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A Personalized Profound Complicational Neural Network for Covid-19 Detection

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Abstract: *The world is still experiencing the devastation caused by the covid-19 virus. It is vital notonly to promote the vaccine and have people vaccinated as soon as possible, but it is also important to test more individuals and isolate those who are sick from the general population and stop the disease spread. While the nasal swab test model is now used over the world to identify covid patients, radiography evaluation provides an alternative and more efficient method. This proposed work utilizes Personalized Profound Complication Neural Network (PPCNN) technique and identify patients who test positive for Covid-19 on chest X-rays. Theoutput accuracy of the proposed model is 97.93 percent when using openly accessible chest X-ray images*

Keywords: Personalized Profound Complication Neural Network (PPCNN), Covid-19 Detection,Chest X-Rays

I. INTRODUCTION

Covid-19 has shattered over millions of lives and declared so as one of the deadliest pandemic outbreaks ever since the Spanish flu, the virus belongs to the SARS COV-1 variant which was earlier detected in the year 2012. The virus mainly causes respiratory problems causing acute shortage of breathing leading to fever, cold and severe cough. Although vaccination camps have started worldwide with billions of doses already carried forward, still there's an abnormal spike of the cases at certain areas.

At present the only form of detecting this virus is through the nasal swab testing method called Reverse Transcription Polymerase Chain Reaction (RT-PCR). It is considered to be accurate and would quickly identify a virus micro particle [1]. However, this test takes an ample amount of time to get the result and prepare a report, which keeps a patient under confusion and doubt, at times get mistakenly detected and is also an expensive process. These are also exposed to manual human errors. Apart from that, there to exist some image detection technique that helps in detecting the virus through x-ray images but they lack precision because of the improper way of training the model due to which patients with a medical history of flu and lung disease and also people with smoking habits were being detected as a covid patient which leads to failure of existing model [2, 3].

A novel covid-19 detection technique builds in this proposed system which is an alternate system that would detect the virus in a cheaper and quicker process in presence of anexperienced physician or radiologist with chest x-rays through using the proposed PPCNN method to identify the covid-19 virus. This model utilizes both positive and negative covid affected patient chest x-rays to train PPCNN model and help it differentiate. Personalized Profound Complication Neural Network (PPCNN) is an ensemble of many convolution and deep neural network layers, developed to build an accurate Covid-19 detection model with great precision. PPCNN is based on the concept that an ensemble of model predictions performs better than individual models. This ensemble model boosts the efficiency of thedeep learning classifier, which combines several layers of convolution and neural network layers into a single predictive model for minimizing the variance, and bias, for enhancing model accuracy

1.1 Motivation of PPCNN Covid-19 detection model

This proposed model intends to develop a fast and reliable Covid-19 identification system using PPCNN model. The present nasal swab-based testing method is more prone to human error. As a result, our suggested method overcomes the disadvantage of nasal swab-based testing. This suggested method detects Covid-19 with excellent accuracy using the PPCNN, saving time and effort.

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1.2 Problem formulation

The key contributions to the proposed research include: There have already been numerous studies on the diagnosis of corona viruses using X-ray images, but almost all of them make useof pre-trained models, including ResNet-50, VGG 16, and Inception v3. The majority of thesestudies were carried out in 2020, when covid was still relatively new and datasets were not widely available, and the available data had to be supplemented to obtain a large dataset.

As a result, the proposed model used a larger dataset and aimed to achieve higher accuracythan the existing models. This proposed model reached 97.93 percent accuracy, which is higherthan that of other models.

1.3 Organization of this article

Section1 introduction discussed the idea in a little more detail and the problem with the currentcovid testing model and how our proposed method aims to solve it. The following are the remaining sections of the paper: Section 2 highlights recent research on Covid-19 detection models; Section 3 details the suggested PPCNN classifier; Section 4 includes experimental analysis of the research results; and Section 5 outlines the suggested work conclusion.

III. STATE-OF-THE-ART RESEARCH ON COVID-19 DETECTION MODEL

Many authors have published their research on Covid disease detection using deep neural network (DNN) models. This section highlights the research on Covid -19 detection deep learning methods. Emrah Irmak et al. [4] developed Convolutional Neural Network, which has twelve weighted layers, two convolution layers, and one fully connected layer with ReLU activation function. The fully connected layer makes 2-dimensional vector, which is then fed into the softmax classifier, which generates the final prediction. The prediction has two possible outcomes,and the output layer has two neurons. The first convolutional layer is made up of 96 7x7 kernels with stride 4 and padding of zero. The second convolutional layer is made up of two sets of 128 kernels with stride 1 and padded 2. The input photos are 227x227x3 in size.

Jingxin Liu et al. [5] developed DNN algorithm using Computed Tomography (CT) image of 721 covid-19 patients from various hospitals, with 600 training images, for covid-19 detection. Asu Kumar Sing et al. [6] developed Hybrid Optimized Support Vector model with Chest X-Ray input Images. The input features are retrieved using a modified social group optimizationtechnique, which are classified using Support vector algorithm to predict Covid-19. Kehran et al.

