Brain SegNet: 3D Local Refinement Network for Brain Lesion Segmentation

CURRENT STATUS: ACCEPTED

BMC Medical Imaging BMC Series

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DOI:

10.21203/rs.2.14749/v1

SUBJECT AREAS

Nuclear Medicine & Medical Imaging

KEYWORDS

Brain tumor segmentation, stroke outcome prediction, 3D brain MRIs, curriculum learning

Abstract

MR images (MRI) accurate segmentation of brain lesions is important for improving cancer diagnosis, surgical planning, and prediction of outcome. However, manual and accurate segmentation of brain lesions from 3D MRIs is highly expensive, time-consuming, and prone to user biases. We present an efficient yet conceptually simple brain segmentation network (referred as Brain SegNet), which is a 3D residual framework for automatic voxel-wise segmentation of brain lesion. Our model is able to directly predict dense voxel segmentation of brain tumor or ischemic stroke regions in 3D brain MRIs. The proposed 3D segmentation network can run at about 0.5s per MRIs - about 50 times faster than previous approaches 1,2. Our model is evaluated on the BRATS 2015 benchmark for brain tumor segmentation, where it obtains state-of-the-art results, by surpassing recently published results reported in 1,2. We further applied the proposed Brain SegNet for ischemic stroke lesion outcome prediction, with impressive results achieved on the Ischemic Stroke Lesion Segmentation (ISLES) 2017 database.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

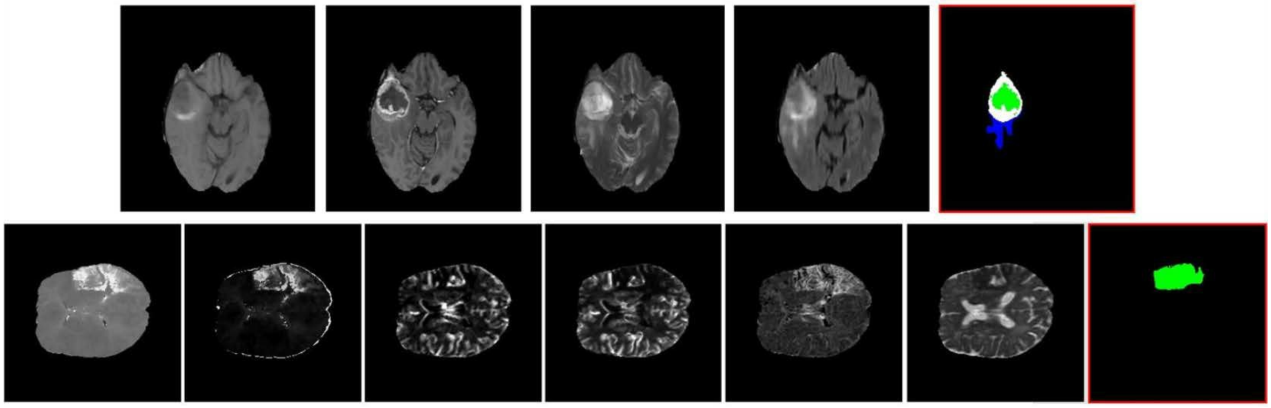

Figure 1

Examples of multi-modality brain MIRs for brain tumor segmentation (from BRATS 2015 database [21]) and stoke lesion segmentation (from ISLES 2017 database [15]). Top (left ! right): MRI modalities of fT1, T1-contrast, T2, FLAIRg and brain tumor segmentation results (with a RED bounding box); Bottom (left ! right): MRI modalities of fTTP, Tmax, rCBV, rCBF, MTT, ADCg and stoke lesion outcome prediction results.

