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Reviewing the Role of Machine Learning and Deep Learning-Based Methods in Early Stage Detection of COVID-19 Disease

Gurjot Kaur , Dr Harmeet Singh

[1]*Research Scholar CT University Ludhiana*

[2]*Deputy director IPR Cell Ct University Ludhiana*

ABSTRACT

The rapid transmission of COVID-19 has underscored the importance of early detection in preventing further spread of the infection. Lung images, precisely chest X-ray and CT scans offer an important part in detecting coronavirus infections. DL techniques have confirmed to be highly effective and efficient in various computer vision and medical imaging uses. As the COVID-19 pandemic persists, investigators are increasingly employing deep learning methods to identify coronavirus infections in lung images. This article examines the recently available machine and deep learning techniques used for detecting coronavirus infections in lung and chest images. It analyses the current usage of ML and DL methods such as DT, RF, SVM, CNN, and others to support efforts in addressing the Covid-19 crisis. By utilizing ML and DL characteristics, the article explores the analysis of databases for the purpose of rapid detection of the Covid-19 disease. The analysis reveals that ML and DL methods have a major impact on early-stage detection of Covid-19 with high accuracy rates. However, it should be noted that many of the existing techniques are still in development and have not been thoroughly evaluated in clinical settings.

Keywords- *Covid-19 Disease Detection, Machine Learning, Deep Learning, Chest X-Ray Images, Lung Images.*

INTRODUCTION

The Covid-19 epidemic has precious human lives over several issues initiating losses globally. In Wuhan, China had described the major circumstance. Several cases saved cumulative and have, at present, spread to most nations, affecting public lives and dropping the population worldwide. This epidemic has controlled to huge commercial and collective destruction. Numerous general public is at risk of decreasing into dangerous deficiency. A large number of originalities have been opposite reality threats. Virtually partial of the domain's 3.3 billion workforces are at hazard. There are approximately 219 nations and areas that have verified COVID-19 circumstances. The requirement is to grow the correct and operative injection in contradiction of the COVID-19 virus [1]. Coronaviruses are caused of germs or infections that are recognized to reason illnesses fluctuating from the public cold to more chances of sicknesses, for instance, Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The coronaviruses spread these two main infections termed MERS-CoV and SARS-CoV. In 2002, SARS was major perceived in China, and in 2012, MERS was leading

realized in Saudi Arabia. The SARS-COV-2 type of covid virus interduced in Wuhan, China and it foundations coronavirus [2].

In 2020, the more patients validated to the illness cases 39,500,000 Over One hundred eighty countries in October 2020. The number of societies diseased is possibly significantly higher. Further, 1,110,000 individuals have passed away from this disease. This disease remains to challenge health systems globally in several characteristics, with severe rises in demands for clinic beds and dangerous deficiencies in health tools, whereas several health-care employees have been diseased. So, the dimensions for fast experimental resolutions and operational practice of healthcare assets are fundamental. The utmost confirmed analysis to test for COVID-19, with RT-PCR, has an extensive deficiency in emerging countries. It pays to augment infection degrees and delays serious protective events. COVID-19 can alleviate the problem in healthcare structures. Prediction replicas used for to estimated the the hazard of illnessin the form of some features composition have been established, hoping to support universal health supervision in tri-ageing patients, particularly in the context of limited healthcare properties. These prototypes practice structures such as CT scans, experimental signs, research test centre, and these structures combined. But, earlier representations were constructed on data from hospitalized diseased persons and are ineffective in selection for SARS-CoV-2 in wide-ranging people. The Israeli Ministry of Health publicly general statistics of all entities verified for SARS-CoV-2 using RT-PCR analysis of a nasopharyngeal swab. Due to the COVID-19 epidemic in Israel, all investigative research test centre tests for these diseases were completed per benchmarks the Israeli Health Ministry predicted. But matter to modify, the criteria or benchmarks applied in the training time involved the occurrence and severity of experimental indicators, potential exposure to persons with COVID-19, and assured geographic zones. The threat of difficulties if diseased [3]. But for minor alternative, verified understudies in the middle of healthcare staff, all the entities confirmed had warnings for challenging. So, there is no deceptive recommendation preference concerning the huge common matters in the dataset recycled for specific tasks or implementation. Several methods of DL, ML and other skills are key components in contradicting the innovative COVID-19 syndrome. These methods have paid to a fast and strong investigation that has delivered the capability to realize the virus and its spread over several uses. The administration's struggles in distorting the epidemic, like lockdowns, deadlines, curfews and strategies, assist individuals in surviving COVID-19. Several types of research are obtained for COVID-19 infection detection and prevention etc. **Ali Narin et al. [5]** developed model to implement twofold classifications using five-fold CV (cross-validation), reaching 98% accuracy and 96% recall. The pre-trained Res_Net_50 system provided excellent productivity. Further, **Linda Wang et al. [5]** recommended that CXR pictures robotically launch an innovative COVID-Net deep model to sense COVID-19 occurrences. They were expanding a 13,975 CXR pictures-based dataset. This prototype has a peak classification performance achieved as 93.3% accuracy. This methodology's critical power was that the intangible arrangement might generate stability between several aims, such as correctness and computational expenditures over structural strategy ranges. **Ezz- El-Din Hemdan et al. [6]** familiarized COVID X-Net, a DL structure for identifying COVID-19 impurities in CXR pictures. An insignificant dataset of fifty pictures

