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Detection and Classification of COVID-19 Using Machine Learning Techniques: A Review

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Abstract

The pandemic COVID19, caused by a member of the coronavirus family (SARS-COV-2), occurred in Wuhan in 2019 and can cause the severe acute respiratory syndrome, fatal complications, and death. One of the main problems of the twenty-first century is coronavirus illness (COVID-19), which SARS-CoV-2 brings on. This virus, which has killed 6,654,361 people globally and infected 649,605,347 people, is currently causing widespread global conflict. Due to the high infection incidence in China and other nations within a short time, the WHO (World Health Organization) declared it a pandemic on February 11, 2020. Numerous individuals perished as a result of the COVID-19 pandemic epidemic. This virus has already infected millions of individuals, and new infections are occurring every day. Researchers are attempting to employ medical imaging like CT and X-ray images to identify COVID-19 With the use of modern AI technologies both the cost and time required to run a traditional RT-PCR test for detection are prohibitive. In order to combat the impacts of the new coronavirus illness, this research presents a thorough assessment of using artificial intelligence (AI) in the form of machine learning (ML) and deep learning (DL) approaches in identifying (COVID-19). The primary objectives of this paper lie in identifying the broad and important outlines of the process of systematically researching the mechanisms of detection and classification of the Coronavirus through a review of a group of researchers; in addition, to compile the most used methods for independently identifying COVID-19 from medical images, and knowing the data sources of cross-sectional images. The researchers relied on Lung and x-rays in identifying the process, Furthermore, to discussing the accuracy of the results of the research through a review of the machine learning and general learning techniques used by the researchers are discussed. So, a novice researcher can evaluate prior works and come up with a better solution.

Keywords: *COVID-19, Deep Learning, Medical Image, Artificial intelligence, coronavirus, computed tomography, CT images, Machine learning, X-ray.*

1 Introduction

One of the main problems of the twenty-first century is coronavirus illness (COVID-19), which is brought on by SARS-CoV-2. This virus, which has killed 6,654,361 people globally and infected 649,605,347 people, is currently causing widespread global conflict.

Due of the high incidence of infection in China and other nations within a short period of time, the WHO (World Health Organization) on February 11, 2020, declared it a pandemic. It is a respiratory illness that affects people of all ages and is very infectious. Some of the recognized symptoms include fever, sore throat, headache, cough, exhaustion, and bodily discomfort. Two to fourteen days may pass between the time of infection and the beginning of symptoms. Infection is brought on by direct or indirect contact with infected people and spreads by airborne droplets (Y.-H. Jin et al., 2020). Due to the high incidence of infection in China and other nations within a short period of time, the WHO designated it as a pandemic on February 11, 2020. It is a respiratory illness that affects people of all ages and is very infectious. Some of the recognized symptoms include fever, sore throat, headache, cough, exhaustion, and bodily discomfort. Two to fourteen days may pass between the time of infection and the beginning of symptoms. Infection is brought on by

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direct or indirect contact with infected people and spreads by airborne droplets (Peng et al., 2022).

The Results from PCR tests often take 4-6 hours to appear. In addition, there is a difficulty with test kit availability. Therefore, further options for the early identification of COVID-19 include chest radiography, which includes chest X-Rays and CT-Scans. Medical professionals can use artificial intelligence (AI) to develop prospective technology solutions that will aid in making diagnoses based on chest scans (Fang et al., 2020).

The first suspected case of coronavirus disease in Iraq was identified on February 24, 2020, for a student of Iranian origin studying in southern Iraq. The health team's routine examinations of guests and students at their lodging locations led to the discovery of this instance. Thus, it can be said, by reviewing the research, that the process of detecting and classifying Coronavirus by means of radiographs and X-rays can sometimes be more accurate and faster than the expensive PCR test which is not available in all health centres in Iraq. PCR testing is difficult to administer in collection sites and communities is complex, and takes time to obtain results (Abdulmajeed & Saleem, 2021).

Artificial intelligence (AI), is a software technology that can be used in the field of medical image analysis that are used directly to assist medical personnel in combating the new Coronavirus by effectively providing high-quality diagnostic results and greatly reducing or eliminating staff (Shi et al., 2020)(McCall, 2020)(Vaishya et al., 2020).

The primary goal of this study is to examine current advancements in COVID-19 diagnostic systems based on data gathered from medical imaging samples and machine learning and deep learning techniques. The most important research has been evaluated that has been done to diagnose COVID-19, focuses on elements like trial data, data segmentation technologies, and assessment measures. Also, it gives an open discussion of the difficulties with deep learning-based systems. This research review has Seven parts which are arranged as follows: Section Two is an application of artificial intelligence and machine learning in the fight against COVID-19, and the searching techniques are presented in Section Three. The types of classification are described in Section Four. The COVID-19 Data Set and Resource Description are discussed in Section Five. The performance comparison of COVID-19 Detection and Classification has been done in the Sixth section. Finally, the conclusion is outlined in the Seventh section, followed by acknowledgment and a list of references.

2 Application of artificial intelligence and machine learning in the Fight against COVID-19

COVID-19 screening has been greatly improved in terms of diagnosis, prediction, and classification through research and development in the use of artificial intelligence technologies. The use of these technologies has led to a better expansion of the scope of this work, rapid response, and more reliable and effective results, and sometimes intelligent technologies outperform humans in health care tasks and follow-up of the patient's condition. (Sipior, 2020)(Alsharif et al., 2020).

Among the many trending disciplines in the field of AI, machine learning (ML) and deep learning (DL) are some of the leading technologies in the field of AI. In this article, different applications of machine learning and deep learning and their role in detecting the COVID-19 pandemic will be reviewed (Albahri et al., 2020)(Khan et al., 2021). Fig.1 shows the schematic perspective of machine learning and applications of deep learning in the fight against COVID-19.

