Deep Learning approaches for X-ray image classification

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Abstract -COVID-19 is found in December 2019 across the world and become a major health problem. To test Covid-19 RT-PCR (Real-time reverse Transcription Polymerase Chain Reaction) test is used which is very time consuming and specific and its sensitivity is also variable. We can use X – ray images or CT (Computerized Tomography) scan images to identify affected lung areas. So main aim is to study different deep learning techniques like GAN (Generative Adversarial Network), Extreme Learning Machine (ELM), Long /Short Term Memory (LSTM), CVOIDX-Net framework, Confidence-Aware Anomaly Detection (CAAD) model, an anomaly detection module, Segmentation , NN (Neural Network) for image classification and work on a technique that gives effective result as well as cost effective. So using Image Classification of X ray and CT Scan Images of lungs , we can identify whether the patient is Covid-19 positive or not and if not covid-19 positive than any other virus pneumonia fiver

***Key Words*:** CAAD, CNN methods, COVID-CXNET, Covid-net, Deep Transfer Learning, ELM, GAN, LSTM.

1. INTRODUCTION

The coronavirus disease (COVID-19) pandemic emerged in December 2019 and became a serious public health problem worldwide. COVID-19 is caused by the coronavirus-2 that causes severe acute respiratory illness (SARS-CoV-2). Coronaviruses (CoV) are a large group of viruses that cause illnesses like Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS). COVID-19 is a new disease found in 2019 and has not been previously recognized in humans. The world is now battling the COVID-19 outbreak. The number of people dying from pneumonia caused by the SARS-CoV-2 virus is increasing every day. The following is how the rest of the paper is laid out: Section 2 describes Literature Summary. Section 3 describes Materials and datasets. Section 4 describes experimental results and section 5 shows Conclusion.

Machine Learning and Deep Learning:

Machine learning has various methods to teach computers to do tasks where no algorithm is available. It trains computers to learn from given data so they carry out certain tasks. There are two kinds of machine learning.

1. Supervised learning: The computer is trained with example inputs and their desired outputs, given by a "teacher", and the aim is to learn a rule that maps inputs to outputs.

2. Unsupervised learning: Like supervised algorithm, no labels are given to the unsupervised learning algorithm, it learns on its own to find hidden patterns in data.

Deep Learning: A sub method of artificial intelligence known as deep learning consists of networks that can learn unsupervised from unstructured or unlabeled data. The capability of deep learning is to extract higher-level features from input data using layers of machine learning algorithms. Edges in an image may be identified by a lower layer, while a higher layer may identify human concepts such as letters, faces, or digits. Deep-learning having various architectures such as deep neural networks, recurrent neural networks and convolution neural networks which have been applied in fields like a few examples are computer vision, Speech recognition, natural language processing, audio recognition, social network filtering, machine translation, bioinformatics, and machine translation, machine vision, drug design, and medical image analysis.

Chest radiography (X-ray) is one of the most important methods used for the diagnosis of pneumonia. A chest X-ray is a quick, low-cost, and widely used healthcare procedure. An X-ray of the chest has a lower radiation dose than computed tomography (CT) or magnetic resonance imaging (MRI).

X-ray images require expertise and experience to determine the correct diagnosis, however. It is much more difficult to diagnose using a chest X-ray than other imaging modalities such as CT or MRI.

Only a specialist physician can diagnose COVID-19 based on a chest X-ray. The number of specialists who can make this diagnosis is few than the number of normal doctors. Even in normal times, the number of doctors per person is less in countries around the world. Disasters such as COVID-19 pandemic, demanding health services at the same time is impossible due to the insufficient number of hospital beds and health staff.

Also, COVID-19 is a highly infectious disease, and doctors, nurses, and volunteers are most at risk. Early diagnosis of pneumonia has a vital importance both in term of slowing the speed of the epidemic by quarantining the patient and in the recovery process of patient.

Doctors can diagnose pneumonia from the chest X-ray more quickly and accurately due to computer-aided diagnosis (CAD). Use of artificial intelligence methods are increasing in the field of medical services. Integrating CAD methods into radiologist diagnostic systems greatly reduces the workload of doctors and increases reliability and quantitative analysis.