wasrecycled to relate seven DL methods and achieved better results as 91% accuracy using Dense-Net-201, having the best performance.

This paper arranged as: sec. 2 defines the literature survey of several existing investigations regarding Covid-19. Sec. 3 represents several risks, causes and symptoms of Covid-19. Sec 4 describes the various ML and DL methods utilized for COVID-19 prediction, and Sec 5 displays the conclusion and further enhancement of COVID-19 disease prediction.

RELATED WORK

This section describes several methods frequently utilized to tackle predicting difficulties: ML, DL, soft computing models etc, which can be used to determine massive COVID patients. **Ruifang Ma et al., (2021) [7]** described COVID-19 spreading fast to nations all around the domain from the end of 2019, which greatly impacted global health and enormously influenced several countries. As there was still no effective management, it was considered important to construct effective estimates for functional divisions to various reactions and measures in development. In the restricted statistics, the forecast error of LSTM perfect growth according to time. Also, it disposed to large bias for middle and long-term prediction. The authors proposed an LSTM-Markov model to reduce these issues. This projected model utilized the Markov model to eliminate the LSTM's prediction ratio. Constructed on confirmed statistics situations in different countries. The preparation faults of this model created the prospect sent back to the Markov model using the errors. The outcomes of the standard LSTM model eliminated 75% error, and RMSE reduced by 60% errors. **Mahdi Mahdavi et al., (2021) [8]** described early prediction of personal mortality hazards in a sickness reduction mortality through comforting well-organized resource distribution and cure development. This training intended to progress and related prediction ML models constructed on an intrusive research laboratory and non-invasive experimental and demographic statistics from special access. Three SVM simulations were established and associated with and without invasive and together clusters for this motive. The outcomes recommended that non-invasive structures deliver mortality estimated related to the invasive and incompletely on similarity using the cooperative model. Initial mortality forecasts using non-invasive models offered visions collectively through innovative tools, such as wearable wireless strategies. These models produced dominant structures for numerous medical projects and patient triage. **Sina F. Ardabili et al.,(2021) [9]** described that officials worldwide use numerous outbreak methods for COVID-19 to create learned results and implement suitable control methods. The characteristic models for COVID-19 worldwide epidemic forecast, modest epidemiological and geometric models, required additional conventional consideration by experts and were generally broadcast. The specific methods for COVID-19 wide-reaching widespread prediction, diffident epidemiological and statistical models, have more conventional consideration by authorities and were general in the broadcasting. Due to great ambiguity and deficiency of important statistics, normal prototypes have exposed low precision for durable prediction. The authors offered a comparative study of ML and SC (soft computing) replicas to forecast the COVID-19 epidemic differently from disposed of diseased and improved vulnerable visible diseased and improved (SEIR) representations. This paper delivered the first benchmarking to prove the possibility of ML and an unaffected

