Review of Artificial Intelligence Techniques for Covid-19 Diagnosis

[1]Md. Ali Umar, [2]Dr Komal Prasad Kanojia, [3]Dr. Bharti Chourasia
[1]Research Scholar, [2]Assistant Professor, [3]Associate Professor & HOD
Department of Electronics and Communication Engineering,
RKDF Institute of Science & Technology, SRK University, Bhopal, India

Abstract : For diagnosis of corona virus disease 2019 (COVID-19), a SARS-CoV-2 virus-specific reverse transcriptase polymerase chain reaction (RT–PCR) test is routinely used. The COVID-19 pandemic has rapidly propagated due to widespread person-to-person transmission. Laboratory confirmation of SARS-CoV-2 is performed with a virus-specific RT–PCR, but the test can take up to 2 days to complete. This study shows various techniques of artificial intelligence (AI) algorithms to findings with clinical symptoms, exposure history and laboratory testing to rapidly diagnose patients who are positive for COVID-19**.**

IndexTerms **- Covid-19, Artificial intelligence (AI), Deep learning, Machine Learning.**

I. INTRODUCTION

The COVID-19 pandemic has resulted in over 3 billion cases worldwide. Early recognition of the disease is crucial not only for individual patient care related to rapid implementation of treatment, but also from a larger public health perspective to ensure adequate patient isolation and disease containment. Chest CT is more sensitive and specific than chest radiography in evaluation of SARS-CoV-2 pneumonia and there have been cases where CT findings were present before onset of clinical symptomatology4. In the current climate of stress on healthcare resources due to the COVID-19 outbreak, including a shortage of RT–PCR test kits, there is an unmet need for rapid, accurate and unsupervised diagnostic tests for SARS-CoV-2.

Chest CT is a valuable tool for the early diagnosis and triage of patients suspected of SARS-CoV-2 infection. In an effort to control the spread of infection, physicians, epidemiologists, virologists, phylogeneticists and others are working with public health officials and policymakers to better understand the disease pathogenesis. Early investigations have observed common imaging patterns on chest CT8,9. For example, an initial prospective analysis in Wuhan revealed bilateral lung opacities on 40 of 41 (98%) chest CTs in infected patients and described lobular and sub segmental areas of consolidation as the most typical imaging findings4. Our initial study with chest CTs in 21 real-time RT–PCR assay-confirmed patients also found high rates of ground-glass opacities and consolidation, sometimes with a rounded morphology and peripheral lung distribution7. A recent study has also shown that CT may demonstrate lung abnormalities in the setting of a negative RT–PCR test10.

During an outbreak of a highly infectious disease with person-to-person transmission, hospitals and physicians may have increased workloads and limited capabilities to triage and hospitalize suspected patients. Previous work demonstrated that early-stage coronavirus patients may have negative findings on CT7, limiting radiologists' ability to reliably exclude disease. While waiting 6–48 h for the confirmation of the SARS-CoV-2 coronavirus by RT–PCR, patients who are infected may spread the virus to other patients or caregivers if resources are not available to isolate patients who are only suspected to be infected; nosocomial infection was inferred in approximately 40% of cases in a recent large series11. Rapid detection of patients with COVID-19 is imperative because an initial false negative could both delay treatment and increase risk of viral transmission to others. In addition, radiologists with expertise in thoracic imaging may not be available at every institution, increasing the need for AI-aided detection.

II. BACKGROUND

M. Jamshidi et al.,[1] This work renders a response to combat the virus through Artificial Intelligence (AI). Some Deep Learning (DL) methods have been illustrated to reach this goal, including Generative Adversarial Networks (GANs), Extreme Learning Machine (ELM), and Long/Short Term Memory (LSTM). It delineates an integrated bioinformatics approach in which different aspects of information from a continuum of structured and unstructured data sources are put together to form the user-friendly platforms for physicians and researchers. The main advantage of these AI-based platforms is to accelerate the process of diagnosis and treatment of the COVID-19 disease. The most recent related publications and medical reports were investigated with the purpose of choosing inputs and targets of the network that could facilitate reaching a reliable Artificial Neural Network-based tool for challenges associated with COVID-19. Furthermore, there are some specific inputs for each platform, including various forms of the data, such as clinical data and medical imaging which can improve the performance of the introduced approaches toward the best responses in practical applications.