2. Literature Summary

All Research paper are studied in domain deep learning and sub domain image Classification

Sr No	Paper Title/ Year of Publication	Method	Data Set
1	Detecting COVID-19 in X-ray images with Keras, Tensor Flow, and Deep Learning[1]	Noisy-or Bayesian function(Confidence Score),Keras, Tensor Flow machine learning library	X ray image data set of libraries keras tensor flow
	June 2020		
2	Lung Infection Quantification of COVID-19 in CT Images with Deep Learning[]	DL--Based Segmentation Network: VB-Net Human in the loop (HITL) strategy	300CT images from300COVID-19 patients(from Shanghai)
	30 March 2020		
3	Rapid AI Development Cycle for the Corona virus (COVID-19) Pandemic: Initial Results for Automated Detection & Patient Monitoring using Deep Learning CT Image Analysis	2D Slice Analysis, 3D Volume Analysis (Nodules and opacity)	China and U.S image data set
	March12, 2020		
4	A Generative Adversarial Network-based Deep Learning Method for Low-quality Defect Image Reconstruction and Recognition[]		
	August 11,2020		
5	Artificial Intelligence and COVID-19: Deep Learning Approaches for Diagnosis and Treatment[]	(GANs),Extreme Learning Machine (ELM), (LSTM), RNN	Covidx
	June 24, 2020.		
6	COVID-Net: A Tailored Deep Convolutional Neural Network Design for Detection of COVID-19 Cases from Chest X-Ray Images	COVID-Net, covidx data set (VGG 19, ResNet-50)	(DCNN)s
	11 May 2020		
7	COVIDX-Net: A Framework of Deep Learning Classifiers to Diagnose COVID-19 in X-Ray Images	COVIDX-Net-Visual Geometry Group Network (VGG19)	clinical X-VIRAL dataset, X COVID dataset
8	Viral Pneumonia Screening on Chest X-rays Using Confidence-Aware Anomaly Detection	CAAD (Confidence-Aware Anomaly Detection) - X viral dataset, Feature extractor	Covid x
	27 September 2020		
9	COVID-ResNet: A Deep Learning Framework for Screening of COVID19 from Radiographs	COVID-ResNet, Covidx dataset,	Covid x

10	Towards an Effective and Efficient Deep Learning Model for COVID-19 Patterns Detection in X-ray Images 9 July 2020	CNN- VGG, ResNet, EfficientNet - Mobile Inverted Bottleneck Conv (MBconv)	RSNA Pneumonia Detection Challenge dataset, COVID-19 image data collection, COVIDx dataset
11	COVID-CXNET: DETECTING COVID-19 IN FRONTAL CHEST X-RAY IMAGES USING DEEP LEARNING	COVID-CXNET -Contrast Limited Adaptive Histogram Equalization (CLAHE)	EuroRad, SIRM (Society of Medical and Interventio nal Radiology)
	29 July 2020		
12	Covid-19: automatic detection from X-ray images utilizing transfer learning with convolutional neural networks	CNN with transfer learning VGG19, MobileNet v2 , Inception, Xception, Inception ResNet v2	(a) (RSNA), (b) SIRM)
13	Prediction and analysis of COVID-19 positive cases using deep learning models: A descriptive case study of India	(RNN) based long-short term memory (LSTM) variants such as Deep LSTM, Convolutional LSTM and Bi directional LSTM	Indian dataset
	20 May 2020		
14	Research on Recognition Method of COVID-19 Images Based on Deep Learning	CNN Methods	
	December 11, 2020		
15	COVID-19 Detection in Chest X-Ray Images using a New Channel Boosted CNN	CNN- Channel boosting- Split Transform mergeing (STM), CB-STM-Renet	CoV-Healthy-6k,CoV-NonCoV-10k,CoV-NonCoV-15k Chest X-Ray images
16	Fighting together against the pandemic: learning multiple models on tomography images for COVID-19diagnosis	Image augmentation, transfer learning, Ensemble learning	COVID-19 related papers published in medRxiv, bioRxiv, NEJM, JAMA, Lancet
	2 Dec 2020		
17	StackNet-DenVIS: a multi-layer perceptron stacked ensembling approach for COVID-19 detection using X-ray images	StackNet-DenVIS-> screening process- transfer learning, Stacked Generalization, GAN	(1) Chest X-ray Images [dataset] (2) Covid-19 chest X-ray data [dataset] (3) Covid-19 radiograph y database dataset](4) Covid-19 Chest X-ray dataset [dataset].
	21 November 2020		
18	Covid-19 Classification Using Deep Learning in Chest X-Ray Images	CNN-ResNet, Transfer learning	SIRM, data set , Chestvx-ray images data set
19	On Transfer Learning for Classifying COVID-19 in Chest X-Rays Images	14 CNNs- Transfer learning	ImageNet
20	Convolutional-Neural-Network-Based-Classification-of-Patients-with-Pneumonia-using-X-ray-Lung-Images	Linear Discriminant Analysis (LDA), Ensemble transfer learning based, Logistic Regression	Optical Coherence Tomograph y (OCT) and Chest X-Ray images
21	Fast deep learning computer-aided diagnosis of COVID-19 based on digital chest x-ray images	data augmentation, transfer learning, and abnormality localization with different backend deep learning networks: ResNet18, ResNet50, ResNet101, and	ChestX-ray

