

EMERGING TRENDS IN COMPUTATION & ARTIFICIAL INTELLIGENCE

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Emerging Trends in Computation & Artificial Intelligence

First Edition

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CHAPTER - 8
CLASSIFICATION OF LUNG DISEASES FROM CHEST X-RAY AND CT IMAGES USING A
MULTI-CLASS DEEP LEARNING ARCHITECTURE

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ABSTRACT

Medical imaging is considered a suitable alternative testing method for the detection of lung diseases. Many researchers have been working to develop various detection methods that have aided in the prevention of lung diseases. To better understand the condition of the lung disease infection, chest X-Ray and CT scans are utilized to check the disease's spread throughout the lungs. This study proposes an automated system for the detection multi lung diseases in X-Ray and CT scans. A customized Convolutional Neural Network (CNN) and two pre-trained deep learning models with a new image enhancement model are proposed for image classification. The proposed lung disease detection comprises two main steps: pre-processing, and deep learning classification. The new image enhancement algorithm is developed in the pre-processing step using k-symbol Lerch transcendent functions model which enhancement images based on image pixel probability. While, in the classification step, the customized CNN architecture and two pre-trained CNN models Alex Net, and VGG16Net are developed. The proposed approach was tested on publicly available image datasets (CT, and X-Ray image dataset), and the results showed classification accuracy, sensitivity, and specificity of 98.60%, 98.40%, and 98.50% for the X-Ray image dataset, respectively, and 98.80%, 98.50%, 98.40% for the CT scans dataset, respectively. Overall, the obtained results highlight the advantages of the image enhancement model as a first step in processing.

KEYWORDS

Lung Disease Classification, Deep Learning, CNN, Medical Imaging, Chest X-ray, CT Scan.

INTRODUCTION

Lung diseases, including pneumonia, tuberculosis, COPD, and lung cancer, represent significant health challenges worldwide. Early and accurate detection is crucial for effective treatment and improved patient outcomes. Traditional methods of diagnosing these conditions, which rely heavily on radiologists' expertise, are often time-consuming and subject to human error. With the advancement of deep learning, there has been growing interest in utilizing automated systems to assist in the classification of lung diseases from medical images like chest X-rays and CT scans.

Multi-class deep learning architectures, particularly Convolutional Neural Networks (CNNs), have proven effective in classifying a wide range of lung conditions. These models are trained on large datasets, enabling them to learn hierarchical features directly from images. Unlike binary classifiers, multi-class architectures can simultaneously identify multiple diseases, making them suitable for real-world clinical settings. This approach enhances diagnostic speed, accuracy, and supports healthcare professionals in making informed decisions.

LITERATURE SURVEY

Deep learning, particularly multi-class CNN architectures, is widely used in medical imaging for lung disease classification from chest X-rays and CT scans. These models excel in detecting conditions like pneumonia, tuberculosis, lung cancer, and COPD. This study reviews recent papers on deep learning approaches for lung disease classification.

Several studies have explored deep learning models for the classification of lung diseases from medical imaging. [1] developed a multi-class CNN model for detecting pneumonia and tuberculosis from chest X-

rays, highlighting the power of deep learning in improving diagnostic accuracy. [2] proposed a CNN-based architecture that achieved high accuracy in identifying multiple diseases, including pneumonia, tuberculosis, and lung cancer, from chest X-ray images.

In [3] introduced a deep learning model for CT scans, demonstrating strong performance in detecting diseases like lung cancer and pneumonia. [4] showcased a deep CNN approach for lung disease classification, utilizing a large dataset of chest X-ray images. In [5] provided a comprehensive review of deep learning models, covering various architectures and challenges. [6] focused on pneumonia detection from X-rays, while [7] applied 3D CNN models for improved lung disease classification from CT scans.

