Covid-19 Detected Automatically From Ct Images with Ensemble Learning and a Convolutional Neural Network

R.Anitha[1], M.Saranya[2], C.Vijayashanthi[3]
[1]*Asst.professor P.S.R.R College of Engineering, Sivakasi*
[2,3]*UG Student P.S.R.R College of Engineering, Sivakasi*

Abstract - Corona Virus Disease (COVID-19), caused by a novel coronavirus, is a worldwide pandemic that has claimed millions of lives. The disease is still not under control a year after it first appeared. COVID-19 is resurfacing in several countries, posing a major threat. COVID-19 can be contained and diagnosed early, preventing large-scale spread.COVID-19 diagnosis with RT-PCR is the gold standard. . However, in most parts of the world, the ability to perform RT-PCR tests is limited. CT is useful in the detection of COVID-19 studies. As a readily available and less expensive modality, CT could be used as a substitute for RT-PCR tests in areas where RT-PCR testing is not available. Machine intelligence algorithms may extract information from CT images and classify them into COVID-19 and non-COVID categories. The most extensively used machine intelligence technology for disease prediction from photos is the convolutional neural network (CNN). COVID-19 identification using various pre-trained CNNS is compared in this work.

Index Terms **- COVID-19; Auto detections; CAT; Machine intelligence techniques**

I. INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus outbreak a worldwide pandemic. Severe acute respiratory syndrome coronavirus-2 is the virus that causes it (SARS- COV-2). According to accounts, the virus mostly attacks the human respiratory tract, causing severe pneumonia with a dry cough and a high temperature.In extreme circumstances, death may result. No cure or vaccination is 100 percent successful in stopping the spread of the disease. The reverse transcription-polymerase chain reaction (RT-PCR) is a time-consuming, uncomfortable, and difficult clinical diagnostic for COVID-19 detection. The ability to perform RT-PCR tests is limited in most parts of the world due to a scarcity of test kits. Furthermore, the RT-PCR diagnosis procedure is unpleasant, and its availability in rural areas is limited. One of the most common clinical diagnoses is chest CT, which is used to detect a variety of pulmonary abnormalities. CT pictures, which are less expensive than CT scans, are readily available in such places. The patient is exposed to a comparatively low dose of radiation during a CT scan. (As a result, it should not be done on pregnant women). Because some organs are more vulnerable to radiation than others, CT is preferred because it causes less damage to cells that grow and divide quickly. The current machine learning techniques can be utilized for the construction of a computer-aided diagnosis system to identify an alternate strategy to combat the COVID-19 epidemic. As a result, a deep learning strategy based on pre-trained CNN could be considered as an alternative for diagnosing covid-19. Deep Learning is a collection of machine learning algorithms aimed mostly at automatically extracting and classifying features from photographs. Object identification and medical picture categorization tasks are two of their most common uses. Machine learning and deep learning have established themselves as established disciplines in the application of artificial intelligence.

