Predicting COVID-19 With An Approach Of Machine Learning Based On CNN Using Chest X-Ray Images

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Abstract: In March 2020, The WHO (World Health Organization) announced COVID-19 as a worldwide epidemic. The Artificial Intelligence can play a vital role in different ways, such as machine learning in identifying COVID-19 patients by analyzing their chest X-Ray visually. Classifying the chest X-Ray with a new machine learning method, COVID-19 patients and non-COVID-19 patients can be identified. The new ML method can lower the development cost, also can detect & diagnose the virus in a test with large number of datasets. The ML method can be a useful tool to scan and analyze large number of the chest X-Ray as an image and also with accurate outcomes. This ML approach can work with rapid amount of data in short time and accurately from the Chest X-Ray image. With an improved Convolutional Neural Network (CNN), the X-Ray image can be segmented in fewer iterations. By analyzing and segmenting the chest X-Ray image, the detection process can be optimized with its histograms and threshold techniques. a new model based on Convolutional Neural Network (CNN) that automatically detects COVID-19 using chest images is presented. that most of the affected people have no common symptoms before checkup COVID-19. If the detection results are incorrect, the patient will not be able to understand that he or she has Covid19. The proposed model is evaluated by Python libraries namely TensorFlow and Keras.

Keywords: CNN, Covid-19 affected dataset, Chest Images, Python, TensorFlow.

I. INTRODUCTION

The COVID-19 pandemic, also known as the coronavirus pandemic, is an ongoing global pandemic, caused by severe acute respiratory syndrome coronavirus (SARS-CoV-2). The outbreak was first identified in December 2019 in Wuhan China. The World Health Organization (WHO) declared the outbreak a Public Health Emergency of International Concern on 30 January 2020 and a pandemic on 11 March. As of 7 August 2020, more than 18.9 million cases of COVID-19 have been reported in more than 188 countries and territories, resulting in more than 712,000 deaths; more than 11.4 million people have recovered. The virus is being transmitted via the respiratory tract when a healthy person comes in contact with the infected person. Severe Acute Respiratory Syndrome (SARS) and COVID-19 are the same family of coronaviruses, where detecting in SARS cases usually using chest images proposed by several methods and for pneumonia detection in general. Machine Learning has performed for image processing like image analysis, image classification and image segmentation. Also, deep neural network-based methods provide high performance in classified the images according to the given features. According to Machine Learning, different efforts fulfill that machine learning-based methods to Classify the chest x-ray images into COVID-19 patient class or normal case class. So, all of these Efforts utilized deep learning-based approaches. It is very difficult to calculate the risk factors of all the patients together and it a lengthy process to find the patients class accurately in a short, thus we need to find out another faster and effective way to do the job with the help of technology. Here, the motivation of our research is to propose an accurate classification method for COVID19 chest x-ray image. We are several types of models like, a hybrid model for COVID-19 detection using an improved marine predator's algorithm (IMPA) for overcoming the multithreshold image segmentation problems of chest X-Ray images. Second, a new method, namely ranking-based diversity reduction (RDR), has been proposed to improve the MPA by moving the positions of the worst solutions to be near to the best solution.

A. MOTIVATION

We have been facing a lot of difficulties for this global pandemic COVID-19, causing huge crisis and taking thousands of human lives. Developing and undeveloped countries are not being able to provide test to all corona suspected patients due to over population, limited test facilities and limited medical team. To minimize the difficulties, we are trying to get a possible solution for detection of deadly corona virus infected patients. This is the primary motivation behind our work. Again, since we are responsible citizens of our country and we are getting the privilege to study technological subject we realized that we should try to do something for the betterment of our country through our field and agreed to work towards a solution for providing possible test to corona suspected patients.

B. OBJECTIVES

The main objective of this thesis is to introduce a technological approach to determine the symptoms of corona and patient's stage if he/she is infected. Our goal is to do this job of detecting possibilities of corona in a patient with the help of machine learning and image processing by capturing photos of a lung (X-ray) and compare these photos (X-rays) and collected data of a healthy lung. We aim to generate the condition or stage of a patient if he/she is found infected. We are to keep information about basic information treatment of the patients according to their stage. And check the lung condition of the patient from X-ray image segmentation. Above all, we aim to provide test to all the corona suspect patients and decrease the rate of people dying even without getting tested.