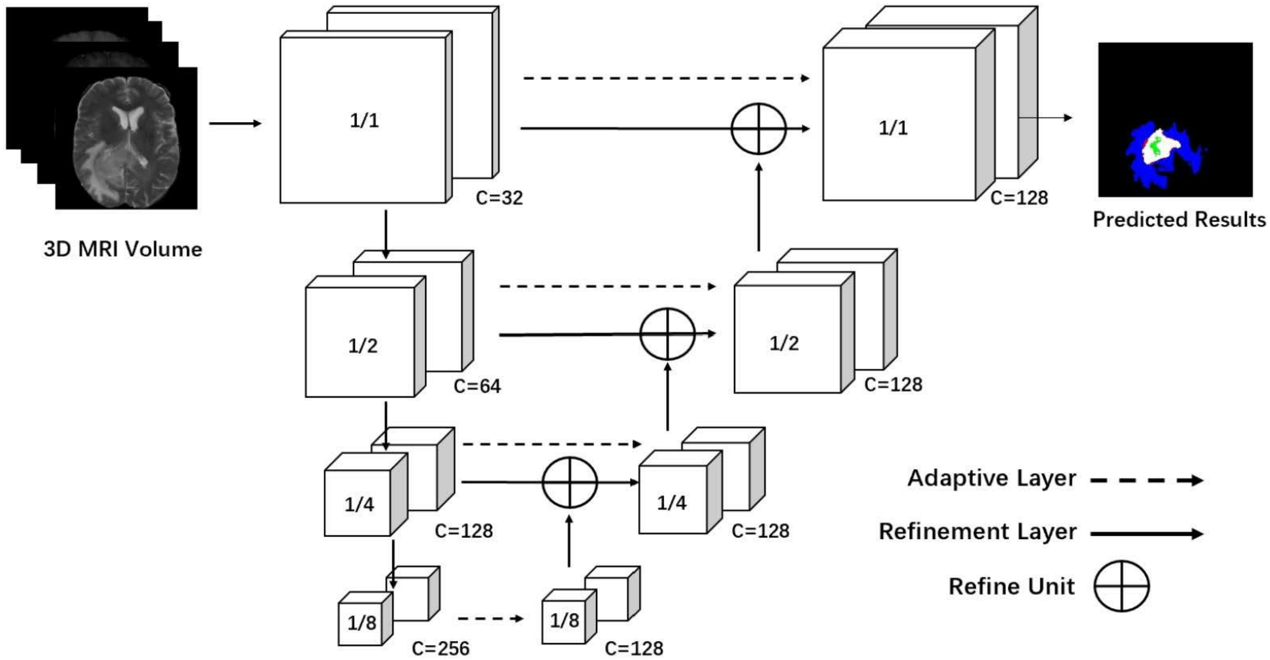

Figure 2

Architecture of the proposed 3D brain segmentation network (Brain SegNet) for brain lesion segmentation from MRIs. The input is multi-modality 3D MRI volume data. It has four convolutional blocks, and contains 17 convolutional layers in total, with residual units. It includes a renement module capable of aggregating rich ne-scale 3D volume features over multiple convolutional blocks. An adaptive layer and an renement layer are applied to each block for computing multi-level convolutional features.

