Section: Research Paper

A Review on AI Methods for Diagnosing Covid Variants using Radiology Imaging

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Abstract. Medical imaging is the central part for diagnosing and detecting diseases in today's healthcare system. Covid has shut down the whole world with affecting millions of people. Number of deaths and critical cases were more. The medical practitioner's ability to identify coronavirus (COVID-19) is now crucial. Even after vaccination, there are still possibilities to get infected by corona. Covid19 has taken many forms as Delta plus variant, Omicron virus, and now recently NeoCov variant. As a result, identifying the ill people is crucial in preventing the disease from spreading. This research examines the many medical imaging methods used to diagnose the covid19 virus and other infections. Furthermore, an introduction of AI ideas in medical imaging, with an emphasis on various ML and DL approaches. A taxonomy is constructed to categorize the study articles for optimal understanding.

Key words: AI, Deep learning, Machine Learning, Medical imaging modalities, Detection, corona, covid 19, Omicron, NeoCov.

INTRODUCTION

Medical imaging is a critical component of contemporary medicine's better results. The following are examples of medical imaging procedures:

- X-rays are a form of x-ray that is used to diagnose a variety of conditions.
- MRI stands for magenetic resonance imaging(MRI)
- Ultrasound Machines
- The Endoscope
- Imagery that is tactile
- Computed Tomography(CT-scan)

AI (Artificial Intelligence) is enhancing the capacity of medical imaging systems to analyse and assess outcomes. Machine learning is being used to detect issues that are not easily visible to the naked eye. Functional imaging technologies in medicine, such as Positron - Emission (PET) scans, are also valuable diagnostic imaging therapies. Another application of radiology imaging is to determine how effectively your body is reacting to a fracture or condition therapy.

The following is how the paper's format: **Sec - 2** discusses works connected in imaging modalities and radiology imaging for covid 19, utilised in clinical practise. **Sec - 3** examines AI in medical imaging trends, with a focus on Machine learning and Deep learning analytics along with why DL is preferred than ML. The survey tables in **Sec - 4** are subdivided into three. **Table 1**- discusses the two different imaging modalities, namely Xray and CT-scans along with the number of classes, and approaches utilised in recent works for finding covid19. **Table 2**- Survey based on Input data type and Deep learning methods to detect Covid19. Finally, **Table 3** - lists out the papers-based on Machine learning techniques to detect various diseases along with Input dataset sources and findings. **Sec-5** gives an overview of recent works in Fuzzy and Genetic (GA) based algorithms along with a tabular format, followed by overall summary and conclusion.

Medical chest scans must be classified as normal or diseased, which necessitates extensive data gathering and a novel AI module design. Artificial intelligence has made substantial advances in medical diagnosis and medication development. Experts say artificial intelligence will help radiologists and doctors diagnose and identify diseases more

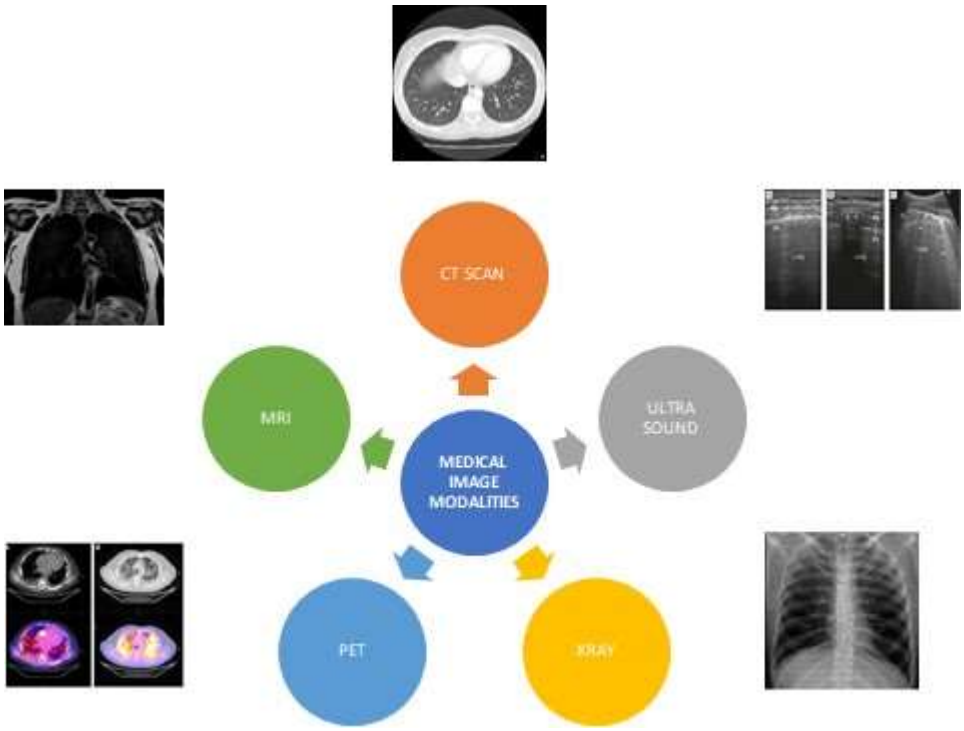

FIGURE 1. Medical Imaging Modalities Types

accurately, leading to improved treatment outcomes. Using contemporary technology like artificial intelligence to build intelligent and self-contained healthcare solutions is becoming increasingly vital. [1]