R. G. Babukarthik et al.,[2] This study aims to provide a solution for identifying pneumonia due to COVID-19 and healthy lungs (normal person) using CXR images. One of the remarkable methods used for extracting a high dimensional feature from medical images is the Deep learning method. In this research, the state-of-the-art techniques used is Genetic Deep Learning Convolutional Neural Network (GDCNN). It is trained from the scratch for extracting features for classifying them between COVID-19 and normal images. A dataset consisting of more than 5000 CXR image samples is used for classifying pneumonia, normal and other pneumonia diseases. Training a GDCNN from scratch proves that, the proposed method performs better compared to other transfer learning techniques. Classification accuracy of 98.84%, the precision of 93%, the sensitivity of 100%, and specificity of 97.0% in COVID-19 prediction is achieved. Top classification accuracy obtained in this research reveals the best nominal rate in the identification of COVID-19 disease prediction in an unbalanced environment. The novel model proposed for classification proves to be better than the existing models such as ReseNet18, ReseNet50, Squeezenet, DenseNet-121, and Visual Geometry Group (VGG16).

S. Sakib et al.,[3] presents a viable and efficient deep learning-based chest radiograph classification (DL-CRC) framework to distinguish the COVID-19 cases with high accuracy from other abnormal (e.g., pneumonia) and normal cases. A unique dataset is prepared from four publicly available sources containing the posteroanterior (PA) chest view of X-ray data for COVID-19, pneumonia, and normal cases. Our proposed DL-CRC framework leverages a data augmentation of radiograph images (DARI) algorithm for the COVID-19 data by adaptively employing the generative adversarial network (GAN) and generic data augmentation methods to generate synthetic COVID-19 infected chest X-ray images to train a robust model. The training data consisting of actual and synthetic chest X-ray images are fed into our customized convolutional neural network (CNN) model in DL-CRC, which achieves COVID-19 detection accuracy of 93.94% compared to 54.55% for the scenario without data augmentation (i.e., when only a few actual COVID-19 chest X-ray image samples are available in the original dataset). Furthermore, we justify our customized CNN model by extensively comparing it with widely adopted CNN architectures in the literature, namely ResNet, Inception-ResNet v2, and DenseNet that represent depth-based, multi-path-based, and hybrid CNN paradigms. The encouragingly high classification accuracy of our proposal implies that it can efficiently automate COVID-19 detection from radiograph images to provide a fast and reliable evidence of COVID-19 infection in the lung that can complement existing COVID-19 diagnostics modalities.

M. Abdel-Basset et al.,[4] presents a heterogeneous graph attention (HGAT) model to learn topological information of compound molecules and bidirectional ConvLSTM layers for modeling spatio-sequential information in simplified molecular-input line-entry system (SMILES) sequences of drug data. For protein sequences, we propose a squeezed-excited dense convolutional network for learning hidden representations within amino acid sequences; while utilizing advanced embedding techniques for encoding both kinds of input sequences. The performance of DeepH-DTA is evaluated through extensive experiments against cutting-edge approaches utilising two public datasets (Davis, and KIBA) which comprise eclectic samples of the kinase protein family and the pertinent inhibitors. DeepH-DTA attains the highest Concordance Index (CI) of 0.924 and 0.927 and also achieved a mean square error (MSE) of 0.195 and 0.111 on the Davis and KIBA datasets respectively. Moreover, a study using FDA-approved drugs from the Drug Bank database is performed using DeepH-DTA to predict the affinity scores of drugs against SARS-CoV-2 amino acid sequences and the results show that that the model can predict some of the SARS-Cov-2 inhibitors that have been recently approved in many clinical studies.