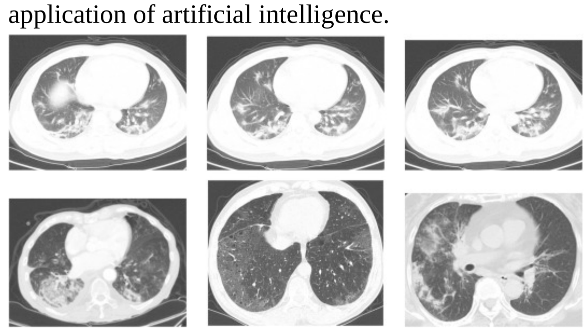

Fig.1.Different Chest CT images were used in the project

II. RELATED WORK

In this section, we will discuss some notable works that have been published in the literature. The first paper we'll discuss was published in 2020 by Abraham et al. [2]. For the estimate of COVID-19, the technique combines features retrieved from multi-CNN with the correlation-based feature selection (CFS) technique and the Bayes Net classifier. Two public sites were used to test the method.on both datasets and produced great results on both. The studies confirmed the usefulness of pre-trained multi-CNN over single CNN in the identification of COVID-19 using a dataset of 453 COVID-19 images and 497 non-COVID images. Pereira et al. [3] suggested a multiclass classification and hierarchical categorization classification schema. Also, to rebalance the distribution of classes, employ resampling procedures in the schema. Because the texture is one of the most important visual characteristics of CXR images, the classification schema extract features using a combination of well-known texture descriptors and a pre-trained CNN model. The schema investigates early and late fusion strategies to take advantage of the strengths of several texture descriptors and base classifiers at the same time.To test this strategy, researchers established the RYDLS20[3] (1144) database, which contains CXR images of pneumonia caused by various bacteria as well as CXR images of healthy lungs. For training and testing, 802 and 342 photos were used, respectively. [4] Rahimzadeh et al. Various deep convolutional networks were built with new training methodologies for classifying CT images into three groups using two open-source datasets: normal, pneumonia, and COVID-19. 180 CT scans of patients infected with COVID-19 are included in the data. A concatenation of the Xception and ResNet50V2 networks is proposed as a neural network. The proposed network was able to achieve the best accuracy by merging multiple features acquired by two robust networks. To reflect the real accuracy achieved, the network was assessed using 11302 pictures.This model was trained using 125 non-standard chest X-ray images taken on the spur of the moment. Diagnostic tests performed on recovered people after 5–13 days are determined to be positive. COVID-19 was identified utilizing CT images obtained from two different sources. The Darknet classifier is utilized as a foundation for this successful architecture. This is a useful method for assisting specialists in their diagnosis. There are 1427 CT scans in Ioannis D et al [6], including 224 photographs demonstrating proven Covid-19 illness, 700 photos demonstrating confirmed common bacterial pneumonia,and 504 photos demonstrating normal conditions. Second, there's a dataset with 224 photos of Covid-19 sickness and 714 photos of bacterial and viral infections. Khan et al [7] created a Deep Convolutional Neural Network model named CoroNet to detect COVID-19 infection from chest CT images automatically. CT images were obtained from two publically accessible sources. On the prepared dataset, CoroNet was trained and tested.The preliminary results are promising, and they can be improved further as more training data becomes available. On a tiny prepared dataset, CoroNet generated encouraging results, hinting that with more data, the system could do much better.The proposed model can produce superior results with less pre-processing. Ucar F et al [8] implemented the SqueezeNet decision-making system for COVID-19 diagnosis from CT images in April 2020. SqueezeNet, a state-of-the-art deep learning model inspired by the well-known AlexNet, has a substantially smaller model size. Because of its practical structure and generalization performance, the SqueezeNet is preferred in embedded applications. The Bayes optimization approach was utilized to optimize the SqueezeNet structure to produce a robust and long-term learning model. Bayesian optimization aids in the creation of the best-performing model using a validation dataset. Marques et al. [9] proposed using the EfficientNet convolutional neural network to automate the medical diagnosis of covid-19. The suggested CNN model was trained using the stratified 10-fold cross-validation method. Item 1 of the table

TABLEI.LITERATUREANALYSIS

METHOD	PERFORMANCE	PROS	CONS
[1]For COVID-19 prediction, a mixture of features collected from multi-CNN with (CFS) methodology and Bayes Netclassifier isused.	AUC.963 Accuracy91.16% AUC.911 Accuracy97.44%	Showed theeffectiveness of multiCNN oversingleCNN	Limiteddataset

[2] Use of a multiclass classification and hierarchical classification,	Macro avg F1-score 0.65(multiclass)0.89(hierarchical	The best ratewas obtained inanunbalancedenvironment with 3classes. Helps in the screening of patients in emergency	Lack oflargerdatabase
[3]The suggested neural network is a concatenation of the Xception and ResNet50V2 networks.	99.50% Averageaccuracy	The bestaccuracy isachieved bycombiningtwo robustnetworks'retrievedfeatures	Datasetislimited.Thecovid-19 classhas apoorlevel ofprecision.
[4]Based on this effective architecture, the Dark Netclassifier is used.	Accuracy 98.08%(binaryclasses) 87. 02% (multi-classcases.)	Employedto assistthe radiologist	Lessreliability
[5]transfer learning with convolutional neural networks for x-ray image detection	96.78%Accurracy98.66 %sensitivity 96.48specificity	Low-costRapid Automaticdiagnosis	Need more data
[6]On the prepared dataset, CoroNet has been trained and tested	89.6%Accuracy(4) 93%Precision(4) 98.2%Recall(4) 95%Accuracy (3)	Promising results. A very useful tool for clinical practitioners and radiologists	Lack of data
[7]COVID-19 Diagnosis from X-ray pictures using a deep Bayes-Squeeze Net decision-making system	98.04%accuracy	Fine tuned and augmented datasets give good results. Better result	Datasetlimitation
[8]10-foldcross-validationwas used to verify the approach	99.62 %(binary)96.70%(multiclass)	Rapiddiagnosis	Need moredata