The study's main goal is to assess current COVID-19 diagnosis and detection methods utilizing DL and ML.

In medical imaging, computer-assisted image processing has shown to be crucial. Recent breakthroughs in artificial intelligence (AI), particularly deep learning, have resulted in a huge advancement in the domain of image interpretation, allowing computers to detect, categorize, as well as measure patterns in medical pictures. [2]

The desire for improving quality and efficacy in clinical therapy was a driving cause behind the introduction of AI in clinical imaging. When compared to the number of qualified readers accessible, data from radiological imaging tends to grow at a rapid rate. As a result, health-care providers have been under pressure to compensate by being more efficient in their image analysis. [3]

High Temperature, Dry Cough, Muscle Aches, Breathlessness, and Headaches are among the most prevalent symptoms of the newly discovered Coronavirus [4], [5], but in rare cases, no symptoms are perceptible (symptomless), making the disease an even greater threat to public. The following are some of the review's major contributions:

1. To provide the examined works and important information in a clear and succinct manner, taking into account crucial components such as the experimental data set and the procedures utilised.

2. To systematically review the ML and DL based models for diagnosis and detection systems from CT- scans and Xray radiology imaging data.

3. In addition to ML and DL based research works, Genetic and Fuzzy based works are also presented.

RELATED WORKS

Medical Imaging Modalities

X-rays and CT scans are powerful instruments, but they must be used with caution due to the presence of ionising radiation. Cancer, cataracts, cellular mutation, and improper foetal development are among risks associated with

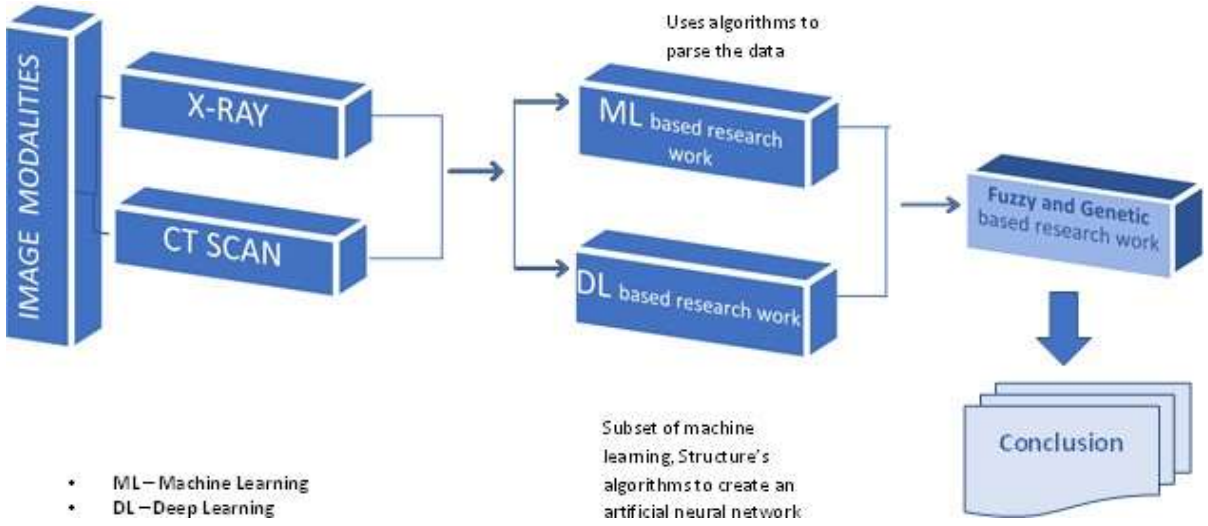

FIGURE 2. Taxonomy of the research work

ionising radiation. MRIs, such as nuclear magnetic resonance (NMR), have fewer side effects and emit no ionising radiation. Ultrasound is one of the safest techniques of medical imaging because it uses ultrasonic vibrations to create images.