In [8] explored a multi-class CNN model for detecting pneumonia and other lung diseases from chest X-rays, showcasing the ability of CNNs to differentiate multiple disease categories. [9] proposed a hybrid approach combining chest X-ray and CT scan features to enhance classification accuracy. [10] introduced a hybrid model integrating CNNs for feature extraction and support vector machines (SVMs) for classification, applied to multi-class lung disease detection. [11] focused on multi-label classification, using CNNs to predict multiple disease labels from X-ray images, improving diagnostic accuracy in complex cases. [12] applied transfer learning with pre-trained CNN models for lung disease classification from both X-ray and CT scans, significantly improving performance, particularly when labeled data was scarce. These approaches contribute to more accurate, efficient, and scalable lung disease diagnosis.

Research gaps in relation to CT and chest X-Ray chest of lung disease include degraded image quality due to artifacts, movement, or technical errors. Combining imaging modalities or predicting multiple conditions can enhance performance but presents challenges. Further research is needed to optimize transfer learning from non-medical datasets to improve classification accuracy and diagnostic

outcomes.

PROPOSED WORK

The methodology used in the study is shown in Fig. 1 as a block diagram. The study examined two types of lung images: CT scans of the lungs and X-Rays of the chest from publicly available datasets. The three main approaches in this study are presented: the proposed image enhancement model, the proposed customized CNN model, and the two tuned-pre-trained deep learning models for three different lung disease classifications.

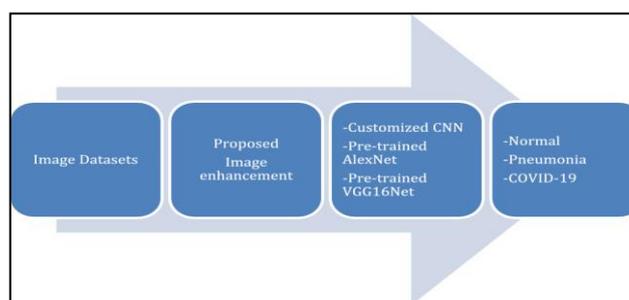


Fig 1. Proposed work Block Diagram

Proposed Image Enhancement Model

CT and X-ray imaging have transformed healthcare by enabling non-invasive disease diagnosis. However, artifacts, noise, and low resolution can hinder interpretation and lead to misdiagnosis. Minimizing these issues before processing is essential to prevent CNN misclassification. This study explores a novel image enhancement model using non-linear functions, which effectively address complex image challenges, improving clarity and accuracy in medical imaging analysis.

Non-linear functions in image enhancement offer benefits like capturing complex textures and preserving edges. Lerch transcendent functions (LTFs) excel in handling image non-linearity's, such as noise and lighting changes, outperforming traditional methods. LTFs provide a structural framework for special functions in number theory. Additionally, fractional calculus enhances image contrast and detail. By applying the k-fractional symbol in LTFs, image enhancement improves by modifying pixel values, leading to better visual

quality. This approach ensures more realistic and effective image enhancement compared to linear techniques.

The proposed K-LTF image enhancement model improves image quality by enhancing pixels with minor gray-level changes based on pixel probability. It effectively enhances low-contrast images by estimating improved pixel values. The fractional parameter β is crucial, with α set at 0.5. BRISQUE, a blind image quality evaluator, was used to assess enhancements, where lower scores indicate better quality. The optimal β value, determined from Fig. 2, is 0.11, achieving the best BRISQUE score. The model's power parameters, α and β , play a key role in enhancement effectiveness, ensuring improved image contrast and clarity through precise pixel intensity adjustments.

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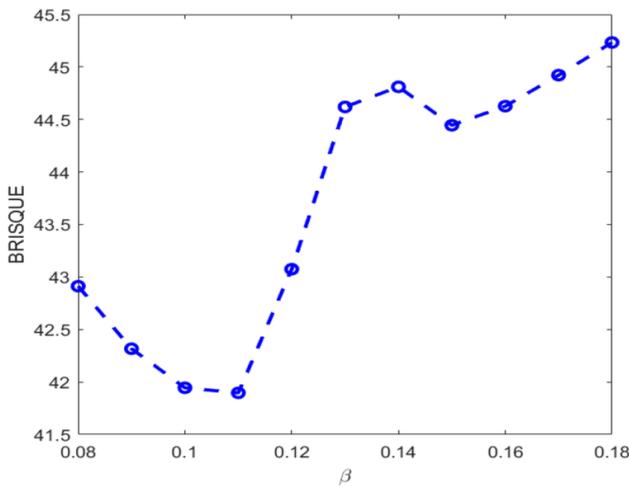


Fig 2. The average of BRISQUE with different values of β

The qualitative outcomes of this model are shown in Figs. 3 and 4 respectively in CT scan and X-Ray images. The input images, enhanced images, and histogram plots are all shown in the figures. The original image pixel probability histogram plot appears dense, whereas the enhanced image pixel probability histogram plot appears scattered which indicates the improvement in the image's contrast.