C. PROBLEMS STATEMENT

In spite of all our efforts and hard work, we might face some problems. Some possible problems are discussed below- Accuracy**:** The accuracy of the result of our system may not be 100 percent accurate. Even in case of Pneumonia, the lungs of patients can get infected. So, for 100 percent accuracy we might need a basic manual test of the patients of whose lungs are found infected by our system. Result: The result might not always be 100 percent accurate. We have known about some corona infected patients who didn't carry any specific symptoms. As our system scans image of a lung and compares it with a healthy lung, it might not give the most accurate result in every case. Information Collection and storing: Some information about a patient might be missed while data collecting, and some data might not be stored properly.

II. LITERATURE REVIEW

Guan ET. al., [1] experiment about CT scan analysis including bilateral pulmonary parenchymal ground-grass, consolidative pulmonary opacities and sometimes with a rounded morphology, peripheral lung distribution. In this experiment, the high-resolution computed tomography (HRCT) is analyzed with early imaging features. The work was done with forty-six COVID-19 pneumonia patients. Each of their first CT was recorded for: sizes, sites, peripheral or central locations, ground-glass opacity or consolidation and other abnormalities. Each CT was scanned with previous CT to be ensure about the COVID-19 pneumonia. There they found 89.13% higher proportion of supply pulmonary artery dilation among 46 patients and 67.57% air Broncho gram. Calcification, Cavitation or lymphadenopathy were not in their observation. Han, J., ET. al.,[2] found a new approach of multi-threshold image segmentation using state transaction algorithm. This model works with a class of pixels, normalized histogram of image which is fitted by liner combined normal distribution functions that represents the class of pixels. The model transforms the fitting problem into nonlinear and non-convex optimization because of image fitting problem. So, with this fitting problem, comparing multilevel thresholding problems with OSTU, PSO, GA, DE and analyzing with STA algorithm, a competitive performance has been achieved in terms of optimization results and thresholding segmentation. Abdel-Basset ET. al.,[3] proposed a hybrid model of COVID-19 detection using an improved marine predator's algorithm and a ranking-based diversity reduction strategy which works with X-ray image segmentation. In the work, Kapur's entropy has also used for multilevel threshold method, by which optimal threshold values can be found from the image. Thus, the threshold values represent the segmented image into multiple regions, where Kapur's entropy method enrolls. After obtaining the threshold values from the entropy, MPA is used to simulate optimal foraging mechanism to find their prey: predator use Lévy strategy and Brownian movements. There velocity will be v which represents the tradeoff between Brownian and Lévy strategies. In the experiment RDR algorithm has also used. Kapur ET. al.,[4] has an entropy that determines the optimal threshold from his multi-level method. He showed an advanced process comparing the old threshold method of obtaining method of threshold values. In our research we will use improved multilevel thresholding method using Kapur's threshold method. The improved method will give the optimal threshold values based on the entropy of segmented regions. Faramarzi, A., Et al.,[5][6] has applied MPA and its application in engineering. Focusing the simulation of foraging strategy namely Lévy and Brownian movements in finding their prey when there is a low concentration of prey and when there is abundant prey with a velocity ratio from the prey to the predators. Marine Predators Algorithm (MPA) is a nature-inspired optimization algorithm that follows the rules that naturally govern in optimal foraging strategy and encounters rate policy between predator and prey in marine ecosystems. The optimal encounter rate policy in biological interaction between predator and prey is also dependent on the type of the movement that each of the predator/prey is taking and the velocity ratio of prey to predator. Marine predators use Lévy strategy for the environment with a low concentration of prey while employing Brownian movement for the areas with abundant prey. there are different types of velocity value for Levy and Brownian like if velocity ratio 0.1 then the best strategy for predators is Levy. if velocity is 1 then the best strategy for predators is Brownian, if prey moves in Levy in high velocity ratio the best strategy for predator is not moving, either prey is moving Brownian or Levy. Based on this MPA is divided into three main phases when prey is moving faster than predator (high velocity) when prey and predator are moving at same pace (Unit velocity). predator is moving faster than prey (low velocity). The detection of COVID-19 based on X-ray images can be traced back to February 2020, AI et al. [7], who pointed out that chest X-ray (CXR) examination can be used as the main screening tool for COVID-19. More and more researchers have devoted themselves to COVID-19 diagnosis based on X-ray images, such as Wang et al. [8], Zhang et al. [9]and Hemdan et al. [10]. Narin et al. [11] used the pretrained model of ImageNet dataset to train, in which the pre-trained Resnet50 model could achieve 98% diagnostic accuracy. X. Wei, Y. Chen and Z. Zhang,[12] "Comparative Experiment of Convolutional Neural Network (CNN) Models Based on Pneumonia X-ray Images Detection, & quot; aims to reveal the relationship between the Convolutional Neural Network (CNN) model's behavior and the depth of the model. Due to the worldwide coronavirus pandemic, the training dataset is the chest x-ray images of the lungs,which are infected by pneumonia. The contrastive study incorporates three models a classic model, which is the imitation of LeNet5, VGG16, and Residual Network 50. This research is based on pneumonia detection, and it can give people a deeper understanding of CNN's mechanism rather than only focusing on the result of different models. The explainable analysis visualizes the loss value and accuracy curves, CAM & Grad-CAM images, and activation maps. DenseNet realizes feature reuse by connecting features on channels [13]. DenseNet puts forward a dense connection mechanism: all layers are connected to each other. Specifically, each layer will accept all the previous layers as its additional input. This can realize the reuse of features and improve efficiency Threshold techniques are based on two approaches: parametric and non-parametric [14]. In a parametric approach, some parameters for each class in the image need to be computed using a probability density function. However, in a non-parametric approach, the technique searches for the optimal threshold values based on maximizing an appropriate function (such as Kapur's entropy [4], fuzzy entropy [16], and Otsu function

