CISTIB Center for Computational Imaging & Simulation Technologies in Biomedicine

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Learned Local Attention Maps for Synthesizing Vessel Segmentations

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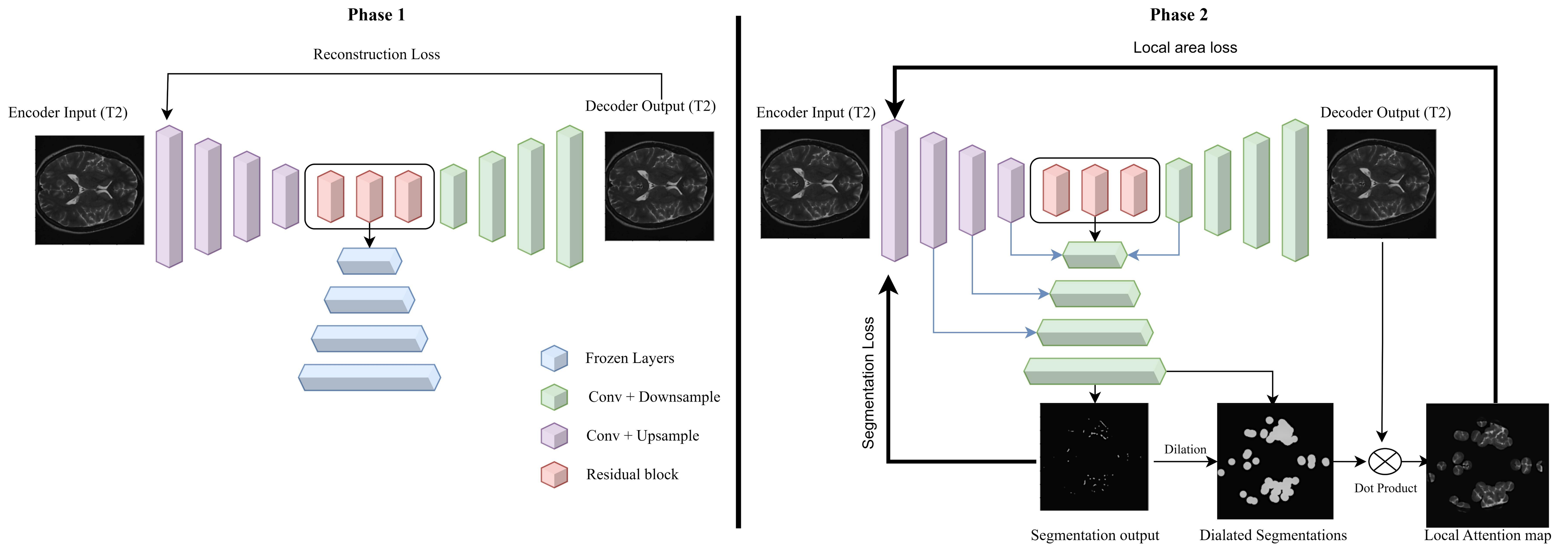

Fig 2. Network Architecture

Introduction

Magnetic resonance angiography (MRA) is an imaging modality used to visualise blood vessels in the brain. It is useful for several diagnostic applications and for assessing the risk of adverse events such as haemorrhagic stroke. However, MRAs are not very routinely acquired due various reasons such as cost, invasive nature etc. It would therefore be useful to be able to synthesize blood vessels from more routinely acquired non-invasive MR modalities, such as T2/T1-weighted MR images. T2/T1 modalities do not contain explicit vessel information like MRAs but contain some latent information that could be used to synthesize the brain vessels.

Methods

We propose a branched U-net based approach which is trained with two-phase multi-task learning. At training time, paired T2 images and ground truth MRA segmentations are available. As vessels only make up a very small portion of the brain image (<4%) and the location of the vessels is different in every slice of the brain, we need an adaptive attention mechanism to accurately focus and capture the vessels from the brain images. To tackle this problem we introduce learnable local attention maps which help the network generate and learn attention maps during runtime to focus on the parts of the brain that contain vessel information .

