Learning Tumor Edges and Segments for Brain Tumor Segmentation Using Deep Learning

Subin Sahayam
(COE18D001)
Department of Computer Science and Engineering
Indian Institute of Information Technology, Design, and Manufacturing, Kancheepuram

Abstract

Tumors are the uncontrolled multiplication of cells in the human body. Benign tumors are non-cancerous and do not spread to other body parts. Even though benign tumors are less aggressive, they can increase in mass and become malignant. If a tumor spreads to other organs, it is called metastasis. Malignant tumors are cancerous, may penetrate nearby tissues, and migrate to other organs. These cells aggressively multiply at an unpredictable rate and can be life-threatening. Diagnosing a tumor and treatment planning is important for improving a patient's prognosis.

In the diagnosis phase, clinicians and radiologists use medical radiology images of the brain to locate and analyze the characteristics of any likely tumor. The general literature focuses on using MR imaging as it provides a non-invasive, non-ionizing, and information-rich Spatiotemporal image. They show good contrast over the softer body tissues that help the clinician better understand the tumor and its surrounding tissues. From the MR images, identification of tumor volumes, shape, and size is important for treatment planning. However, manual identification of brain tumors from MR images is laborious, time-consuming, and human error-prone. Automatic segmentation of brain tumors from MR images aims to bridge the gap.

Manual delineation of tumor regions from magnetic resonance (MR) images is time-consuming, requires an expert, and is prone to human error. Deep learning models have focused on efficiently and accurately automating the process of segmentation. U-Net for semantic segmentation of medical images has achieved good results in the literature. However, U-Net and its' variants tend to over-segment tumor regions. The edges of the tumor are as important as the tumor regions for accurate diagnosis and treatment planning. In the proposed work, the authors aim to extract edges from the ground truth using a derivative-like filter followed by edge reconstruction to obtain an edge ground truth in addition to the brain tumor ground truth. Utilizing both ground truths, the author studies several U-Net and its' variant architectures with and without tumor edges ground truth as a target along with the tumor ground truth for brain tumor segmentation. The author used the BraTS2020 benchmark dataset to perform the study. The authors tabulate the dice and Hausdorff95 mean and median results for whole tumor (WT), tumor core (TC), and enhancing tumor (ET). Compared to the baseline U-Net and its variants, the models that learned edges along with the tumor regions performed well in the enhancing and core tumor regions in both training and validation datasets.