[17]) without needing to calculate parameters at the outset. Khan et al.[18] get 89.60% accuracy in detecting covid-19 using CoreNet architecture. Hussain et al. [19] achieve an accuracy of 91.20% using CoreDet architecture Mangal et al, [20] acquire a success accuracy rate of 87.20 % using CovidAID architecture model. Joshi et al, [33] has the accuracy rate of 76.46% with DarkNet model.

III. PROPOSED MODEL

In this chapter we will discuss and analyze about the developing process of Covid-19 including software requirement specification (SRS) and acceptance design of this model.

A. ARCHITECTURE

In this proposed model, we used the CNN feature to get better accuracy. The proposed Model consists of four CNN layers namely Convo 2D, Max_pooling2D, Flatten, and Dense Layer. We used four Convo2D and two dense layers. These covo2D are (8, 16, 32, 64) and Dense are (512, 1).The size of Maxpooling2D used in the model is 2x2 with same padding. A flatten layer is used to create a single long feature vector size of 12544. The activation functions used in the dense layers are ReLu and Sigmoid. The activation function ReLu applied to the final dense layer (512x1) to classify the Covid -19 in binary manner (positive or negative).

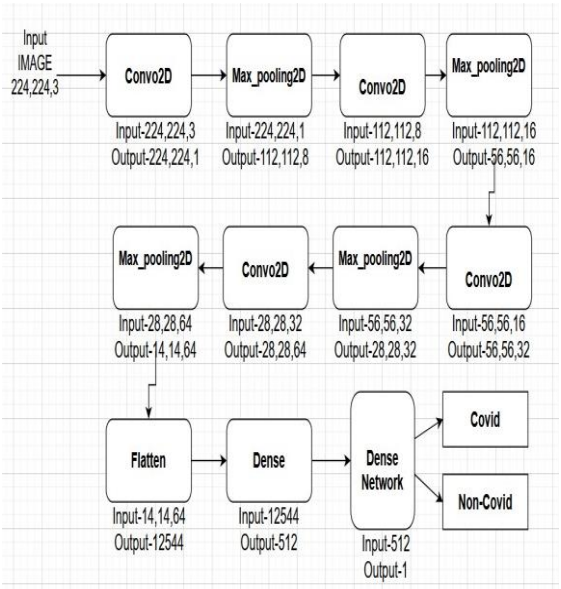

Fig: Architecture of Proposed Model