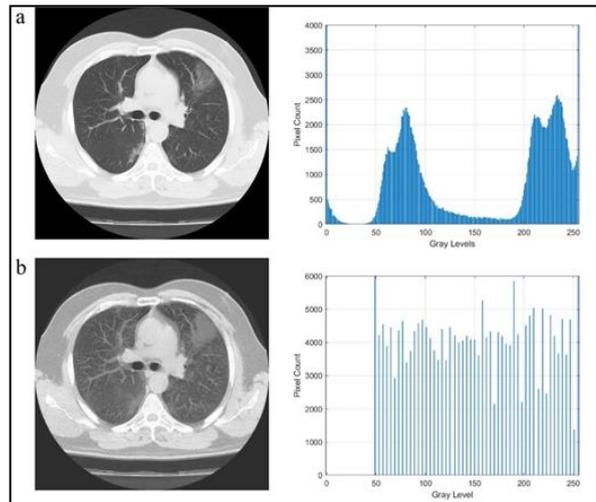


Fig 3. Results of the CT Scan Image Enhancement

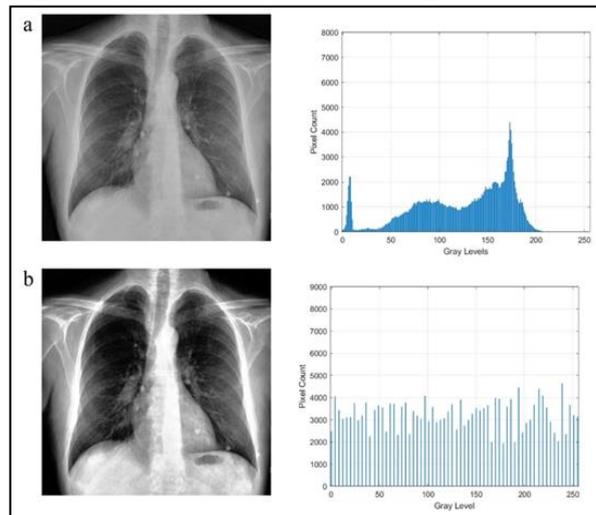


Fig 4. Results of the X-Ray Image Enhancement

(a) Original image, (b) Enhanced image.

The histogram plots in Figs. 3 and 4 are used to quantitatively assess the impact of the proposed image enhancement method on the image characteristics. Histogram analysis shows that input images lose details, while the proposed enhancement method stretches contrast, making details brighter and more distinct. Enhanced images exhibit a more even pixel intensity distribution, with histogram plots revealing a compact pixel probability distribution, demonstrating significant improvements in image contrast and clarity.

Proposed Deep Learning Classification Model

The objective of the proposed method is

to effectively classify lung diseases into three categories using deep learning CNN methods.

The Modified CNN model is built from scratch to classify lung diseases in X-Ray and CT scans. The proposed customized CNN model has 4 “convolution layers”, 3 “pooling layers”, and the

“fully connected layer”. In the training process, the input image size for the proposed customized CNN is 227×227 . The “batch Normalization Layer”, “rectified linear layer” (ReLU layer) and “maxpooling” comes after the “convolutional layers” (ConvLs) as shown in Fig. 5.

