Chapter 5
Classification of Lung Images of COVID-19 Patients With the Application of Deep Learning Techniques

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ABSTRACT

This study introduces a smart approach that uses deep learning and feature extraction from chest CT scans to detect COVID-19 quickly and accurately. Strategically integrating transfer learning with pre-trained models to improve COVID-19 diagnosis is the major innovation. Two key phases comprise the research approach. Transfer learning is first used to deep learning models using CNNs like MobileNet, DenseNet, Xception, ResNet, InceptionV3, InceptionResNetV2, VGGNet, and NASNet. PCA is used to improve feature representation and classification accuracy in these models after extensive training, testing, and validation. Kapur's entropy thresholding, morphology-based segmentation, and k-means clustering, enriched by transfer learning paradigms, are used for feature extraction. High-quality features are extracted using these methods, improving CT picture interpretability and informativeness. The results reveal that this integrative strategy improves detection accuracy, sensitivity, specificity, and performance.

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INTRODUCTION

In December 2019, Wuhan, China, witnessed the emergence of SARS-CoV-2, a novel coronavirus responsible for inducing COVID-19 in humans. This infectious disease, marked by its potential fatality, prompted the World Health Organization (WHO) to declare a global pandemic by March 2020. Belonging to the group of coronaviruses, which primarily infect birds and mammals, SARS-CoV-2 stands out as a positive-sense, single-stranded RNA virus (Huang et al., 2020). Unlike its predecessors, such as SARS-CoV and MERS-CoV, known for causing severe respiratory illnesses, COVID-19 exhibits a lengthier symptom onset and a tendency to manifest mildly, allowing for transmission through asymptomatic carriers and contributing to the ongoing pandemic. Even though the World Health Organization (WHO) places a strong emphasis on widespread testing and contact tracing as a means of mitigating the epidemic, numerous nations are confronted with difficulties in the form of limited laboratory resources and delayed test results, which facilitate the spread of the virus among non-confirmed cases that have mild or no symptoms (World Health Organization. Coronavirus disease, COVID-19).

The recent surge in interest in medical imagery, propelled by the advent of deep learning algorithms, has revolutionized the computational analysis of pulmonary diseases (Zumla et al., 2016). The automated assessment of computed tomography (CT) scans, renowned for its ability to detect cancerous nodules, has proven valuable in diagnosing tuberculosis symptoms and other cardiothoracic abnormalities (Cheng et al., 2007). In response to the COVID-19 pandemic, researchers have explored CT and X-ray imaging as alternatives to the time-consuming RT-PCR testing. While these imaging studies have successfully identified lung, abnormalities associated with COVID-19, the extensive implementation of AI-based CT and X-ray imaging for large-scale screening encounters impediments such as equipment costs, mobility constraints, accessibility issues, and sterilization processes (Chan et al., 2015). Deep learning (DL) networks have eclipsed traditional machine learning (ML) methods in popularity, automating the processes of feature extraction, feature selection, and classification (Munster et al., 2020).

Gozes et al. (2020) have harnessed DL algorithms to automate the evaluation of CT scan images for COVID-19 detection. Despite promising results, two primary limitations hinder progress. The first obstacle that stands in the way of the creation of more powerful artificial intelligence algorithms is the lack of lung image CT-scan datasets that are available to the public due to privacy concerns. Secondly, the lack of portability in trained models limits their applicability across different healthcare institutions (Meraj et al., 2019). Transfer learning emerges as a solution to these challenges, utilizing pre-trained models with preset weights and biases on specialized datasets (Sahlol et al., 2020). This approach significantly reduces training time for deep neural network models and simplifies the initialization of weights and biases. Noteworthy studies (Raghu et al., 2019) have explored the application of transfer learning in medical image processing, showcasing its benefits, including improved scaling and convergence speedups. Transfer learning has proven effective in identifying pneumonia from chest X-ray datasets and detecting lung cancer from CT scan images (Albahli et al., 2021).

Background and Significance

In order to differentiate between COVID-19 and normal pictures, Akram et al. (2021) performed preprocessing on CT data. They did this by employing key feature extraction and selection methods. After conducting research on a number of different classifiers, they came to the conclusion that a Naive Bayes classifier obtained an accuracy of 92.6 percent. X-ray images that were combined with Generative Ad-