Coronavirus Classification using Deep Convolutional Neural Network Models. and Chest X-ray images

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***Abstract*— The COVID-2019 virus, which was discovered for the first time in December 2019 in the city of Wuhan, China, went on to become a pandemic after rapidly spreading around the globe. As there are currently no reliable automated toolkits on the market, there has been an increase in the demand for supplementary diagnostic tools for COVID19 patients. It may be possible to improve the accuracy of the diagnosis of covid19 disease by making use of more recent developments in artificial intelligence (AI) approaches and radiological imaging. In this research, three different convolution neural networks were applied to raw chest x-rays before the histogram filter was used for the basic pre-processing. The goal was to automatically detect COVID-19. The results that we obtained using the three suggested models indicate that the ResNet50 model provides the greatest classification performance with 96% accuracy , while the InceptionV3 model only achieves 95% accuracy, and the Inception-ResNetV2 model only achieves 82% accuracy**

Index Items: Coronavirus, CNN , Artificial Intelligence ,Deep learning

1. Introduction

The World Health Organization (WHO) identified COVID-19 as a virus that has a rapid transmission rate and poses a significant health risk. (COVID-19) used to be referred to as SARS-CoV-2 in the past. The city of Wuhan in China is credited with being the origin of the outbreak of this virus, which quickly spread to other cities in a brief amount of time [1]. The majority of corona-viruses impact animals; however, due to the fact that they are zoonotic, they have the potential to also be transmitted to humans or individuals. In the United States of America, the first seven conditions were discovered on January 20, 2020, and the number of cases increased to more than 300,000 by April 5, 2020. Exceptionally severe form of the acute respiratory syndrome SARS-CoV and Middle East respiratory syndrome both caused by the Coronavirus MERS-CoV is a coronavirus that has been linked to a wide variety of severe respiratory diseases and deaths in people. Corona disease can cause a person to experience a variety of symptoms, including fatigue, headaches, shortness of breath, chest pains, aches and pains in the muscles, fever, coughing, and a sore tongue. [2] In severe cases, the infection may lead to the failure of multiple organs, difficulty breathing, pneumonia, and ultimately mortality. The health care infrastructure of a number of industrialized countries has crumbled as a direct result of the rapid acceleration in COVID-19's rate of replication. These types of systems are currently suffering from a shortage of testing kits and ventilators. Several countries announced that they would implement a complete lockdown and asked their populations to remain inside and avoid gatherings. In order to eliminate and eradicate corona, it is necessary to conduct a thorough examination of individuals who are afflicted with the illness. Therefore, infected people could be separated from the general population, inspected, and given treatment. . In recent times, the most common screening method that has been used to identify COVID-19 is called rRT-PCR. The test is performed on a sample taken from the patient's respiratory system, and the findings can take anywhere from a few hours to a few days to arrive. It's possible that chest radiography images could serve as an alternative to the PCR screening procedures. There have been multiple studies that have been published in the Radiology magazine indicating that the images obtained from chest