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Lung Cancer Diagnosis Using Artificial Intelligence: A Radiomics-Based Approach

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Abstract

Cancer is one of the most serious health threats we face today, with lung cancer standing out as the globe. If it's not caught early, the chances of survival for lung cancer patients can be quite low. Medical imaging spotting diseases by allowing us to look inside organs and tissues. When it comes to lung cancer screening but CT scans are often the go-to choose because they provide detailed insights into tumors within the lungs. However, identifying lung cancer through medical images can be a tough and time-consuming task. Radiologists are under immense pressure, especially with the rising number of cancer cases and the impact of the COVID pandemic. To make matters worse, there aren't enough radiologists to meet the demand—an Indian report highlights that there's only one radiologist for every hundred thousand patients. This is why we need automatic diagnosis techniques to help doctors analyze patient data quickly and make timely treatment decisions. We've tested our proposed deep learning algorithms on both publicly available datasets and those from local Indian hospitals. Additionally, we developed the Indian lung nodule dataset for nodule segmentation and the lung tumor dataset to predict how patients will respond to treatment, all in collaboration with medical professionals.

Keywords: Lung Cancer, CNN, Deep Learning, Segmentation.

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Introduction

According to the GLOBOCAN report from 2020, the global incidence and mortality rates for lung cancer stand at 11.4% and 18%, respectively. This makes it the second most common cancer, just behind breast cancer. Notably, in 2018, both the number of lung cancer cases and the deaths attributed to it reached their peak, as highlighted in the GLOBOCAN report of that year. The globe is only 21%, and this rate drops even further for those diagnosed at advanced stages. Early detection is crucial for improving survival rates, yet lung cancer is often identified in its later stages (Roy et al., 2015). A recent study from Indian hospitals in 2020 revealed that approximately. Cancer itself is characterized by the uncontrolled growth of abnormal cells, and when this growth occurs in the lungs, it's referred to as lung cancer. These abnormal cells can cluster together to form a mass known as a tumor. Both benign and malignant lung tumors are possible; benign tumors do not spread to adjacent tissues or other body parts, whereas malignant tumors have the ability to expand outside of the lungs and develop into new tumors. Generally, benign tumors are considered non-cancerous, whereas malignant tumors are classified as cancerous (Ignatious & Joseph, 2015).

A lung tumor that measures between 3mm and 30mm in diameter is typically referred to as a lung nodule or pulmonary nodule. These nodules can be categorized using two main criteria. When it comes to the intensity profile, nodules can be classified as solid, subsolid, or ground-glass nodules (GGN) (Rendon-Gonzalez & Ponomaryov, 2016). Solid nodules have a consistent intensity throughout, whereas GGN or subsolid nodules display a nonuniform intensity distribution, are less dense, and don't obscure the underlying lung tissue