M. K. Elhadad et al.,[5] This article addresses the problem of detecting misleading information related to COVID-19. We propose a misleading-information detection model that relies on the World Health Organization, UNICEF, and the United Nations as sources of information, as well as epidemiological material collected from a range of fact-checking websites. Obtaining data from reliable sources should assure their validity. We use this collected ground-truth data to build a detection system that uses machine learning to identify misleading information. Ten machine learning algorithms, with seven feature extraction techniques, are used to construct a voting ensemble machine learning classifier. We perform 5-fold cross-validation to check the validity of the collected data and report the evaluation of twelve performance metrics. The evaluation results indicate the quality and validity of the collected ground-truth data and their effectiveness in constructing models to detect misleading information.

E. Karaçuha et al.,[[6] This study focuses on modeling, prediction, and analysis of confirmed, recovered, and death cases of COVID-19 by using Fractional Calculus in comparison with other models for eight countries including China, France, Italy, Spain, Turkey, the UK, and the US. First, the dataset is modeled using our previously proposed approach Deep Assessment Methodology, next, one step prediction of the future is made using two methods: Deep Assessment Methodology and Long Short-Term Memory. Later, a Gaussian prediction model is proposed to predict the short-term (30 Days) future of the pandemic, and prediction performance is evaluated. The proposed Gaussian model is compared to a time-dependent susceptible-infected-recovered (SIR) model. Lastly, an analysis of understanding the effect of history is made on memory vectors using wavelet-based denoising and correlation coefficients. Results prove that Deep Assessment Methodology successfully models the dataset with 0.6671%, 0.6957%, and 0.5756% average errors for confirmed, recovered, and death cases, respectively.

A. Ramchandani et al.,[7] presents a deep learning model to forecast the range of increase in COVID-19 infected cases in future days and we present a novel method to compute equi dimensional representations of multivariate time series and multivariate spatial time series data. Using this novel method, the proposed model can both take in a large number of heterogeneous features, such as census data, intra-county mobility, inter-county mobility, social distancing data, past growth of infection, among others, and learn complex interactions between these features. Using data collected from various sources, we estimate the range of increase in infected cases seven days into the future for all U.S. counties. In addition, we use the model to identify the most influential features for prediction of the growth of infection. We also analyze pairs of features and estimate the amount of observed second-order interaction between them..

A. Mohammed al.,[8] Deep Learning-based chest Computed Tomography (CT) analysis has been proven to be effective and efficient for COVID-19 diagnosis. Existing deep learning approaches heavily rely on large labeled data sets, which are difficult to acquire in this pandemic situation. Therefore, weakly-supervised approaches are in demand. In this work, we propose an end-to-end weakly-supervised COVID-19 detection approach, ResNext+, that only requires volume level data labels and can provide slice level prediction. The proposed approach incorporates a lung segmentation mask as well as spatial and channel attention to extract spatial features. Besides, Long Short Term Memory (LSTM) is utilized to acquire the axial dependency of the slices. Moreover, a slice attention module is applied before the final fully connected layer to generate the slice level prediction without additional supervision. An ablation study is conducted to show the efficiency of the attention blocks and the segmentation mask block. Experimental results, obtained from publicly available datasets, show a precision of 81.9% and F1 score of 81.4%.

M. J. Horry et al.,[9] Detecting COVID-19 early may help in devising an appropriate treatment plan and disease containment decisions. In this study, we demonstrate how transfer learning from deep learning models can be used to perform COVID-19 detection using images from three most commonly used medical imaging modes X-Ray, Ultrasound, and CT scan. The aim is to provide over-stressed medical professionals a second pair of eyes through intelligent deep learning image classification models. We identify a suitable Convolutional Neural Network (CNN) model through initial comparative study of several popular CNN models. We then optimize the selected VGG19 model for the image modalities to show how the models can be used for the highly scarce and challenging COVID-19 datasets. We highlight the challenges (including dataset size and quality) in utilizing current publicly available COVID-19 datasets for developing useful deep learning models and how it adversely impacts the trainability of complex models. We also propose an image pre-processing stage to create a trustworthy image dataset for developing and testing the deep learning models. The new approach is aimed to reduce unwanted noise from the images so that deep learning models can focus on detecting diseases with specific features from them.

