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Deep Learning for Brain Tumor Segmentation Using Magnetic Resonance Images

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Abstract - Brain tumors are among them ostcritical and life-threatening neurological disorders. Early detection and accurate segmentation of brain tumors are essential for effective treatment and surgical planning. Magnetic Resonance Imaging (MRI) provides high-resolution images that help visualize tumor regions.

Traditional manual segmentation methods are time-consuming and prone to human error. In recent years, deep learning techniques, particularly Convolutional Neural Networks (CNNs), have demonstrated significant potential in automating brain tumor segmentation with high accuracy. This paper presents a comprehensive study of deep learning models for brain tumor segmentation using MRI, comparing U-Net, SegNet, and DenseNet architectures. Experimental results demonstrate that deep learning-based approaches outperform conventional image processing techniques in terms of segmentation accuracy and efficiency.

KeyWords:
Brain Tumor, MRI,Deep Learning, CNN, U-Net, SegNet, DenseNet

INTRODUCTION

Brain tumors are abnormal growths of cells in the brain, which can be benign or malignant. Accurate detection and segmentation of brain tumors are crucial for diagnosis, treatment planning , and patient monitoring. MRI is widely used for brain imaging due to its non-invasive nature and superior soft-tissue contrast.

Manual tumor segmentation by radiologists is labor-intensive, subjective , and prone to variability.

Deep learning (DL), a subset of machine learning, has revolutionized medical image analysis by automatically learning complex features from large datasets. CNN-based models have shown remarkable performance in classification, detection, and segmentation of tumors. This research focuses on using DL for automated segmentation of brain tumors in MRI images, aiming to reduce human intervention and improve accuracy.

1SubHeading1

Several studies have applied deep learning for brain tumor segmentation, , SegNet, and DenseNet. Traditional methods like Random Forest srelyonh and-crafted features, which are less effective.

Preprocessing techniques like normalization, resizing, and augmentation improve model performance and generalization.

METHODOLOGY

Dataset

The study uses the BRATS dataset, which provides multi-modal MRI sequences(T1,T1c, T2, FLAIR) along with ground truth masks for tumor regions: enhancing tumor, edema, and necrotic core.

Deep Learning Models

- **U-Net:** Encoder-decoderwithskip connections for localization.
- **SegNet:** Encoder-decoder using max-pooling indices for upsampling.
- **DenseNet:** Dense connections to enhance feature propagation.

Training and Evaluation

- **LossFunction:** DiceLoss.
- **Optimizer:** Adam,learning rate 0.001.
- **Metrics:** DSC,IoU,Accuracy, Precision.

Table-1:Model Performance

BrainTumorSegmentationusingU-Net			
Model	**DSC**	**IoU**	**Accuracy**
U-Net	0.87	0.79	0.92

including U-NET

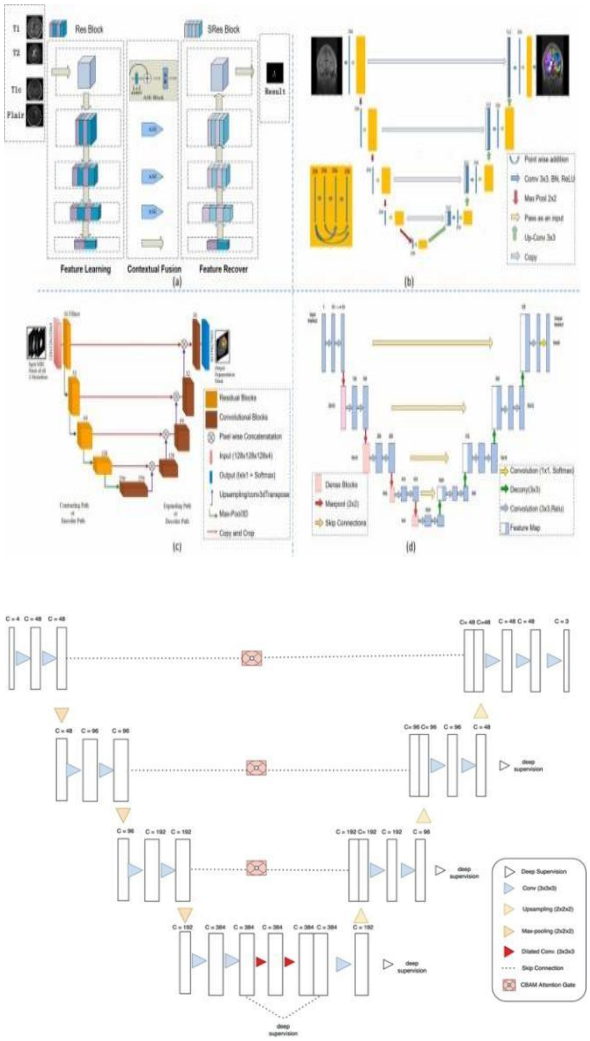

Fig-1:Brain Tumor Segmentation

DenseNet achieves the highest segmentation accuracy, followed closely by U-Net. Deep learning models outperform traditional methods due to automatic feature extraction. Challenges include limited datasets, heterogeneous tumor shapes, and MRInoise.

2. CONCLUSIONS

Deep learning techniques, especially DenseNet and U-Net, provide accurate tumor delineation in MRI images. Future work includes integrating multi-modaldata,3DCNNs, and transformer-based models.

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