		SqueezeNet.	
22	Artificial Intelligence applied to chest X-Ray images for the automatic detection of COVID-19. Athoughtful evaluation approach	CNN methods	chest XR datasets
	29 Nov 2020		
23	Using CFW-Net Deep Learning Models for X-Ray Images to Detect COVID-19 Patients	convolutional neural network, CFW-Net, based on the CFWE (channel feature weight extraction)module.	chestxray-dataset
	17 Nov 2020		
24	UNCERTAINTY-DRIVEN ENSEMBLES OF DEEP ARCHITECTURES FOR MULTICLASSCLASSIFICATION. APPLICATION TO COVID-19 DIAGNOSIS IN CHEST X-RAY IMAGES	Bayesian Deep Learning approach, Multi-level Ensemble Classification	CXR images
	27 Nov 2020		
25	An automatic approach based on CNN architecture to detect Covid-19 disease from chest X-ray images	(AlexNet, GoogleNet, ResNet-50, Se-ResNet-50, DenseNet121, Inception V4, Inception ResNet V2, ResNeXt-50, and Se ResNeXt-50).	X ray data set
	9 October 2020		
26	An Image Segment-based Classification for Chest X-Ray Image	CXR Classification-ResNet 18, ResNet 50, Xception	CXR images from U.S. National Library of Medicine (NIH)
27	Understanding Automatic COVID-19 Classification using Chest X-ray images	CNNs	X ray dataset
28	Explainable-by-design Semi-Supervised Representation Learning for COVID-19Diagnosis from CT Imaging	(i) a novel conditional variational autoencoder (CVAE)	COVID-19 CT data-set
	2 Dec 2020		
29	Attention-based VGG-16 model for COVID-19 chest X-ray image classification	VGG-16 and the attention module	
	31 October 2020		
30	An efficient mixture of deep and machine learning models for COVID-19 diagnosis in chest X-ray images	Transfer learning, CNN VGG16, InceptionV3, ResNet50, DenseNet121, Xception	ChestX-ray14 dataset, covidx
	17 Nov 2020		
31	A novel hand-crafted with deep learning features based fusion model for COVID-19 diagnosis and classification using chest X-ray images	FM-HCF-DLF model	Chest X-ray dataset.
	6 October 2020		
32	MULTI SCALE ATTENTION GUIDED NETWORK FOR COVID-19 DETECTION USING CHEST X-RAY IMAGES	MAG- SD	CXR image dataset
	11 Nov 2020		

Table 1: Literature Summary

3. Materials and Methods

3.1 Dataset

In this study, chest X-ray images of COVID-19 patients have been obtained from the different dataset like Deep convolutional neural networks (DCNNs), CXR image

dataset, covid x, COVID-19 CT data-set, thorax CXR images from U.S. National Library of Medicine (NIH), (https://github.com/ieee8023/covid-chestxray-dataset), Labeled Optical Coherence Tomography (OCT) and Chest X-Ray images for Classification, ImageNet, COVID-19 related papers published in medRxiv, bioRxiv, NEJM, JAMA, Lancet, CoV-Healthy-6k, CoV-NonCoV-10k, CoV-NonCoV-15k, Chest X-Ray images, Indian dataset, Radiological Society of North America (RSNA), Radiopaedia, Italia Society of Medical and Interventional Radiology (SIRM), NEU dataset.Deep convolutional neural networks (DCNNs) are one of the powerful deep learning architectures and have been widely applied in many practical applications such as pattern recognition and image classification in an intuitive way [30]. As follows, DCNNs can handle four kinds of situations: 1) training the neural network weights on very large available datasets; 2) fine-tuning the network weights of a pre-trained DCNN based on small datasets; 3) Applying unsupervised pre-training to initialize the network weights before putting DCNN models in an application; and 4) using pre-trained DCNN is also called an off-the- shelf CNN being used as a feature extractor.

3.2 Methods

3.2.1 DL-Based Segmentation Network: VB-Net

CT scans are segmented into COVID-19 infection regions using DL-based segmentation using "VB-Net" neural networks.It uses human-in-the-loop (HITL) strategy is adopted to loop (HITL) strategy to assist radiologists to refine automatic annotation of each case. It uses 1×1×1, 3×3×3 and 1×1×1 convolution kernels, where 1×1×1 reduces s the number of channels and feeds the data for a regular 3×3×3 kernel layer processing, and then the channels of feature map restored by another 1×1×1 kernel layer.