For fully connected 12544x512 neural network, we used sigmoid function as the activation function. We used sigmoid function as the activation function. The fully connected layer passed to the ReLU layer to normalize the binary classification Vector. After the output of the classification vector, two categories i.e. Covid-19 positive or Negative for evaluation. All the hidden layers use sigmoid as their activation function. The Sigmoid function is more computationally efficient.

A. Data Flow Diagram

A Data Flow Diagram is a graphical representation of the flow of data through an information system. After collecting dataset, proposed model trained to predict the Covid-19 virus from images. We used three types of datasets to train the model. After collecting the database, proposed model train to predict the accuracy of images from database. There is a performance evaluation process before making the final decision. We used a small database to train the model.

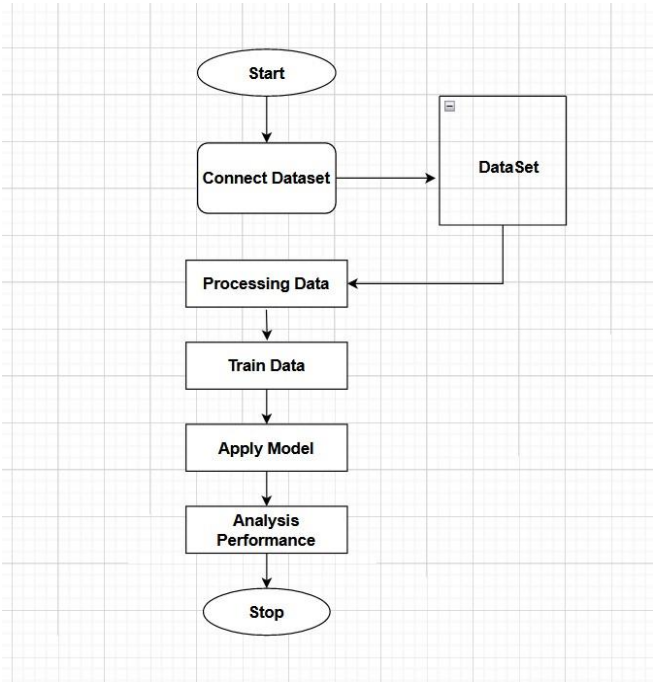

Fig: Data Flow Diagram

B. UML

Unified Modeling Language is a graphical modeling language for describe, visualizing, projecting and documenting of object-oriented systems. UML used for modeling of organizations and their business processes, for development the big projects, the complex software applications.

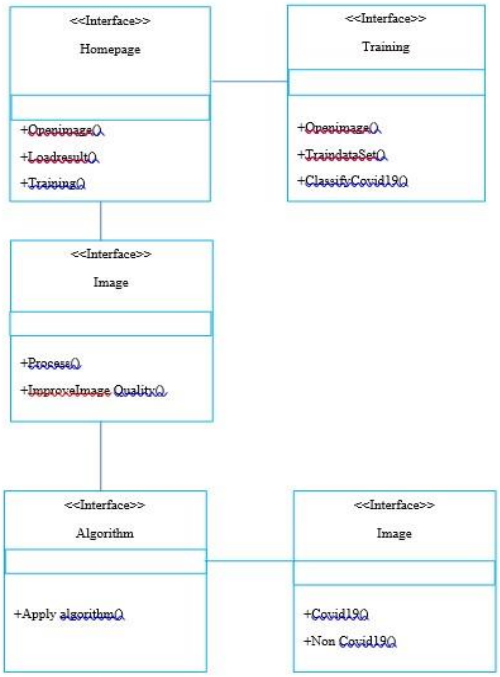

Fig: UML Diagram

IV. EXPERIMENTAL SETUP

A. DATA PRE-PROCESSING

Data preprocessing is the process of transforming raw data into an understandable format. It is also an important step in data mining, as we cannot work with raw data. The quality of the data should be checked before applying machine learning. We used to class test and train.