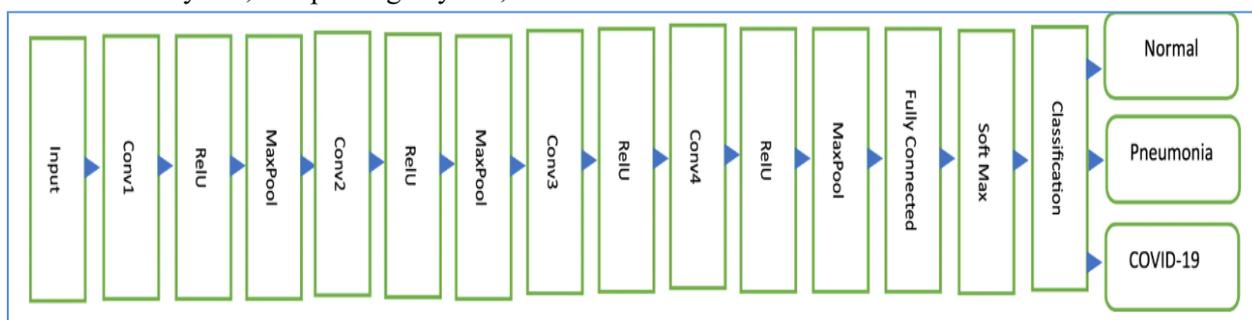


Fig 5. The Proposed Modified CNN Architecture

In the CNN model, the batch normalization layer is used for stabilizing the learning and is applied right before the ReLU, while the pooling layer is used to reduce feature size extracted by the convolutional layers. The ‘fully connected’ and ‘softmax layers’ are used for lung diseases. The learnable parameters of the proposed customized CNN model are illustrated in Table 1.

Layer	Weight	Filters
Conv1	$5 \times 5 \times 3 \times 16$	$1 \times 1 \times 16$
Conv2	$5 \times 5 \times 16 \times 32$	$1 \times 1 \times 32$
Conv3	$5 \times 5 \times 32 \times 64$	$1 \times 1 \times 64$
Conv4	$5 \times 5 \times 64 \times 128$	$1 \times 1 \times 128$
Fully connected		3×1

Table 1: Parameters for the Modified CNN model.

In CNNs, Conv1 ($5 \times 5 \times 3 \times 16$) defines the properties of a convolutional filter. The 5×5 represents the spatial dimensions of the filter, scanning 5 pixels in height and width. The 3 corresponds to the input depth, typically RGB image channels. The 16 indicates the number of filters, each learning different features, resulting in 16 feature

maps. As the CNN progresses, layer depth increases, capturing more abstract patterns. This convolutional layer extracts essential features from the input, enhancing representation for deeper layers. The output depth of this layer is 16, corresponding to the number of filters applied to the input.

The input images were standardized to 227×227 pixels, with a batch size of 32. Validation accuracy was calculated at the end of each epoch. The customized CNN model used optimal hyperparameters: learning rate = 0.0001, batch size = 32, MaxEpochs = 30, iterations per epoch = 2, maximum iterations = 60, Momentum = 0.9, and Validation Frequency = 30. Batch normalization was applied after each convolutional layer to maintain stable activation distributions, placed before the ReLU non-linearity layer. Early stopping was used to prevent overfitting by halting training if validation loss ceased to improve. The datasets were split 70% for training and 30% for testing. Five-fold cross-validation was applied to reduce bias and improve model performance, ensuring an equal distribution of observations across the three lung disease classes.

The training process and the number of iterations for the proposed CNN model using CT scans are shown in Fig. 6. During the first 10

iterations, there is noticeable instability; however, after 25 iterations, the training accuracy reaches nearly 100%. The customized CNN model achieved the highest training accuracy on CT scans, showcasing how the simplified structure of the proposed CNN—by reducing the number of layers—can deliver significantly more accurate results compared to transfer learning approaches.

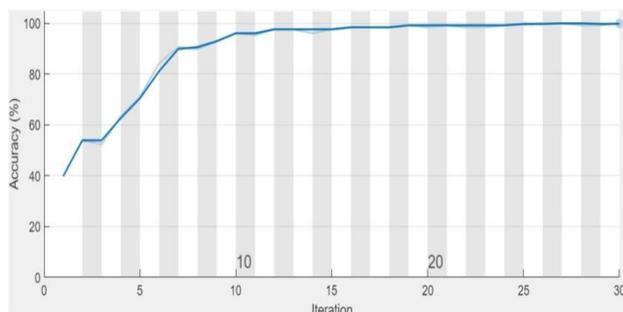


Fig 6. Proposed Modified CNN model's training process

Image datasets

The dataset used consists of 1,714 images, including 810 CT scans and 904 chest X-rays. The CT scan dataset includes 337 COVID-19, 196 Pneumonia, and 277 Normal images from SIRM and Radiopaedia. The X-ray dataset contains 237 COVID-19, 250 Pneumonia, and 417 Normal images in JPG format.

