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Review Article

Empowering Healthcare with Machine Learning: A Comprehensive Review of Machine Learning-based COVID-19 Detection, Diagnosis and Treatment

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A B S T R A C T

The COVID-19 pandemic has raised significant concerns due to its unique nature and potential for severe illness and death. This article discusses machine learning, a technique that extracts patterns from complex data and offers potential solutions to the pandemic's issues. Machine learning systems can identify COVID-19 from various sources, forecast case severity, and identify individuals at high risk of complications. Diagnostic methods based on machine learning can reliably categorise COVID-19 cases and rule out other illnesses. Personalised treatment regimens are being developed using machine learning, which can improve patient outcomes and reduce side effects. However, challenges such as large datasets, complexity of models, and regulatory clearance for machine learning-based applications must be overcome. Despite these challenges, machine learning has the potential to revolutionise COVID-19 identification, diagnosis, and treatment. Thus, as the technology behind machine learning continues to progress, we can anticipate the appearance of even more cutting-edge applications that will assist us in containing this epidemic and saving lives.

Keywords: Machine Learning, COVID-19 Detection, Diagnosis, Treatment, Healthcare Empowerment

Introduction

The COVID-19 pandemic has generated extensive apprehension and distress on account of its unparalleled characteristics and the risk of life-threatening complications.[1-3] Machine learning (ML), an exceptionally potent instrument capable of deriving patterns from intricate datasets, presents encouraging prospects for tackling the obstacles presented by the pandemic.[4-6] The detection, diagnosis, and prediction of COVID-19 have been successfully executed using ML-based approaches, providing healthcare professionals with insightful data that facilitates well-informed decision-making.[7-10] Through the provision of support to healthcare professionals and the alleviation of the psychological effects of the pandemic, ML has emerged as a promising solution amidst this worldwide emergency.[11,12]

ML-based COVID-19 Detection

Early discovery of COVID-19 is critical for controlling and reducing the virus's effect. ML systems have shown exceptional accuracy in identifying COVID-19 from a variety of data sources, including chest X-rays, CT scans, and biological signals. Chest X-rays may be analysed by ML models to detect minor anomalies suggestive of COVID-19 pneumonia, CT scans can detect COVID-19-specific lung lesions with high sensitivity and specificity, and biological signals can indicate possible infections. Machine learning models trained on clinical text data, deep learning models for chest X-ray image processing, symptom prediction models, and AI-assisted diagnosis utilising CT scans are examples of ML-based techniques for COVID-19 identification and diagnosis. With the ever-increasing access to new data, these methodologies are always developing, and new methods are being developed accordingly. Finally, early diagnosis of COVID-19 is critical for limiting the virus and minimising its effects. ML algorithms can analyse clinical reports, categorise chest X-ray pictures, forecast the chance of infection based on symptoms, and discover COVID-19 cases automatically from chest CT scans.[2–12]

ML-based COVID-19 Diagnosis and Treatment

ML has shown potential in COVID-19 diagnosis and therapy. Medical imaging, test reports, and clinical data may be analysed to increase its accuracy. ML models accurately predict COVID-19 diagnosis, severity, and prognosis. Analysing trends and finding signs of minor illness may help in the early discovery of such cases. ML algorithms can help triage patients and allocate healthcare resources. Analysing patient data and finding the best treatments may help optimise therapy. ML algorithms can help in the prediction of COVID-19 prognoses, allowing healthcare practitioners to manage patients and allocate resources. ML-based systems can analyse wearable devices and remote monitoring data for COVID-19 telemedicine and monitoring. ML models accurately predict COVID-19 diagnosis, severity, and prognosis, aiding early detection, triage, and resource allocation and improving healthcare system efficiency. Though ML has shown potential in COVID-19 diagnosis and therapy, further study is needed to improve the robustness and reliability of COVID-19 diagnostic and treatment ML systems.[13–17]

Challenges and Future Directions

Despite advances in ML-based COVID-19 applications, difficulties are still experienced. These include data shortages, skewed datasets, and difficulties pertaining to new varieties. ML algorithms trained on certain viral variations may fail to identify novel variant infections. Since deep learning models are black boxes, their decision-making process is hard to comprehend. Chest X-ray pictures and clinical text data depend on high-quality input data, which might lead to erroneous forecasts and diagnoses. ML techniques may perpetuate biases in training data, resulting in COVID-19 detection and diagnostic inequalities among groups. Ethics are also important. Fair healthcare results require addressing these prejudices. To overcome these constraints, ML research and advances are underway. ML models must be trained on varied and representative datasets to avoid bias and provide accurate healthcare results. Widespread clinical application of ML models requires improving explainability and transparency. Clinical validation and regulatory clearance are also needed to ensure the safety and effectiveness of ML-based COVID-19 applications before their clinical deployment.

Conclusion

The COVID-19 pandemic has caused widespread illness, death, and economic misery worldwide. Machine learning algorithms have improved accuracy, decision-making, and therapy personalisation in all COVID-19 management domains. These algorithms have been utilised to construct tools for accurate COVID-19 diagnosis using chest X-rays, CT scans, and biological signals to screen patients, identify cases early, and follow progression. Analysing clinical symptoms, laboratory tests, and imaging studies using machine learning improves COVID-19 diagnosis and rules out other conditions.[18] This may avoid misdiagnosis and ensure adequate therapy. In addition to detection and diagnosis, machine learning is used to provide personalised treatment recommendations based on patient data including genetics, medical history, and therapeutic response. This personalised approach may improve patient outcomes and reduce risks.

However, challenges still remain. To train machine learning algorithms, large datasets of patient data from diverse ages, races, and ethnicities are needed. Machine learning models can be challenging to explain, leading to a lack of confidence among healthcare practitioners and limiting their use in clinical practice. For safety, efficacy, and dependability, regulatory clearance is necessary for machine learning-based applications. Despite these challenges, machine learning might revolutionise COVID-19 detection, diagnosis, and therapy.

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