METHOD

As part of this study, CT scans of diverse patients were correctly labeled with "COVID-19" or "Non COVID-19" for computer-assisted COVID19 detection. Image Data Generator modifies the original photos (rotation, zooming, etc.) at each epoch and then uses them for training. Not only will this improve the model's reliability, but it will also save memory. A convolution neural network transfer learning approach will be utilized to distinguish CT images as "COVID-19" or "Non COVID-19." Keras-trained CNNs such as VGG16, RESNET50 VGG19, Xception, Densnet121 EfficientnetBo, and others were used. In this article, we calculated precision, recall (or sensitivity), and the F1- score to assess and analyze the CNN model's performance. Deep learning can be used to extract significant biomarkers linked to COVID -19 disease.

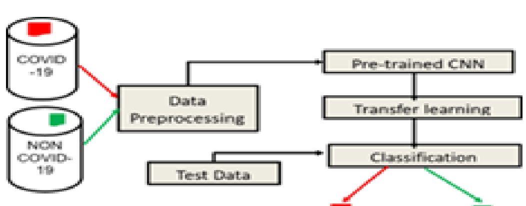

Fig.2.The architecture of the proposed method

The next sections go over the various steps in the process.

A.DATASET

The dataset created by Cohen et al. consists of 783 chest X-ray images. The 783 chest CT images were composed of 504 COVID-19 and 279 non-COVID images. To solve the data imbalance problem, 263 pneumonia images are taken from paul Mooney's dataset and added up with non- covid images. Thereby forming 542 non-Covid images. A total of 1046 chest CT images are utilized for the transfer learning model.

B.PREPROCESSING

The major challenge with the above-mentioned datasets is data imbalance. The number of COVID-19 images is predominantly greater than that of non-COVID images. In such scenarios, the classifier is more likely to favor the class with the most instances. To solve the data imbalance problem, we used the Image Data Generator method like random rotation flipping and horizontal and vertical shift of the images.

C.TRANSFER LEARNING

Feature representations in Convolutional Neural Networks (CNNs) are more efficient than typical hand-crafted features. A large number of pictures are required to train a CNN from scratch. However, due to ethical concerns, obtaining a large number of CT photos of patients for medical diagnostic applications such as COVID-19 detection using CT scans is problematic. It's impossible to train a CNN from scratch since the data in the proposed public dataset is so sparse. To extract characteristics from the data at hand, pre-trained CNNs trained on a large number of natural pictures, such as the Imagenet database, can be used. Transfer learning is a deep learning technique that entails training a neural network model on a problem that is similar to the one at hand. Transfer learning has the benefit of reducing the training duration of a learning model while also lowering generalization error. The Keras-trained CNNs VGG16, RESNET50, VGG19, Xception, Efficientnet Bo, and others were explored. The learning rate annealer was employed in this experiment. The learning rate annealer reduces the learning rate if the error rate does not change after a certain number of epochs. When this methodology is used to test validation accuracy, the learning rate is reduced by 0.01 if it appears to have achieved a plateau after 5 epochs. Dense layers, Global Average Pooling layers, Dropout layers, as well as batch normalization and activation, have all been introduced. Unfroze a couple of the top layers of a frozen model base and train the newly inserted classifier levels as well as the base models. It allows us to "fine-tune" the higher-order feature representations of the underlying model to make them more relevant for the task at hand.

D. EVALUATION MEASURES

Correctly recognized diseased cases (True Positives, TP), erroneously identified diseased cases (False Negatives, FN), correctly identified healthy instances (True Negatives, TN), and incorrectly classified healthy cases (False Negatives, FN) were all recorded for the CNNs' classification job (False Positives, FP). With the help of equations (1), (2), (3), (4), and (5), we compute the model's accuracy, sensitivity, specificity, precision, and f1 score based on those metrics. (TP + TN) (TP + TN + FP + FN) (TP + TN + FP + FN) (TP + TN + FP + FN) (TP + TN + FP + FN) ((1)

TP (TP + FN) = Sensitivity (2)

TN (TN + FP) = Specificity (3)

Precision = (TP + FP) / TP (4)

2TP / (2TP + FP + FN) = F1 Score (5)