scans could be significant in detecting this virus. According to studies, individuals who are experiencing the symptoms of COVID-19 have few visual signs such as haze darkened spots and ground glass opacities that differentiate patients who are infected with COVID-19 from patients who do not have the infection. There have only been a handful of studies that have suggested that a method based on chest radiology could be an effective instrument for detecting quantification and following up on COVID19 cases. In addition, detection systems that are based on chest radiology images might have various characteristics when compared to more conventional methods. It is possible that it would be very quick while simultaneously analyzing a number of instances and having more availability. These methods may be useful in hospitals that have restricted resources or none at all, including testing kits. Due to the significance of radiography in determining who among a population has coronary disease, it is offered at a high level of service in all healthcare facilities and hospitals. For the purpose of combating such a pandemic, numerous studies are being conducted in a wide variety of disciplines. Many preprint scientific studies for detecting this virus from the chest radiography images were reported in a lot of studies [3]. There were a lot of studies done, on small datasets, with significant findings in a lot of the studies. However, none of them were even close to being ready for production, and before they could be utilized, they all needed to go through extensive testing and a lot of improvement work. After that, many data scientists who were attempting to construct accurate and dependable methods that used deep learning (DL) to manage and recognize COVID-19 focused their attention on DL approaches for detecting certain features from the chest radiography of patients who were afflicted with COVID-19. In recent years, DL has become increasingly significant in a variety of visual activities that involve the examination of X-ray medical images. The DL has developed an automatic method for the diagnosis and administration of diseases by meticulously analyzing, locating, and categorizing patterns in medical images. The fact that DL does not depend on manually handcrafted features but rather on algorithms that learn features automatically from the data itself [3] is one of the reasons why it is of such high importance. In the past, DL was successful in illness classification when chest radiography images were used as the dataset. It was based on a network called Chex-Net, which uses deep learning to identify pneumonia from chest X-rays [4]. Chex-Net identifies pneumonia. ChexNet was able to achieve outstanding results by surpassing the performance of the typical radiologist. Applying Deep Learning to chest radiography images was another method that was developed for the purpose of identifying thorax diseases. This method was referred to as (ChestNet). The primary objective of this experiment is to propose three models for the prediction of (COVID-19) patients, including trained ResNet (50), Inception (V3), and Inception ResNet (V2) models, and to compare these results with the result from the previous experiment. In addition, superior outcomes were achieved when compared to the techniques used previously. According to the findings, the pre-trained model with the ResNet-50 algorithm produced the greatest accuracy out of the three different approaches. The second contribution is that there are standards that are used in this work. Some examples of these standards include recall, specificity, precision, and A correctness. It is our intention to evaluate the task that has been proposed.