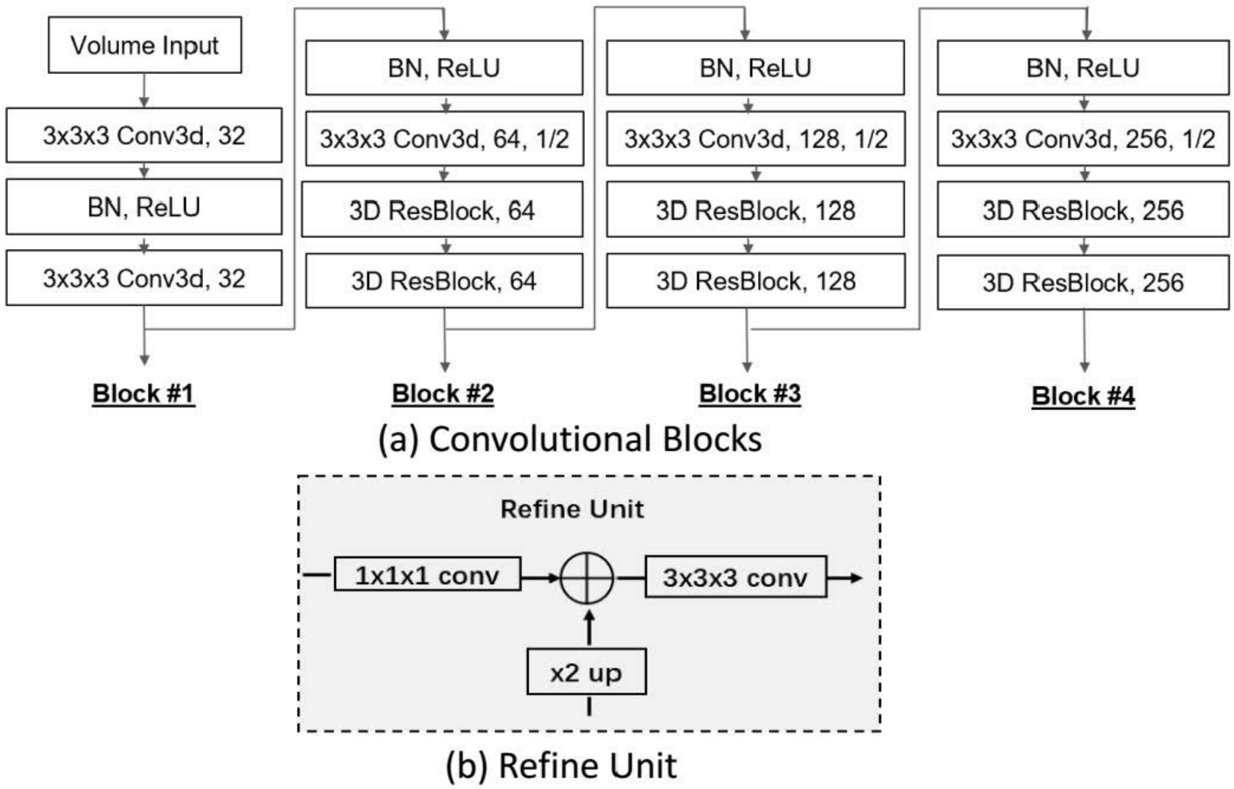

Figure 3

(a) Layers of the proposed 3D model in four convolutional blocks. (b) Details of the proposed rene unit.

