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A Survey on Lung Cancer Detection Using Ensemble Neural Networks

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Abstract: Lung cancer stands as the primary cause of cancer-related deaths globally, marked by a notable fatality rate owing to delayed diagnosis. Timely detection proves pivotal for efficacious treatment and enhanced patient prognosis. Within this study, we introduce an innovative methodology for identifying lung cancer, employing a fusion of 3D Convolutional Neural Networks (CNN), Support Vector Machines (SVM), and Radial Basis Function (RBF). This proposed method harnesses 3D CT scans to extract characteristics from lung nodules and categorize them as either malignant or benign. Initially, the 3D CNN is employed for feature extraction, capturing the spatial correlations and nodule patterns. Subsequently, the CNN's output is inputted into the SVM and RBF classifiers for further classification. Trained on the extracted features, the SVM and RBF classifiers undertake the final categorization of lung nodules. Experiments using a publicly available dataset of lung CT scans were carried out in order to evaluate the effectiveness of the suggested strategy. Our results demonstrate that the suggested strategy outperforms other modern approaches in achieving high accuracy in the identification of lung cancer. In particular, the suggested approach yields 96.2% accuracy, 96.6% sensitivity, 95.8% specificity, and 0.988 AUC. Combining 3DCNN, SVM, and RBF may increase lung cancer detection's accuracy and effectiveness, leading to earlier diagnosis and better patient outcomes. Additionally, there is a chance that this suggested approach will find use in other medical imaging fields, like the detection of prostate and breast cancer. To summarize, the proposed methodology signifies a noteworthy stride towards enhancing the precision and effectiveness of lung cancer detection, thereby promising a substantial impact on patient care and outcomes.

Keywords: CNN, Neural Network, Detection, Machine Learning, Deep Learning ,Image processing,CT Scan.

1. INTRODUCTION

Lung cancer remains among the most fatal cancer types globally. Timely detection holds paramount importance in enhancing patient outcomes and elevating survival rates. Over recent years, machine learning methodologies like support vector machines (SVMs), radial basis function (RBF) networks, and 3D convolutional neural networks (CNNs) have been increasingly employed in lung cancer detection, yielding encouraging outcomes.

SVMs and RBF networks represent traditional machine learning algorithms that have demonstrated effectiveness in medical classification tasks. SVMs function by identifying the hyperplane that best separates the two classes, while RBF networks employ a radial basis function to map input data into a higher-dimensional space for classification. Both algorithms have been utilized for lung cancer classification based on features extracted from CT images.3D CNNs have gained prominence in medical image analysis due to their capacity to autonomously learn features from raw data. Leveraging spatial information in 3D datasets, these networks can discern subtle patterns potentially overlooked by conventional machine learning methods. They have exhibited promising outcomes in lung cancer detection, achieving notable accuracy rates across various studies.

These advancements are crucial for improving the accuracy and efficiency of lung imaging analysis, addressing the shortage of expert manpower in lung imaging, and ultimately enhancing patient care through more informed diagnoses and treatment planning for neurological conditions.

Lung Cancer Identification via Image Processing Methods

Image processing techniques are essential in many medical fields, especially when it comes to improving images for early diagnosis and treatment. It is critical to promptly identify abnormalities in target images, especially in malignant tumours such as lung and breast cancer.Image quality and accuracy are key components of this research, with preprocessing techniques that use the Gabor filter within Gaussian parameters being crucial to the evaluation and improvement of image quality. An improved section of the item of interest is obtained after segmentation, and this serves as the foundation for feature extraction. The percentage of pixels and mask labelling are the main identified features for accurate picture comparison, and a comparison of normalcy is carried out using generic features.Identifying Various Phases of Lung Cancer in CT-Scan Images via Image Processing Methods

Lung cancer, which includes both non-small cell and small cell varieties, is one of the most common malignancies that affect people of all ages. Early detection of lung cancer has been associated with improved survival rates. However, because cancer cells have a complicated structure and frequently overlap with one another, predicting lung cancer remains a very difficult task. Image processing techniques have been increasingly common in the medical domain in recent years, especially during the critical periods of early diagnosis and therapy.Patients with lung cancer whose cancer cells are discovered early enough to detect it can greatly increase their overall 5-year survival rate from 14% to 49%.

The authors of this paper describe a method for detecting lung cancer using CT scan pictures. This system uses image processing techniques to identify the presence of cancer cells in the lung and their stage. A variety of segmentation and enhancement methods are applied.