The remaining portions and overall structure of the document Related material is covered in Section 2. In COVID-19, Section 3 is devoted to Applications of Artificial Intelligence (AI), and Section4 Structure of convolution layers, section 5 Methodology. Section 6: Implementation, section 7, Discussion and Results and a Concluding Statement in Section 8

2. Literature Review

A method that is founded on deep learning (also known as DL) is already being used in a number of different fields. It makes it possible to model the entire process from beginning to finish, delivering significant results by making use of input data and eliminating the need for manual feature extraction. The use of ML techniques for diagnostics in the field of medicine is of utmost significance, and it is one of the supplementary instruments available to medical professionals. In addition, a molecular diagnostic method of new coronavirus has been proposed [3]. This method involves the development of two 1-step quantitative real-time reverse-transcription PCR assays for the detection of regions of the viral genome. Researchers have investigated the clinical and epidemiological characteristics of the newly discovered corona virus, including the records that are connected to all patients who have been infected with the COVID-19 virus and identified by the Chinese Center for Disease Control and Prevention up to January 26, 2020. Recently, a significant number of radiological images have been extensively utilized for the purpose of detecting the confirmed instances of COVID-19. In a study that was carried out by Sethy et al. [5,] the researchers classified the characteristics that were obtained from different CNN models by using SVM Classifier and X-Rays. In addition, a research project that was carried out by Wang et al. [6] suggested a deep model for the recognition of patients who were experiencing COVID19 and reached 92.40% accuracy in standard classes classification, non COVID, as well as COVID-19 Pneumonia. In a separate piece of research that was carried out by Narin et al. [7], a model of ResNet5026 was suggested, which achieved 985 detection accuracy of COVID-19. (Loannis et al.) accomplished a success rate of 98.75% when using 2 classes for COVID-19 detection using deep learning models, and they obtained a success rate of 93.48% when using 3 classes. A research project that was carried out by Hemdan et al. [9] recommended the COVIDX-Net model, which is capable of detecting the confirmed conditions of COVID-19. The model was comprised of multiple CNN models. In addition, Karmany et al. [10] proposed a framework that is based on transfer learning for the purpose of identifying medical conditions and illnesses that can be treated by utilizing image-based deep learning. This framework can be found here. There is a large number of authors who have already recommended many different methods for the detection of biomedical images. M.I.Razaak [11] discussed the difficulties that currently exist in the field of (x-ray) image processing as well as its bright future. According to Dinggang Shen [12], a significant amount of work has already been done for the detection of illnesses such as heart disease, kidney disease, brain disease, and respiratory system disease by utilizing deep learning techniques. Using a dataset consisting of twenty-nine patients treated at Tongji Hospital in Wuhan, China, Yan et al. suggested using machine learning (ML) to develop a prognostic prediction algorithm (PPA) to predict the mortality risk of a human that has been infected. This algorithm would be used to make the prediction. However, Jiang et al. used AI to identify people who would be affected by COVID-19 disease, and their prediction was accurate 80% of the time. Yeen Huang and Ning Zhao) [13] was applied methodology for assessing the mental health burden which is related to the Chinese public throughout the outbreak and exploring the possible influence factors when utilizing web-based cross-sectional survey, the data utilized in experiment are collected from (7236) self-selected volunteers. [13] was applied methodology for assessing the mental health burden which is related to the Chinese public throughout the outbreak and exploring the possible influence factors. The comparison is made using the symptoms of anxiety, disorder, quality of sleep, and melancholy as the criteria for analysis. The regression logistic method demonstrated that age (less than 35) and the amount of time spent on the COVID-19 virus (greater or equal to 3 hours each day) were related to GAD. It's possible that health care workers had poor sleep quality, and the method also showed that age was related to GAD.The employees in the health care industry have been at an increased risk of having poor quality sleep. whereas Fullana et al. [14] selected an adult sample size of 5545 from the general population of Spain to conduct their survey. As a direct consequence of this, sixty-five percent of the population showed signs of anxiety and depression. The experiment also demonstrated that individuals who participated in hobbies and spent the greatest amount of time outside experienced the lowest rates of both anxiety and melancholy. Medical images and artificial intelligence were the tools that FengShi et al. [15] used in the past to identify COVID-19 disease. In this investigation, medical imaging techniques like X-rays and CT scans were utilized. Many researchers have turned to methods that involve artificial intelligence in an effort to slow the phenomenon of new viruses being disseminated around the globe. For the purpose of classification, for instance, (Wang et al) [16] utilized the convolution neural network (CNN) technique. When applied to (45) corona patients, the precision was determined to be 83.5%. On the other hand, Shaymaa Adnan Abdulrahman and Abdel-Badeeh M [17] implemented Deep belief network with C-.SLBP as a categorization technique. When a chest X-ray picture was utilized as the dataset, the accuracy reached 90%. Shown Table 1.

Table1: Feature Extraction with different classification methods

Authors	Years	Pre-processing & Feature Extraction	Machine Learning	Accuracy
[Shaymaa adnan Abdulrahman and Abdel-Badeeh]	2020	RBB	CNN	81%
[Sethy et al]	2020	SVM	CNN	93.4 %
[Narin et al]	2020	five-fold cross-validation	CNN	96.1 %
[Shaymaa adnan Abdulrahman and Abdel-Badeeh]	2020	C-.SLBP	Deep belief network	90%