Radiological Imaging _ Covid 19 Diagnosis

COVID -19 highly depends on radiological imaging. RT-PCR, on the other hand, employs transcription from the reverse and COVID-19 is detected via a polymerase chain reaction. It has drawbacks that make the sickness that is harder to predict. RT-PCR is indeed a time-consuming, difficult, expensive, and labour-intensive procedure. One disadvantage of this strategy is that it necessitates the use of laboratory equipment, which may be difficult to come by in various countries during emergencies and epidemics. [6]

In order to diagnose COVID-19, radiological imaging, such as X-rays and CT scans, is required. Standard medical and health advice advocate it as the first step in epidemic screening. [7, 8]

Chest radiography images can help diagnose and manage COVID-19, which affects the respiratory system [9]. Corona has adopted several alterations, most recently the omicron form. Unlike other viruses, COVID-19 spreads quickly and capable of taking many forms as delta variant and omicron variant, thus allowing it to rapidly become a worldwide pandemic. Medical and health-care organisations are constantly investigating and analysing it in order to gather more reliable data and develop a better grasp of this essential issue of fast expansion.

In Italy and other countries, X-rays of the chest have long been used as a first-line diagnostic tool [10]. The state of the lungs, as well as the various stages of illness or recovery, can be accurately diagnosed utilising radiological scans [11]. COVID-19 has been classified as among the most dangerous illnesses representing a serious hazard to civilization. Many screening approaches, including as CT scans and X-rays, are regarded as effective procedures for COVID-19 detection and diagnosis [12] – [14]. Traditional healthcare imaging techniques serves as an important and significant part in the pandemic's containment.

LITERATURE SURVEY

AI in MEDICAL IMAGE PROCESS: ML and DL

Artificial Intelligence (AI), a constantly developing in the field of clinical image analysis, software technology is becoming increasingly important., has indeed aided in the fight against the new coronaviruses [15–17] by rapidly

ensuring superior diagnostic accuracy while substantially decreasing the need for human intervention. ML and DL, two important fields of AI, have lately gained a lot of traction in medical applications.

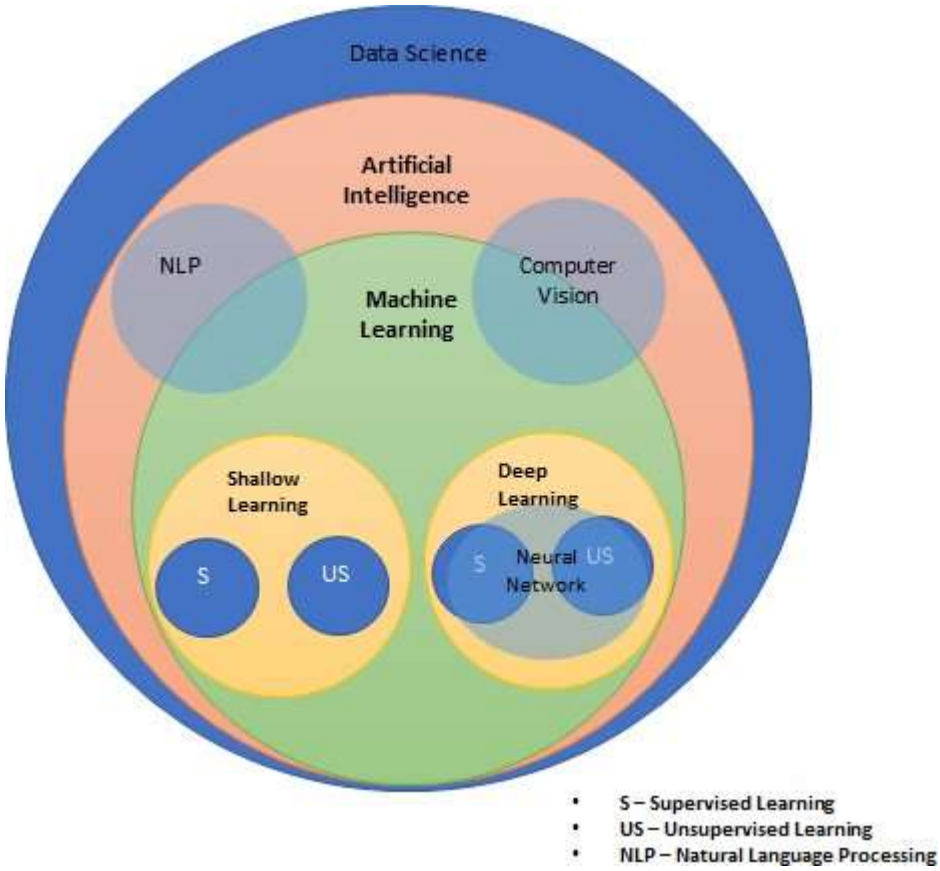

FIGURE 3. AI- Artificial Intelligence Overview

Machine learning is a key field of AI. It involves creating algorithms that can learn from previous data and forecast future ones. Deep learning (DL) approaches have been utilised to dramatically increase image analysis performance in the medical imaging sector [18], [19]. Microscopy photos [20], brain tumour categorization [21], MRI images [22], and retinal photographs [23] are just a few examples of where DL has been used frequently.