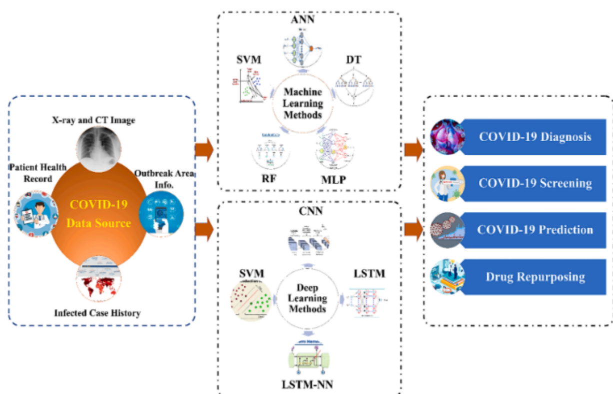


Figure 1: Shows the schematic perspective of applications of machine learning and deep learning in the fight against COVID-19(Khan et al., 2021).

Machine learning is a subset of AI which is capable of learning from experience automatically and adjusting its performance without explicit programming. Characteristic features are generally used in ML-based algorithms (Salehi et al., 2020)(Mbunge, 2020). ML-based approaches may be used to create a complicated and enormous amount of data. Such methods have been employed by numerous researchers in the COVID-19 pandemic for COVID-19 screening, classification, diagnosis, medication repurposing, and prediction (Swapnarekha et al., 2020)(Jamshidi et al., 2020). SVM is an excellent, efficient, effective, and powerful classification tool for binary and multiclass classification problems. Classification and prediction by support vector machines are widely used. Model selection and building a good predictive model is very important in SVM Research (Z. Xu et al., 2009).

The short-term long-term memory algorithm, which is an improved version of recurrent neural networks, was introduced by Hochreiter and Schmidhuber in 1997, to address the problems and drawbacks of recurrent neural networks by adding additional interactions to each unit or cell. Short-term long-term memory algorithm, a special type of recurrent neural network, is able to learn long-term dependencies and remember information for long periods of time (Le et al., 2019). Artificial Neural Networks (ANN) are computer systems that are based on biological neural networks. which contains units of neurons that resemble biological cells. These neurons are linked to each other by synapses to transmit signals from one neuron to another, and neurons have weights that vary with the depth of learning. The neurons are placed in layers in which they occur. Each layer transforms until the output layer is reached. The fundamental purpose of utilizing industrial networks was, to think as the human mind thinks, to solve issues. A number of tasks have been covered by neural networks, including computer viewing, machine translation, voice recognition, medical diagnostics, and video gaming. After human achievement in 2017, these networks proved useful (Tino et al., 2015). Convolutional Neural Network also known as CNN is a deep learning technique that derives, they're its name from the "Convolution Operation"., it has been widely used recently to detect and classify diseases depending on analysing of visual images, such as the retina, X-ray lung, CT-Scan lung, and breast cancer (X. Wang et al., 2020). Multilayer Perceptron (MLP). networks usually have three or four layers of processing elements with one or more hidden layers, depending on the program. The task of the input layer only task is to receive external stimuli and spread them to the next layer. The hidden layer receives the weighted sum of incoming signals sent by the input units and processes it by an activation function. an activation function. Most of the activation functions that are widely used are sigmoid and hyperbolic tangent functions. In turn, the hidden units give the output signal to the next layer's neurons (Grosse, 2019).

Researchers are making great efforts in the field of artificial intelligence to develop new and rapid diagnostic methods using deep and machine learning algorithms. ML is being used in the development of new diagnostic tools. For instance, by analyzing the designs of SARS-CoV-2 virus strains using a gene editing system known as CRISPR, researchers were able to create a fast and sensitive screening method (Riva et al., 2020)(Metsky et al., 2020). Neural network classifiers for mass screening have been developed based on the peculiar breathing pattern of COVID-19 patients (Beck et al., 2020)(Y. Wang et al., 2020). A deep learning-based system was created to analyze thoracic CT images in a manner similar to this in order to automatically identify and monitor COVID-19 patients over time (Gozes et al., 2020). Automated diagnostic systems based on AI are being created at a rapid rate, and they have the potential to increase diagnostic speed and accuracy while safeguarding healthcare workers by reducing their contact with COVID-19. Fig. 2 illustrates the use of artificial intelligence in fighting COVID-19 (Alimadadi et al., 2020).

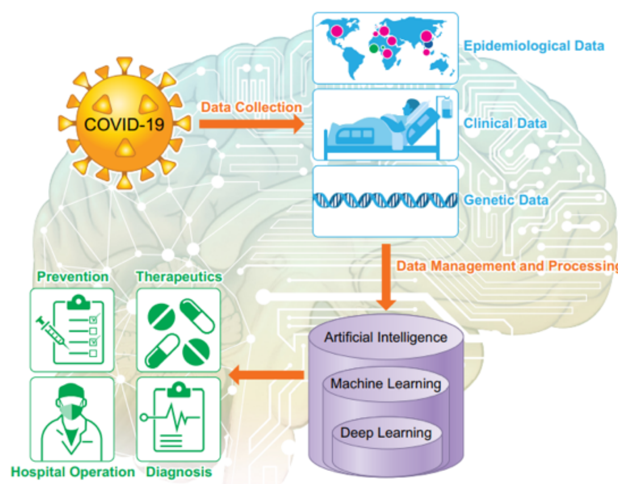


Figure 2: Combating COVID-19 with the use of artificial intelligence (Alimadadi et al., 2020).

Additionally, a new medication-like molecule against SARSCoV-2 has been created using a DL-based drug discovery process (Zhavoronkov et al., 2020). A COVID-19 vaccine's formulation will benefit from the predicted protein structures that Alpha Fold, a deep learning system created by Google Deep Mind. Traditional experimental methods can take months to produce these structures. Additionally, a recently created Vaxign reverse vaccinology technology linked with machine learning suggested COVID-19 vaccine candidates (Senior et al., 2020). The amount of data about the COVID-19 pandemic is available in hospitals around the world which requires advanced intelligence technologies that are capable of evaluating the therapeutic effects of new patients, as well as predicting hospitalization, infection rates, and stages of progress. Artificial intelligence applications focus on identifying and segmenting COVID-19 using tomography of the lung and X-rays to distinguish among other types of pneumonia. By doing this, doctors may increase their productivity, lessen the intense strain of their jobs, and provide their patients with scientific information and management options (Lu et al., 2019).