[7] developed CNN model with X-ray images through ResNet-50 pre-trained with image augmentation techniques in a time when covid was relatively newand large datasets were not available.

Rakibul Islam et al. [8] developed Novel LeNet-5 CNN model for CT images and detect covid 19 cases, with 80% input utilized for model training and 20% used for model testing. Data Augmentation has been used to enlarge the pre-existing dataset. Taresh et al. [9]developed and optimised a transfer learning model with input X-Ray, with VGG16 and MobileNet getting the maximum accuracy, to improve model prediction accuracy and select the best performing model. Reshi et al. [10] utilized a CNN model, with data preprocessing techniques such as dataset normalization, image analysis, and data augmentation. Despite the lack of a dataset with enough high-quality chest X-ray images and appropriate size, the CNN classifier successfully performed well.

Boran Sekeroglu et al. [11] developed Convolutional Neural Networks (CNN) using Chest X-Rays. CNN classifier training and CNN classifier testing are main stages of this approach. Eightfold cross-validation utilized in this model to measure model performance. Chen Li et al.

[12] utilized a deep transfer learning model from chest X-rays, where 70% of images from eachclass are used for model training, 15% for model validation, and the remaining for model testing. This achieves the greatest classification accuracy of 89.3 percent, with averageprecision, recall, and F1 scores of 0.90, 0.89, and 0.90, respectively. Julia et al. [13] used lungultrasound images with DNN architectures such as Xception, InceptionV3, VGG19, and ResNet50. For model training and optimization, a publicly accessible POCUS dataset of pneumonia patients and healthy COVID-19 patients was used.

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III. PROPOSED METHOD

The proposed model uses PPCNN classifier for Covid identification and make a distinguish between Covid positive and Covid negative X-Ray samples. X-ray samples from patients who tested positive or negative for COVID are obtained and divided 80:20 for model training and testing. The training dataset is pre-processed and then fed into the PPCNN classifier for model training. The time taken for training and how good the model has been trained depends upon the number of epochs. The more the number of epochs, the better a model is trained. After the training part, the model is then tested against the test dataset. The image to be tested is preprocessed and passed as input and the output is generated as positive or negative.

3.1 PPCNN Classifier

The Personalized Profound Complication Neural Network (PPCNN) extracts features from image input, assigns learnable weights and biases to input features and able to differentiate normal sample and covid-19 sample. The main stages in developing a proposed PPCNN are feature extraction and feature classification. In feature Extraction, convolutional layers perform convolutional processes and identify unique feature of the input image. The input of this step is an input vector that is formed when all hidden layers are flattened. The flattened vector is coupled to a fully - connected layers, where the feature classification process determines whether or not the patient has covid-19.

PPCNN requires significantly less preprocessing than other classification techniques. Thex-ray images are processed by removing the background image and filtering the object in the foreground using adaptive threshold to perform morphological operations in the grouped pixelsand tracking it using the kalman filter. The various layers of PPCNN are: Convolutional, padding, Pooling and Fully connected Layer, which are depicted in Figure 1.

In PPCNN, the convolution layer reduces images into a format that is easier to handle while retaining essential features making best prediction model. Convolution Operator retrieves the high-level attributes from the input image, such as edges. PPCNN has various layers. In CNN, the first layer captures low-level properties like gradient direction, colour andedges. The model adapts to the high-level features as more layers are added, resulting in a network that understands the image feature in the dataset in the same manner that humans do.

Padding layer basically helps in increasing the area of the image which is processed by CNN by adding rows and columns to the outer dimension of the images. It helps save the information which are present at the corner of the images from getting chopped off by the convolution process. This helps in maintaining the output size of the data. It helps with better and more accurate analysis of the image. We have used 'same' padding in our proposedmethod which basically adds zero values in the outer frame of the image. The extracted featuresare passed through Max pooling layer which reduces input dimensionality by picking the maximum value from a group of adjacent pixels.

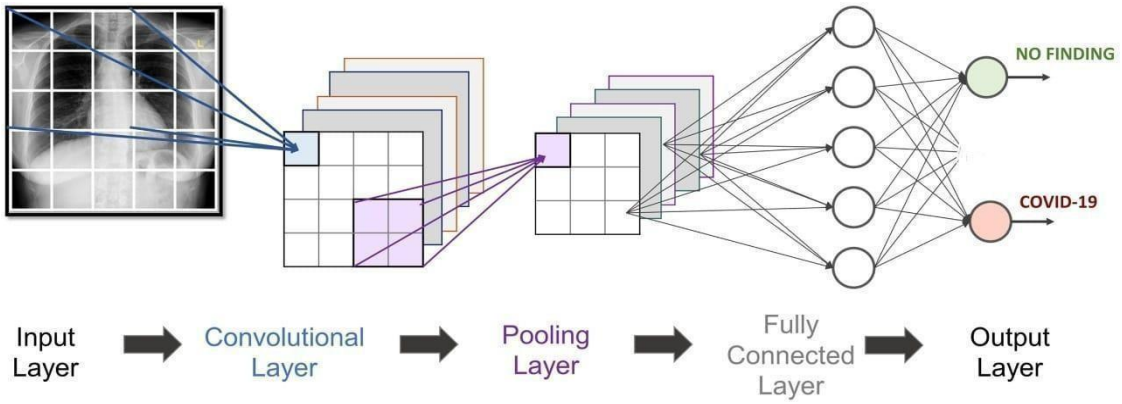

Figure 1. Workflow of Proposed Covid-19 detection model

Through the use of pre-processing filters, a PPCNN efficiently captures the spatial andtemporal dependencies of input features. The suggested PPCNN model is suitable and efficient for the input dataset due to the reduced parameters and the reusable weights. Algorithm 1 depicts the steps needed in developing a PPCNN model.

