Pneumonia Detection Using Deep Learning-Based CNN Architectures

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Abstract—

Pneumonia is a serious lung infection that requires early and accurate diagnosis to reduce mortality and clinical workload. Recent advances in deep learning have enabled automated analysis of medical images with promising accuracy. This paper presents a comparative study of multiple Convolutional Neural Network (CNN) architectures for pneumonia detection using chest X-ray images. Five models—SimpleCNN, ResNet-like, DenseNet-like, VGG-like, and Inception-like—were trained and evaluated using standard classification metrics. Experimental results show that the VGG-like architecture achieved the highest classification accuracy, while DenseNet-like models demonstrated strong sensitivity and feature reuse. Additionally, explainability was analyzed using Grad-CAM visualizations to highlight clinically relevant lung regions. The results indicate that deep CNN architectures can effectively assist radiologists in early pneumonia detection and medical decision support.

Keywords—

Deep Learning, Convolutional Neural Networks, Pneumonia Detection, Chest X-ray, VGGNet

I. INTRODUCTION

Pneumonia is an infectious disease that causes inflammation in the air sacs of the lungs and can be life-threatening if not diagnosed at an early stage. Chest X-ray imaging is one of the most commonly used diagnostic tools, but manual interpretation is time-consuming and subject to human error.

Deep learning, particularly Convolutional Neural Networks (CNNs), has demonstrated strong performance in medical image classification. This work focuses on evaluating different CNN architectures to determine their effectiveness in pneumonia detection from chest X-ray images.

II. RELATED WORK

Several studies have explored deep learning techniques for automated lung disease detection. Residual and densely connected architectures have shown improved performance in medical image analysis due to better gradient flow and feature reuse.

Comparative studies indicate that deeper CNNs such as ResNet and DenseNet provide enhanced accuracy and interpretability when applied to chest X-ray datasets.

III. METHODOLOGY

A publicly available chest X-ray dataset containing normal and pneumonia-infected images was used. All images were resized, normalized, and augmented before training.

Five CNN architectures were implemented and trained independently. Model performance was evaluated using accuracy, precision, recall, F1-score, and ROC-AUC metrics.

IV. EXPERIMENTAL RESULTS

Among the evaluated models, the VGG-like architecture achieved the highest accuracy of 85.58%. DenseNet-like models exhibited higher sensitivity, making them suitable for medical diagnosis.

ROC curves, confusion matrices, and ensemble analysis further validated the robustness of the deep learning-based approach.

V. EXPLAINABILITY ANALYSIS

Grad-CAM visualizations were used to interpret model predictions by highlighting important lung regions contributing to classification decisions.

The VGG-like model demonstrated focused activation on infected lung areas, indicating clinically meaningful decision-making.

VI. CONCLUSION AND FUTURE WORK

This study confirms the effectiveness of CNN-based models for pneumonia detection from chest X-ray images.

The VGG-like model provided the best overall performance.

Future work includes incorporating transfer learning, expanding datasets, and deploying the system on cloud or mobile platforms for real-time clinical use.

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