Evaluating the Efficacy of Deep Learning Segmentation in Oncological Medical Imaging for Cancerous Region Identification

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Lung cancer diagnosis presents significant challenges, especially in the early stages when tumor biomarkers are difficult to detect. Manual diagnosis relies heavily on the experience of radiologists. Automated methods are hindered by computational demands, making them time-consuming, costly, and thus, less feasible for clinical application. Consequently, the majority of lung cancer cases are diagnosed too late for effective treatment. This study proposes a novel U-Net-segmentation-based, feature-aware deep learning model for the precise detection and analysis of lung tumor growth in CT scans. Two deep learning models for lung tumor analysis from CT scans were developed - a conventional 2D U-Net model and a 3D model. The 3D model utilized new techniques such as increased convolutional layers for precision, batch normalization for stability, and larger initial kernel sizes. Through specialized data augmentation and optimization strategies like deep supervision and learning rate adjustments, the 3D model significantly outperformed the 2D model, achieving a Dice Similarity Coefficient (DSC) of 0.85. This represents an improvement (+5% DSC) over existing 3D models using the same datasets and surpasses the performance of the 2D model, which achieved a DSC of 0.65. The 3D model's potential for further training on Low-Dose Computed Tomography (LDCT) scans will facilitate earlier detection of cancer in high-risk patients potentially years before it becomes clinically apparent, making it one of the first models of its kind. This model will allow for a cost-effective, rapid, and non-invasive tool that can be easily used by radiologists worldwide to accurately monitor and detect lung tumors.