In computer vision, speech recognition, medical image analysis, and medication development, deep learning is a strong machine learning technology. A multilayer neural network can predict outcomes from pictures and extract higher level data. Deep learning model training and inference are two phases. With a trained deep learning model, inference is a prediction process. CNN and Recurrent Neural Networks are two common deep learning models. In comparison, CNN is the most widely used, and it may be used to detect/recognize images, classify images, and analyse medical images [26].

To help doctors and radiologists identify radiography images, AI-aided deep learning-based detection methods have been developed [27–29]. The rise of Convolutional Neural Networks (CNNs) has favoured deep learning for most AI issues.

Despite DNN greater performance, traditional machine learning has several benefits over deep learning. Traditional machine learning, for example, can iterate quicker and try out more strategies in less time with less data [30]. Among all classifiers, a machine learning strategy based on the SVM algorithm performed best for COVID-19 diagnosis [31].

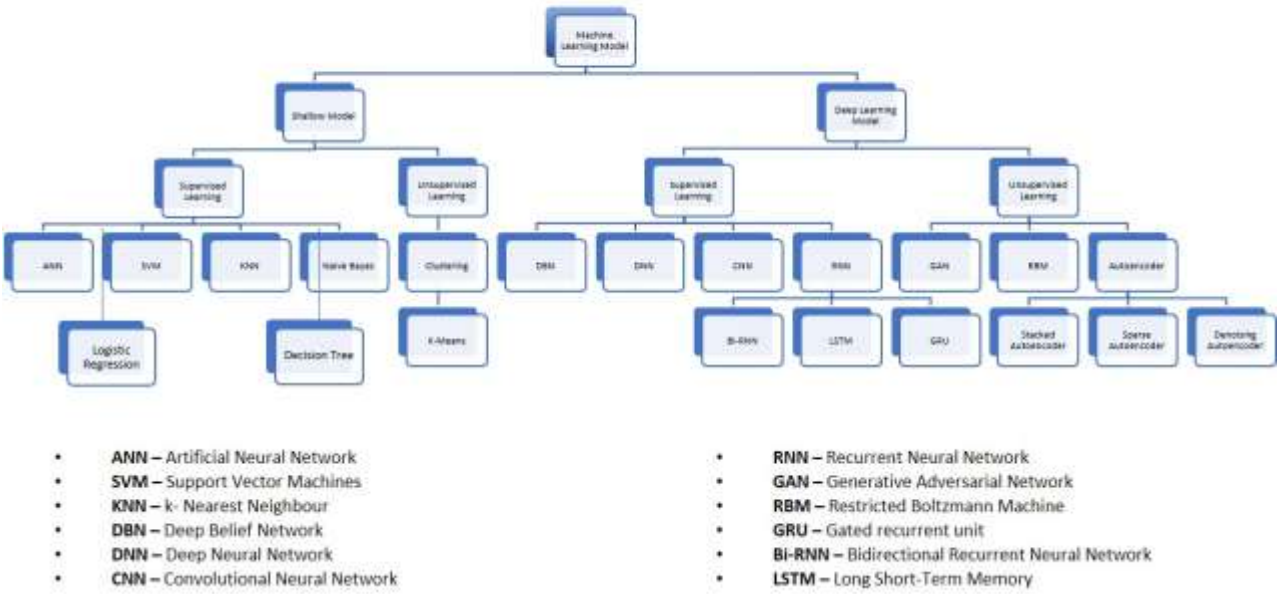

FIGURE 4. Overview of Machine Learning

Machine Learning and Deep Learning

At its most fundamental level, Machine Learning employs algorithms to interpret data, study from it, and make educated judgments depending on what it has discovered. Deep learning develops a self-learning "Artificial Neural Network." Deep Learning is the most human-like AI subset of machine learning. Machine learning can train with smaller data sets and takes less time; however Deep Learning requires big data sets and takes longer to train.