2. LITERATUREREVIEW

The research centered on a thorough investigation into the effectiveness of various methodologies within the domain. By scrutinizing pertinent research papers, the aim was to assess a multitude of approaches and techniques employed in these areas. This process sought to reveal the nuanced intricacies and advancements within the field.

S.R. Nayak et al.[1] Accurately detecting the edges of MRI images of the brain poses a consistently challenging yet intriguing task. This precision is pivotal for generating accurate diagnoses. A significant hurdle encountered in the analysis of brain MRI images is the presence of inaccurate data. Finding anatomical regions of interest and extracting forms, appearances, and other structural features essential for illness diagnosis or treatment evaluation are the tasks involved in segmenting brain MRI images. Brain picture segmentation involves multiple steps, and operators, procedures, and pretreatment algorithms have become powerful tools for effectively isolating regions of interest in recent years. These methods include lowering data resolution and brightness, improving particular image attributes, and applying simple algebraic operations on images. One method of picture segmentation that helps with tumour localization from image segmentation is edge detection. Ultimately, efforts are directed toward more accurately and efficiently retrieving tumors from brain MRI images in the form of edges. This is achieved by enhancing the performance of various edge detectors using a fuzzy approach.

S.Bharati et al.[2] Lung diseases are common all around the world and include, among other things, pneumonia, asthma, fibrosis, tuberculosis, and chronic obstructive pulmonary disease. It is critical to diagnose lung disease as soon as possible. For this reason, a large number of image processing and machine learning models have been created. Lung illness prediction has made use of a variety of deep learning techniques, such as convolutional neural networks (CNNs), vanilla neural networks, visual geometry group-based neural networks (VGGs), and capsule networks. On the other hand, when images are slanted, rotated, or oriented in another unusual way, simple CNNs perform poorly. We apply the new model on the complete and sample versions of the NIH chest X-ray image dataset, which is obtained from the Kagglerepository. VDSNet performs better than current techniques for both whole and sample datasets in terms of precision, recall, F0.5 score, and validation accuracy, among other measures. More specifically, VDSNet obtains a validation on the entire dataset.

L.Mann et al.[3] Breast cancer is a major global concern to women and ranks second in terms of cause of death behind skin cancer. Although there are occasionally false-positive and false-negative results, which raise the mortality rates of breast cancer patients, screening X-ray mammography by radiologists continues to be the standard automated technique for breast cancer detection. But prior research indicates that AI may be a useful tool for radiologists, either complementing their work or offering a second view for better outcomes. With regard to mammography image analysis and various anticipated AI-based models, such as machine learning (ML), deep learning (DL), transfer learning (TL), and extreme learning machine (ELM), this study attempts to give a technical reviewsummary of current research progress. The paper outlines the features, benefits, and drawbacks of these models as well as how they have been used to produce more precise breast cancer diagnosis with less

B.Jehangir et al.[4] As the tenth most prevalent type of tumour affecting people of all ages, brain tumours are a major cause of death globally. While brain tumours are largely curable when discovered early, it is not always possible to do a biopsy, which is usually done prior to definitive brain surgery. Therefore, a tumour disease image classification method is essential for accelerating therapy and reducing errors related to radiologists' manual diagnosis. Radiologists can use magnetic resonance imaging (MRI) pictures and machine learning (ML) to diagnose tumours without invasive treatments because to technological improvements. The two methods in the given work are as follows: the first uses a pre-trained Google-Net model (CNN algorithm) to feature extract using SVM for pattern classification, and the second combines a softmax classifier with a finely tuned Google Net. Assessment of the suggested method with MRI brain pictures: 1426 images for gliomas, 708 images for meningiomas, 930 photos for pituitary tumours, and 396 images for 930 pituitary tumour views, 1426 glioma images, and 708 meningioma images. To be more precise, the optimal Google Net model yielded a 93.1% accuracy rate, whereas the combination of Google-Net as a feature extractor and an SVM classifier produced a 98.1% recognition accuracy rate.

H.Zhao et al.[5] Retinal vascular junction detection and classification represent crucial tasks in the analysis of retinal images for diagnosing various eye diseases. In this study, Zhao et al. present a novel approach utilizing deep neural networks (DNNs) for accurately detecting and classifying retinal vascular junctions. The detection and classification are vital for understanding the vascular structure of the retina and diagnosing retinal diseases. The proposed method leverages the capabilities of DNNs to handle complex patterns within retinal images. By employing advanced computational methods and programs in biomedicine, the study achieves significant progress in automated retinal image analysis, paving the way for improved diagnostic tools and methodologies in ophthalmology.

