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Lung Cancer Segmentation using Convolutional Neural Network in MRI Images

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ABSTRACT: Lung cancer is one of the leading causes of cancer-related deaths worldwide, and early detection is crucial for improving survival rates. Accurate segmentation of lung cancer in MRI images plays a vital role in computer-aided diagnosis and treatment planning. This project proposes a deep learning-based approach for automatic lung cancer segmentation using Convolutional Neural Networks (CNN). The proposed model is trained on MRI image datasets to identify and segment regions affected by lung cancer. Preprocessing techniques such as image normalization, resizing, and augmentation are applied to enhance model generalization and robustness. Performance is evaluated using metrics such as Dice coefficient, Intersection over Union (IoU), and accuracy to ensure reliable segmentation results. This system aims to assist radiologists by reducing manual workload, improving diagnostic precision, and enabling faster decision-making in clinical settings. Future improvements may include transfer learning, integration with 3D imaging, and deployment in real-time applications.

KEYWORDS: Multi-Scale Feature Fusion, Semantic Feature Enhancement, Radiology Image Processing, Shallow and Deep Feature Integration.

I. INTRODUCTION

Lung cancer remains one of the most fatal and prevalent forms of cancer globally, accounting for a significant percentage of cancer-related deaths. Early diagnosis and precise localization of cancer play a crucial role in improving the survival rate of patients. Medical imaging techniques, particularly Magnetic Resonance Imaging (MRI), have become invaluable tools in the detection and assessment of lung cancer due to their high resolution and non-invasive nature.

However, manual analysis of MRI images by radiologists is often time-consuming, subject to inter-observer variability, and limited by the human eye's ability to detect subtle abnormalities in large volumes of image data. In this context, the integration of Artificial Intelligence (AI) and Deep Learning (DL) methods into medical imaging presents a transformative opportunity. One such promising approach is the use of Convolutional Neural Networks (CNNs) for automated image analysis and cancer segmentation.

The primary goal of this project is to develop an efficient and accurate CNN-based model for automated segmentation of lung cancer from MRI images. The segmentation process involves delineating the precise boundaries of the cancer region, which is essential for further diagnosis, treatment planning, and monitoring of disease progression.

This project proposes a pipeline that starts with preprocessing MRI images to remove noise and standardize image dimensions. A CNN-based model is then trained to segment cancer regions, followed by postprocessing steps to refine the segmentation results. Finally, the model's performance is evaluated using standard metrics such as Dice Similarity Coefficient (DSC), Intersection over Union (IoU), accuracy, precision, and recall.

II. LITERATURE SURVEY

The concept of lung cancer segmentation was first introduced by madan et al. [1]. The method was inspired by the lung cancer segmentation in mri images. Susceptibility Weighted Imaging (SWI) is a magnetic resonance imaging (MRI) technique that enhances image contrast by exploiting the differences in magnetic susceptibility between various tissues and substances. This method is especially sensitive to substances like deoxygenated blood, iron, and calcium, making it valuable for detecting microbleeds, venous structures, and iron deposits in the brain. In the SWI process, both magnitude and phase images are acquired. The phase image contains information about the local magnetic field variations caused by susceptibility differences by E. Mark Haacke, 2024. [2]. Tracking-based segmentation is a widely used method for extracting vascular structures from medical images, particularly in the lungs. These approaches are designed to follow the course of vessels by starting from a known location (a seed point) and then incrementally tracing the vessel path using local image information. A vesselness filter, such as the Frangi filter, is often used to enhance tubular features and reduce noise by Cemil Kirbas 2024. [3]. Carotid Vasculature Modeling From Patient Ct Angiography Studies For Interventional Procedures Simulation by M. Freiman, 2004. This method presents a sophisticated approach for modeling carotid vasculature from CT angiography (CTA) scans, specifically aimed at enhancing interventional procedure simulations such as stenting or catheter navigation.[4]. Statistical Cerebrovascular Segmentation for Phase-Contrast MRA Data by Mohamed Sabry , 2024.[5] Three-Dimensional Multi-Scale Line Filter for Segmentation and Visualization of Curvilinear Structures in Medical Images by Yoshinobu Sato, 2024.

III. METHODOLOGY

The proposed methodology follows a structured pipeline designed to achieve efficient and accurate segmentation of lung tumors in MRI images using Convolutional Neural Networks. The major steps include:

Data Collection: Obtain annotated MRI lung cancer datasets from publicly available sources such as the LIDC-IDRI or similar.

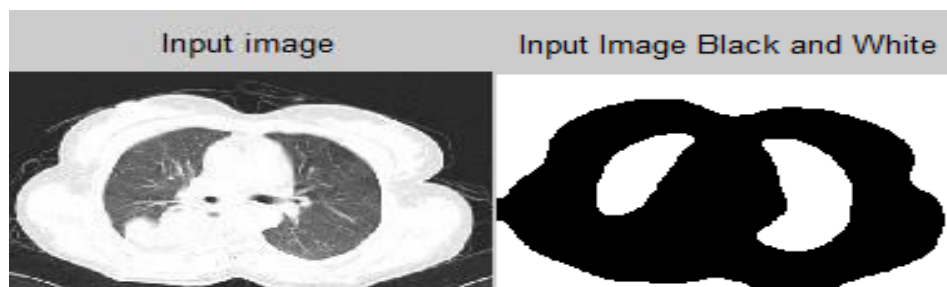
Data Preprocessing: Normalize image intensities, resize to standard dimensions, and apply augmentation techniques (rotation, flipping, scaling) to increase dataset variability and model generalization.