3.Applications Artificial Intelligent (AI) in COVID-19

When it came to the elevated risks of occupational viral exposures, those working in the health care industry were particularly susceptible. In addition, the imaging technicians and specialists were extremely important in the sense that they allowed for any potential interaction with the virus to be managed and avoided. Along with personal protective equipment (PPE), one ought to take into consideration specialized imaging facilities as well as workflows, as these elements were extremely important in terms of lowering the risks and saving lives. When screening for COVID-19 and making a diagnosis, CT and chest X-rays were used extensively [17]. The use of an automated and contactless picture acquisition workflow is of utmost significance throughout the entirety of COVID-19 in order to mitigate the extremely high risk of infection. However, there is no way to prevent interaction between patients and technicians in the traditional imaging workflow. In particular, with regard to patient positioning, the technicians are initially assisting in posing the patients based on a certain protocol, such as feet-first versus head-first, and prone versus supine in the CT. This is succeeded via identifying (by the visual inspection) the location of the target body part on patient as well as in a manual manner, altering relative position and pose between X-ray tune and patient, such process is putting the technician in close contact with the patien As a result, an automated and contactless imaging workflow was necessary in order to reduce the amount of physical interaction. For the purpose of keeping an eye on patients, many cutting-edge CT and X-ray devices come complete with built-in cameras. During the course of the COVID-19 outbreak, devices of this type made the implementation of contactless scanning processes more accessible. Additionally, technicians are able to observe patents from a control room using live video streamed from camera equipment. However, if the technician only has the overhead view from the camera, it can be challenging for them to determine the parameters of the scanning, such as the scan range. Regarding this type of scenario, AI is capable of automating the process [1] by identifying the shape and posture of patients based on the data collected by visual sensors such as RGB, Time-of-Flight (TOF) pressure imaging, or thermal (FIR) cameras. This information can be gleaned from the images captured by these types of cameras. As a result, the parameters for screening that are most effective could be described. A common parameter for screening that could be evaluated with the artificial intelligence empowered visual sensors was the range of the scan. This parameter defined the start position as well as the end position of the CT scan, and the range of the scan could be specified by identifying anatomical joints related to the subject from images. The evaluation of key-point positions on the patient body in two or three dimensions is the subject of a significant amount of recent research [17]. Such key-point positions typically involve important joints like the knees, ankles, shoulders, neck, elbows, and wrists. According to the findings of a research carried out by Wang et al., the use of automated workflow may be significantly improving the effectiveness of scanning while simultaneously lowering exposure to radiation that is not essential. However, key points typically only represent an extremely sparse sampling of the complete three-dimensional mesh [4] in three-dimensional space (which defines a digital human body), whereas other significant scanning parameters may be inferred through the use of artificial intelligence, specifically ISO cantering. Additionally, the ISO cantering signifies that the target body area of the subject is being aligned. As a result, the center that is related to the target body area overlaps with the ISO center of the scanner, and as a consequence, the overall quality of the imaging was at its highest possible level. According to the findings of some studies, it is possible to reduce the amount of radiation exposure while maintaining an equivalent level of imaging clarity by using ISO cantering that is more precise. [1] In order to properly align the target body area with the center of the ISO, and under the assumption that anatomical keypoints typically represent nothing more than an extremely sparse sampling related to a complete three-dimensional mesh in three-dimensional space, the following steps must be taken. (specifying the digital human body).

4. Structure of Convolution layers

Convolutional Layer

Convolution Layers are the most basic layers, this layer is considered the most important layer in the CNN. The work of these layers basically convolves the pixel matrix generated or created by image or object to. produce an activation. map for the given. image.

Pooling

Pooling refers to an important phase to further reduce, the dimensions of the. activation map keeping, only the important features, while also reducing the special, invariance. In this step using to resolved the problems of "overfitting"

Fully Connected Layer

This layers refer to the last or final layer which is ,feeded to the neural network. In generally matrices, is flattened before. getting passed on .to the neurons.

5. Methodology

This study suggested a model of convolutional neural network (CNN) for classifying three Pneumonia types: COVID-19 pneumonia, viral pneumonia and bacterial pneumonia. Figure 1 below represents the methodology used.