Results and discussion

MATLAB R2019b on Windows 10 with processor Intel(R) Core i5 @ 2.80GHz with 16 GB RAM was used to produce the test results. Tests were carried out on a set of datasets that were divided into 70% training and 30% testing. The test set is a different set of data used to verify the model after it has been trained. Furthermore, the fivefold cross-validation is used to identify the three lung diseases. Table 2 illustrates the findings of plain X-Ray and CT scans (without image enhancement) for the three classes studied, which averaged about 96%.

Method	Image Dataset	Accuracy %	Sensitivity (Recall) %	Specificity %	Precision %	F1-Score %
Proposed Modified CNN	X-Ray	96.40	95.30	96.30	98.30	96.77
	CT	96.60	96.50	96.30	96.10	96.30
Pre-trained VGG16Net	X-Ray	95.10	95.60	95.50	95.10	95.34
	CTscans	95.30	95.30	96.40	95.00	95.14
Pre-trained AlexNet	X-Ray	96.40	96.20	95.60	95.70	96.00
	CTscans	96.70	96.20	96.10	95.80	96.00

Table 2: Obtained results of X-Ray and CT scans

without image enhancement

In Table 3, all performance metrics improved by more than 98% when using the proposed image enhancement model. This study employs deep learning models to classify COVID-19, pneumonia, and normal cases using a customized CNN and pre-trained AlexNet and VGG16Net, along with a novel image enhancement model. The proposed models

were evaluated for accuracy, sensitivity, and specificity. The customized CNN achieved 96.80% accuracy on CT scans and 98.60% on X-rays. VGG16Net attained 98.20% accuracy on X-rays and 98.10% on CT scans, while AlexNet reached 98.20% on X-rays and 98.40% on CT scans. These results highlight the effectiveness of the enhancement model in improving classification performance.

Method	Image Dataset	Accuracy %	Sensitivity %	Specificity %	Precision %	F1-Score %
Proposed Modified CNN	X-Ray	98.60	98.40	98.50	98.30	98.35
	CT	98.80	98.50	98.40	98.60	98.55
Pre-trained VGG16Net	X-Ray	98.20	98.30	98.30	98.15	98.22
	CTscans	98.10	98.10	98.20	98.00	98.05
Pre-trained AlexNet	X-Ray	98.20	98.20	98.30	98.10	98.15
	CTscans	98.40	98.10	98.20	98.00	98.05

Table 3: Proposed Modified CNN with preprocessing

using proposed image enhancement

CONCLUSION

This study introduces deep learning models for image classification, integrating a novel image enhancement algorithm based on the k-symbol Lerch transcendent function to improve accuracy. A customized CNN model and fine-tuned AlexNet and VGG16Net were used on X-ray and CT scan datasets. The customized CNN achieved 98.60% accuracy for X-rays and 98.80% for CT scans, demonstrating the effectiveness of the enhancement technique. While AlexNet and VGG16Net also performed well, class imbalance may have affected disease detection. Future work should address class imbalance and incorporate additional fine-tuned CNN models to enhance classification across a wider range of lung infections.