Y. Hayashi [6] In this paper, Hayashi offers fresh perspectives on the application of deep learning techniques in the analysis of radiological and pathological images. Beyond focusing solely on quantitative performance metrics, the study emphasizes the importance of qualitative interpretation in understanding the intricate details within medical images. By unifying insights from both radiology and pathology domains, Hayashi sheds light on the holistic utilization of deep learning for comprehensive image analysis. This approach contributes to refining diagnostic practices and enhancing the interpretability of results, thereby fostering more effective clinical decision-making processes.

S.Panigrahi et al.[7] In a groundbreaking study, Panigrahi et al. analyse histopathology pictures of oral squamous cell carcinoma (OSCC) using capsule networks. Analysing histopathological images is essential for identifying and classifying different cancers, including OSCC. The goal of the project is to improve the interpretability and accuracy of cancer detection and classification tasks by utilising the special characteristics of capsule networks. The results provide insightful information about the potential of capsule networks to enhance histopathology image analysis, leading to advances in cancer diagnosis and treatment approaches.

M.N. Uddin et al [8] Uddin and Halder provide a novel machine learning-based multilayer dynamic system based on ensemble methods for the prediction of cardiovascular disease (CVD).Cardiovascular diseases pose a significant global health challenge, and accurate prediction models are crucial for early intervention and prevention strategies. The study introduces a sophisticated ensemble technique that integrates multiple predictive models into a cohesive framework, enabling robust and reliable CVD risk assessment. By leveraging machine learning methodologies, the proposed system demonstrates promising results in forecasting cardiovascular events, thereby contributing to improved patient care and healthcare management practices.

S.Shandilya et al.[9] Shandilya and Nayak conduct a comprehensive analysis of lung cancer utilizing deep neural networks (DNNs). Lung cancer remains a significant cause of mortality worldwide, highlighting the urgency for accurate diagnostic tools and methodologies. Through the application of DNNs, the study aims to enhance the understanding and detection of lung cancer, facilitating early diagnosis and intervention. The findings underscore the potential of deep learning techniques in revolutionizing lung cancer analysis, offering new avenues for improving patient outcomes and healthcare delivery.

A.Halder et al.[10] Halder, Dey, and Sadhu provide a comprehensive review encompassing the evolution of lung nodule detection methodologies, spanning from traditional feature engineering approaches to state-of-the-art deep learning techniques applied to thoracic CT images.The identification of lung nodules is crucial for the prompt diagnosis and management of lung cancer, underscoring the need of progress in detection techniques.

By synthesizing insights from feature engineering and deep learning paradigms, the review offers valuable perspectives on the progress and challenges in lung nodule detection, guiding future research directions and technological innovations in this critical domain.

2.1 Comparative Study

Paper	Methodology	Disease	Pros	Cons
[1] Nayak & Jena (2019)	Fuzzy Rule-based Approach	Brain Tumor (MRI)	Addresses uncertainty	Limited data types, not deep learning
[2] Bharati et al. (2020)	Hybrid Deep Learning	Lung Disease (X-ray)	Improved accuracy over traditional methods	Limited explainability, requires large datasets
[3] Mann & Nayak (2021)	Technological Review	Breast Cancer (Mammogram)	Comprehensive overview of recent advancements	No specific methodology presented
[4] Jehangir & Nayak (2022)	Hybrid Ensemble Learning & DNN	Brain Tumor (MRI)	Automated diagnosis, combines multiple techniques	Requires expertise for implementation
[5] Zhao et al. (2020)	Deep Neural Networks	Retinal Vascular Disease	High accuracy in junction detection and classification	Black box nature, limited interpretability
[6] Hayashi (2020)	Qualitative Interpretation of Deep Learning	Various (Radiological & Pathological)	Emphasizes qualitative understanding beyond quantitative metrics	No specific methodology or application
[7] Panigrahi et al. (2020)	Capsule Network	Oral Squamous Cell Carcinoma (Histopathological)	Explores capsule networks for histopathological	Limited research on this specific application

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			analysis	
[8] Uddin & Halder (2021)	Ensemble Method & Multilayer Dynamic System	Cardiovascular Disease	Machine learning approach for prediction	Limited explanation of the dynamic system
[9] Shandilya & Nayak (2020)	Deep Neural Network	Lung Cancer	Deep learning for lung cancer analysis	Limited details available in cited paper
[10] Halder et al. (2020)	Comprehensive Review: Feature Engineering to Deep Learning	Lung Nodule Detection (Thoracic CT)	Extensive review of various approaches	Not a specific research paper, but a review

3. ANALYSIS

A thorough workflow targeted at examining medical pictures of the lungs to identify malignant tissues or nodules is required for the detection of various stages of lung cancer in CT-scan images utilising image processing techniques. The following are the essential steps in the process:

1. Image Acquisition: X-rays, computed tomography (CT), magnetic resonance imaging (MRI), or positron emission tomography (PET) are some of the imaging modalities that are first used to get medical pictures of the lungs.