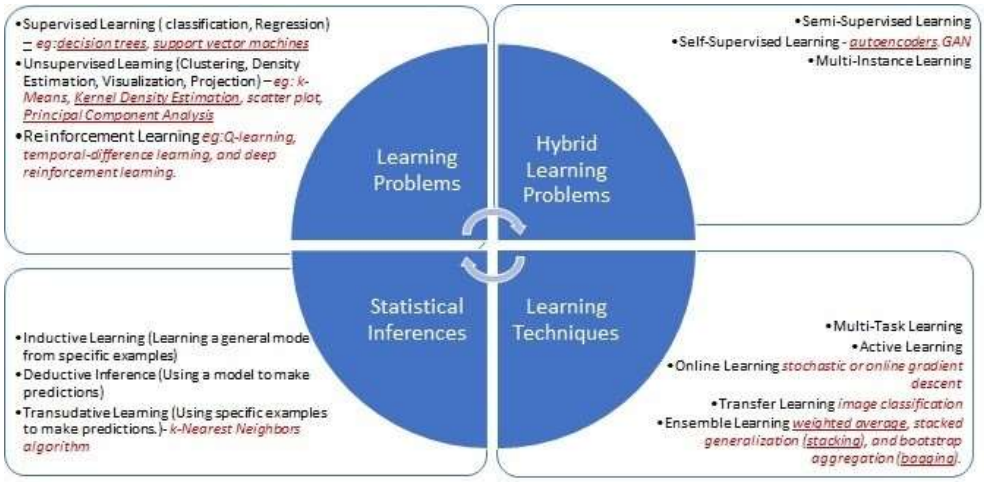

FIGURE 5. Different Types of Machine Learning Techniques

One of the main advantages of DL over other ML approaches is its ability to self-engineer features. A deep learning system will analyse data for aspects that correlate and integrate them to facilitate rapid learning without being explicitly trained.

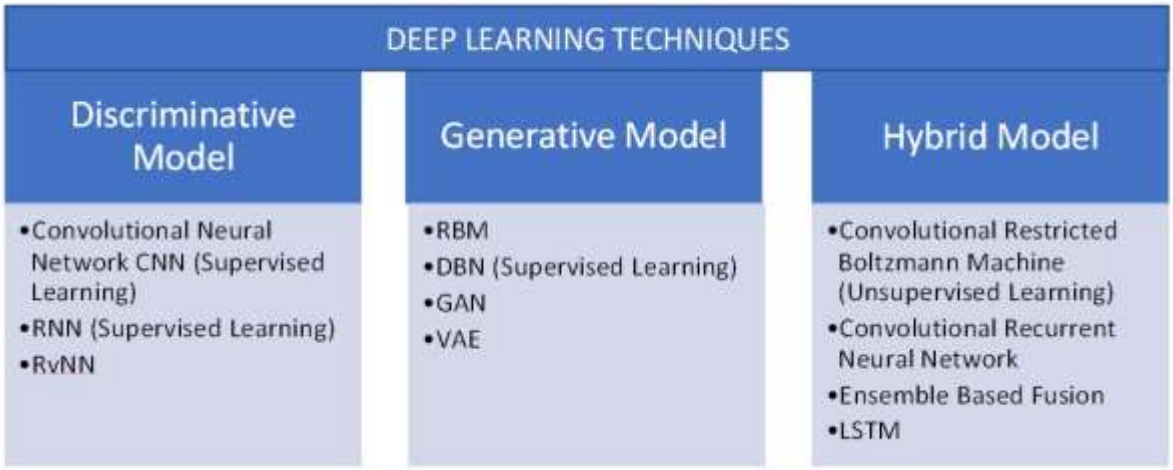

FIGURE 6. Different types of Deep Learning Techniques

Fuzzy and Genetic Algorithm

Computer-aided diagnosis (CAD) in medicine is one of the most common domains where fuzzy logic is used. The power of fuzzy logic resides in its capacity to process nonlinear relationships. In decision making, **Fuzzy Logic** addresses uncertainties, imprecisions, and obscurity. Fuzzy logic enables AI to model complex situations more accurately. For more than two decades, fuzzy machine learning has made a great number of related advances. Learning from data is always fraught with uncertainty. On the other hand, fuzzy inferences membership functions can model and overcome uncertainty using possibility theory. As a result, it appears that using fuzzy inferences in machine learning approaches may generate decent outcomes in most circumstances. In addition, by removing decision boundary constraints, fuzzy rule induction can improve classification accuracy.