IV .RESULTS

Specificity Eighty percent of the photos were used for training and twenty percent for testing. The best result in transfer learning was achieved using the EfficientnetB0 pre-trained CNN. Figure 3 shows the COVID-19 detection confusion matrix using EfficientnetB0. 11 normal and 27 non-covid photos are misclassified as Covid and non-Covid, respectively, in the above matrix. There are 98 normal photos and 74 COVID-19 images that have been accurately categorized. A graph depicting model accuracy and model validation accuracy for 20 epochs is also shown in fig. 4. The validation accuracy is 81.9 percent. (TN + F) y = TN

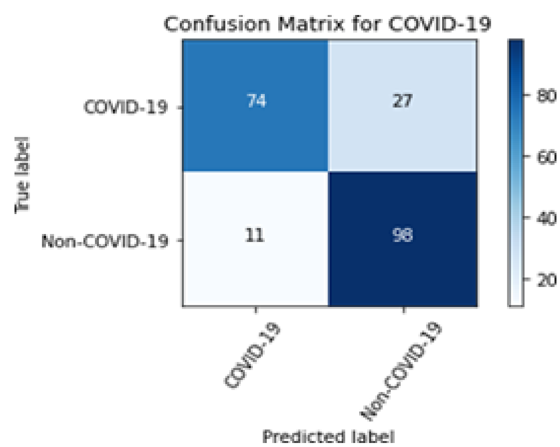

Fig.3ConfusionmatrixofEfficientNetBo

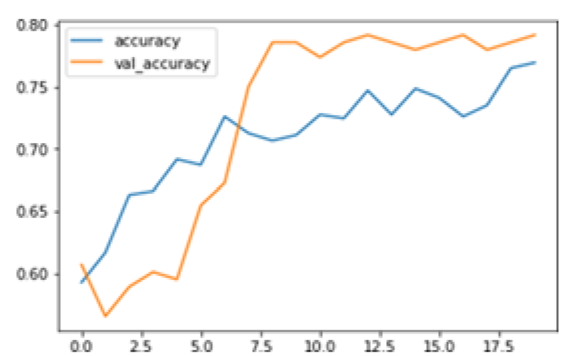

Fig.4. The graph represents model accuracy and model validation accuracy for20epochs

Below table II shows the computed accuracy, sensitivity, specificity, precision and f1score of the model.

TABLEII. RESULTS

MEASURE	VALUE(%)
Accuracy	81.90
Sensitivity	87.06
Specificity	78.40
Precision	73.27
F1Score	79.57

A few CNNs, such as VGG16, VGG19, and Xception, were tested to compare the efficiency of the proposed model, and the validation accuracy acquired via transfer learning is presented in fig.5. Validation accuracy was 73.81, 58, and 77 for VGG16, VGG19, and Xception, respectively. This pie chart clearly shows that EfficientNetBo has a higher validation accuracy than EfficientNetBo.

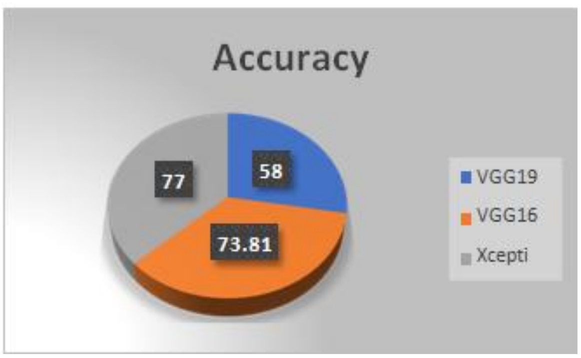

Fig.5.Validationaccuracybytransferlearning

Only a few further categorization trials are carried out. Pre-trained CNNs were used to extract features, which were then categorized using SVM. EfficientnetB0 outperforms the other strategies, according to the results. The performance of EfficientnetB0 is compared to that of other approaches in Figures 6 and 7.

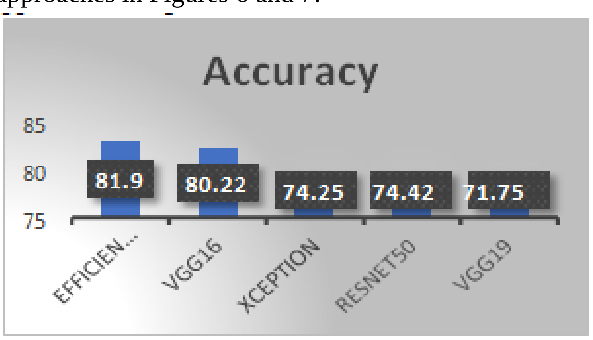

Fig.6 Comparing accuracy obtained by transfer learning using Efficient netB0 against feature extraction using VGG19, VGG16, Xception, and Resnet50 and classification using SVM.

