

An Advanced Deep Learning Technique for Detecting Respiratory Diseases

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Abstract—

Machine learning is a field of computer science concerned with algorithms that improve automatically through experience. Segmentation and classification tasks require models capable of assigning appropriate class labels to data. A simple example is classifying emails into *spam* and *non-spam*, while more complex cases involve multi-class classification. In most binary medical classification scenarios, the model distinguishes between *normal* and *abnormal* states. This study focuses on predicting lung-related diseases using chest X-ray images with a binary classification approach. The system uses several Python libraries, including TensorFlow, Keras, and NumPy. The research demonstrates the application of a deep learning model—specifically the VGG16 architecture—for lung disease detection and provides a complete implementation example with source code.

Index terms — Deep Learning, VGG16, Lung Disease Detection, CNN.

I. INTRODUCTION

The human body depends heavily on a continuous oxygen supply, making the lungs essential organs. They facilitate oxygen absorption and carbon dioxide removal, but due to their constant exposure to the external environment, they are susceptible to numerous diseases. These include lung cancer, chronic obstructive pulmonary disease (COPD), COVID-19, asthma, chronic bronchitis, influenza, lung fibrosis, sarcoidosis, and tuberculosis.

Rising pollution, climate change, and lifestyle shifts have increased the global prevalence of respiratory illnesses. In 2016, COPD alone caused 3.4 million deaths, while asthma claimed approximately 400,000 lives. Low-income regions are especially vulnerable due to higher exposure to air pollution and limited healthcare resources. The World Health Organization reports that nearly 4 million deaths annually can be attributed to illnesses linked to indoor air pollution.

Early and accurate diagnosis of lung disease is essential for effective treatment. With recent advancements in deep learning, medical image-based disease classification has significantly improved. Convolutional Neural Networks (CNNs) have proven especially effective for this purpose. However, basic CNN models often fall short, leading to the development of improved architectures. This research introduces a deep learning-based system for predicting lung diseases using the VGG16 architecture. The model is trained on an X-ray dataset sourced from Kaggle. Experimental results show that VGG16 achieves high accuracy, recall, precision, and F1 scores for both the complete and sample

datasets. The system's performance demonstrates its potential usefulness to clinicians for faster lung disease detection.

II. LITERATURE REVIEW

Teja et al. highlighted that automated lung scan analysis can significantly reduce physicians' workload. Deep learning models outperform traditional machine learning techniques in medical image classification; however, existing datasets often lack balance and diversity.

Anuradha D.Gunasingh et al. proposed a machine-learning-based decision support system to improve diagnostic accuracy for diseases such as asthma, COPD, tuberculosis, pneumothorax, and lung cancer.

Neha Panpaliya et al. implemented a decision tree algorithm to detect lung cancer based on patient attributes such as weight, age, and score. Their system used histogram equalization during preprocessing and a neural network classifier to determine whether lung images were normal or abnormal.

III. EXISTING SYSTEM

Existing models exhibit several limitations:

- Difficulty in classifying images containing rotation or tilt.
- Loss of spatial information during processing, affecting classification accuracy.
- Lack of coordinate frames, which are essential for human-like visual understanding.
- Poor spatial invariance to input variations.

IV. PROPOSED SYSTEM

Diagnosing diseases requires reliable evaluation methods, especially when using X-ray imaging to detect lung abnormalities. Recent advancements in AI and deep learning have improved lung disease identification and classification.

In the proposed system, a large labelled dataset of chest X-ray images—acquired from Kaggle—is used. The dataset includes multiple classes such as COVID-19, tuberculosis, and pneumonia. After collecting and preparing the data, the VGG16 model is trained sequentially, layer by layer.

VGG16 is a convolutional neural network consisting of 16 layers, utilizing small 3×3 kernels to capture spatial patterns efficiently. Its strengths include:

- Conceptually simple and widely used
- Strong performance in image classification
- Faster training compared to more complex architectures
- Easy implementation and transfer learning compatibility
- Achieves up to **91.1% accuracy** in the proposed system
- Pre-trainable on ImageNet, enabling effective feature extraction

V. METHODOLOGY

A. Deep Learning

Deep learning trains computers to learn from examples much like humans. It powers technologies such as autonomous cars and voice-activated devices. Deep learning models learn directly from images, text, or audio, often outperforming human performance on complex tasks. These models require substantial labelled datasets and multi-layer neural architectures.

B. Convolutional Neural Networks (CNNs)

CNNs are widely used in computer vision, including radiology. They automatically learn hierarchical spatial features using convolution, pooling, and fully connected layers. Despite their success, CNN applications in radiology face challenges such as limited datasets and overfitting. Various strategies, including augmentation and transfer learning, help address these issues.

C. VGG16 Architecture

VGG16 is a deep network containing 16 layers and approximately 138 million parameters. While large, its design is straightforward and effective. It uses small convolutional filters, enabling precise spatial feature extraction.

VI. MODULE DESCRIPTION

A. Data Collection

The first step involves gathering a suitable dataset. For lung disease detection, chest X-ray or CT scan images, along with demographic factors such as age and smoking history, may be collected.

B. Data Preprocessing

Before training, the dataset undergoes cleaning, normalization, resizing, and formatting to ensure compatibility with deep learning models.

C. Model Evaluation

The model architecture is selected (e.g., CNN, VGG16). The dataset is then used for training. Performance is evaluated using metrics such as:

- Accuracy
- Precision
- Sensitivity
- Specificity
- AUC (Area Under ROC Curve)

VII. CONCLUSIONS

Research on lung disease detection using deep learning has grown significantly in recent years, but comprehensive reviews of these advancements remain limited. A taxonomy of current deep learning-based lung disease detection methods was developed, highlighting major research themes and trends. Among the surveyed techniques, CNNs and transfer learning were the most widely used. Except for ensemble methods, most approaches showed steady growth over the years.

To address ongoing challenges, four strategies are recommended:

1. Expanding publicly available datasets
2. Adopting cloud-based computing
3. Incorporating additional feature sets
4. Using ensemble learning

Understanding past research helps maintain progress and enhances the development of more accurate and efficient disease detection systems. The proposed taxonomy can guide future work and improve implementation in clinical environments.

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