3 Searching Techniques

The proposed Review started by searching process using the most used keyword such as: "COVID-19", "Radiological image", "classification", neural network", "CT images", " X-ray", "machine learning", "deep learning", "artificial intelligence", "deep learning", CNN". And choosing the date of publication for the years that followed the discovery and spread of Coronavirus, we experimented with various keyword combinations, and we looked through the database for international studies. For those articles with the article title and keyword terms, we reviewed and analyzed those articles.

4 Types of Classification

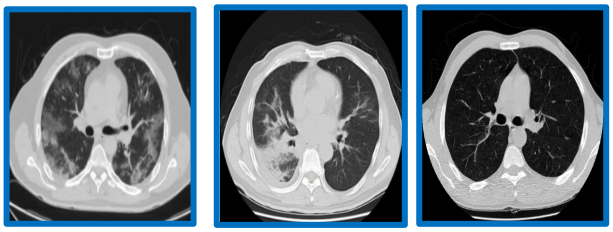
The X-ray images and CT scans were classified using binary classification - that is, two classes, or multiclass classification to perform the task of detecting COVID-19. Each class had a rating of the following labels: "COVID-19," "healthy" "normal," "COVID-19 positive," "no results," "pneumonia," or "COVID-19 negative." The binary classification included "COVID-19" as one of the categories and any of the others, i.e., "non-COVID" as another. The designations for the three categories were "COVID-19", "pneumonia" and "normal". Two or three categories were used in the investigations.

Table 1: a summary of the various articles' categorization techniques for both CT-Scan and X-ray images

Types of Classification	Papers
Binary Classification	(Sarhan, 2020)(C. Jin et al., 2020)(Elaziz et al., 2020)(Yoo et al., 2020)(Tammina, 2022)(Cifci, 2020)(Shi et al., 2021) (Al-Karawi et al., 2020)(Wu et al., 2020)(Amyar et al., 2020)(S. Wang et al., 2021)(Medhi et al., 2020)
Multiclass Classification	(Gilanie et al., 2021)(L. Wang et al., 2020)(Hernandez et al., 2020)(Moutounet-Cartan, 2020)(Elzeki et al., 2021)(Ozturk et al., 2020)(X. Xu et al., 2020)

5 COVID-19 Data Set and Resource Description

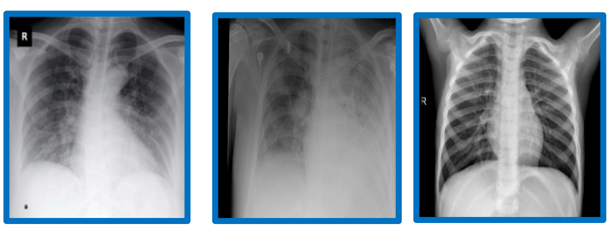
The data that will be used to effectively train a model must be the initial emphasis. The diagnosis of COVID-19 patients will be aided by this data using machine learning (ML) or deep learning (DL) methods. Researchers have developed an alternate technique to detect COVID-19 using AI on chest CT or X-ray pictures due to RT-PCR has drawbacks. Computed tomography is used to obtain a cross-sectional image of the CT chest which is essentially a collection of several X-ray images obtained from various angles. Fig. 3 shows a representation of the CT scans (Normal and COVID-19 infected) (Abdulmajeed & Saleem, 2021).



(a (b) (c)

Figure 3. Examples of CT-Scan images include those for (a) COVID-19 (b) pneumonia and (c) normal.

The value of early illness detection and diagnosis in the COVID-19 pandemic cannot be overstated. The data that will be used to effectively train a model must be the initial emphasis. The diagnosis of COVID-19 patients will be aided by this data using machine learning (ML) or deep learning (DL) methods. Researchers have developed an alternate technique to detect COVID-19 since RT-PCR has drawbacks. Using AI on chest CT or X-ray pictures. A computed tomography (CT) scan process is used to create a chest CT picture, which is essentially a collection of several X-ray images obtained from various angles. Fig (3). shows a representation of the CT scans (normal and COVID-19-infected) (Abdulmajeed & Saleem, 2021).



(a) (b) (c)

Figure 4. Examples of X-rays images include those for (a) COVID-19 (b) pneumonia, and (c) normal.

Some of the most popular research group datasets have been collected from various sources. Sarhan (Sarhan, 2020) Cohen provided the chest X-ray pictures of the COVID-19 subjects. The COVID-19 photos were collected by Cohen from various open sources. 125 chest X-ray pictures with COVID-19 diagnoses were stored in the database. The photos were including 82 males and 43 females with positive diagnoses. The pictures were in various forms (png, jpg, and jpeg). From this database, 88 positive cases and 88 normal (no-findings) cases totalled 88. 176 chest X-ray pictures altogether. Since there weren't enough COVID-19 photos available, only 20% were utilized for testing and 80% were used for training. Jin et al (C. Jin et al., 2020) gathered information from Jianghan Mobile Cabin Hospital, Western Campus of Wuhan Union Hospital, and Wuhan Union Hospital, three facilities in Wuhan. The institutional review board of Wuhan Union Hospital, which oversees three centres, has approved the research.