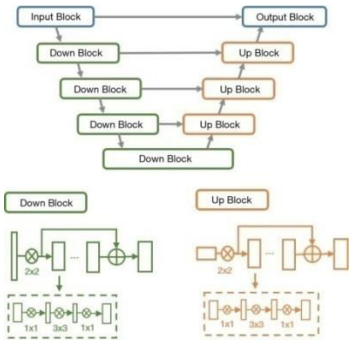

Figure1 : DL based segmentation

3.2.2. 2D Slice Analysis, 3D Volume Analysis [3]

Subsystem A: 3D analysis of the case volume for nodules and focal opacities using existing, previously developed algorithms; and Subsystem B: newly developed 2D analysis of each slice of the case for detecting and localizing diffuse opacities that may represent Corona viruses.

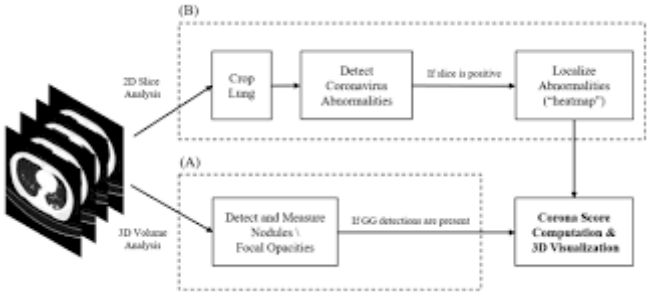

Figure 2: 2D Slice Analysis, 3D Volume Analysis [3]

3.2.3. GAN for Low-quality Defect Reconstruction [4][5]

GAN is fixed to reconstruct the low-quality defect images, and the reconstructed images are used to train the VGG16 network.

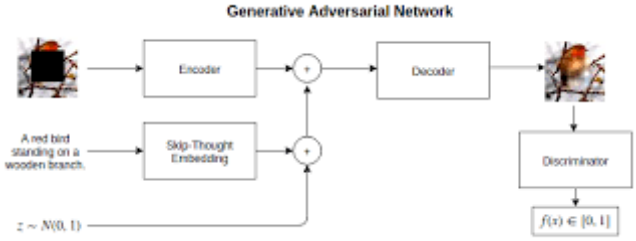

Figure 3: GAN using encoder and decoder

3.2.4. Covid-Net [6][7]

This open source project works to detect COVID-19 cases from CXR images, using deep convolutional neural networks. As COVID-Net uses a method to explain predictions, clinicians can gain greater understanding into critical factors associated with COVID cases, which can aid in screening as well as boost trust and transparency in accelerated computer-aided screenings performed using COVID-Net. While maintaining computational efficiency, it provides enhanced representational capacity.

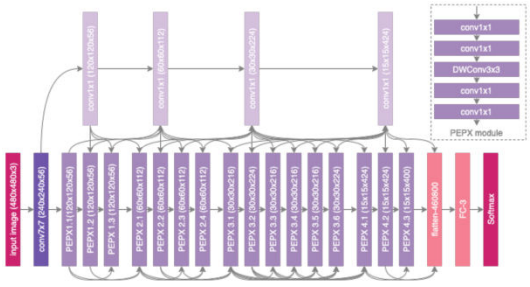

Figure 4: Covid-net architecture

3.2.5. CAAD (Confidence-Aware Anomaly Detection) [8]

CAAD is a confidence-aware anomaly detection model that comprises of a feature extractor, an anomaly

detection module, and a confidence prediction module. If the anomaly score produced. An input will be accepted as an anomaly case (i.e., viral pneumonia) if the confidence score estimated by the anomaly detection module is large enough.

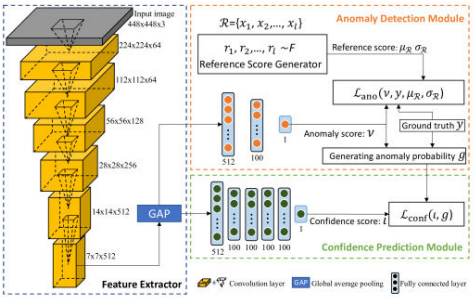

Figure 5: CAAD model

3.2.6. Covid Res-Net [9]

We present a 3-step method for enhancing the performance of a pre-trained ResNet-50 architecture and reducing the training time. As input images are resized to 128x128x3, 224x224x3, and 229x229x3 pixels, the network is fine-tuned at each stage.