Algorithm 4.1: Covid-19 detection using PPCNN algorithm

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Input	:	Input dataset Ds consists of N training samples.
Output	:	Covid-19 prediction model
Step 1	:	Fetching and creation of a dataset.
Step 2	:	Feeding the dataset into the program. The image vectors have been normalized from 0 to 255.It has been divided by 255 so that the input image pixel intensity ranges between 0 to 1.
Step 3	:	Dividing the dataset into training dataset and testing dataset of 80:20.
Step 4	:	Create and train a PPCNN model with best fitting parameters andweights.
Step 5	:	To Calculate classifier prediction accuracy using testing samples.

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

4.1 Experimental setup of PPCNN model

Dataset 1 [14] and dataset 2 [15] are combined to create the proposed model dataset. Initially, we started off with just dataset1 and we got an accuracy of 96.02 percent. After combining bothdatasets, a total of 487 images were divided into training and testing models in a 4:1 ratio. Wehave tried various methods starting from increasing the hidden layers and the number of epochs to attain high accuracy of 97.9 percentages. The output accuracy of the model is decided by a lot of factors like the epochs, the dataset size, and the hidden layers.

4.2 Performance evaluation and output of PPCNN model

The Covid-19 detection model uses the Personalized Profound Complication (PPCNN) wherethe data to be trained is pre-processed and then fed into the model to train. The model accuracy is determined by the epochs. Confusion matrix evaluates the proposed model performance. True Positive ($True\ Pos$), False Positive ($False\ Pos$), False Negative ($False\ Neg$), and True Negative ($True\ Neg$) are determined as four components of the confusion matrix, and the model accuracy is calculated in following Equation

$$Model\ Accuarcy = \frac{(True\ Pos\ +\ True\ Neg)}{(True\ Pos +\ False\ Pos +\ True\ Neg +\ False\ Neg}$$

The $Model\ Accuarcy$ is the ability of the classier to differentiate between the classes correctly. The result for various epoch(s) by the PPCNN model is given in the Table 1.

Table 1. Output of the proposed PPCNN model

Epoch(s)	Training Accuracy	TrainingLoss	Test Accuracy	Test Loss
10	0.9700	0.0607	0.9251	0.1799
20	0.9500	0.0554	0.9535	0.1252
30	0.9800	0.0420	0.9328	0.1558
40	0.9600	0.0506	0.9690	0.0940
50	**0.9700**	**0.0504**	**0.9793**	**0.0598**

The PPCNN classifier has a 97.93% accuracy at 50 epochs. Each epoch was obtained at an equal interval of $15s$ ($1s$/step). Figure 2 and 3 shows the accuracy and loss graph of PPCNN model

Figure 2: Accuracy Graph of PPCNN

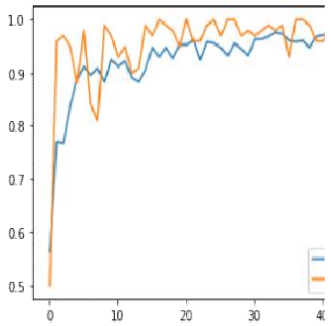
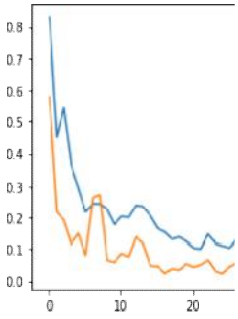


Figure 3. Loss Graph of PPCNN



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V. CONCLUSION

Covid-19 is mutating itself at a pretty rapid manner. There have been new mutants found everytwo to three months since its inception in December 2019. Even in December 2021, it shows no signs of slowing down. The public should respect and follow all the protocols imposed by the government and the government should set up more covid detection centers and speed up the vaccination campaign in order to efficiently battle the disease. The current system of Covidtesting is an accurate method to a very good extent but has its own set of drawbacks. It takes alot of time in the swab testing and then the sample is sent to the laboratory for RT-PCR testing.This makes it inconvenient for people in this fast-paced lifestyle. The project aims to introducea novel method for the testing of coronavirus in India which is simpler, time efficient and more convenient than the existing method. Chest X-Rays are utilized for training PPCNN model and differentiate between a covid-19 positive and a covid-19 negative sample image and afterthe model is trained, we can input test data to detect covid patients. The full process includes comprehending the problem, selecting the model, creation of a dataset, creating and then training a model, implementing the model and then finally getting the output with accuracy of 97.3 %.

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