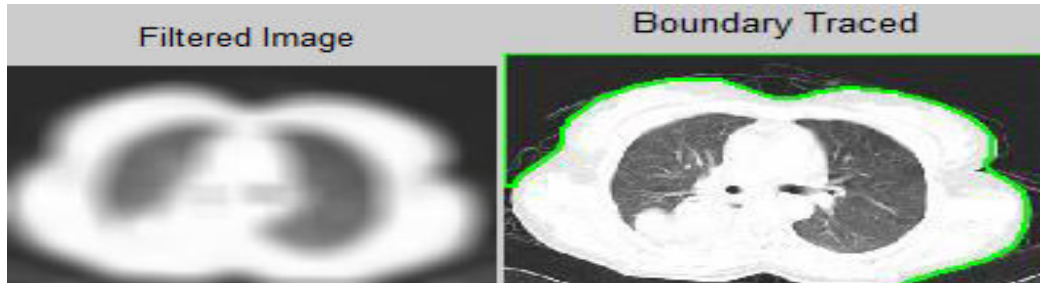
Model Selection: Use U-Net architecture, a popular deep learning model known for its effectiveness in biomedical image segmentation tasks.

Model Training: Train the U-Net model on the preprocessed dataset using appropriate loss functions such as Dice loss or Binary Cross-Entropy, with validation performed during training to avoid overfitting

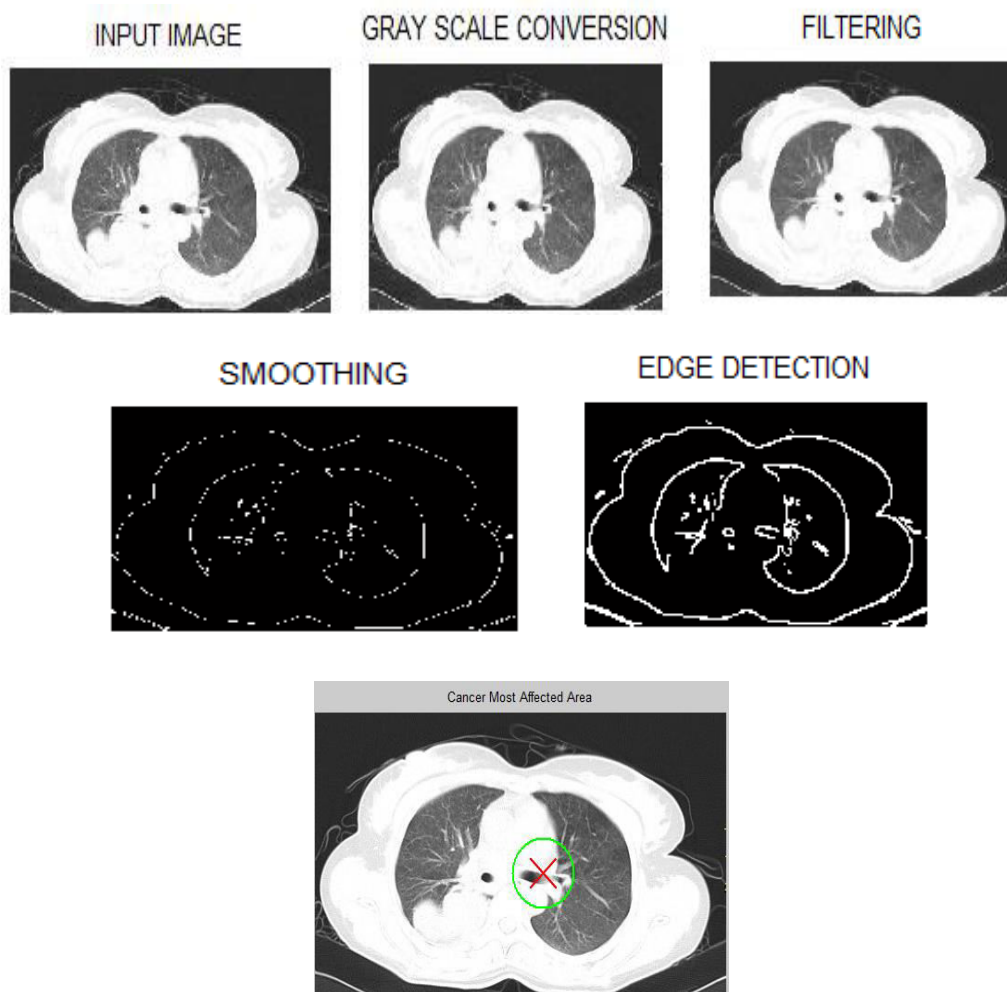
IV. EXPERIMENTAL RESULT

Figure a, b, c, d shows the result of the lung cancer segmentation using convolutional neural network in MRI images





The input MRI image of the lung was first collected from the dataset. A Gaussian filter was applied to reduce noise and enhance features for better clarity. The filtered image was then converted to black and white using thresholding to separate the tumor region. A CNN model was used to segment the tumor, and boundary tracing was done to outline the affected area. The final output clearly highlights the tumor on the original MRI images.



V. CONCLUSION

This project addresses few image processing methods for a CAD system for lung cancer. However these algorithms are applied with assumptions such as asymmetric property of CXR and nodules represents are only lung cancer nodules. As for further development segmentation process can be improved along with the lung nodule extraction methods where artificial intelligent methods can be used which ultimately increase the accuracy of the tested results. This project also needed to be continuing on lung nodule detection from blob area values which needed to be incorporated with further testing.

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