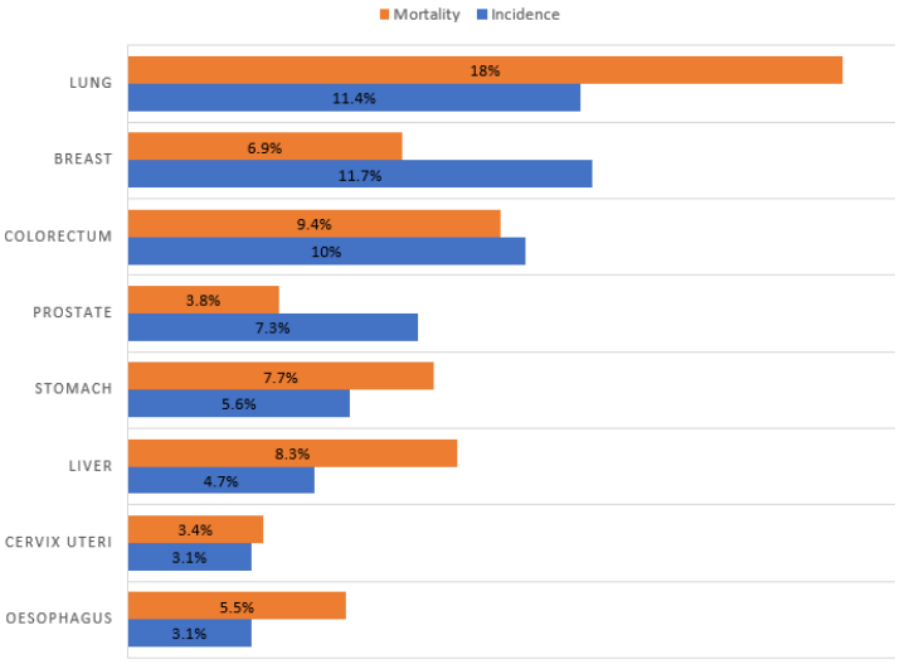


Fig. 1: Incidence and mortality rates of 8 most common cancers

Proposed Work

In order to lessen the workload for radiologists, computer-aided diagnosis is essential. In the beginning, CAD systems were created using traditional image processing and machine learning methods, which called for manually created features like shape, volume, sphericity, eccentricity, solidity, and mean intensity for various diagnostic tasks like segmentation, classification, and cancer detection. These methods aren't suitable for handling large datasets, though. These techniques' primary drawbacks are their manually constructed characteristics and their susceptibility to variations in various CT scans and screening parameters. Deep learning addresses this limitation. In a number of domains, including medical image analysis, AI and DL have produced noteworthy outcomes (Bhuvaneswari & Therese, 2015). Deep hidden layers (DL) are a type of machine learning technique that increases the accuracy of extremely complex processes by extracting high-level characteristics from a big dataset.

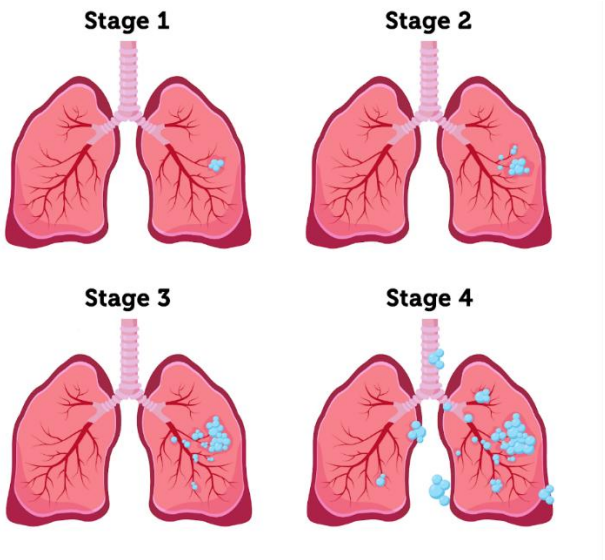


Fig. 2: Stages of lung cancer

The NSCLC-Radiomics dataset, a publicly available dataset for lung cancers, is used to assess this suggested method. Radiologists will be able to label lung cancer locations more effectively with the help of the suggested method. It can be employed in a computer-aided diagnosis (CAD) system that detects lung cancer automatically (Lakshmanaprabu et al., 2019). Convolutional neural networks enable DL-based CAD systems to extract tumor features from medical image data with varying parameters.