innovation in occurrence prediction recognized by incorporating ML and models. **María A Callejon-Leblic et al., (2021) [10]** described the COVID-19 outbreak widely worldwide. Multiple-centre case control training was accomplished, in that assumed cases for COVID-19 were verified through simultaneous RT-PCR. That was up-to-date nearby the occurrence and severity of issues with VAS. ML procedures were realistic to the composed statistics to forecast a COVID-19 analysis using a fifty-fold CV structure through casually severe the patients in the preparation of 75% and challenging datasets. Around 777 individuals were involved, and harmful smells and tastes were the indications, with 6.21 and 2.42 sophisticated odds ratios for COVID-19 positivity. The ML procedures functionally extended 80% and 82% of accuracy and sensitivity, respectively. **R. Lakshmana Kumar et al., (2021) [11]** described the detection and forecast of Covid-19 existing unique dares designed for the health investigation open because of its common throughout the globe. Procedures determined through AI support predict specific limitations, dangers, and effects of such a sickness. DL-based methods have demonstrated different chances to regulate many complications in the forecast. The authors proposed a twofold learning set of rules, explicitly DL and reinforcement learning (RL), which were recognized to forecast COVID-19. The investegators constructed a model with the RNN model, mainly the Adapted LSTM model, to predict the computation of freshly affected entities, fatalities, and treatments in the subsequent few days. This proposed model also recommended DL required for the improvement of COVID-19's analytical consequence based on signs. Practical statistics were employed to analyze the accomplishment of the recommended system. The outcomes demonstrate the potentially predicted outcomes regarding recent COVID-19 sickness and improved the LSTM and the ML models, LR, in error rate expressions. **Arushi et al., (2021) [12] described** COVID-19 in progress in the Chinese region of Hubei's Wuhan in 2019. Subsequently, numerous influences of covid-19 were successful persons completely around the domain. Peoples badly struggle with COVID-19 in the world. Healthcare and strong points of detecting systems were anxious to test the sickness. Several cases had been experimental in which these types of diseases were recognized at an accurate time. So, the loss peal payable to COVID-19 was rising. So, the loss peal payable to COVID-19 was rising. This project proposes an organized method to better struggle with this epidemic with several ML methods, their performance, and the excellent result to predict the disease. This proposed paper suggested an applied resolution using a health monitoring model that can alleviate the loss done by COVID-19. When stimulating features were limited, this structure was used, among other effects, to arrange difficulties for COVID-19.

Table 1 represents the existing methods, tools, and models utilized for COVID-19 prediction. This table shows the proposed method, problem, and tool utilized for performance as a parameter and outcome.

Table 1: Analysis of various existing COVID-19 Prediction Methods/Tools

Authors Name	Proposed Method	Problem	Tools	Parameters	Outcome
Ruifang Ma et al., (2021) [7]	Proposed an LSTM model joint through the Markov model for covid prediction.	Several influence factors degrade the positive image of the model.	MATLAB	MSE	This model offered the analysis of several countries simultaneously.

Mahdi Mahdavi et al., (2021) [8]	Proposed a model for covid-19 disease prediction.	Convergence and running speed are very low.	MATLAB	AUC Accuracy	The models presented optimal forecasts, making them appreciated assistive implements for scientific decision-making and resource allocation in different settings.
Sina F. Ardabili et al.,(2021) [9]	Proposed relative analysis of ML and soft computing simulations to predict COVID-19.	The lack of fundamental statistics and epidemiologic representations has exposed low accuracy for the long-term forecast.	----------	RMSE MSE Accuracy	This model offered a high simplification capability for the long-term forecast.
María A Callejon-Leblic et al., (2021) [10]	Developed a comprehensive ML modeling frame to evaluate the analytical value of smell and taste syndromes.	The prediction process for COVID-19 is very time-consuming.	MATLAB	Sensitivity Specificity Accuracy	This method provides a comprehensive ML modeling structure to evaluate the analytical value of smell and taste illnesses, with further COVID-19 infection.
R. Lakshmana Kumar et al., (2021) [11]	Developed a DL-based COVID-19 prediction model.	A limited prediction risk ratio exists.	----------	MAE RSME	The DL scheme can proficiently predict upcoming results of COVID-19.
Arushi et al., (2021) [12]	A systematic method for COVID-19 pandemic.	The need is required to improve the real-time prediction process.	Python	Recall Accuracy F1-score Precision	Able to forecast the COVID-19 with high accuracy.