In another study, Abd Elaziz et al (Elaziz et al., 2020) used two separate datasets. The first dataset that Lan Dao, Paul Morrison, and Joseph Paul Cohen posted to GitHub. The pictures are taken from 43 various magazines. Each image's references are included in the metadata. There are 1,675 COVID-19 chest x-ray images that are negative and 216 COVID-19 positive chest x-ray images. Yoo (Yoo et al., 2020) used East datasets from Asian hospital data. Tammina (Tammina, 2022) gathered information from Multiple hospitals which contains4334 COVID-19 and 1576 Normal Chest X-ray. This dataset's data folder is divided into three folders: train, test, and validation. Each folder was once more divided into the COVID-19 and Normal subfolders. There are 5910 chest X-ray images total, divided into 2 groups (Pneumonia/Normal). The library contains 1576 Normal Chest X-ray pictures and 4334 COVID-19 images. 4248 X-ray pictures are provided for training models, 1062 X-ray photos are supplied for model validation, and 600 X-ray images are awarded for model testing out of a total of 4334 X-ray images.

Moreover, Cifci (Cifci, 2020) downloaded from the Kaggle site, 5800 CT pictures were downloaded. 4640 CT pictures (80%) are utilized for training, while 1160 (20%) images are used for testing. In another study Gilanie (Gilanie et al., 2021) used Normal = 7021, Pneumonia = 7021 and Covid-19 = 1066. The Department of Radiology, Bahawal Victoria Hospital, Bahawalpur (BVHB), Pakistan, produced a locally built dataset and three publicly available datasets to acquire chest pictures. Wang (L. Wang et al., 2020) collected their data set from Radiological Society of North America. In another study Hernandez (Hernandez et al., 2020) From 70 different cases, we selected 58 with a frontal perspective, collected their data set from Italian Society of Medical and Interventional Radiology and University of Stanford.

Shi (Shi et al., 2021) collected CT scans of a total of 2685 subjects. 1658 cases in this dataset were COVID-19 that had been verified as such by positive nucleic acid testing and confirmed by the national CDC. Patients with CAP made up the other 1027 cases. Three of the facilities involved were China-Japan Union Hospital of

Jilin University, Fudan University's Shanghai Public Health Clinical Centre, and Tongji Hospital of Huazhong University of Science and Technology. Al-Karawi (Al-Karawi et al., 2020) chest CT-scan images of COVID-19 examined patients (275 positives and 195 negatives) were downloaded from COVID-CT-Dataset: a CT-scan dataset about COVID-19.

Wu (Wu et al., 2020) also gathered 495 chest CT scans from three hospitals in China. The training set consisted of 395 cases (80%, 294 of COVID-19, 101 of other pneumonia), the validation set consisted of 50 cases (10%, 37 of COVID-19, 13 of other pneumonia), and the testing set consisted of 50 cases (10%, 37 of COVID-19, 13 of other pneumonia). And Moutounet-Cartan (Moutounet-Cartan, 2020) examined the posteroanterior chest X-rays of 327 individuals, 152 of whom were healthy and 125 of whom had pneumonia other than COVID-191. The information was gathered from Kermany et al. and Cohen et al. (2020). (2018). Amyar (Amyar et al., 2020) were able to expand the database and added 1044 CT-Scan pictures from Hospital Henri Becquerel (COVID-19=449, non-COVID-19=595). Pre-processed and saved in png format the database. Wang (S. Wang et al., 2021) gathered 1065 CT scans of COVID-19 patients from three institutions for different research. The Xi'an Jiaotong University first affiliated Hospital (center 1), Nanchang University First Hospital (center 2), and Xi'an No. 8 Hospital of Xi'an Medical College were the facilities that provided the photos (center 3). Before transmitting any CT pictures for examination, they were all verified again. Each collaborating institute's institutional review board has approved.

Farid (Farid et al., 2020) gathered the CT images dataset from the Kaggle benchmark dataset. Several CT scans can be found in the medical dataset. The CT image dataset consists of two classes of pictures: training and testing. Each class has a total of about 51 images divided into coronavirus and Sars, respectively. Additionally, Mehdi (Medhi et al., 2020) employed two distinct datasets: one for statistical analysis and the other for identifying chest X-rays. The Kaggle data archive included both gathered datasets. The initial dataset was created by John Hopkins University using daily data from cases, fatalities, and recovery rates related to COVID-19 in Wuhan City. With 44 distinct parameters, including age, gender, date of onset, date of confirmation, travel history, symptoms, chronic conditions, etc., this dataset comprises information on more than 14000 patients. The clinical symptoms and chest X-ray pictures of more than 150 distinct COVID-19 patients were gathered from Wuhan city and are included in the second dataset.

Elzeki (Elzeki et al., 2021) utilized three distinct datasets: the first, Dataset-1 Includes 25 negative instances that are normal and 25 COVID-19 cases (positive cases). Dataset-2 is the second one (Mooney, 2020; Bachir, 2020). Dataset-2 was obtained from two distinct independent sources. The first, Paul Moony (Mooney, 2020), provided 5,863 chest x-ray pictures with the classification's pneumonia and normal cases. The pediatric patients from Guangzhou Women and Children's Medical Centre, aged one to five, were retrospective cohorts from which the chest x-ray pictures, also known as posterior-anterior, were chosen. All chest X-ray imaging was done as part of the regular clinical treatment provided to patients. Only 234 normal cases, chosen from 1,341 image-based cases (17.44%), and 148 pneumonia cases, chosen from 3,875 trained instances, were employed. The second one contains 221 COVID-19 examples (70.38%) that were chosen from 314 photos. The information was compiled from 205 individuals, both male and female, ranging in age from 120 to 88. The third dataset was posted to Menedely (Shams et al., 2020a). 603 chest x-ray pictures with the class labels normal, COVID-19, and pneumonia cases—234, 221, and 148, respectively which are included in this collection of data. In different research, Ozturk (Ozturk et al., 2020) employed 1125 photos altogether (125 COVID-19, 500 Pneumonia, and 500 No-Findings). The database contains 82 male cases and 43 female cases that tested positive. In this collection, not all patients have full information available. 26 COVID-19 positive participants' ages are disclosed, and the average age of these subjects is around 55 years old. For normal and pneumonia pictures, the ChestX-ray8 database supplied by Wang was used, and randomly selected 500 pneumonia class frontal chest X-ray pictures and 500 no-findings frontal chest X-ray images from this database in order to prevent the imbalanced data issue. In a different study, Jiang (X. Xu et al., 2020) collected a total of 618 CT samples from hospitals in Zhejiang Province: 219 from 110 patients with COVID-19, 224 from 224 patients with pneumonia, and 175 from healthy individuals. The hospitals were the People's Hospital of Wenzhou, the People's Hospital of Wenling, and the Hospital of Zhejiang University.