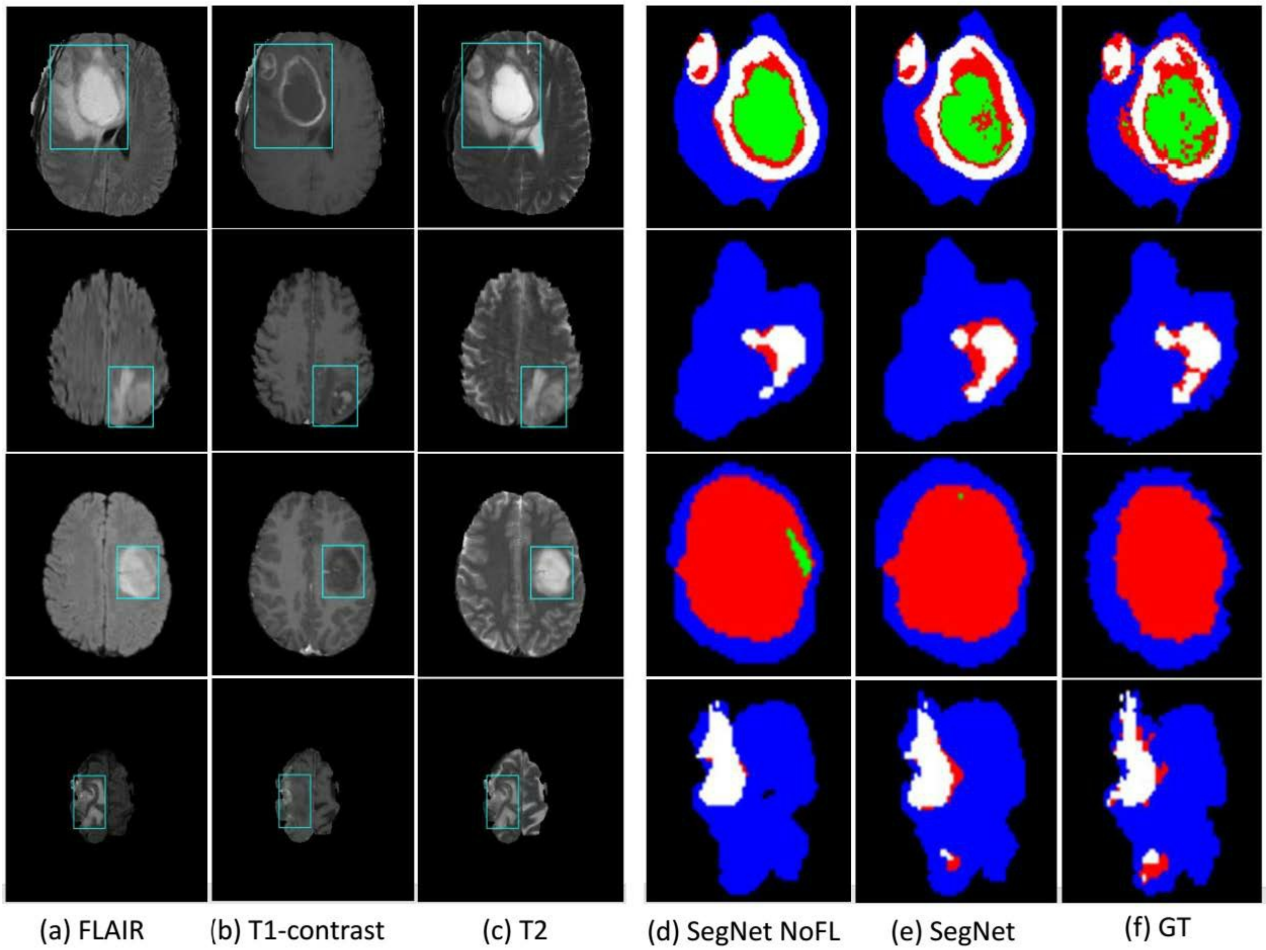

Figure 4

Segmentation results on several examples. (a) FLAIR, (b) T1-contrast, (c) T2, (d) results of Brain SegNet without Focal loss, (e) results of Brain SegNet with Focal loss, and (f) ground truth. Colors: necrotic core (red), oedema (green), non-enhancing core (blue), and enhancing core (white).

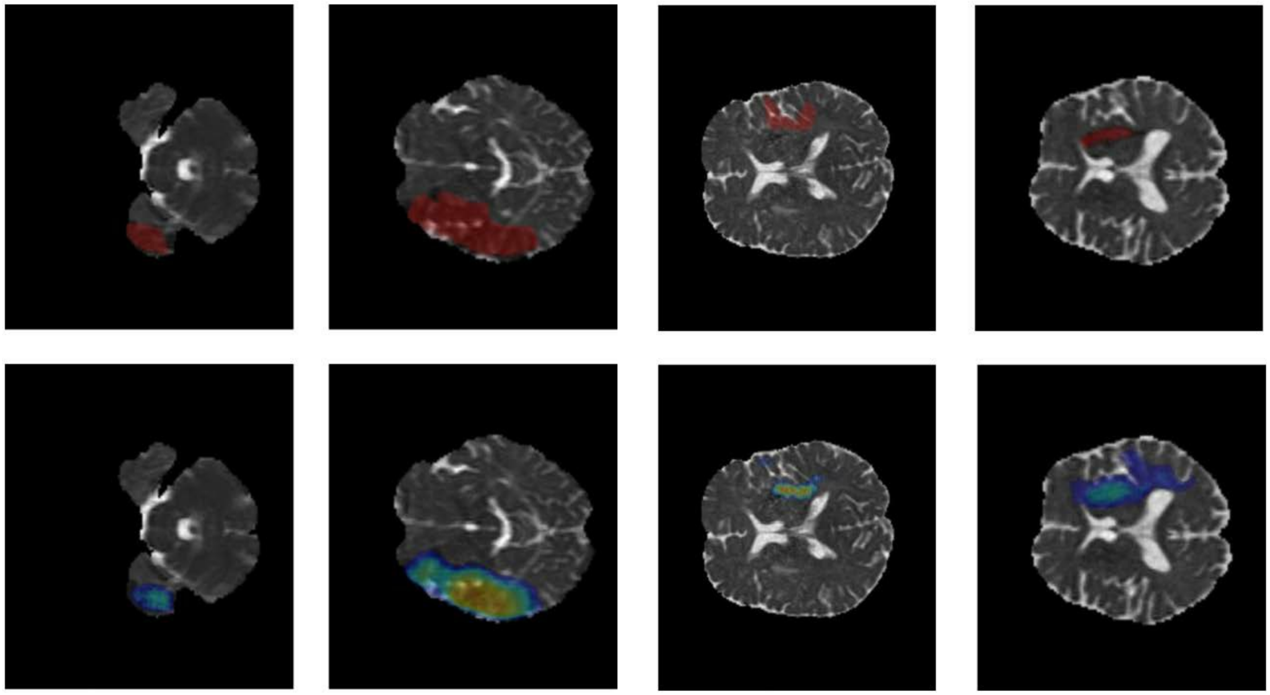

Figure 5

Segmentation results of ischemic stroke lesion on a number of MRI slides (3D MRI diusion map (ADC)). (Top): clinician results; (Bottom): model prediction (color indicates the predicted probability at each pixel.)