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III. RISK FACTORS AND CAUSES OF COVID-19 DISEASE

The risk factor analysis involved around 384,137 persons diseased through SARS-COVID-2 by the lowest three months of development. While expanding the WHO classification of extensive COVID, some socio-demographic and scientific risk factors remained considerably related through protracted COVID. Ladies were at augmented risk associated with males. Adults older than thirty were related to a sophisticated risk of reporting extensive COVID signs in the uni-variate investigation. But, subsequently regulating for standard covariates, adult age was related to a minor risk, with aged individuals such as 30–39 years consuming a 6% negligible risk and those aged more than seventy years have a 20-25% lesser risk related to individuals aged thirty years. There were relations in the hazard of commentary extensive COVID-19 indications as well as assured cultural smaller collections in the multiple variable models, through improved risks realized in Black Afro-Caribbean ethnic collections, diverse ethnicity and additional alternative ethnic clusters containing patients through built-in American, Intermediate Eastern or Polynesian foundation as related to grey ethnic clusters. The risk was similarly augmented with cumulative stages of socio-economic deficiency through an 11% augmented risk in individuals who remained most socioeconomically deprived compared to those least disadvantaged [13].

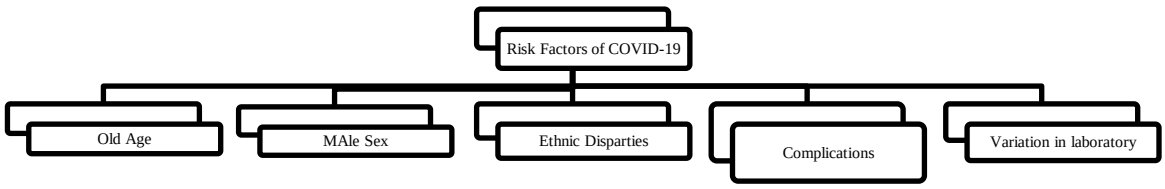

Figure 1. Risk Factors of COVID-19 [14]

Figure 1 Fragment of the protection and risk factors of Corona Virus Disease. A healthy diet, good diet, atopic circumstances, and COVID-19 injection are protecting issues in contradiction to the disease and growth of COVID-19. Improved anti-inflammatory cytokines and reduced ACE-2 are used to protect against these issues' effects. Too, stimulation of anti-body reply and T-cell stimulation by COVID-19 injection can help avoid infection, development, and reduced experimental result. On the other hand, old age, man gender, and national or ethnic breaches are risk problems for the disease of COVID-19.

- Neighbouring interaction with somebody who has COVID-19, particularly somebody with signs.
- Existence coughed or sneezed arranged through a diseased individual.
- Being neighbouring a diseased individual when in an inside universe through unfortunate air movement.

3.1. Causes of COVID-19 Disease

Some main causes of Covid-19 as [14] ;

- Infection through simple severe respirational disease COVID-19- 2, or SARS-CoV-2, reasons COVID-19 infection.
- The disease that reasons COVID-19 ranges quickly amid the publics. Data has exposed that the COVID-19 virus generally ranges from single person to another between individuals in close connection.

- The disease spreads through respirational drops unrestricted when somebody diseased with coughs, sneezes, talks, breathes, sings. These drops could be inhaled or land in a person's nose, or eyes nearby, mouth.
- This type of virus is influenced when an individual is unprotected from minor drops or sprays that halt in the air for numerous actions or times — termed airborne program.

3.2. Sign and Symptoms

Individuals diseased with COVID-19 must have symptoms ranging from unimportant signs to severe disease. Signs might seem two- fourteen days after coverage of the virus. Any slight to simple symptoms are shown in Table 2 as fever or anxieties, cough, rapidity of breath, trouble breathing, weakness, strength or body pains, headache, the novel defeat of flavour or smell, painful gullet, congestion or runny nose, Vomiting or unsettled stomach and Diarrhoea etc.