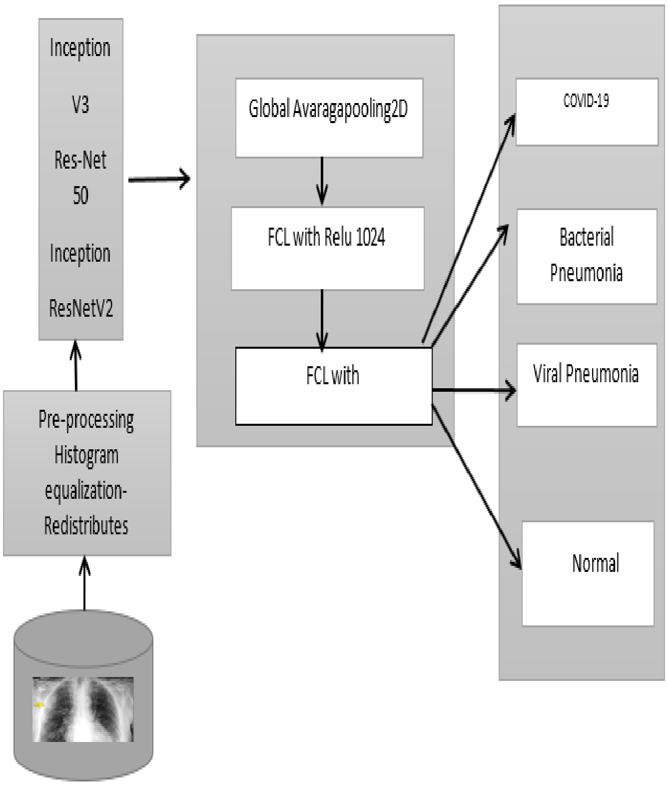

Figure -1 : Proposed Methodology

5.1 DataSet

When referring to deep learning, all of the data that is used as propellant in such learning models is indicated. There is not a dataset of an appropriate size that could be utilized for this work because COVID-19 is considered to be one of the modern diseases. This is one of the reasons why this work cannot be done. Therefore, a dataset was produced for the research by collecting images of chest X-rays from a variety of image databases that are accessible to the general public. The X-ray picture of COVID-19 was made available at an open source repository on Github through the efforts of Joseph et al. For the purposes of research, the authors collected images of radiology taken from a variety of reliable sources (RSNA Radiopaedia, etc.) pertaining to cases of the COVID-19. The majority of studies pertaining to this virus use images taken from reliable sources. In addition to this, the repository features an open database of COVID19 cases that have chest CT or X-rays, which is kept up to current on a consistent basis. Due to the fact that this research is conducted during the COVID-19, the database contains approximately 310 chest radiography pictures associated with the COVID-19. These chest X-rays have been obtained from the Kaggle collection known as "Chest X-Ray Images (Pneumonia)" [17]. They show bacterial pneumonia, pneumonia, and normal chest X-rays. In addition, the cases of pneumonia included in the data collection are classified as either normal (1200), bacterial (630), or viral (920). See chart 2. This research collected a total of one thousand images from such sources; after collecting the images, they were resized to have a dimension of 224 by 224 pixels and a resolution of 92 dpi.

Table 2: Number of medical images

Covid -19	Bacterial Pneumonia	Viral Pneumonia	Normal
310	630	920	1200

5.2. Data Pre-processing

The quality of images, particularly medical images, can be affected by a great number of different variables. These aspects contribute to the pictures' unfavorable appearance. Because of this, strategies for image enhancement have been utilized in order to extract data more effectively. Mathematics, trend elimination, convolution edge detection, filtering, and histogram analysis are among these approaches. The Gaussian Histogram Equalization algorithm redistributes the intensities of the image across the full spectrum of those intensities that are conceivable. (usually 256 gray-scale levels). The most frequent applications for this kind of filter are found in pictures like (medical images). In order to make use of histogram equalization-redistributes, three stages were carried out. The details of each are as follows:

Step1: Histogram Formation

Step2: We calculated the new intensity values for each of the levels of density by using the following mathematical equation [17].

al equation [17]

$$Q_i = \left[\sum_{j=0}^{i} N_j\right] x \frac{\text{Max. intensity Levels}}{\text{\#No of (pixels)}} \quad (1)$$

Step 3: Using the new intensity value, replace the old intensity value that was previously used. The term "Max Intensity Levels" refers to the highest possible degree of intensity that a pixel can achieve. The third stage is to use the new intensity level rather than the one that was used previously. To accomplish this, the value of (Qi) is written into the picture for each pixel. Here, Qi represents the updated intensity value, and (i) represents the intensity level that existed before the update

5.3 . CNN Technique to detect Covid.19 Disease

Deep learning, also known as DL, is a technology that has been hailed as a game-changer in the field of artificial intelligence [4]. The word "deep" refers to the increase in the size of the network that occurs when the number of layers increases. In addition, the structure was given the term convolution, which is derived from the mathematical concept known as a "operator." The most common construction for CNNs includes a convolution layer, which is responsible for the extraction of features from input using filters. In contrast to the fully-connected layer, which is denoted by the symbol NN, it uses a pooling layer in order to lower the required computational performance capacity [17] . A model of CNN will be produced by combining one or two of these levels together. On the other hand, its internal parameters will be modified so that it can successfully complete a particular mission, such as (object recognition and classification). An approach that is more rational and makes use of prior techniques that have been shown to be effective is utilized here rather than developing the deep learning model from the ground up. The composition of ResNet-50 is depicted in Figure 2.