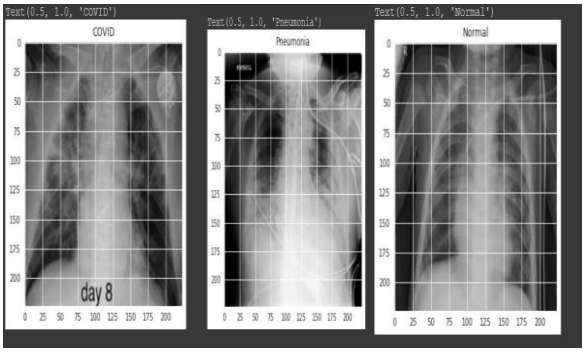

Fig: Data processing

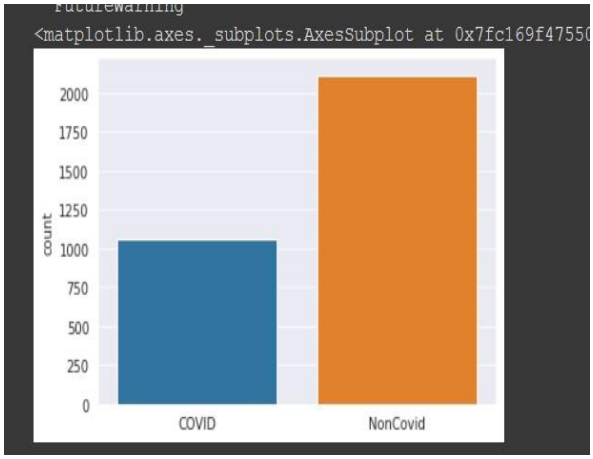

Fig: Data visualization

B. DATASET RETRIEVES AND BATCH SIZE

We use images height and width is 224. The image batch of our dataset is ("64", "224", "224", and "3").

C. CONFIGURATION DATASET FOR PERFORMANCE

We call data from database by path function. After get the data, we normalized the data by normalized method. We divided data in two different method x_train and y_train. After normalized the data we reshaped picture and inversion every data in different set. Data augmentation is a technique to artificially created new training data from existing training data. This means, variations of the training set images that are like to saw by the model. Using augmentation models get better performance and better accuracy. We were using the CNN model. In addition, we are using four CNN layers (Convo 2D, Maxpooling2D, Flatten, Dense). We used four Convo2D and two Dense. Those covo2D are (8,16,32,64) and Dense are (512,1).The Maxpooling2D size of our model (2,2). Activation is ReLU and sigmoid.

D. RESULT OF THE MODEL

The evaluation metrics used to measure the accuracy of the results and the detailed analysis of the results.

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 224, 224, 8)	224
max_pooling2d (MaxPooling2D)	(None, 112, 112, 8)	0
conv2d_1 (Conv2D)	(None, 112, 112, 16)	1168
max_pooling2d_1 (MaxPooling2D)	(None, 56, 56, 16)	0
conv2d_2 (Conv2D)	(None, 56, 56, 32)	4640
max_pooling2d_2 (MaxPooling2D)	(None, 28, 28, 32)	0
conv2d_3 (Conv2D)	(None, 28, 28, 64)	18496
max_pooling2d_3 (MaxPooling2D)	(None, 14, 14, 64)	0
flatten (Flatten)	(None, 12544)	0
dense (Dense)	(None, 512)	6423040
dense_1 (Dense)	(None, 1)	513

Total params: 6,448,081
Trainable params: 6,448,081
Non-trainable params: 0

Fig: CNN Model Summary

We train this model five times and gets the best result.