The Genetic Algorithm (GA) is a metaheuristic that is based on natural selection and belongs to the Evolutionary Algorithms family (EA). To solve optimization and search problems effectively, Genetic Algorithms utilize biologically inspired operators such as **Mutation, Crossover, and Selection**. Given below are the steps to execute Genetic algorithm,

- Step 1: Generate random population of n chromosomes.
- Step 2: Evaluate the fitness of each chromosome in the population.
- Step 3: Create a new population by repeating the following operations like selection , crossover and mutation. The new offspring is placed in the new population.
- Step 4: Use the new generated population for the further run of the algorithm.
- Step 5: If the end condition is satisfied, stop and return the best solution in current population.
- Step 6: If the termination condition is not satisfied then go to step 2

SURVEYS IN TABULAR FORMAT

TABLE 1. Recent works on CT-SCAN AND X-RAY Imaging Modalities, Methods and No. of classes for diagnosing Covid

S. No	AUTHOR	YEAR/ JOURNAL	INPUT DATA TYPE	METHODS	NO. OF CLASSES
1.	Xiangjun Wu et al. [32]	May2020 Elsevier	CT- SCAN	ResNet-50	2(COVID-19, OTHER PNEUMONIA)
2.	Lin Li et al. [33]	Mar 2020 Radiology	CT- SCAN	Deep Learning ResNet50	3(COVID-19, CAP, NON- PNEUMONIA)
3.	M. Yousefzadeh et al. [34]	May2021 Plus one	CT- SCAN	CNN, DenseNet ResNet Xception EfficientNetB3	2 (COVID19 NON- COVID19)
4.	Cheng Jin et al. [35]	Oct 2020 Nature Communication	CT- SCAN X- RAY	Deep CNN, ResNet152	2(COVID_19+, COVID_19-
5.	XiaoweiXu et al. [36]	Oct 2020 Elsevier	CT- SCAN	Deep Learning ResNet18	3(Covid19 Influenza-A-viral-Pneumonia, Not relevant-to-infection)
6.	BoWang Shuo Jin et al. [37]	Jan2021 Elsevier	CT- SCAN	DPN 92, Inception V3, ResNet50, ResNet50 with 3D UNet++	2(Covid-19 Pos., Covid-19 neg.)
7.	Tahereh Javaheri et al. [38]	Feb2021 npj Digital Medicine	CT- SCAN	Deep Learning BCDU -Net (UNet)	3(Covid-19, CAP, Other Diseases)
8.	Ali Abbasian Ardakani et al. [39]	Jun 2020 Elsevier	CT- SCAN	Alex-Net, VGG 16, VGG 19, Squeeze Net Resnet18 ResNet50 ResNet 101 Xception	2(Covid-19, Normal)
9.	Jun Chen et al. [40]	Nov 2020 Scientific reports	CT- SCAN	ResNet-50 UNet++	2(Covid-19, Other Diseases)
10.	Mehmet Akif Cifci et al. [41]	Apr 2020 IJSR	CT- SCAN	Deep Learning-Inception- V4 AlexNet	2(Covid-19, Other Pneumonia virus)
11.	Ioannis D. Apostolopoulos & Tzani A. Mpesiana et al.	APR2020 Springer	X- RAY	Transfer Learning, Deep Learning VGG19,	3(Covid-19, Pneumonia, Normal)

	[42]			MobileNetv2 Inception ResNetv2	
12.	Mohamed Loey et al. [43]	Apr 2020 symmetry	X- RAY	GAN, AlexNet, GoogleNet ResNet18	4(Covid, Normal, Pneumonia_ bact, Pneumonia_ virus)
13.	Sethy and behra et al. [30]	Apr 2020 Researchgate	CT- SCAN X- RAY	Machine learning, Deep Learning, transfer Learning	2(Covid19+, Covid19-)
14.	ShervinMinaee et al. [44]	Oct 2020 Elsevier	X- RAY	ResNet-18, ResNet-50, SqueezeNet DenseNet-121	2(Covid19, Non-Covid)
15.	Narinder Singh Punn et al. [45]	Oct 2020 Springer	X- RAY	Deep Learning, ResNet Inception V3, DenseNet169 ResNet-V2 NASNetLarge	3(Covid 19, Pneumonia, Normal)
16.	Ali Narin et al. [46]	May 2021 springer	X- RAY	Deep Transfer Learning, CNN Inception V3 Inception-ResNet V2, ResNet 152	2(Covid19, Normal)

TABLE 2. Survey based on Machine Learning Techniques for Detecting Various Diseases with Input Dataset Sources and Findings