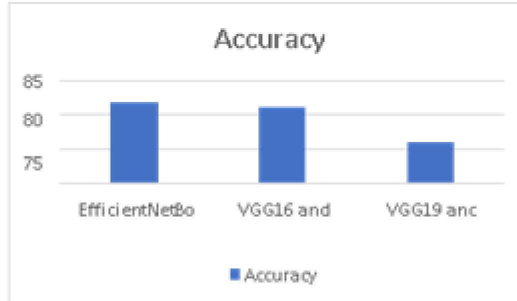

Fig.7 Comparing the accuracy of Efficient netB0 against the accuracy of the models concatenated and classified using SVM.

Principal component analysis (PCA) was performed after concatenated models were categorized using SVM. In terms of quality, The EfficientNetBo beats other concatenated models in terms of accuracy, and it is thus recognized as a good classification model.

V.CONCLUSION

The findings suggest that pre-trained CNNs can be utilized to detect COVID-19. For COVID-19 diagnosis, a transfer learning model can be utilized as an alternative. It is possible to use data augmentation techniques to obtain extra data from limited datasets. We compared the performance of various pre-trained CNNs for COVID-19 detection. We extracted features using CNN and performed classification using SVM to evaluate the performance of transfer learning. We also concatenated features extracted from multi- CNN and classified them using SVM. EfficientNetBo outperformed the other approaches in transfer learning. Future research can solve some of the study's shortcomings. More patient data is needed for a more in-depth examination, especially for those with Covid-19. Patients with moderate symptoms should be distinguished from those with pneumonia symptoms in future studies, as these symptoms may not be diagnosed accurately or at all on X-rays. The multi-class classification of COVID-19 and diverse forms of pneumonia will be the focus of future research. The Generic Adversarial Network (GAN) technology could be employed in the future to overcome the data imbalance problem. It has yet to be examined if pre-trained CNN features may be combined with handcrafted features (GLCM texture features, GLRLM, GLSZM, and NGTDM features).

REFERENCE

[1] Cohen JP, Morrison P, Dao L. Covid-19 image data collection; 2020, arXiv2003.11597.https://github.com/ieee8023/covid-chestxray-dataset.

[2] B Abraham, MS Nair, Computer-aided detection of COVID-19 from X-ray images using multi-CNN and Bayesnet classifier Biocybernetics and biomedical engineering, 2020

[3] Pereira, R.M., Bertolini, D., Teixeira, L.O., Silla, C.N., Costa, Y.M.G. COVID-19 identification in chest CT images on flat and hierarchical classification scenarios. Computer Methods and Programs in Biomedicine, Volume 194, October 2020

[4] Rahimzadeh, M., Attar, A. A modified deep convolutional neural network for detecting COVID-19 and pneumonia from chest CT images based on the concatenation of Xception and ResNet50V2 Informatics in Medicine Unlocked, Volume 19, 2020

[5] Ozturk T, Talo M, Yildirim EA, Baloglu UB, Yildirim O, Rajendra Acharya U.Automated detection of COVID-19 using deep neural networks with CT images Comput Biol Med. 2020 Jun;121:103792. DOI: 10.1016/j.compbiomed.2020.103792. Epub 2020 Apr 28.PMID: 32568675

[6] Ioannis D. Apostolopoulos, TzaniBessiana March 2020,Covid-19: Automatic detection from CT images utilizing Transfer Learning with Convolutional Neural Networks Physical and Engineering Sciences in Medicine 43:635-40;2020

[7] Khan,A.I.,Shah,J.L,Bhat,M. Coronet: a deep neural network for detection and Diagnosis of covid-19 from CT images Computer Methods and Programs in Biomedicine, Volume 196, November 2020

[8] Ucar F, Korkmaz D.COVIDiagnosis-Net: Deep Bayes-SqueezeNet based diagnosis of the (COVID-19) from CT images Med Hypotheses.2020Jul;140:109761.DOI:10.1016/j.mehy.2020.109761. Epub 2020 Apr 23

[9] Marques, G., Agarwal, D., de la Torre Díez, I. Automated medical diagnosis of COVID-19 through EfficientNet convolutional neural network Applied Soft Computing Journal, Volume 96, November 2020