Chapter 4
Thorough Analysis of Deep Learning Methods for Diagnosis of COVID-19 CT Images

Gnaneswari Gnanaguru
CMR Institute of Technology, India

S.Silvia Priscila
Bharath Institute of Higher Education and Research, India

M. Sakthivanitha
Vels Institute of Science, Technology, and Advanced Studies, India

Sangeetha Radhakrishnan
Vels Institute of Science, Technology, and Advanced Studies, India

S. Suman Rajest
https://orcid.org/0000-0001-8315-3747
Dhaanish Ahmed College of Engineering, India

Sonia Singh
Toss Global Management, UAE

ABSTRACT

Since March 2020, WHO has classified COVID-19 a pandemic. This respiratory-system-focused viral infection causes atypical pneumonia. Experts stress the necessity of early COVID-19 detection. Isolating affected people is essential to stopping the virus. Early identification and efficient tracking are crucial for treatment and transmission reduction due to urgency. CT scans are fast and accurate COVID-19 screening tools. Using these scans to classify COVID-19 requires a radiologist, which can prolong the process. This chapter examines common deep learning (DL) techniques for COVID-19 detection. Their use in image processing is explored to improve diagnostics. Deep learning, a subset of machine learning (ML), can automate screening with medical practitioners to improve diagnostic accuracy and efficiency. The review discusses DL methods' pros and cons and their importance in radiologists' and doctors' collaboration.

DOI: 10.4018/979-8-3693-5946-4.ch004

INTRODUCTION

The prevalence of COVID-19 pneumonia is notably high, representing a respiratory infectious disease (Munster et al., 2020; Wu et al., 2020; Wang et al., 2020). The World Health Organization (WHO) officially identified a new coronavirus, Coronavirus Disease 2019 (COVID-19), as the causative agent of this outbreak on January 8, 2020. Acknowledging the severity of the situation, the WHO declared the epidemic of new coronavirus-infected pneumonia a "global emergency health event of international significance" on January 30. The virus has spread to numerous countries, and the tally of confirmed infections continues to rise (Chen et al., 2020). By March 2020, the global impact of COVID-19, caused by the SARS Coronavirus-2 (SARS-CoV-2), had escalated to pandemic levels (Bala Kuta & Bin Sulaiman, 2023). According to a WHO bulletin from January 2021, the worldwide count of positive cases surpassed 91 million, resulting in 1.9 million fatalities. With a daily surge of 300,000 confirmed positive cases, the role of artificial intelligence in clinical COVID-19 diagnosis has gained prominence (Zhang et al., 2020). While reverse transcription-polymerase chain reaction (RT-PCR) and gene sequencing remain the gold standard for diagnosing COVID-19, these tests, conducted on sputum, pharyngeal swabs, and lower respiratory secretions, are time-consuming (Angeline et al., 2023). Despite a widespread reliance on nucleic acid testing for discharge criteria after medication, the persistent increase in daily COVID-19 infections suggests an evolving epidemiological situation (Aditya Komperla, 2023; Tak & Sundararajan, 2023).

Nucleic acid testing encounters challenges such as prolonged wait times, false negatives, and shortages of test reagents. In the context of COVID-19 diagnosis, chest imaging modalities like chest X-rays and computed tomography (CT) play crucial roles in detecting abnormal lung changes (Ocoró et al., 2023). Chest CT scans, in particular, are valuable diagnostic tools, often revealing ground-glass opacities, multifocal patchy consolidation, and/or interstitial changes with a peripheral distribution in COVID-19 patients (Li Geng et al., 2020; Zhu et al., 2020). The immediate differentiation of patient types based on chest CT images can offer valuable insights before definitive results are available, enhancing diagnosis and characterizing disease effects (Kuragayala, 2023). CT imaging results become pivotal for pneumonia diagnosis, especially in cases where RT-PCR results are inconclusive (Fang et al., 2020).

Despite the efficacy of CT scans, they may overlook small and lightly infected areas, particularly in the early stages of infection (Rajest et al., 2023a). A timely and accurate diagnosis necessitates well-trained radiologists, who are critical for administering treatment and screening, and responding to the broader population (Rajest et al., 2023b). A study by Chen et al. (2020) involving 29 COVID-19-positive patients revealed bilateral and multiple lesions with patchy shadows and ground-glass opacities on chest images (Regin et al., 2023a). In the initial stages of the disease, COVID-19 CT images commonly exhibit ground-glass opacities, pulmonary consolidations, and nodules, as noted by Pan and Guan (2020). Despite this challenge, the arduous and time-intensive training required for radiologists has led to a shortage of qualified professionals, amplifying the difficulty of achieving accurate diagnoses amidst the notable increase in cases in recent years (Kanne, 2020). There is an urgent need to develop a more automated and efficient method for COVID-19 diagnosis based on CT scans to enhance both reliability and speed. Several researchers have pointed out that Artificial Intelligence (AI), which has demonstrated considerable success in diagnosing various diseases (Lee et al., 2020; Komura & Ishikawa, 2018), should similarly prove effective in pneumonia detection (Mei et al., 2020; Menni et al., 2020). Numerous studies affirm the potential of deep learning in the analysis of chest CT images (Ardila et al., 2019), particularly in lung cancer image analysis (Ding et al., 2017; Zhu et al., 2018). Consequently, various models integrating