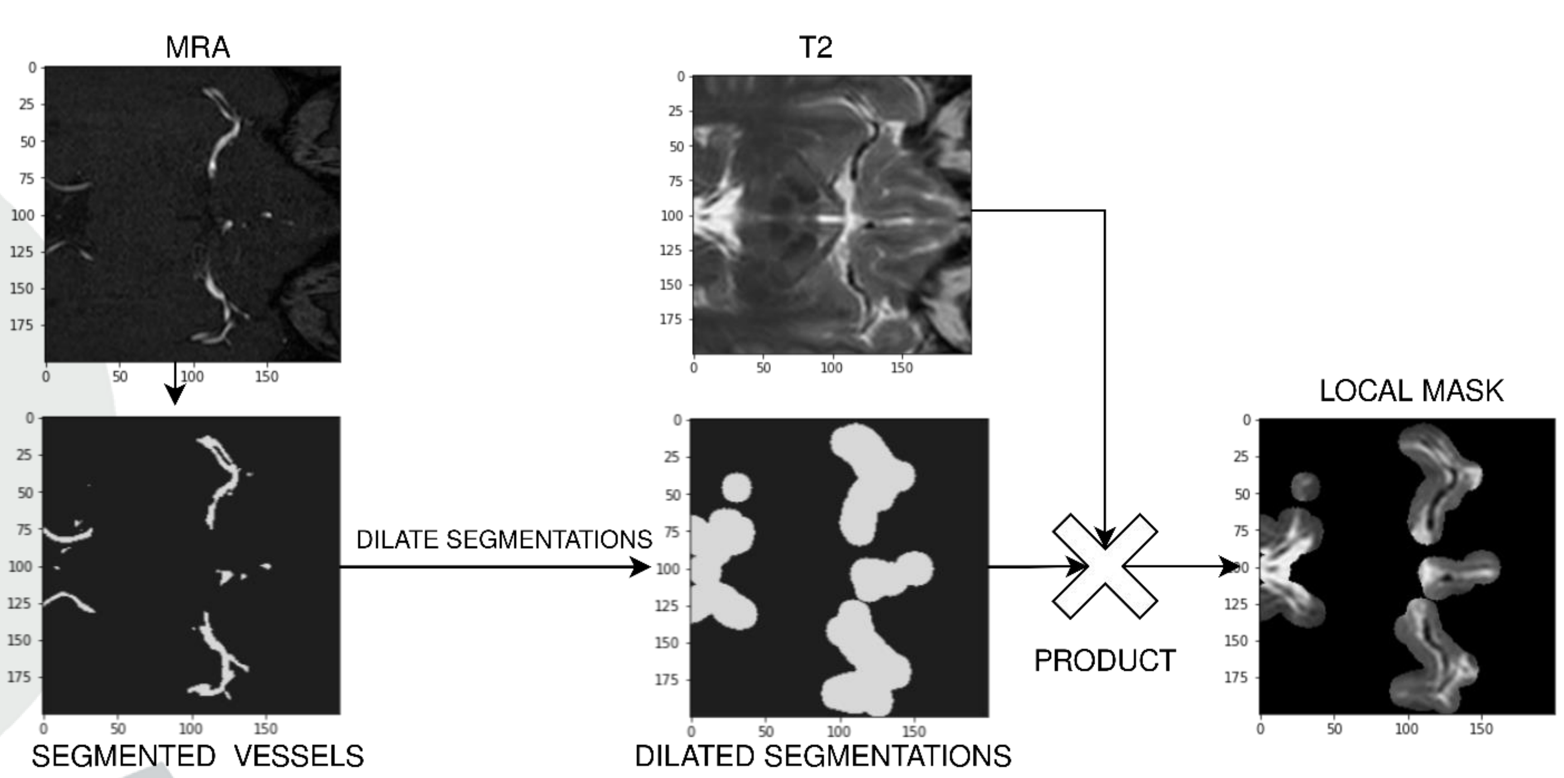

Fig 1. Generation of Attention Masks

We first pre-train the model on just T2 images then use an uncertainty-based multi-task learning approach [1] to simultaneously and collaboratively train the local attention maps and the segmentations.