In another study, Waheed (Waheed et al., 2020) gathered 192 testing samples, 331 COVID-CXR training samples, and 601 Normal-CXR training samples (COVID-CXR: 72 images and Normal-CXR: 120 images). Resizing and normalizing processes are the two image preparation stages that are involved. Since the scale of the photos in the dataset varies, all of the images are adjusted using SciKit's image processing to 112 * 112 * 3. Which gathered three publicly available datasets for our dataset. The initial instance of (IEEE Covid Chest X-ray dataset). the second dataset from the COVID-19 Chest X-ray Dataset, and the third dataset from the COVID-19 Radiography Database. Moreover, the Hussain distinct COVID-19 dataset—which was provided from the open-source Kaggle repository—has been integrated (Kaggle, 2020). There are 2200 total photos in the dataset repository, divided between normal patients (1400 images) and COVID-19 infected chest X-ray and CT images (800 images). 20% of the dataset is utilized for testing, while the remaining 80% is used for training. The Gray levels, patch sizes, dimensions, and other features of the resulting X-ray pictures are varied. Table 2. Shows the essential characteristics of both CT and X-ray images in these investigations which will be covered in the sections that follow.

Table 2:A summary of information for the different sources used in this review.

Papers	Data set source	Type	No. of images
(Sarhan, 2020)	GitHub covid-chestxray-dataset	X-ray	dataset consisted of 88 COVID-19 images and 88 normal images
(C. Jin et al., 2020)	"Wuhan Union Hospital, Western Campus of Wuhan Union Hospital, Jianghan Mobile Cabin Hospital"	CT-Scan	"COVID-19 positive =496, COVID-19 negative =1385"
(Elaziz et al., 2020)	(Joseph Paul Cohen Paul Morrison Lan Dao) GitHub	x-ray	216 COVID-19 positive 1,675 COVID-19 negative
(Yoo et al., 2020)	(East Asian Hospital data) U.S. National Library of Medicine (Shenzhen set)	X-ray	814 (COVID-19 positive 263 COVID-19 negative)
(Tammina, 2022)	Multiple hospitals	X-ray	4334 COVID-19 and 1576 Normal Chest X-ray
(Cifci, 2020)	kaggle.com (benchmark web of dataset science)	CT-Scan	5800
(Gilanie et al., 2021)	GitHub, kaggle.com And Bahawal Victoria Hospital, Bahawalpur (BVHB), Pakistan	CT-Scan X-ray	Normal = 7021, Pneumonia = 7021 and Covid-19 = 1066
(L. Wang et al., 2020)	Radiological Society of North America. COVID-19 radiography database	X-Ray	Covid-19 = 68, Normal = 1203, and Pneumonia = 931
(Hernandez et al., 2020)	Italian Society of Medical and Interventional Radiology, and Chex Pert	X-Ray	From 70 different cases, we selected 58 with a frontal perspective
(Shi et al., 2021)	Three hospitals were involved, including Tongji Hospital of Huazhong University of Science and Technology, Shanghai Public Health Clinical Center of Fudan University, and China-Japan Union Hospital of Jilin University	CT-Scan	CT images of a total of 2685, 1658 COVID-19, and 1027 cases were community acquired pneumonia (CAP)
(Al-Karawi et al., 2020)	Dataset: data from a CT scan for COVID-19	CT-scan	275 positive and 195 negatives

(Wu et al., 2020)	The dataset (CT-scan) was gathered from three Chinese hospitals.	CT-scan	(COVID-19 = 368, additional pneumonia = 127)
(Moutounet-Cartan, 2020)	X-ray image database for COVID-19	X-Ray	327 (COVID-19=125, normal=152, pneumonia=50)
(Amyar et al., 2020)	Hospital Henri Becquerel	CT-Scan	1044 (449 for COVID-19, 595 for non-COVID-19).
(S. Wang et al., 2021)	Xi'an Jiaotong University, Nanchang University, and Xi'an Medical College are three separate hospitals.	CT-Scan	1065 (740 = COVID-19 , 325 = normal)
(Farid et al., 2020)	Kaggle benchmark dataset	CT-Scan	102 (COVID-19=51, SARS=51)
(Medhi et al., 2020)	Kaggle dataset was generated by John Hopkins University	X-Ray	"Chest X-ray images of more than 150 confirmed COVID-19 patients from the Kaggle data"
(Elzeki et al., 2021)	Dataset-1 from (Faizan, 2020) is the name of the first one, while Dataset-2 from is the name of the second one (Mooney, 2020; Bachir, 2020). and Dataset-3, the third dataset, was posted on Menedely (Shams et al., 2020a).	X-Ray	Set 1 data: 25 Normal COVID-19, 25 Dataset 2: 234 Normal, 221 COVID-19 Dataset 3: 148 Pneumonia, 221 COVID-19, and 234 Normal
(Ozturk et al., 2020)	ChestX-ray8 database provided by Wang et al.	X-Ray	500 Pneumonia and 125 COVID-19 No findings
(X. Xu et al., 2020)	Hospital of Wenzhou	CT-Scan	219 COVID-19 , 224 Viral pneumonia, and 175 Healthy
(Waheed et al., 2020)	We gathered three publicly available datasets for our dataset.The first one from (IEEE Covid Chest X-ray dataset). the second from COVID-19 Radiography Database, the third dataset from COVID-19 Chest X-ray Dataset	X-Ray	331 COVID-19 601 Normal

6 Performance Comparison of COVID-19 Detection and Classification

Many artificial intelligence (AI) algorithms have been proposed for the diagnosis of COVID-19 using X-ray and CT images. The effectiveness of conventional approaches for COVID-19 detection or prediction has been enhanced by the use of ML and DL due to the extensive infection of the coronavirus. We have chosen a few of the automated approaches that have been offered to identify illnesses using medical imaging (CT, X-ray), but there are many others. Our goal is to provide an overview of current and successful methods.