S.NO	REF NO.	YEAR	DISEASES	ML METHODS	DATASET SOURCE	FINDING
1.	[47]	2020	Skin cancer	SVM and KNN	The information was gathered from ISIC 2017 datasets with 1000 instances.	The SVM classifier outperforms with 97.8 percent accuracy and a 0.94 AUC score.
2.	[48]	2020	Thyroid disease	Naïve Bayes, KNN, and SVM algorithm.	UCI data repository site	Better cost and facility administration are required for thyroid patients' treatment.
3.	[49]	2020	liver fibrosis	Random forests, MLP, logistic regression algorithm.	Ain Shams University's Faculty of Medicine at El Demerdash Hospital gathered the data.	In this research, MLP had the greatest predictive performance other than ML techniques.
4.	[50]	2020	Cardio Vascular	RF, DT, LR, SVM & K-NN.	NIDDK.	Under the study of categorising CVD victims, the random forest is outperformed by all classifiers.
5.	[51]	2020	Lung cancer	SVM, Random Forest, ANN algorithms	UCI machine learning repository	The system can distinguish between benign and malignant tumours, and textural and region-based ANN have higher accuracy.
6.	[52]	2020	Prostate cancer	SVM, Decision Tree, and MLP algorithm.	github.com	Efficient for both non-prostate and prostate cancer detection.
7.	[53]	2020	Alzheimer	SVM, decision tree algorithm	ADNI database	The model forecasts the patient's condition and differentiates among cognitive problems and dementia.
8.	[54]	2019	Leukemia Cancer	SVM, KNN, Naïve Bayes, and Decision Tree (C4.5) algorithms	Microarray dataset	Microarray dataset accuracy rate and performance results are superior to that of other classification method.

9.	[55]	2019	Hepatitis (A, B, C, and E)	KNN, random forest, and naïve Bayes algorithm.	Real data of hepatitis patients	The suggested technique is suitable for detecting the hepatitis virus.
10.	[56]	2019	Heart	KNN, Random Forest, Logistic Regression, and Ensemble Method algorithms.	UCI dataset	The ensemble technique outperforms each classifier separately in terms of accuracy.
11.	[57]	2019	Atherosclerosis	ANN, KNN, K-medoids, and K-mean algorithm.	The University of California Irvine's Cleveland heart disease database.	The suggested approach might aid in the development of a more efficient clinical detection method for atherosclerosis.
12.	[58]	2019	Brain Tumors	SVM, KNN, RF, algorithm	A total of 33 patients were represented by Rembrandt image planes, with an average of 20 photos per subject.	In comparison to other approach, SVM is more accurate.
13.	[59]	2019	Diabetic Eye	SVM algorithm	FLIR.com 283 eye thermal images	The results show that tailored IR thermal imaging devices may be used to diagnose diabetic thermal vision disorders.
14.	[60]	2018	Thyroid	SVM, KNN, Decision Trees algorithm	The UCI machine learning repository	As a result of the reduced set of parameters, the patient saves both time and resources.
15.	[61]	2018	Breast Cancer	ANN and the logistic algorithms	Wisconsin Breast Cancer Database.	Without particular medical understanding, ANN is capable of assessing key human data and performing pre-diagnosis.
16.	[62]	2018	Chronic Kidney	K-Means and SVM algorithm	UCI Machine Learning Website.	The RBF is the finest kernel approach in the SVM.
17.	[63]	2018	Liver	LR, K-NN, & SVM Techniques	Indian Liver Patient Dataset (ILPD).	KNN and Logistic Regression exhibit good accuracy, while Logistic Regression does have the maximum sensitivity. As a result, logistic regression seems to be a better model.
18.	[72]	2021	Covid_19	Machine learning-	Github -JP Cohen,	Better prediction

				SVM	Kaggle Repository	Accuracy among other classifiers in covid19 diagnosis.
19.	[84]	2020	Covid_19	KNN	"Covid19 CT segmentation dataset;" "Chest X-RAY (Radiopaedia)"	The KNN classifier has improved accuracy compared with RF, SVM-RBF, and DT.
20.	[85]	2020	Covid_19	LSTM	Radiopaedia and cancer imaging archive websites	Improved classification performance of LSTM to discriminate between COVID19, Pneumonia and healthy.
21.	[86]	2020	Covid_19	Machine learning-SVM	From the Italian society of medical and Interventional Radiology.	The proposed method outperforms with better accuracy results.
22.	[87]	2020	Covid_19	KNN	"Cohen JP -Xray image datasets", "Italian society of medical and Interventional radiology Covid19 database"	Proposed approach achieved high accuracy among other DNN.

TABLE 3. Survey based on Input data type and Deep Learning Methods to detect Covid19

S.NO	AUTHORS	YEAR/ JOURNAL	INPUT DATA TYPE	METHODS/TECHNIQUES USED
1	Elene Firmeza Ohata et al. [64]	Jan2021 IEEE	X-RAY	CNN, Mobile net with SVM, Transfer Learning
2	MD. Milon islam et al. [65]	Feb2021 IEEE	CT-SCAN X-RAY	Deep Transfer Learning
3	Aras M. Ismael et al. [66]	Sep 2020 Elsevier	X-RAY	Deep Learning, CNN
4	Sowmya Ranjan Nayak et al. [67].	Nov2020 Elsevier	X-RAY	CNN, ResNet 34
5	Ozturk et al. [11]	June2020 Elsevier	X-RAY	Machine Learning, DarkCovidNet.
6	Rekha Rajagopal et al. [68]	June 2021 springer	X-RAY	CNN, Transfer learning, CNN Feature Extraction +SVM, CNN + XG BOOST

