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RESEARCH ARTICLE

TransResUNet: Revolutionizing Glioma Brain Tumor Segmentation Through Transformer-Enhanced Residual UNet

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ABSTRACT Accurate segmentation of brain tumors from MRI (Magnetic Resonance Imaging) sequences is essential across diverse clinical scenarios, facilitating precise delineation of anatomical structures and disease-affected areas. This study presents an innovative deep-learning method for segmenting glioma brain tumors, utilizing a hybrid architecture that combines ResNet U-Net with Transformer blocks. The proposed model adeptly encompasses both the local and global contextual details present in MRI scans. The architecture includes an encoder based on ResNet for extracting hierarchical features, followed by residual blocks to enhance feature representation while maintaining spatial information. Additionally, a central transformer block, incorporating multi-head attention mechanisms, enables the modeling of long-range dependencies and contextual comprehension, progressively refining feature interactions. To handle structural scale variations within MRI images, skip connections are utilized during the decoding phase. Transposed convolutional layers in the decoder upsample feature maps, retaining details and incorporating contextual information from earlier layers. A rigorous assessment of the model's functionality was carried out with the BraTS2019 dataset, employing a comprehensive set of evaluation metrics including accuracy, IOU score, specificity, sensitivity, dice score, and precision. The evaluation focused on individual tumor classes, namely the whole, core, and enhancing tumor regions. During validation, the suggested model demonstrated remarkable dice scores of 0.91, 0.89, and 0.84 for the whole tumor, core tumor, and enhancing tumor, respectively, yielding an impressive overall accuracy rate of 98%.

INDEX TERMS Glioma, segmentation, MRI, ResNet-transformer, deep learning.

I. INTRODUCTION

In recent years, advances in medical imaging leveraging deep learning (DL) have substantially enhanced various sectors [1], [2], [3] including the healthcare sector, with a focus on refining the accuracy and effectiveness of automated disease detection, segmentation, and classification [4], [5]. This progress is driven by the pressing need to improve diagnostic procedures and treatment strategies for patients afflicted with various ailments. Within this domain, two primary categories of approaches have emerged as focal points of innovation: those that employ generative approaches and those that rely on discriminative approaches [6]. Generative models, such as diverse neural networks, strive to grasp the underlying data distribution of diseases, thereby generating highly lifelike disease analyses [7]. These methods hold

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