Table 2. Sign and Symptoms of COVID-19 [15]

Sign and Symptoms of COVID-19
Rapidity of breath
Weakness
Vomiting
Unsettled stomach
Diarrhoea
Painful gullet
Cough
Fever
Runny nose

IV. SEVERAL MACHINE LEARNING AND DEEP LEARNING DETECTION METHODS

ML is a subdivision of AI that focuses on generating classifications that can be acquired from samples and expanded without being openly automatic. This method field has increased approval for resolving many practical difficulties for some years. These methods can be separated into some parts: supervised, un-supervised, and re-inforcement learning. In supervised learning, acquiring from a dataset through pre-defined tags is acceptable. Supervised learning has two forms Classification and regression. Un-supervised procedures crack to acquire from unlabelled datasets. The procedures process the unlabelled dataset for feature extraction and recognition of patterns. Samples of unsupervised ML procedures consist of collecting and dimensionality decline of huge and great dimensional datasets. In RL, the procedure acquires over experimental and fault [16]. Further, the DL approach has been demonstrated to be an appropriate feature extractor in numerous computerized schemes that are recycled to boost classification precisions. The CNN technique acquires a feature extraction classical, recognized as a dominant system in several computerized visualization classifications. The classification performance has been boosted with the help of DL and traditional image structures [17]. So, a return and penalty tool is engaged in the training phase. Various methods are detailed for COVID-19 prediction.

4.1 KNN (K-nearest neighbour) Classifier

This method is non-parametric. The learning and estimation analysis uses a given problem or dataset. In this classification model, the forecast is decently constructed on neighbour statistics standards without some hypothesis on the dataset. In the KNN [18] method, the number of adjacent neighbors statistics standards are denoted by K. Constructed on K, such as several nearest neighbors. The assumption is accomplished through the KNN process of classifying the specified dataset. The KNN method straight classifies the dataset for training. It funds the forecast of a novel happening completed through searching to the equivalent 'K' neighbour cases in the complete training set and organizing constructed utmost instances. An analogous illustration is determined with the Euclidean distance formula.

4.2. DT (Decision Tree) Method [18]

The decision tree processes are the dominant forecast model designed for together classification and regression difficulties. The DT models are signified in the procedure of a twofold tree. It resources the specified difficulty or dataset is resolved by using severe or categorizing them as a binary tree. In this, the prediction is completed through the root node of the twofold tree using a single input variable, severe the dataset constructed on the adjustable, and its leaf nodes of the binary tree must be caused as the output variable, from the root node, the tree is crisscrossed finished each branch with their separations, and prediction is prepared through the leaf nodes. It practices the greedy technique to severe the dataset in a binary method.

4.3. CNN (Convolutional Neural Network) Method

It is an alternative famous DL method and has similarly been realistic in predicting COVID-19 infections. Various pieces of training presented that this model is outstanding for noise filtration in input statistics and eliminating additional constructive features for the ultimate estimating model. While typical CNNs are compatible with 3-D auto-connected statistics, they remain occasionally adapted to manage complex and lengthy chronological dependencies. CNN method consists of several layers, such as the convolutional layer (CL), fully connected layer (FCL), pooling layer (PL) etc. These are performed as appropriate tasks during implementation [19]. Table 3 defines the CNN layers with kernel dimensions and feature map values. Carlos Eduardo Belman-López [20] developed a novel tool for COVID-19 disease detection, such as pneumonia belongings with CNNs models and X-ray pictures. This method is advanced when it derives from image organization, and they deliver improved outcomes in non-linear difficulties using incredibly dimensional places. These CNN models offered precise diagnostics in additional productivity classes, whereas the accuracy improved through comparison.