3.2.7. COVID-CXNet1[11]

The proposed model includes a CheXNet-based CheXNet model that is fine-tuned for the COVID-19 CXR dataset. CheXNet is constructed using a variety of architectures, out of which DenseNet has shown better results in detecting lung diseases. fine-tuning on a larger dataset along with several overfitting-prevention methods such as dropout layer and naming smoothing will offer assitance our model beat in terms of accurately localizing pneumonia in CXRs.

3.2.8. Recurrent neural network (RNN) based long-short term memory (LSTM) [13]

LSTM illustrate with slightest botch is chosen for anticipating each day and week by week cases. Significant LSTM/Stacked LSTM -there are various secured up layers with diverse memory cells. Stacking distinctive layers increases the significance of the neural frameworks where each layer contains a few information and passes it on to the another. Convolutional LSTM (Conv-LSTM)-In convolutional LSTM , the input x vector,cell surrender vector y , secured up state vector h and the entryways(i t , f t , o t) are 3D tensors with the ultimate two estimations as spatial estimations. Bi LSTM – it comprises of forward pass.

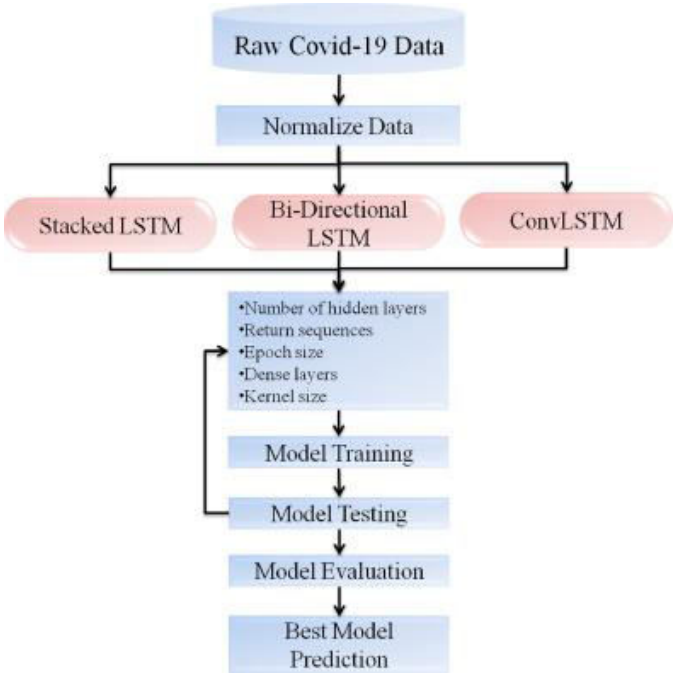

Figure 6: LSTM

3.2.9. Channel Boosted STM-RENet (CB-STM-RENet) [15]

Radiographic data exhibits large variations in images; thus, robust CNN is required for good discrimination. The discrimination ability of the proposed STM (Split Transform and Merge)-RENet is enhanced by exploiting Channel Boosting. The idea of Channel Boosting is used for solving complex problems. Within the proposed procedure, Channel Boosting is performed by producing assistant highlight channels from two pre-trained systems by means of TL to make strides the execution of STM-RENet.

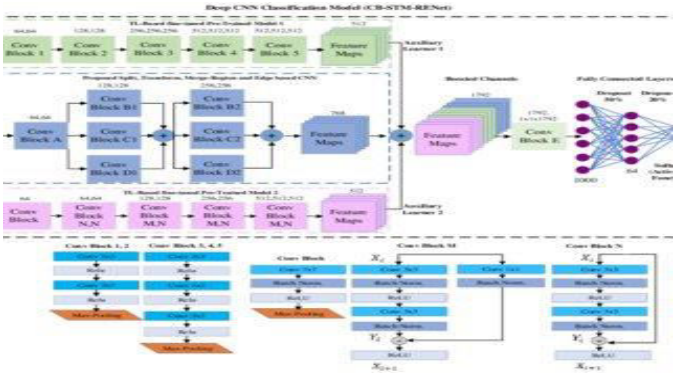

Figure 7: CB-STM-RENet

3.2.10. StackNet-DenVIS [17]

StackNet-DenVIS, which was supposed to be used as a screening tool, has been conducting existing swab tests for some time now. The show tries to reduce the Untrue Negative rate of classification using an innovative approach that combines Exchange Learning and Stacked Generalization.