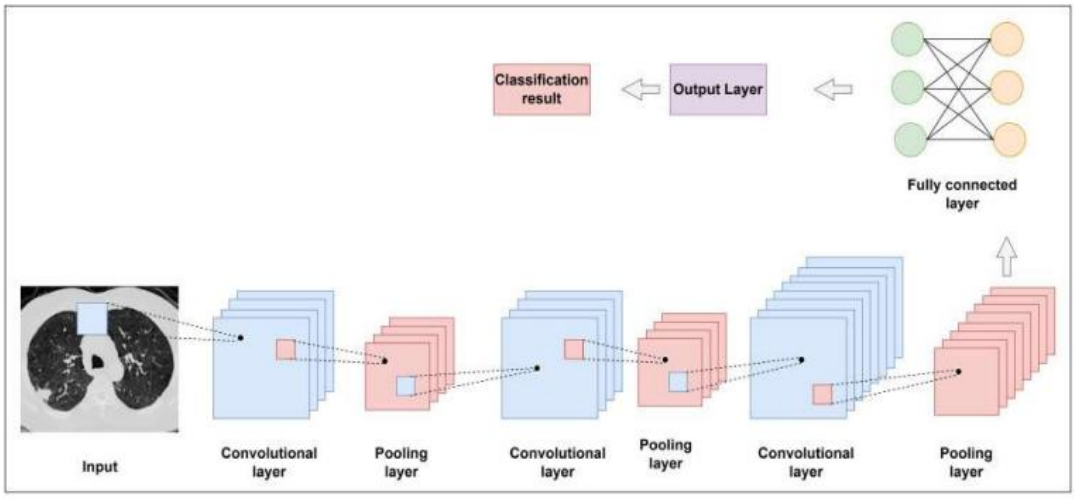


Fig. 3: CNN for classification

These networks are trained using image data along with annotations from radiologists. Once trained, they can effectively apply what they've learned to new, unseen data with impressive results. When it comes to deep learning algorithms, CNNs are the preferred option. During its training phase, a CNN, a kind of deep neural network, concentrates on extracting important properties from the data (Alves et al., 2018). In recent years, researchers have introduced a variety of CNN architectures. CNNs have demonstrated exceptional performance in computer vision tasks like object detection, classification, and segmentation. Furthermore, convolutional neural networks have demonstrated state-of-the-art performance in the field of medical image processing.

Experimental Results & Discussion

The proposed approaches are qualitatively evaluated through visual results, while the quantitative assessment relies on specific evaluation metrics, which are outlined below. Precision, sensitivity, the Dice Similarity Coefficient (DSC),

the Jaccard Index (JI), and the Harsdorf Distance (HD) were the five main metrics we used to evaluate the suggested segmentation networks for our quantitative research. Notably, True Positives (TP), False Positives (FP), True Negatives (TN), and False Negatives (FN) can be used to calculate all of these metrics, with the exception of HD.

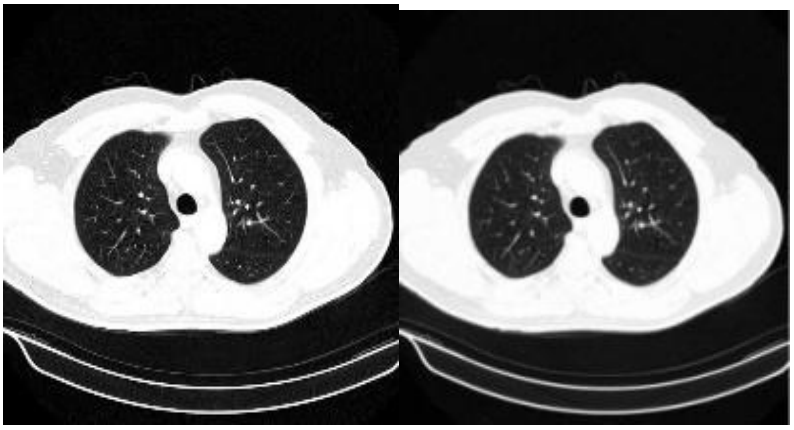
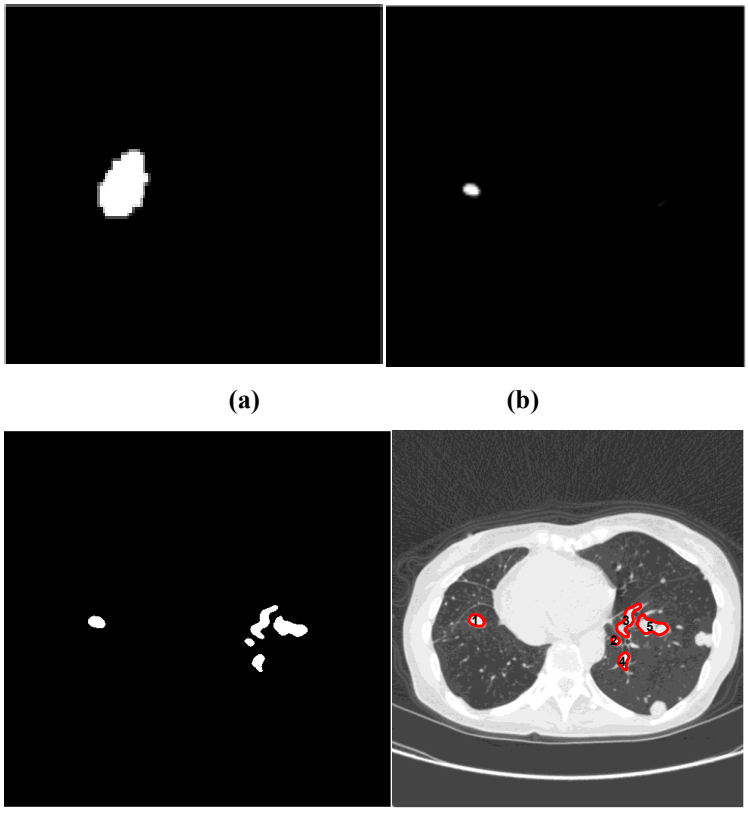


