiciously leverage the nnU-Net as a fundamental framework, strategically recalibrating both network architecture and parameter configurations to engender heightened synthesis performance.

References

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