Sarhan (Sarhan, 2020) suggested a new threshold scanning method that is used by the recommended system retrieves depending on just specific high-energy approximation coefficients. A modified run-length encoding (RLE) approach is used to encode the threshold coefficients. The characteristics representing the input picture which are taken from the generated code vector. The SVM is then given with these constrained characteristics for classification (normal or

COVID-19). The suggested technique considerably streamlines the SVM classifier's work and improves accuracy through the use of few features. The system's temporal complexity is decreased, which is another benefit of reducing the number of characteristics. The highest accuracy of the suggested method is 94.5%. Afterward, Jin et al.(C. Jin et al., 2020) created a coronavirus detection method based on artificial intelligence utilizing ResNet152, a CNN version. 152 convolutional, subsampling, and fully-connected layers were employed in the pre-trained model. The utilized dataset was compiled from two publicly accessible databases and three notable hospitals in China. A total of 1881 instances are taken into account, of which 496 involve individuals who have COVID-19 and 1385 do not. For experiments, the dataset is randomly divided. The system's performance in the trial was 94.98% accurate, 94.06% sensitive, 95.47% specific, 91.53% precise, 92.78 F1-score, and 97.91% AUC. Moreover, Abd Elaziz et al (Elaziz et al., 2020) was presented ML approach was presented to divide the COVID-19 patient and non-COVID-19 person groups depending on the chest x-ray pictures. Chest X-ray characteristics were retrieved utilizing novel Fractional Multichannel Exponent Moments (FrMEMs). A parallel multi-core computing architecture that is used to speed up processing. The most important traits were then chosen using a modified Manta-Ray Foraging Optimization based on differential evolution. With the use of two COVID-19 x-ray datasets, the suggested approach was assessed. For the first and second datasets, the suggested technique had accuracy rates of 96.09% and 98.09%, respectively. Suggested al [28] suggested to use a deep learning-based decision-tree classifier for possibility of COVID-19 detection from CXR images. The suggested classifier consists of three binary decision trees that were each trained using a deep convolution neural network learning model based on the PyTorch frame. The CXR pictures are categorized as normal or abnormal in the first decision tree. The third tree does the same function for COVID-19 whereas the second tree detects the aberrant pictures that contain symptoms of TB. The first and second choice trees' accuracy rates are 98 and 80%, respectively, while the third decision tree's accuracy rate is 95% on average. Before RT-PCR data are available, pre-screening patients may be utilized to expedite decision-making and conduct triage using the suggested deep learning-based decision-tree classifier. In addition.

Tammina (Tammina, 2022) suggested a new framework, which is recommended for exploiting chest X-ray images to identify lungs afflicted with pneumonia. The suggested system was developed using the deep transfer learning models “Inception-V3, VGG16, VGG19, ResNet-50, DenseNet-121, and MobileNetV2”. These models were pre-trained on ImageNet, which sped up model training. For greater accuracy, these models are further adjusted using image augmentation methods. The study comes to the conclusion that the ensemble model developed using these models' majority voting technique has a classification accuracy of 96.83% when it comes to diagnosing pneumonia. Radiologists can easily confirm and identify COVID patients by using the framework mentioned above. The goal of this study is to properly divide the chest X-ray pictures into two groups, namely Pneumonia and Cancer, using artificial intelligence models and image enhancement techniques. In addition, Cifci (Cifci, 2020) used pre-trained models and deep transfer learning, a was created and demonstrated for the early identification of coronavirus. The pre-trained models for medical image analysis include AlexNet and Inception-V4. CT scans are used to conduct the investigation. 5800 CT scans are taken from a public source to build the system. 4640 (80%) CT samples are utilized for training, while 1160 (20%) samples are used for testing. According to experimental findings, AlexNet outperformed Inception-V4 in terms of performance. Overall accuracy for AlexNet was 94.74%, with the sensitivity, specificity readings of 87.37% and 87.45%, respectively.

Gilanie et al (Gilanie et al., 2021)It has been recommended to use (CNN) to identify Covid-19. The Department of Radiology, (BVHB), Pakistan, provided three publicly available and one locally generated dataset. The accuracy, specificity, and sensitivity of the suggested approach were all on the average high (96.68%, 95.65%, and 96.24%). The proposed model is employed in the Radiology Department, (BVHB), Pakistan, and was trained on a sizable dataset. Wang et al (L. Wang et al., 2020) have suggested a way for accurately detecting COVID-19 instances from chest X-ray pictures utilizing VGG-19, ResNet-50, and COVID-Net. This method is open-source and accessible to the general public. The suggested technique uses a learning rate strategy that sees a learning rate decline when learning becomes inactive for a while. It was trained on the COVIDx dataset using the Adam optimizer. Hernandez et al (Hernandez et al., 2020) suggested a method for detecting cases of infected individuals. Due to the restricted computing resources and the scarcity of the data, Due to the restricted computing resources and the scarcity of data, the researcher developed a unique Convolutional Neural Network (CNN) from scratch using a sizable historical data set of pulmonary X-rays that do not conform to COVID-19. With the use of COVID-19 X-ray pictures, fine-tune the final layers; and ii) use transfer learning by using pretrained CNN models (ResNet, VGG, DenseNet) and COVID-19 data. On this difficult challenge, we were able to get almost 90% accuracy using the second strategy.