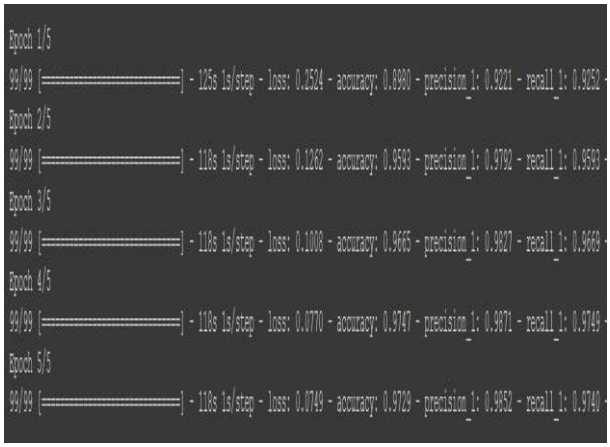

Fig: Result of Epoch (i)

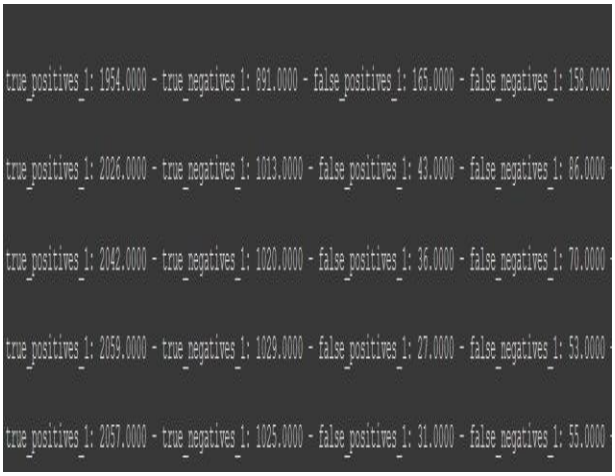

Fig: Result of Epoch (ii)

Accuracy, Recall and Precision are the core metrics for evaluating a classification model. Informally, accuracy is a fraction of what our model accurately estimates. In general, accuracy has the following definitions.

$$\text{Accuracy} = \frac{\text{Numberofcorrectpredictions}}{\text{Totalnumberofpredictions}}$$

Accuracy= Accuracy can be calculated in terms of positives and negatives as follows:

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

$$\text{Recall} = \frac{TP}{FN+TP}$$

$$\text{Precision} = \frac{TP}{FP+TP}$$

Where TP = True Positives, TN = True Negatives,
FP = False Positives, and FN = False Negatives.

Now Accuracy for proposed model $= \frac{TP+TN}{TP+TN+FP+FN}$

$= \frac{2057.00+1025.00}{2057+1025+31+55}$

=0.97*100

=97%

Matrix of the Recall for proposed model $= \frac{TP}{TP+FN}$

$= \frac{2057.00}{55.00+2057.00}$

= 0.97*100

=97%

Matrix of the precession $= \frac{TP}{FP+TP}$

$= \frac{2057.00}{31.00+2057.00}$

= 0.98*100

=98%

Matrix of F1 Score$=\frac{2*(0.98*0.97)}{0.98+0.97}$

=0.97*100

=97%

TABLE1 PERFORMANCE METRICS

Accuracy(%)	Recall (%)	Precision (%)	FI-Score(%)
97	97	98	97

I. Conclusion And Future Work

The purpose of this project is to predict Covid-19 using chest X-ray. Now a day detect Covid much difficult so if the doctor detects Covid at early stage it is so helpful for us. We use a Convolutional neural network with chest images and get a satisfactory accuracy of 97% of our model. In future work, we intend to increase the layer in convolutional neural networks (CNN) using the most powerful hardware to improve the accuracy of model.

REFERENCES

[1] Guan, C.S., et al., Imaging Features of Coronavirus disease 2019 (COVID-19): Evaluation on Thin-Section CT. Academic Radiology, 2020.

[2] Han, J., et al., A new multi-threshold image segmentation approach using state transition algorithm. Applied Mathematical Modelling, 2017. 44: p. 588-601.