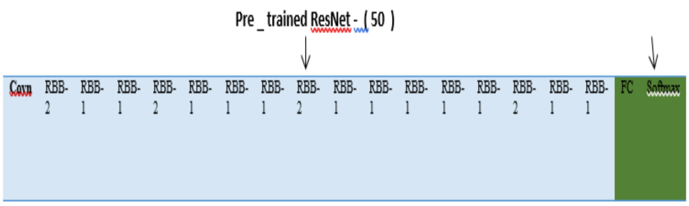

Figure 2: structure of ResNet(50)

The Residual Building Block, also known as the RBB, is an essential part of the Res.Net system.(50). The RBB algorithm is predicated on the concept of bypassing blocks of the convolutional layer by making use of shortcut connections. These shortcuts are essential for optimizing trainable parameter in error back-propagation to avoid the vanishing -exploding gradients problems, which can help to construct deeper (CNN) structure to improve final performance for fault diagnosis. In addition, these shortcuts are important for avoiding the problems of vanishing -exploding gradients. CNN including pre-trained ResNet (50), Inception (V3) and Inception ResNet(V2) models for the prediction of (COVID-19) patients, bacterial pneumonia, viral pneumonia, pneumonia, and normal patients, the application of the residual neural(NesNet) method is a new and improved version of convolution neural networks. Additionally, when a problem is solved, (NesNet) adds a shortcut between two or more layers, and bottleneck –blocks are incorporated in (Res-Net) to make the training process go more quickly. The Res-Net(50) network is a thirty-layer system that was learned using the medical image dataset. On the other hand, Inception (V3) takes a somewhat of a CNN-style strategy

6. Implementation

The ResNet50, Inception (V3), and Inception ResNet(V2) Convolution Neural Network approaches were all pre-trained with random initialization weights using the Adam algorithm [17]. The data collection that was used was randomly divided into four separate datasets, with 85% of each dataset being used for training and the remaining 15% being used for testing. During the course of this research, four parameters were applied in order to evaluate the effectiveness of deep transfer learning methods such as [17].

Accuracy =: (TN + TP) / (TN + TP + FN + FP) (2)

Recall =: TP / (TP + FN) (3)

Specificity: = TN / (TN + FP) (4)

Precision: = TP / (TP + FP) (5)

The following key can be used to decipher the symbols used in the calculations presented above: The abbreviations T.P, F.P, T.N, and F.N each stand for the amount of "True Positives," "False Positives," "True Negatives," and "False, Negatives," respectively. On the other hand, we were successful in obtaining confusion matrices for each of the architectures. Figure 3 shows confusion matrices for COVID-19, bacterial pneumonia, viral pneumonia, and other respiratory illnesses. The outcome of the model's normal testing is presented here.

COVID-19	Normal	Bacterial Pneumonia	Viral Pneumonia
60	0	0	1
2	65	3	2
0	1	70	9
3	2	6	53

Fold (A)

COVID-19	Normal	Bacterial Pneumonia	Viral Pneumonia
64	0	0	1
2	70	3	2
0	1	89	9
2	2	6	64

Fold (B)

COVID-19	Normal	Bacterial Pneumonia	Viral Pneumonia
74	0	1	2
2	85	0	2
1	1	75	10
3	2	11	60

Fold (C)

Figure 3 : Confusion Matrices of (COVID-19)and normal (A) Inception (V3) (B) ResNet50 (C) Inception-ResNetV2

When we examine the picture that is located above, we notice the following processes:

First, the Inception (V3) pre-trained model identified ten out of the four cases of pneumonia (COVID-19 pneumonia, viral pneumonia, and bacterial pneumonia) as True Positives for fold-5, while it classified ten out of the normal as True Negatives.