7	Mustafa Ghaderzadeh et al. [69]	Mar2021 Healthcare engineering	CT-SCAN X-RAY	CNN Models
8	Sadman sakib et al. [70]	Sep2020 IEEE	X-RAY	Deep Learning, CNN, GAN
9	Rachna Jain et al. [71]	Oct 2020 Springer	X-RAY	Xception, Inception net v3, ResneXt, CNN
10	Shuai Wang et al. [8].	Feb 2021 Springer	CT-SCAN	Deep Learning M- Inception
11	Sohaib Asif et al. [73].	Sep2021 IEEE	X-RAY	Deep Convolutional Neural Network

Table 4. Survey based on Recent works on Fuzzy and Genetic Algorithm

S.NO	AUTHORS	YEAR/ JOURNAL	METHODS	MERITS AND LIMITATIONS
1	Rohit Kundu et al. [74].	Elsevier 2021	Sugeno Fuzzy integral based CNN	Improved Accuracy, false positive rate is low. Unable to classify mild covid situations.
2	A. Senthilselvi et al. [75].	Springer 2021	Adaptive Neuro Fuzzy inference system, genetic algorithm + Fuzzy logic System, Gravitational search algorithm + Fuzzy, Mean Filter (MNF) and median Filter (MDF)	ANFIS performs better than FIS with optimization algorithm. Maximum PSNR when compared with other methods.
3	Upendra Kumar Acharya et al. [76].	Elsevier 2021	GAAHE method- Genetic Algorithm based Histogram Equalization	Enhanced visibility of low contrast medical images, less information loss and more anti-noise performance.
4	Dilbag Singh et al. [77].	IEEE 2021	MMCGA - Modified Multi-Crossover Genetic Algorithm based DCov-Net.	Increased computation speed. Better Accuracy for screening Covid.
5	M. Jayalakshmi et al. [78].	Tech Science 2021	Fuzzy rule-based Engine.	Improved performance in accuracy, specificity and efficiency. Data loss of transferring 30GB per day is less than 0,64 percent.
6	Majid Ghasemi et al. [79].	Springer 2020	AFDL method - Adaptive Fuzzy Dictionary Learning, SIMCO, MOD, K-SVD.	Improved accuracy and sensitivity. AFDL out performs other dictionary learning techniques.
7	Sourabh Katoch et al. [80].	Springer 2020	Genetic Algorithm	Information about each component of GA.

8	G. Thippa Reddy et al. [81].	Springer 2020	AGAFL – Adaptive Genetic algorithm with Fuzzy logic	Efficently handle noisy data avoids entrapment in local optimum. AGAFL outperforms than other hybrid combination methods.
9	Sayantari Ghosh et al. [82].	Elsevier 2020	Sequential Evolutionary Genetic Algorithm Epidemiological model, Probablistic Cellular Automata, PCA using GA.	Performs robust prediction with limited data.
10	Vigneshwari K et al. [83].	Turkesh 2021	GAFLICM, HKCNN.	Better Accuracy and less time. Improved Detection results when compared to other classifiers.

SUMMARY

Computer Aided Detection's purpose is to detect and locate anomalous or suspicious areas in structural images, alerting doctors. The goal of CADe is to improve the identification rate of sick areas while lowering the false-negative rate, which might occur owing to human mistake or weariness. This is possible by the use of AI methods for diagnosing Covid and other lung diseases. In medical imaging, computer-aided detection (CADe) is well-known, but deep learning algorithms have improved its efficacy. According to studies, CT scans and X-rays are commonly used to identify Covid 19 and other lung disorders. Although there are other imaging technologies for detection, CT scan and Xray provide the best results. A collection of publications based on machine learning for detecting various diseases is also offered in a tabular style. Finally, Fuzzy and Genetic Algorithm based research works are also provided in table 4. The Input data type, AI techniques, and number of classes utilised to detect the Covid 19 are all clearly described in this survey.

CONCLUSION

Deep Learning CNN models are the most often employed approach by researchers for improved outcomes, according to this review. Since the virus has taken many forms as delta plus variant, omicron variant, and NeoCov variant, maximum number of datasets are needed to effectively detect the virus. Using real datasets as inputs, the researcher can apply Machine Learning or Deep Learning methodologies. In Future, Deep learning models can classify the different variants of Covid based on the affected regions as Covid19, Deltaplus variant, Omicron variant and NeoCov variant. CT-Scans and X-Ray imaging gives better results for finding the affected regions in lungs. With maximum datasets in Deep Learning CNN models, Fuzzy and Genetic Algorithm can be used for better optimization and classification performance results.

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