Table 3. CNN Layers Description

Name of Layer	Kernel Dimensions	Feature Map
Input layer	256*256	
Convol_1	3*3	256*256*16

Max_pooling_1	2*2	128*128*16
Convol_2	5*5	128*128*32
Max_Pooling_2	2*2	64*64*32
Convol_3	5*5	64*64*64
Max_Pooling_3	2*2	32*32*64
Convol_4	7*7	32*32*128
Fully Connected	1*3	1*3

4.4. SVM (Support Vector Machine) Method

This method is a supervised non-parametric geometric concept-based method. So, in this method, there is no need for any hypothesis on spreading fundamental facts. This method delivers huge benefits, for example, the sparsely of the resolution, worldwide optimization, hard imaginary base, simplification, and non-linearity. In the innovative preparation of SVMs, the scheme discovers an optimum splitting hyper plane with an extensive conventional of remarks using recognized labels such as training sets through exploiting the boundary between twofold classes. The word optimal splitting hyper plane [21] denotes the reduction of misclassifications. A support vector is defined as the subset of data on the boundary. Innovative unlabelled statistics are assigned to a class constructed on their symmetrical place compared to the function. The data points are belonging to different groups associates overlay one another, challenging linear reparability.

4.5. RF (Random Forest) Method

This classifier is an ensemble ML procedure recycled for Classification and mechanism to a DT. It practices the bootstrap combining technique designed for preparation. The general prediction was completed by averaging forecasts of entirely separate trees. As soon as feature vectors are considered as input, the RF method forms a subset of arbitrarily nominated statistics using the assistance of several DTs. Subsequently, the process is entirely up to the divisions of the DTs to regulate the Forecast of COVID-19 or not. Table 4 and figure 2 represented the performance analysis of various approaches such as DT, RF, CNN, SVM, and KNN. CNN method provides better performance as compared to other methods. CNN model has achived high accuracy rate as compared with other methods.

Table 4. Performance Analysis

Classifiers	**Accuracy**
DT [18]	75%
KNN [18]	80%
CNN [20]	94%
RF [21]	93%
SVM [21]	87%

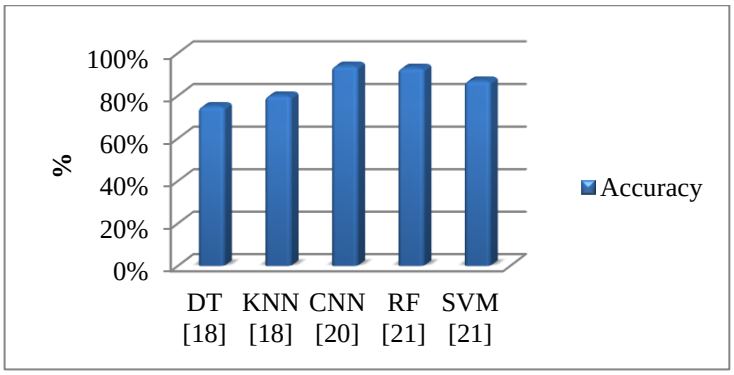

Figure 2. Comparative Analysis with different machine and deep learning classifier performance: Accuracy (%)

IV. CONCLUSION AND FUTURE SCOPE

This paper analyses the utilization of ML and DL methods in the fight against the Covid-19 disease, following the guidelines set by the WHO. The analysis reveals that ML and DL models, such as KNN, SVM, RF, DT, and others, efficiently classify the number of confirmed cases attributed to the SARS-CoV-2 virus. Severe diseases are most likely to develop in older individuals and those with pre-existing health issues similar cardiovascular illness, diabetes, prolonged respiratory syndrome, or cancer. COVID-19 can affect individuals of any age, leading to severe illness or even death. This paper explores ML and DL methods, including KNN, SVM, random forest, CNN, and DT, for predicting COVID-19. It also identifies various risk factors, causes, and symptoms associated with the disease. The study indicates that the CNN method better predicts the COVID-19 syndrome. Additionally, the article suggests future directions for developing accurate models to detect and prevent the COVID-19 virus. During an epidemic crisis, analysts focus on designing CNN models for appropriate COVID-19 disease diagnosis. The research demonstrates that using DL methods can enhance the detection capabilities of X-ray images and improve the accuracy of diagnosis. The article summarizes DL and ML methods, highlighting performance challenges and showcasing the potential for rapid virus diagnosis and detection. Furthermore, it provides a comprehensive overview of existing methods, defining the classification of Covid-19 using DL and ML approaches, and discussing their cost-effectiveness and financial implications.

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