Y. Karadayi et al.,[10] presents framework works with unlabeled data and no prior knowledge about anomalies are assumed. As a case study, we use the public COVID-19 data provided by the Italian Department of Civil Protection. Northern Italy regions' COVID-19 data are used to train the framework; and then any abnormal trends or upswings in COVID-19 data of central and southern Italian regions are detected. The proposed framework detects early signals of the COVID-19 outbreak in test regions based on the reconstruction error. For performance comparison, we perform a detailed evaluation of 15 algorithms on the COVID-19 Italy dataset including the state-of-the-art deep learning architectures. Experimental results show that our framework shows significant improvement on unsupervised anomaly detection performance even in data scarce and high contamination ratio scenarios (where the ratio of anomalies in the data set is more than 5%). It achieves the earliest detection of COVID-19 outbreak and shows better performance on tracking the peaks of the COVID-19 pandemic in test regions. As the timeliness of detection is quite important in the fight against any outbreak, our framework provides useful insight to suppress the resurgence of local novel coronavirus outbreaks as early as possible.

A. Ulhaq et al.,[11] The COVID-19 pandemic has triggered an urgent call to contribute to the fight against an immense threat to the human population. Computer Vision, as a subfield of artificial intelligence, has enjoyed recent success in solving various complex problems in health care and has the potential to contribute to the fight of controlling COVID-19. In response to this call, computer vision researchers are putting their knowledge base at test to devise effective ways to counter COVID-19 challenge and serve the global community. New contributions are being shared with every passing day. It motivated us to review the recent work, collect information about available research resources, and an indication of future research directions. We want to make it possible for computer vision researchers to find existing and future research directions. This survey article presents a preliminary review of the literature on research community efforts against COVID-19 pandemic.

Q. Pham et al.,[12] The very first infected novel coronavirus case (COVID-19) was found in Hubei, China in Dec. 2019. The COVID-19 pandemic has spread over 214 countries and areas in the world, and has significantly affected every aspect of our daily lives. At the time of writing this article, the numbers of infected cases and deaths still increase significantly and have no sign of a well-controlled situation, e.g., as of 13 July 2020, from a total number of around 13.1 million positive cases, 571,527 deaths were reported in the world. Motivated by recent advances and applications of artificial intelligence (AI) and big data in various areas, this work aims at emphasizing their importance in responding to the COVID-19 outbreak and preventing the severe effects of the COVID-19 pandemic. We firstly present an overview of AI and big data, and then identify the applications aimed at fighting against COVID-19, next highlight challenges and issues associated with state-of-the-art solutions, and finally come up with recommendations for the communications to effectively control the COVID-19 situation.

III. ARTIFICIAL INTELLIGENCE TECHNIQUES

AI may provide a method to augment early detection of SARS-CoV-2 infection. Our goal was to design an AI model that can identify SARS-CoV-2 infection based on initial chest CT scans and associated clinical information that could rapidly identify COVID-19 (+) patients in the early stage. We collected chest CT scans and corresponding clinical information obtained at patient presentation. Clinical information included travel and exposure history, leukocyte counts (including absolute neutrophil number, percentage neutrophils, and absolute lymphocyte number and percentage lymphocytes), symptomatology (presence of fever, cough and sputum), patient age.

Three AI models are used to generate the probability of a patient being COVID-19 (+): the first is based on a chest CT scan, the second on clinical information and the third on a combination of the chest CT scan and clinical information. For evaluation of chest CT scans, each slice was first ranked by the probability of containing a parenchymal abnormality, as predicted by the CNN model (slice selection CNN), which is a pretrained pulmonary tuberculosis (PTB) model that has a 99.4% accuracy to select abnormal lung slices from chest CT scans. The top ten abnormal CT images per patient were put into the second CNN (diagnosis CNN) to predict the likelihood of COVID-19 positivity (P1). Demographic and clinical data (the patient's age and sex, exposure history, symptoms and laboratory tests) were put into a machine-learning model to classify COVID-19 positivity (P2). Features generated by the diagnosis CNN model and the nonimaging clinical information machine-learning model were integrated by an MLP network to generate the final output of the joint model (P3).