In the second phase, the ResNet,(50) model also classified 10 cases of COVID-19 pneumonia, viral pneumonia, and bacterial pneumonia as True Positives for fold-5 and classified 10 cases of normal as True Negatives.

In the third stage, we begin. ResNetV2 categorized ten cases of COVID-19 pneumonia, viral pneumonia, and bacterial pneumonia as True Positives for fold-5, while ten cases of normal were categorized as True Negatives

7 . Result and Discussion

In this study, a comparison of three models was carried out by making use of the test results presented in Tables 3, 4, and 5. For the ResNet(50) model, we were able to achieve the highest performance overall, with an accuracy value of 96%, a recall value of 93%, and a specificity value of 100%. Table 4 displays the lowest performance values, which have resulted in an accuracy of 82%, a recall of 81%, and a sensitivity value of 88% for Inception-ResNet(V2). As a direct consequence of this, the ResNet(50) paradigm offers advantages over. According to [17], the comparison between these results and the prior outcome is considered to be the most accurate.

Table 3 : Comparison of the proposed method when used InceptionV3

#	T.P	T.N	F.P	F.N	ACC	Rec	Spe	Pre
Fold1	8	10	0	5	80	73	100	100
Fold2	10	10	0	0	100	100	100	100
Fold3	10	10	0	0	100	100	100	100
Fold4	10	10	0	0	100	100	100	100
Fold5	10	10	0	0	100	100	100	100
InceptionV3	-	-	-	Mean	95	93	100	100

Table 4 : Comparison of the proposed method when used ResNet(50)

#	T.P	T.N	F.P	F.N	ACC	Rec	Spe	Pre
Fold1	8	10	0	4	80	73	100	100
Fold2	10	10	0	0	100	100	100	100
Fold3	10	10	0	0	100	100	100	100
Fold4	10	10	0	0	100	100	100	100
Fold5	10	10	0	0	100	100	100	100
ResNet(5)	-	-	-	Mean	96	92	100	100

Table 5 : Comparison of the proposed method when used Inception ResNetV2

#	T.P	T.N	F.P	F.N	ACC	Rec	Spe	Pre
Fold1	8	6	3	3	77	77	70	70
Fold2	10	8	3	0	90	100	87	80
Fold3	8	10	1	0	90	100	88	89
Fold4	10	10	0	0	78	90	88	89
Fold5	10	10	0	0	78	90	88	89
InceptionResNetV2	-	-	-	Mean	82	81	88	87

The benefits of our study can be précised as follows:

Step 1: Four data-set: Bacterial Pneumonia, Viral Pneumonia, COVID-19, & Normal images

Step 2: Pre-processing using Histogram equalization-Redistributes to remove noise.

Step 3: Deep convolutional neural network (CNN) for the classification process between four dataset

Step 4: Better results were obtained compared with previous work according to [17]

Step5: Results obtained could help medical institution for early detection of human diseases

8. Conclusion

At this time, there has been an uptick in COVID-19 disease infections, particularly those caused by the newly altered virus. There is a shortage of resources available to fight this epidemic in many countries around the globe. It is essential for researchers to assist medical professionals and organizations in putting a stop to the further spread of this virus. As a result of this, a model was suggested in order to identify COVID-19 disease by making use of a dataset of medical images. The suggested method was trained on a number of medical images, and the results obtained were superior to those obtained using the methods that came before it. According to the findings, the pre-trained ResNet-50 model produced the results with the greatest accuracy out of the three different approaches. The task that is being proposed will be judged based on the criteria that we used. These factors are known as recall, specificity, precision, and accuracy, respectively. When the performance results obtained are taken into consideration, it can be seen that among the other two suggested models, the pre-trained ResNet-50 model provides the greatest classification performance, with an accuracy of 96%. Accuracy of 95% for the Inception-V3 system, and accuracy of 82% for the Inception-ResNe-tV2 system

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