Fig. 4: (a) Input Image (b) Preprocessed Image

When we talk about true positives, we're referring to cases where the cancer area is actually there and is correctly highlighted in the predicted segmented image. On the flip side, a false positive indicates that there's no cancer area in reality, yet it appears in the predicted image (Nithila & Kumar, 2016). True negatives mean that the cancer region is absent in both the original and the predicted images.



(a) **(b)**

(c) **(d)**

Fig. 5: Segmentation

One of the deadliest illnesses in the world today is lung cancer, which is extremely dangerous to people. Better therapy analysis requires an early diagnosis, which is difficult to achieve (Nithila & Kumar, 2019). In subsequent phases, the treatment becomes considerably more challenging. As the number of cancer cases rises, radiologists are overworked.

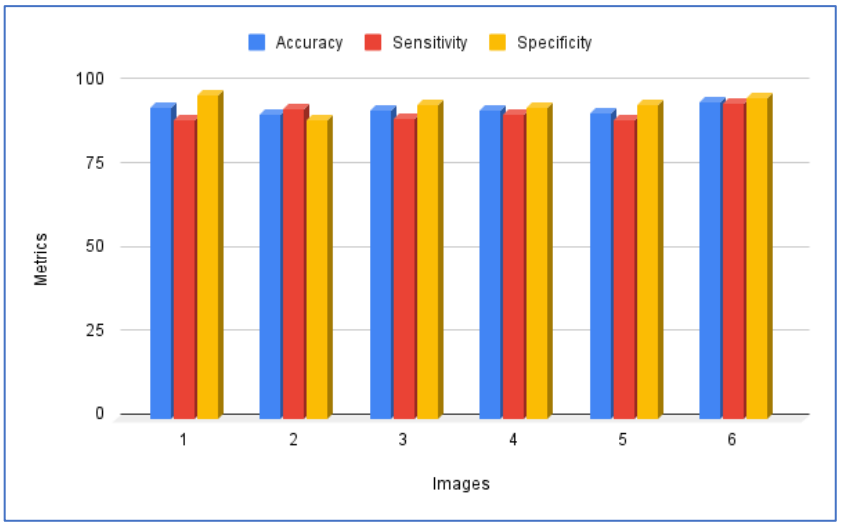


Fig. 6: Performance Comparison

The precise identification and segmentation of the lung tumor areas is crucial for the diagnosis of lung cancer. To help medical professionals with a second opinion and complete the lung tumor segmentation task in the lung CT scan pictures, we have suggested a method based on a densely connected convolutional neural network.

Conclusion

The author has provided examples of various algorithms for identifying lung cancer from clinical photos. Both humans and animals can benefit from using machine learning and deep learning algorithms because they have more trials, which enables training algorithms to learn the raw data without depending on default models. As they gain more experience, they modify their performance in light of the new information. We can evaluate energy use, forecast weather, diagnose illnesses, manage inventory, and trade by using natural phenomena as models. The author examined and assessed a number of classifiers in order to investigate the application of classification algorithms for the early diagnosis of CT images. The author of this paper investigated the implementation of a learning process for the classifications. The labeled class could be evaluated simultaneously.

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