[3] Abdel-Basset, M., et al., A hybrid whale optimization algorithm based on local search strategy for the permutation flow shop scheduling problem. Future Generation Computer Systems, 2018. 85: p. 129-145.

[4] Kapur, J.N.; Sahoob, P.K.; Wongc, A.K.C. A new method for gray-level picture thresholding using the entropy of the histogram. Comput. Vis. Graph. Image Proc. 1985, 29, 273–285.[Google Scholar][CrossRef]

[5] Faramarzi, A., et al., Marine Predators Algorithm: A Nature-inspired Metaheuristic. Expert

[6] Faramarzi, A., & Afshar, M. H. (2014). A novel hybrid cellular automata–linear programming approach for the optimal sizing of planar truss structures. Civil Engineering and Environmental Systems, 31(3), 209–228. https://doi.org/10.1080/10286608.2013.820280

[7] Ai T, Yang Z L, Hou H Y, Zhan C N, Chen C, Lv W Z, Tao Q, Sun Z Y. 2020. Correlation of chest CT and RT-PCR testing for coronavirus disease 2019 (COVID-19) in China:a report of 1 014 cases. Radiology, 296(2): E32-E40

[8] Wang L D and Wong A. 2020a. COVID-Net: a tailored deep convolutional neural network design for detection of COVID-19 cases from chest X-Ray images[EB/OL].[2020-05-13].

[9] Zhang K, Liu X H, Shen J, Li Z H. 2020a. Clinically applicable AI system for accurate diagnosis, quantitative measurements, and prognosis of COVID-19 pneumonia using computed tomography. Cell,

[10] Hemdan E E D, Shouman M A and Karar M E. 2020. Covidx-Net: a framework of deep learning classifiers to diagnose COVID-19 in X-ray images[EB/OL].[2020-05-01].

[11] Narin A, Kaya C and Pamuk Z. 2020. Automatic detection of coronavirus disease (COVID-19) using X- ray images and deep convolutional neural networks[EB/OL].[2020-05-18].

[12] X. Wei, Y. Chen and Z. Zhang, "Comparative Experiment of Convolutional Neural Network (CNN)

[13] G. Huang, Z. Liu, L. and K. Q. Weinberger, "Densely Connected Convolutional Networks," 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, 2017, pp. 22612269, doi: 10.1109/CVPR.2017.243.

[14] Dirami, A., et al., Fast multilevel thresholding for image segmentation through a multiphase level set method. Signal Processing, 2013. 93(1): p. 139-153.

[15] Oliva, D., M.A. Elaziz, and S. Hinojosa, Fuzzy entropy approaches for image segmentation, in Metaheuristic Algorithms for Image Segmentation: Theory and Applications. 2019, Springer. p. 141-147.

[16] Models Based on Pneumonia X-ray Images Detection," 2020 2nd International Conference on Machine Learning, Big Data and Business Intelligence (MLBDBI), Taiyuan, China, 2020, pp. 449-454, doi: 10.1109/MLBDBI51377.2020.00095.

[17] Otsu, N., A threshold selection method from gray-level histograms. IEEE transactions on systems, man, and cybernetics, 1979. 9(1): p. 62-66.

[18] CoroNet: A deep neural network for detection and diagnosis of COVID-19 from chest x-ray images. Khan AI, Shah JL, Bhat MM

[19] CoroDet: A deep learning based classification for COVID-19 detection using chest X-ray images. Hussain E, Hasan M, Rahman MA, Lee I, Tamanna T, Parvez MZ Chaos Solitons Fractals. 2021 Jan; 142():110495.

[20] Mangal A., Kalia S., Rajgopal H., et al. CovidAID: COVID-19 detection using chest X-ray. 2020. https://arxiv.org/abs/2004.09803.

[21] I. Mporas and P. Naronglerdrit, "COVID-19 Identification from Chest X-Rays," 2020 International Conference on Biomedical Innovations and Applications (BIA), Varna, Bulgaria, 2020, pp. 69-72, doi: 10.1109/BIA50171.2020.9244509.