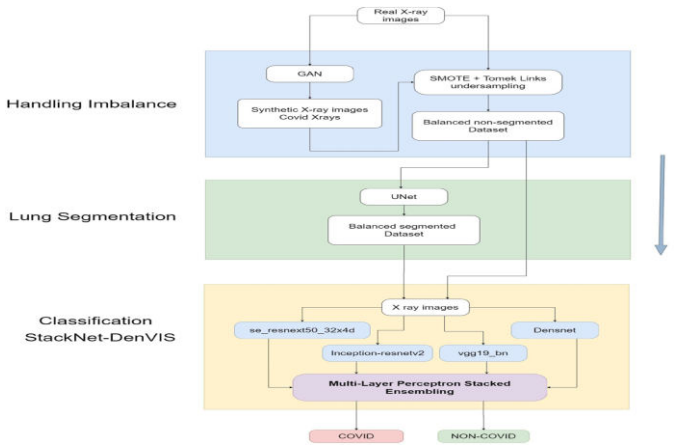

Figure 8: Stacknet-DenVIS

3.2.11. CFW-Net Deep Learning Models [23]

We designed the channel highlight weight extraction (CFWE) module in accordance with the features of chest X-ray images, and presented an unexplored convolution neural network, CFW-Net, based on the CFWE module.. one completely associated (FC) layers, worldwide normal pooling fully-connected (GFC) module and point convolution worldwide normal pooling (CGAP) module. The latter two methods contain fewer parameters, require less calculation, and work better in real time.

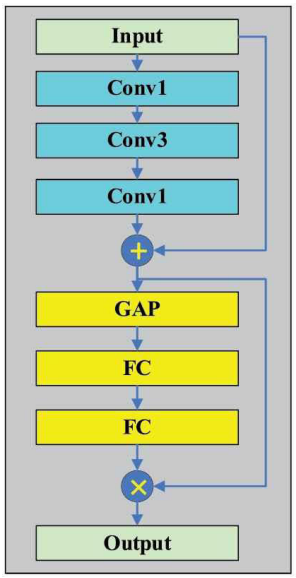

Figure 9: CFWE module

3.2.12. conditional variational autoencoder (CVAE) [28]

We optimized the design of two different systems for CT images: I a novel conditional variation auto encoder (CVAE) with a unique engineering that coordinates the lesson names inside the encoder layers and employs side data with shared consideration layers for the encoder, which make the most important clues for representation learning, and (ii) a downstream convolution neural organize for directed classification utilizing the encoder structure. The proposed conclusion framework for COVID-19 classification is quite persuasive as a result of the reasonable categorization that has been achieved.

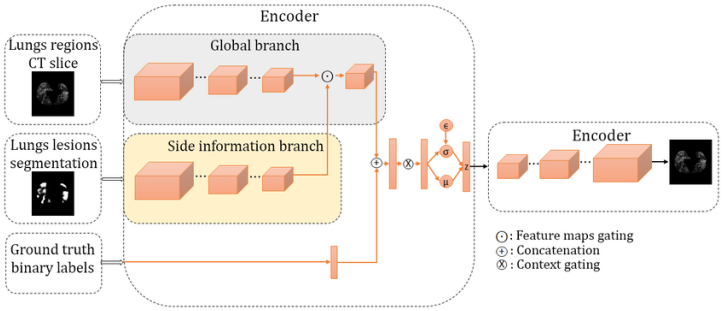

Figure 10: CVAE model

3.2.13. FM-HCF-DLF model [31]

The suggested FM-HCF-DLF demonstration consists of three major types, including Gaussian filtering-based preprocessing, FM for highlight extraction and classification, and FM for highlight extraction and classification. The FM show combines handcrafted features with neighborhood twofold designs (LBP) and profound learning (DL) features, as well as the convolution neural organize (CNN)-based Beginning v3 process. The learning rate scheduler utilizing Adam optimizer is attached to advance make strides in the execution of the Initiation v3 show. Finally, the classification procedure is carried out using multilayer perceptron (MLP).

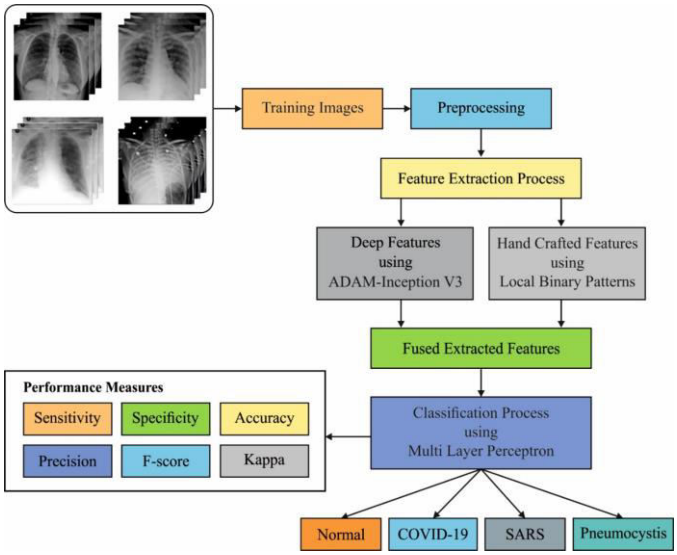

Figure 11: FM-HCF-DLF model

3.2.14. MAG- SD (Multiscale Attention guided deep network with soft distance) model

To automatically categorise COVID-19 from pneumonia CXR images, a multiscale Attention Guided deep network with Soft Distance regularisation (MAG-SD) is proposed.