(Shi et al., 2021) was created automatically analyse CT scans, extract characteristics, and classify COVID-19 from CAP patients. A 3-level decision tree is used in the suggested technique, known as infection size-aware random forest (iSARF), to divide people into several groups according to the size of infected lesions. Random forests are then used to classify subjects within each group. Through a 5-fold cross-validation, the suggested method's performance was assessed. Support vector machine (SVM), neural network, and logistic regression (LR) are examples of comparison techniques (NN). The average of the five folds produced the mean ROC. With the greatest AUC of 0.942, the suggested approach in particular shows an overall improved ROC curve. With a sensitivity of 0.907, specificity of 0.833, and accuracy of 0.879, these results are the best. SVM performs substantially worse than the LR and NN approaches, which are comparable in performance.

Al-Karawi et al (Al-Karawi et al., 2020) built a framework using machine learning to automatically analyse CT scans, extract features, and classify COVID-19 in CAP patients. The average of the five folds produced the mean ROC. With the greatest AUC of 0.942, the suggested approach in particular shows an overall improved ROC curve. In another study Wu et al,(Wu et al., 2020) proposed a fusion concept-based multi-display coronavirus screening framework based on deep learning techniques. The system took advantage of CNN's ResNet50 variation. The disease dataset was collected from two specialized Chinese hospitals. In the trial, 495 images were used, of which 368 were associated with confirmed cases of COVID-19 and 127 were associated with other pneumonia. In this plan, the dataset is divided into parts for training, testing, and validation which are 80%, 10%, and 10%, respectively. Before the network is developed, all the images considered by the system are reduced to 256,256. The system generated in the test scenario.

Moreover Moutounet-Cartan (Moutounet-Cartan, 2020) created a deep learning-based method to analyze X-ray pictures to detect the new coronavirus and other pneumonia illnesses. For diagnosis, the system employed the CNN architectural versions InceptionResNetV2, InceptionV3, Xception, VGG-16, and VGG-19. A total of 327 X-ray pictures were collected for this investigation, of which 152 instances were from healthy individuals, 125 cases were from COVID-19 patients, and the other 50 cases were from different pneumonia disorders. The 5-fold cross-validation approach is used to divide the dataset. The system determined that the VGG-16 model was the top performer, and it achieved overall accuracy of 84.1%, sensitivity of 87.7%, and AUC of 97.4%, only taking into account COVID-19 instances for sensitivity and AUC. Amyar et al.

(Amyar et al., 2020) discovered a technique for diagnosing COVID-19 patients from CT samples using deep learning. The system comprises of a reconstruction encoder, two segmentation decoders, and a multi-layer perceptron for classification. The dataset used had 1044 instances, of which 449 cases had COVID-19 confirmation, 100 cases came from healthy subjects, 98 samples were from proven lung cancer patients, and 397 cases came from different other pathologies. 595 people were not connected with COVID-19, whereas 449 were co. The dataset was divided into three sets: training, validation, and testing, with respective weights of 80%, 10%, and 10%. The suggested approach has 86% accuracy, 94% sensitivity, 79% specificity, and 93% AUC. Afterwards, Wang et al. (S. Wang et al., 2021) developed a method for COVID-19 diagnosis utilizing the modified-Inception CNN approach. Modified-Inception decreases the dimension of characteristics before to final categorization, which is the main distinction between Inception and modified-Inception. 1040 CT scans were utilized in the experiment, 740 of which were labeled as

COVID-19 and 325 as Normal. The training, testing, and validation sets of the dataset were randomly divided. According to the experimental results, the scheme had test sample accuracy, sensitivity, specificity, precision, and F1-scores of 79.3%, 83%, 67%, 55%, and 63%, respectively. Farid et al. (Farid et al., 2020) proposed a fresh method for categorizing COVID-19 infection using CT image features. Four images with 11 filters were combined with a specially devised hybrid composite extraction method to capture the picture parameters. The COVID-19 and SARS data classes, each with 51 photos, were taken into account by the algorithm. To get a better result, the dataset was divided using the 10-fold cross-validation procedure. The created system achieved f1-scores of 94.11%, 99.4%, 94%, and 99.4%, respectively, for accuracy, precision, and AUC. In another study presented Mehdi et al. (Medhi et al., 2020) A DCNN method for swiftly and accurately detecting COVID-19 infection cases from patient chest X-ray images is proposed. In the studies, chest X-ray of over 150 confirmed COVID-19 patients were taken from the Kaggle data pool, and their performance was validated. The proposed strategy properly predicts the outcomes. Elzeki et al. (Elzeki et al., 2021) presented COVID Network (CXRVN), which has unique deep learning architecture with four convolution layers, and three pooling layers, with one fully connected layer. In many experiments, the GAN data augmentation approach and transfer learning were also used, and the impacts on improving the overall accuracy were successfully demonstrated. whereas the suggested CXRVN model has an average accuracy of 94.5%.

Ozturk et al. (Ozturk et al., 2020) introduced a novel architecture for quick COVID-19 detection utilizing CXR pictures to offer trustworthy diagnostic testing for binary classifications (COVID-19 vs. Normal) and multi-class classifications (COVID vs. Normal vs. and Pneumonia). For binary and multi-class classification, their model had accuracy rates of 98.08% and 87.02%, respectively. In another study Using ResNet in conjunction with CT scans, Xu et al. (X. Xu et al., 2020) were able to detect COVID-19 with an 86.7% performance rate. The majority of this prior research lacks the data necessary to build the model. WAHEED et al. (Waheed et al., 2020) developed a model called CovidGAN that uses Auxiliary Classier Generative Adversarial Networks (ACGAN) to create synthetic chest X-ray (CXR) images. We also show how the synthetic pictures created by CovidGAN may be used to improve CNN's effectiveness in detecting COVID-19. With just CNN, classification produced 85% accuracy. The accuracy went up to 95% when CovidGAN's synthetic pictures were added. We anticipate that this technique will hasten the identification of COVID-19 and result in more reliable radiology systems. The summary of the extracted findings for each paper included in our review is concluded in Table 3.