[22] D. Haritha, M. K. Pranathi and M. Reethika, "COVID Detection from Chest X-rays with DeepLearning: CheXNet," 2020 5th International Conference on Computing, Communication and Security (ICCCS), Patna, India, 2020, pp. 1-5, doi: 10.1109/ICCCS49678.2020.9277077.

[23] B. K. Umri, M. Wafa Akhyari and K. Kusrini, "Detection of Covid-19 in Chest X-ray Image using CLAHE and Convolutional Neural Network," 2020 2nd International Conference on Cybernetics and Intelligent System (ICORIS), Manado, Indonesia, 2020, pp. 1-5, doi: 10.1109/ICORIS50180.2020.9320806.

[24] S. Deep Deb and R. Kumar Jha, "COVID-19 detection from chest X-Ray images using ensemble of CNN models," 2020 International Conference on Power, Instrumentation, Control and Computing (PICC), Thrissur, India, 2020, pp. 1-5, doi: 10.1109/PICC51425.2020.9362499.

[25] Y. Khan, P. Khan, S. Kumar, J. Singh and R. M. Hegde, "Detection and Spread Prediction of COVID-19 from Chest X-ray Images using Convolutional Neural Network-Gaussian Mixture Model," 2020 IEEE 17th India Council International Conference (INDICON), New Delhi, India, 2020, pp. 1-6, doi: 10.1109/INDICON49873.2020.9342159.

[26] E. Irmak, "A Novel Deep Convolutional Neural Network Model for COVID-19 Disease Detection," 2020 Medical Technologies Congress (TIPTEKNO), Antalya, Turkey, 2020, pp. 1-4, doi: 10.1109/TIPTEKNO50054.2020.9299286.

[27] S. Tewari, U. Agrawal, S. Verma, S. Kumar and S. Jeevaraj, "Ensemble Model for COVID-19 detection from chest X-ray Scans using Image Segmentation, Fuzzy Color and Stacking Approaches," 2020 IEEE 4th Conference on Information & Communication Technology (CICT), Chennai, India, 2020, pp. 1-6, doi: 10.1109/CICT51604.2020.9312076.

[28] E. -S. M. El-Kenawy et al., "Advanced Meta-Heuristics, Convolutional Neural Networks, and Feature Selectors for Efficient COVID-19 X-Ray Chest Image Classification," in IEEE Access, vol. 9, pp. 36019-36037, 2021, doi: 10.1109/ACCESS.2021.3061058.

[29] M. M. R. Khan et al., "Automatic Detection of COVID-19 Disease in Chest X-Ray Images using Deep Neural Networks," 2020 IEEE 8th R10 Humanitarian Technology Conference (R10-HTC), Kuching, Malaysia, 2020, pp. 1-6, doi: 10.1109/R10-HTC49770.2020.9357034.

[30] O. Saha, J. Tasnim, M. T. Raihan, T. Mahmud, I. Ahmmed and S. A. Fattah, "A MultiModel Based Ensembling Approach to Detect COVID-19 from Chest X-Ray Images," 2020 IEEE REGION 10 CONFERENCE (TENCON), Osaka, Japan, 2020, pp. 591-595, doi: 10.1109/TENCON50793.2020.9293802.

[31] S. V. Militante, N. V. Dionisio and B. G. Sibbaluca, "Pneumonia and COVID-19 Detection using

Convolutional Neural Networks," 2020 Third International Conference on Vocational Education and Electrical Engineering (ICVEE), Surabaya, Indonesia, 2020, pp. 1-6, doi: 10.1109/ICVEE50212.2020.9243290.

[32] U. Singh, A. Totla and D. P. Kumar, "Deep Learning Model to Predict Pneumonia Disease based on Observed Patterns in Lung X-rays," 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, India, 2020, pp. 1315-1320, doi: 10.1109/ICECA49313.2020.9297388.

[33] Joshi R. C., Yadav S., Pathak V. K., et al. A deep learning-based COVID-19 automatic diagnostic framework using chest X-ray images. Biocybernetics and Biomedical Engineering. 2021;41(1):239–254.

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