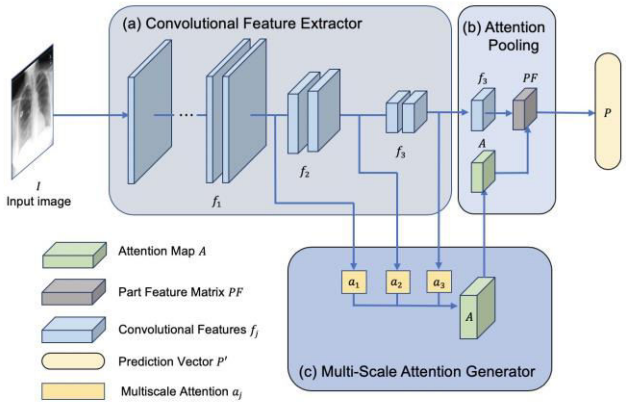

Figure 12: MA- Net

From multiscale feature maps in MAG-SD, MA-Net is used to build a prediction vector and an attention map. Attention guided augmentations and a soft distance regularisation are proposed to alleviate the lack of training data.which requires a few labeled data to generate meaningful augmentations and reduce noise.

3.2.**15.CNN Pre-Train Models [10][12][14][18][19][20][21][22][25][26][27][29][30]**

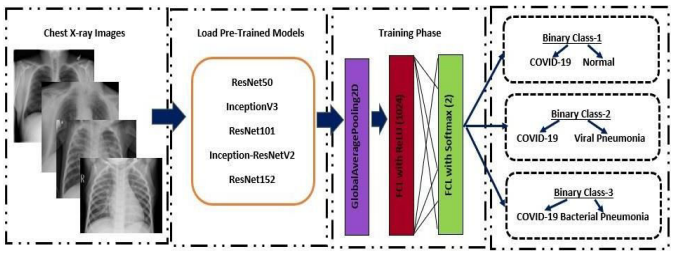

Figure 13. Models for predicting normal (healthy), COVID-19, bacterial, and viral pneumonia patients are depicted schematically.

In the analysis of medical data, one of the biggest difficulties faced by researchers is the limited number of available datasets. Deep learning models often need a lot of data. Labeling this data by experts is both costly and time consuming. The biggest advantage of using transfer learning method is that it allows the training of data with fewer datasets and requires less calculation costs. With the transfer learning method, which is widely used in the field of deep learning, the information gained by the pre-trained model on a large dataset is transferred to the model to be trained.

The diagram of conventional CNN including ResNet50, ResNet101, ResNet152, InceptionV3 and Inception ResNet models for the prediction of normal (healthy), COVID-19, bacterial and viral pneumonia patients were shown in Figure 1. It is also available publicly for open access at https://github.com/drcerenkaya/COVID-19-DetectionV2.

ResNet50

Residual neural network(ResNet) model is an improved version of convolutional neural network (CNN). ResNet adds shortcuts between layers to solve a problem. It avoids the distortion that occurs when the network becomes deeper and more sophisticated as a result of this. In addition, bottleneck blocks are used to make training faster in the ResNet model. The ImageNet dataset was used to train ResNet50, a 50-layer network. ImageNet is an image database with more than 14 million images belonging to more than 20 thousand categories created for image recognition competitions.

InceptionV3

InceptionV3 is a kind of convolutional neural network model. It consists of numerous convolution and maximum pooling steps. It contains a fully connected neural network in the last stage. As with the ResNet50 model, the network is trained with ImageNet dataset.

Inception-ResNetV2

It is made of a deep convolutional network with the use of Inception-ResNetV2 architecture that was trained on the ImageNet-2012 dataset. An image of 299*299 is fed into the model, and an estimated class probability list is output.

ResNet101 & ResNet152

Due to stacked ResNet construction pieces, ResNet101 and ResNet152 have 101 and 152 layers, respectively. You can use the ImageNet database to load a pretrained version of the network that has been trained on over a million photos. As a result, the network has amassed a library of rich feature representations for a wide range of images. Image input size on the network is 224x224.

VGG19

A lightweight design for a deep neural network that doesn't rely on residual design ideas, patterns, and have very low architectural diversity.