7. Conclusions

The diagnosis of COVID-19 patients was studied in this review using CT and X-ray image input together with machine learning and deep learning approaches. In order to speed up the screening process with the minimal involvement of medical personnel, a computerized diagnostic system is required to address the lack of testing kits. There were reviewed and discussed on a variety of deep learning architectures put out by researchers. There is currently a dearth in deploying and exploiting AI models in healthcare, despite significant advancements in AI models and the advent of comprehensive research in the field. Numerous researches have examined the issue of classifying and detecting COVID-19, particularly in light of the pandemic's continuing effects.

Before being put into use, these proposed approaches need to be tested on bigger datasets using defined criteria and assessment metrics. In order to examine the data and identify a trade-off between the deep features learned automatically and the characteristics derived by domain expertise, AI researchers need to collaborate closely with skilled radiologists. The majority of the assessed studies also made use of data augmentation to get around the issue of a lack of COVID-19 data. Implementing a GAN network might be utilized to create fresh data as well as make patient severity predictions using symptom period analysis. This article lists every source of utilized datasets that the academic community may readily understand and access.

Deep learning algorithms, however, are not really expected to take the position of doctors or clinicians in clinical diagnosis at this time. It is envisaged that in the

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near future, radiologists and deep learning specialists would work together to develop effective support systems for diagnosing COVID-19-infected individuals.

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Table 3: Summary of the extracted findings for each paper.

Ref.	Method	No. of images	No. of classes	Accuracy
(Sarhan, 2020)	Wavelet transform + SVM	88 COVID-19 pictures and 88 regular photos made up the dataset.	2 (COVID-19, and Normal)	94.5%.
(C. Jin et al., 2020)	ResNet152	(COVID-19 =496, and Normal =1385)	2 (COVID-19 positive, COVID-19 negative)	94.98 %
(Elaziz et al., 2020)	MRFODE +KNN	216 COVID-19 positive 1,675 COVID-19 negative	2 (COVID-19 positive, COVID-19 negative)	Dataset-1= 96.09% Dataset-1= 98.09%
(Yoo et al., 2020)	Decision-Tree	814 (COVID-19 positive 263 COVID-19 negative)	2 (COVID-19, Normal)	first and second decision trees are 98 and 80%, and Third decision tree is 95%.
(Tammina, 2022)	VGG-16 VGG-19 InceptionV3 ResNet-50 DenseNet-121 MobileNetV2	4334 COVID-19 and 1576 Normal Chest X-ray	2 (COVID-19 positive, and Norma)	96 % 95.6% 92.8 % 91.6 % 95% 94.66 %
(Cifci, 2020)	AlexNet, Inception-V4	5800	2 (COVID-19, other pneumonia)	94. 74% 84. 14%
(Gilanie et al., 2021)	proposed model CNN based architecture	Normal = 7021, Pneumonia = 7021 and Covid-19 = 1066	3 (COVID-19, Normal, and pneumonia)	96.68 %
(L. Wang et al., 2020)	VGG-19 ResNet-50 COVID-Net	68 Covid-19 Images, 1203 Normal Images, and 931 Pneumonia Images	3 (COVID-19, Normal, and pneumonia)	83.0% 90.6% 93.3%
(Hernandez et al., 2020)	Custom CNN ResNet50 VGG 16 DenseNet	From 70 different cases, we selected 58 with a frontal perspective	3 (COVID-19, Healthy, and pneumonia)	0.65 % 0.90 % 0.82 % 0.83 %

(Shi et al., 2021)	Logistic Regression (LR) (SVM) neural network (NN). Proposed	CT images of a total of 2685, 1658 patients with COVID-19, and 1027 cases were community acquired pneumonia (CAP)	2 (COVID-19 positive, and community acquired pneumonia (CAP)	0.927 % 0.915 % 0.927 % 0.942 %
(Al-Karawi et al., 2020)	(SVM)	275 positive and 195 negatives	2 (COVID-19, and negative)	95.37 %
(Wu et al., 2020)	ResNet50	(COVID-19 = 368, additional pneumonia = 127)	2 (COVID-19, and pneumonia)	76 %
(Moutounet-Cartan, 2020)	VGG16, VGG19, InceptionResNetV2, InceptionV3, Xception	327 (normal = 152, COVID-19 = 125, and pneumonia = 50)	3 (COVID-19, normal, and pneumonia)	84.1 % 82.0 % 61.2 % 69.1 % 61.4 %
(Amyar et al., 2020)	"Encoder-Decoder with multi-layer perceptron"	1044 (449 for COVID-19, 595 for non-COVID-19).	2 (COVID-19, non-COVID-19)	86 %
(S. Wang et al., 2021)	Modified-Inception	1065 (740 = COVID-19+, 325 = Normal)	2 (COVID-19+, COVID-19-)	79.3 %
(Farid et al., 2020)	CNN	(SARS=51, COVID-19=51)	2 (COVID-19, SARS)	94 %
(Medhi et al., 2020)	Deep Convolutional Neural Network	More than 150 verified COVID-19 patients' chest X-ray photos taken from the Kaggle data.	2 (COVID-19 positive, and normal)	93 %
(Elzeki et al., 2021)	CXRVN model	Set 1 data: 25 Normal COVID-19, 25 Dataset 2: 234 Normal, 221 COVID-19 Dataset 3: 148 Pneumonia, 221 COVID-19, and 234 Normal	2-3 (COVID-19, normal, pneumonia)	94.5 %
(Ozturk et al., 2020)	DarkCovidNet	125 COVID-19 500 Pneumonia 500 No-finding	3 (COVID-19, Pneumonia No-finding)	98.08% for binary classes and 87.02% for multi-class cases%
(X. Xu et al., 2020)	ResNet þ Location Attention	219 COVID-19, 224 Viral pneumonia, and 175 Healthy	3 (COVID-19, Pneumonia, and Healthy)	86.7 %
(Waheed et al., 2020)	Auxiliary Classi_er Generative, Adversarial Network (ACGAN)	72 COVID-19 120 Normal	2 (COVID-19, and Normal)	Before GAN 85.00 % After GAN 95.00%

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Biography

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