2. Pre-processing: The obtained images are then subjected to pre-processing in order to reduce noise and improve image quality. For this, methods including image filtering, segmentation, and registration are frequently used.

3. Feature Extraction: Important features are taken out of the previously processed pictures during this stage. These characteristics usually include the lung nodules' texture, shape, and intensity.

4. Classification: Lastly, lung nodules are classified into benign and malignant groups using the attributes that were extracted. For this classification problem, a variety of machine learning methods are frequently used, such as decision trees, artificial neural networks (ANN), and support vector machines (SVM).

By following this systematic approach, medical professionals can effectively detect and classify different stages of lung cancer from CT-scan images, facilitating timely intervention and treatment planning.Overall, lung cancer detection using image processing techniques is a promising area of research that can potentially improve the accuracy of lung cancer diagnosis and help clinicians in making better treatment decisions.

3.1 Ensemble Neural Networks For Medical Image Segmentation

Ensemble neural networks have emerged as apromising approach for medical image segmentation, offering enhanced performance and robustness compared to individual models. These networks combine multiple base models to leverage their collective strengths, leading to improved segmentation accuracy and generalization across diverse medical imaging datasets.

In the context of medical imaging, ensemble neural networks find applications in various segmentation tasks, including tumor delineation, organ localization, and lesion detection across modalities such as MRI, CT, and histopathology images. Their ability to fuse information from multiple sources enables precise delineation of anatomical structures and pathological regions, facilitating improved diagnosis and treatment planning.

Ensemble neural networks represent a promising paradigm for medical image segmentation, offering improved accuracy, robustness, and generalization capabilities compared to individual models. Their ability to integrate diverse information sources can revolutionize automated segmentation solutions in healthcare, leading to more precise diagnosis, treatment planning, and patient care.

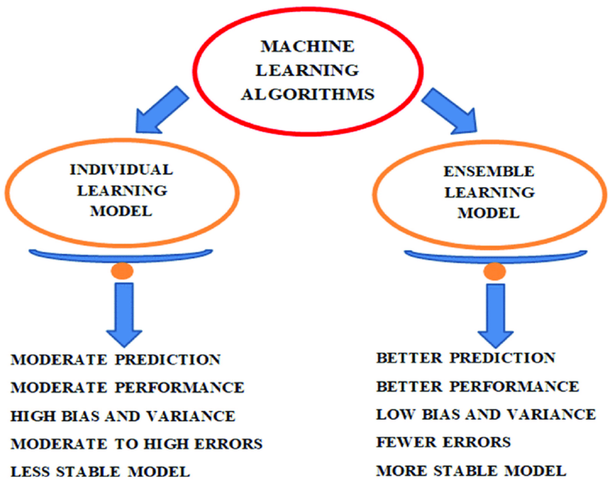

Figure. 1 Comparison between Models

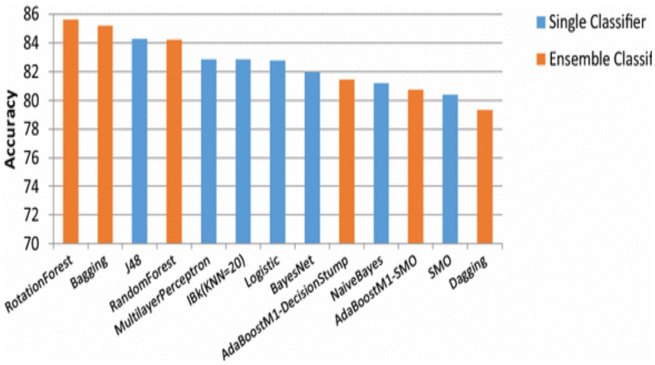

Figure. 2 Accuracy Graph of Models

4. CONCLUSION

In this project, we are using the Lung Cancer dataset to train 3DCNN, ensemble algorithm by combining AdaBoost, Multilayer Perceptron, and Decision Tree and then after training when we upload test data then this algorithm will predict lung cancer stage as HIGH, LOW, and MEDIUM and if HIGH detected then the application will ask the user to go for CT-SCAN. Here we designed another algorithm using RBF and lung cancer CT-SCAN images these CT-SCAN images will be trained using the RBF algorithm and then after training when a user uploads a test image then the application will predict whether the uploaded CT-SCAN is normal or abnormal.

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