VGG 16

It used a smaller convolution kernel, a smaller amount of parameters, and the classification effect is significantly improved. This deep network architecture is available in two different versions: VGG16 and

VGG19.With more layers than VGG16 and a higher number of parameters, VGG19 has a greater overhead.

Xception

Inception is pushed to the limit with Xception. It assumes that cross-channel correlation and spatial correlation can be separated. On top of that, InceptionV3 performed slightly better than ImageNet on the classification task. On large-scale image data sets, the same number of parameters can result in better performance.

Dense Net

DenseNet121 is the latest network architecture. It took first place in ImageNet competition organized in 2017. It uses features to achieve better results and fewer parameters. It can directly connect all layers under the condition of ensuring the maximum information transmission between layers in the network

Efficient Net[10]

The Efficient Net is actually a group of models based on the TABLE 2 baseline network. IThe Mobile Inverted Bottleneck Conversion Block (MBconv) is its main component. EfficientNet is defined by three dimensions: (i) depth; (ii) width; and (iii) resolutions

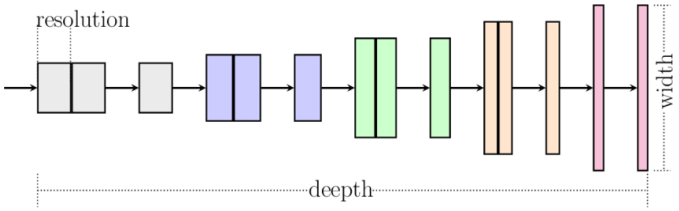

Figure 14 : Efficient Net

4. Experimental Results

Chest X-ray pictures are classified using CNN pre-trained models[30].The transfer learning method has proven to be highly effective. Xception showed a reasonable average accuracy Compared with several other models. By roughly localising the component with high activation intensity, attention improves the models [32]. The sensitivity and specificity of the FM-HCF-DLF model were greater [31].implemented the proposed classification model and CVAE are implemented in Pytorch2. For embedding binary ground truth labels and merging the embedding with gated feature maps, the CVAE employs neural networks. [28]. CVAE and classification model on top of Pytorch2. The CVAE uses neural networks to embed binary ground truth labels and merge the embedding with the gated feature maps [23].StackNet-DenVIS analyses the performance of the suggested implementation by calculating parameters such as Precision, Recall, F1-Score, Accuracy, Sensitivity, and Specificity. [17]. The CB-STM-RENet approach quickly converges to optimal settings.[15]. Deep L STMs, Bi-L STMs, and Conv-L STMs are different types of STMs.

Using these models we can learn how the data behaves dynamically and map itlearning sequence present, in order to generate future projections of the amount of confirme instances present in any given region[13]. CAAD model results on two chest X-ray datasets indicate that (1) anomaly detection works well in term of viral pneumonia screening on chest X-ray images and is superior to binary classification methods, and (2) learning model confidence is useful to predict failures, greatly reducing the false negatives, and (3) our CAAD model, never seeing any COVID- 19 cases, achieves an AUC of and sensitivity of 83:61% on the unseen X-COVID dataset 71:70% [8]. 93.3% accuracy is achieved by COVID-Net test accuracy, thus highlighting the efficacy of leveraging a Using a human-machine collaborative design technique, researchers may quickly create highly customized deep neural network designs. [6]. GAN method achieves the best recognition performances. Comparing with the comparison methods, the recognition results are improved[4].

Comparative Analysis

Category	Supervised	Unsupervised
Model	1. LSTM, 2. BiLSTM, 3. GAN, 4. Attension Based Model 5. Transfer Learning	1. CAAD(Confidence Aware anamoly detection) 2. Efficient Net 3. Transfer learning 4. ResNet 18 5. Inception V3
Training Time	Less training Time Required	More Training time required
Ease	Easy to Implement	Need Expertise
Computational Complexity	High	Low
Accuracy	Accurate accuracy	Moderate accuracy

Table 2: Comparative analysis

5. CONCLUSIONS

Early prediction of COVID-19 patients is important to prevent the spread of the disease to other people. We used Chest X-ray pictures taken from normal, COVID-

19 patients to propose an alternative deep transfer learning based strategy in this study. Because of the improved performance, the results demonstrate that it will assist radiologists in making clinical judgments. In future studies, the features will be extracted using image processing methods on X-ray and CT images to identify whether patients is normal, COVID-19, bacterial and viral pneumonia patients to predict COVID-19. The features that give the best separation between classes will be identified using these extracted features. X-ray pictures can be altered in several cases. So useful information may be lost which may be recovered by GAN algorithm and working with x ray images is cheaper than working with the CT images.

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