ACKNOWLEDGMENTS

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Results

We compare our method to state of the art vessel segmentation models, such as nnUnet ,transformer U-net [2], and some standard image synthesis methods, such as vox2vox [3] . Our model is able to achieve superior performance than the state of the art with a much smaller number of trainable parameters required.

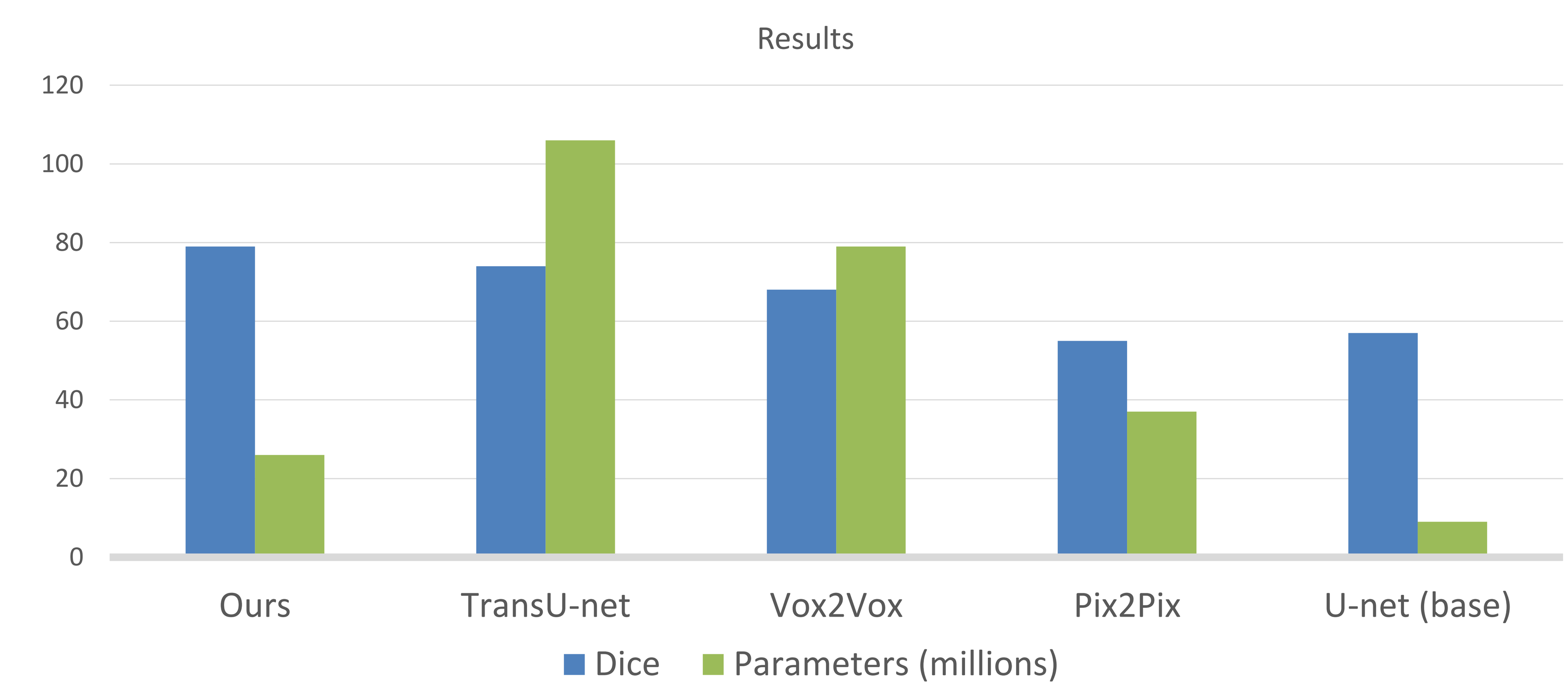

Table 1. Comparing validation dice score and model parameters

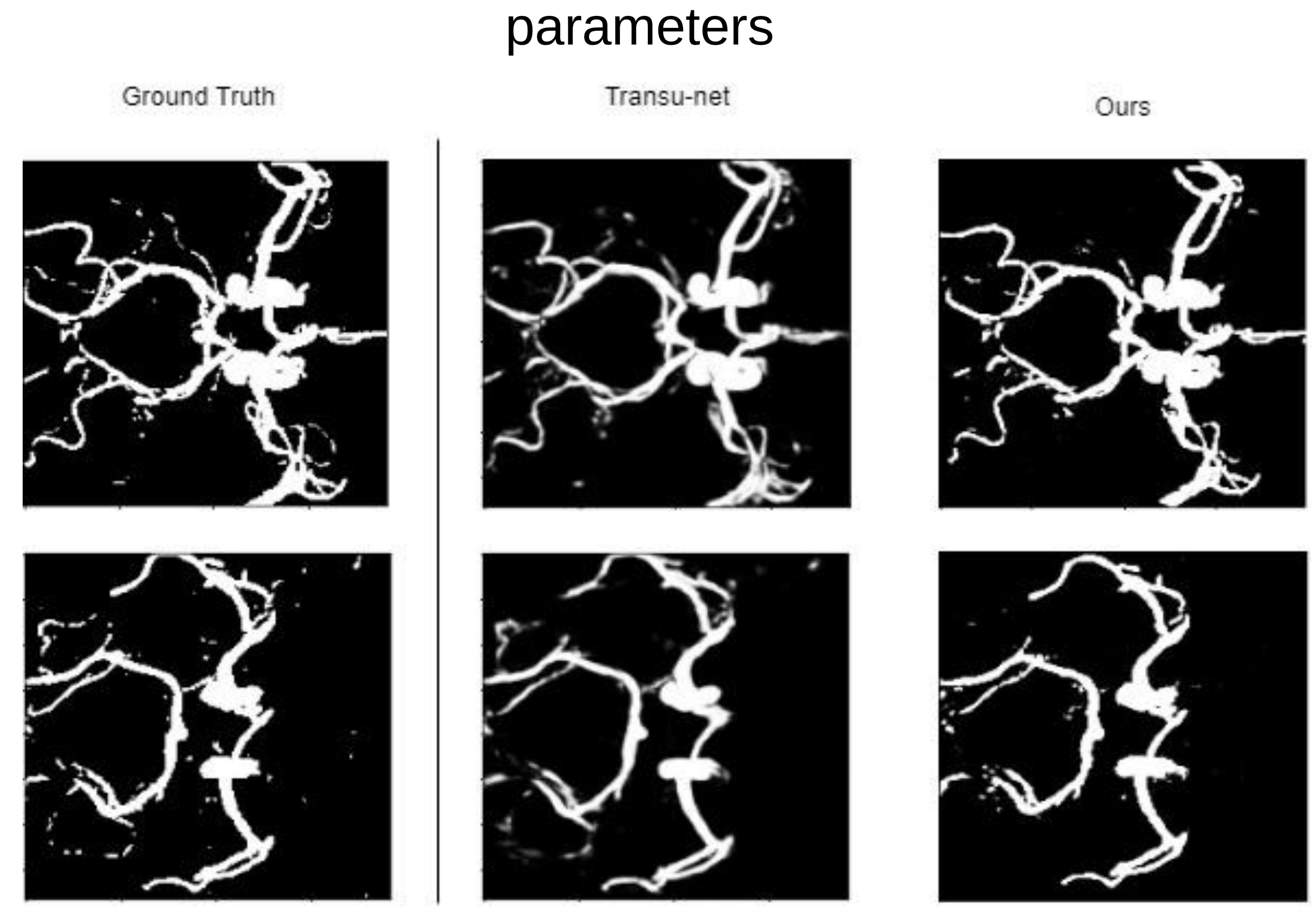

Fig 3. Vessel synthesis comparison between transformer U-net (middle column) and our model (right column) for two cases

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