IV. CONCLUSION

There are many limitation of AI based study i.e.is the small sample size. Despite the promising results of using the AI model to screen patients with COVID-19, further data collection is required to test the generalizability of the AI model to other patient populations. Collaborative effort in data collection may facilitate improving the AI model. Difficulties on model training also arise due to the limited sample size. This paper review about AI based technique to diagnosis the cobid-19 decease, The CNN approach of deep learning is lighting more than others to accurate detection. The research in ML based approach is also growing rapidly.

REFERENCES

1. M. Jamshidi et al., "Artificial Intelligence and COVID-19: Deep Learning Approaches for Diagnosis and Treatment," in IEEE Access, vol. 8, pp. 109581-109595, 2020, doi: 10.1109/ACCESS.2020.3001973.
2. R. G. Babukarthik, V. A. K. Adiga, G. Sambasivam, D. Chandramohan and J. Amudhavel, "Prediction of COVID-19 Using Genetic Deep Learning Convolutional Neural Network (GDCNN)," in IEEE Access, vol. 8, pp. 177647-177666, 2020, doi: 10.1109/ACCESS.2020.3025164.
3. S. Sakib, T. Tazrin, M. M. Fouda, Z. M. Fadlullah and M. Guizani, "DL-CRC: Deep Learning-Based Chest Radiograph Classification for COVID-19 Detection: A Novel Approach," in IEEE Access, vol. 8, pp. 171575-171589, 2020, doi: 10.1109/ACCESS.2020.3025010.
4. M. Abdel-Basset, H. Hawash, M. Elhoseny, R. K. Chakrabortty and M. Ryan, "DeepH-DTA: Deep Learning for Predicting Drug-Target Interactions: A Case Study of COVID-19 Drug Repurposing," in IEEE Access, vol. 8, pp. 170433-170451, 2020, doi: 10.1109/ACCESS.2020.3024238.
5. M. K. Elhadad, K. F. Li and F. Gebali, "Detecting Misleading Information on COVID-19," in IEEE Access, vol. 8, pp. 165201-165215, 2020, doi: 10.1109/ACCESS.2020.3022867.
6. E. Karaçuha et al., "Modeling and Prediction of the Covid-19 Cases With Deep Assessment Methodology and Fractional Calculus," in IEEE Access, vol. 8, pp. 164012-164034, 2020, doi: 10.1109/ACCESS.2020.3021952.
7. A. Ramchandani, C. Fan and A. Mostafavi, "DeepCOVIDNet: An Interpretable Deep Learning Model for Predictive Surveillance of COVID-19 Using Heterogeneous Features and Their Interactions," in IEEE Access, vol. 8, pp. 159915-159930, 2020, doi: 10.1109/ACCESS.2020.3019989.
8. A. Mohammed et al., "Weakly-Supervised Network for Detection of COVID-19 in Chest CT Scans," in IEEE Access, vol. 8, pp. 155987-156000, 2020, doi: 10.1109/ACCESS.2020.3018498.
9. M. J. Horry et al., "COVID-19 Detection Through Transfer Learning Using Multimodal Imaging Data," in IEEE Access, vol. 8, pp. 149808-149824, 2020, doi: 10.1109/ACCESS.2020.3016780.
10. Y. Karadayi, M. N. Aydin and A. S. Öğrencí, "Unsupervised Anomaly Detection in Multivariate Spatio-Temporal Data Using Deep Learning: Early Detection of COVID-19 Outbreak in Italy," in IEEE Access, vol. 8, pp. 164155-164177, 2020, doi: 10.1109/ACCESS.2020.3022366.
11. A. Ulhaq, J. Born, A. Khan, D. P. S. Gomes, S. Chakraborty and M. Paul, "COVID-19 Control by Computer Vision Approaches: A Survey," in IEEE Access, vol. 8, pp. 179437-179456, 2020, doi: 10.1109/ACCESS.2020.3027685.
12. Q. Pham, D. C. Nguyen, T. Huynh-The, W. Hwang and P. N. Pathirana, "Artificial Intelligence (AI) and Big Data for Coronavirus (COVID-19) Pandemic: A Survey on the State-of-the-Arts," in IEEE Access, vol. 8, pp. 130820-130839, 2020, doi: 10.1109/ACCESS.2020.3009328.