REFERENCES

- [1]. Liu, Y., et al. (2020). "A Deep Learning Model for the Diagnosis of Pneumonia and Tuberculosis from Chest X-ray Images." *Journal of Digital Imaging*, 33(3), 431–440.
- [2]. Liu, H., et al. (2019). "A Hybrid Deep Learning Model for Classifying Lung Diseases Using Chest X-ray and CT Images." *International Journal of Computer Assisted Radiology and Surgery*, 14(4).
- [3]. Zhu, Z., et al. (2020). "Deep Learning for Lung Disease Classification Using Chest CT Images." *Medical Image Analysis*, 65, 101742.
- [4]. Kermany, D.S., et al. (2018). "Identifying Medical Diagnoses and Treatable Diseases by Image-Based Deep Learning." *Cell*, 172(5), 1122–1131.
- [5]. Tung, P., et al. (2021). "Multi-Class Lung Disease Classification Using 3D CT Images and Deep Learning." *IEEE Access*, 9, 87233–87242.
- [6]. Chouhan, S., et al. (2021). "A Deep Learning Model for Early Detection of Pneumonia Using Chest X-ray Images." *Journal of Medical Systems*, 45(9).
- [7]. Shen, D., et al. (2021). "Deep Learning for Lung Disease Diagnosis Using X-ray and CT Scan Data." *Journal of Medical Imaging*, 8(4), 045502.
- [8]. Islam, S., et al. (2020). "A Hybrid Deep Learning Approach for the Diagnosis of Lung Diseases Using Chest X-ray and CT Images." *Computers in Biology and Medicine*, 124, 103939.
- [9]. Xu, Y., et al. (2019). "Deep Learning-Based Pneumonia Detection in Chest X-rays with a Multi-Class Architecture." *Medical Image Analysis*, 53.
- [10]. Liu, Q., et al. (2021). "Multi-Class Lung Disease Classification Using Deep Learning and Transfer Learning." *IEEE Transactions on Biomedical Engineering*, 68(3), 789–798.
- [11]. Khan, R.A., et al. (2021). "Deep Learning-Based Pneumonia Detection in X-ray Images Using Multi-Class Convolutional Neural Networks." *Journal of Healthcare Engineering*, 2021.
- [12]. Singh, D., et al. (2020). "A Deep Learning Approach for Detection of Multiple Lung Diseases from Chest X-rays." *Applied Intelligence*, 50(6), 1574–1586.

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About Book

The fields of computation and artificial intelligence (AI) are evolving at an unprecedented pace, revolutionizing industries and redefining the way we interact with technology. *Emerging Trends in Computation & Artificial Intelligence* is an insightful compilation of the latest advancements, methodologies, and applications in AI-driven technologies, showcasing their impact across diverse domains such as healthcare, cybersecurity, education, agriculture, and cloud computing.

This edited volume brings together a wide range of research contributions from scholars and practitioners, covering critical areas like AI-powered disease monitoring, deep learning for personalized content recommendation, cyber-physical systems, and intelligent decision-making in engineering. The book highlights how AI is enhancing smart healthcare security, optimizing agricultural yield predictions, and transforming classrooms with personalized learning experiences. It also explores the intersection of AI with cybersecurity, blockchain technologies, and cloud computing optimization, offering a comprehensive understanding of how computational intelligence is shaping modern digital landscapes.

A significant focus of this book is on the real-world applications of AI, including lung disease classification using deep learning, generative AI for educational personalization, and AI-driven economic growth in India. The inclusion of topics such as neuromorphic intelligence, decision stump classification for student placement, and nutrition label analysis with TinyML demonstrates the versatility of AI in addressing both global and niche challenges. Additionally, discussions on cybersecurity threats, intrusion detection systems, and AI-driven privacy strategies provide valuable insights into safeguarding digital assets in an increasingly connected world.

Designed for academicians, researchers, industry professionals, and students, this book serves as a vital resource for understanding the emerging trends and challenges in AI and computation. By bridging the gap between theoretical advancements and practical implementations, it provides readers with a forward-looking perspective on the future of AI. Whether you are exploring AI's potential in sustainable agriculture, intelligent systems for real-time decision-making, or the mathematics behind machine learning, this book offers valuable knowledge that caters to both beginners and experts in the field.

As AI continues to reshape industries and societies, this book aims to foster discussions on innovative approaches and interdisciplinary research that can drive technological progress. With a diverse range of topics and expert contributions, *Emerging Trends in Computation & Artificial Intelligence* is a must-read for anyone looking to stay ahead in the ever-evolving landscape of artificial intelligence and computational science.

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