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COMPARISON BETWEEN X-RAY AND CT-SCANS IMAGES FOR INFECTED PEOPLE BASED ON DEEP LEARNING

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Abstract- The lung is the part of the body that is most susceptible to contemporary diseases. Because it is the main respiratory center for humans, through which it catches the virus and enters it directly into the lung. For the importance of this part, the latest techniques must be used in order to detect the virus transmitted properly and quickly, in order to prevent the development of infection and the transmission of infection from one person to another. Corona virus is considered one of the most dangerous viruses that infect the respiratory system and has a great speed of transmission through the transfer of droplets, so it must be diagnosed early. This paper presents an effective proposed method for quickly and accurately identifying the lung infected with Covid disease or not. A fully automated system has been proposed in the process of detecting Covid through medical images of the human lung, and this reduces the effort on doctors. Then the area of injury is deducted and identified in any part of the lung. By testing the system on X-rays and CT-Scan images of the lung, there were clear differences between them. Experimental results proved that the value of the measures reached 99, including both accuracy, F-score, precision, and Recall, using a different database, for CT-Scan. X-rays reached rate to 96.666. The detection process is preceded by a preprocessing of the medical images, which increases the accuracy of the detection.

Keywords: Convolutional Neural Network, COVID-19, Deep Learning, Segmentation, CT-Scan, X-Ray.

1. INTRODUCTION

Covid disease has become very well-known and spread all over the world, starting from China in the city of Wuhan, starting with neighboring countries, and then gradually spreading to the world [1, 2]. Because of its rapid spread and lack of preparation and preparation to confront it, it became very difficult to keep pace with and diagnose these huge numbers due to the lack of medical staff and capabilities compared to the number of infected people, which exceeds thousands per day. In addition, these traditional methods require a long time and a diagnosis may be wrong due to the great pressure on the doctors [2, 3].

Therefore, technology had a role and orientation towards reducing and limiting the spread of this disease and its rapid and accurate detection in order to be treated early.

Deep learning has played a major role in this task, as it is able to distinguish between infected and non-affected people by training neural networks on different types of images of infected and non-injured lungs [3]. These networks have the ability to extract characteristics from digital images and rely on them for diagnosis. In this paper, we propose a system based on convolutional neural networks to process medical images that are x-ray images of patients with COVID-19 and CT-Scan images.

This system was proposed in order to rely on the automatic detection of Covid-19 disease quickly and accurately without resorting to nasopharyngeal and nasal swabs that require time and effort, in addition to the pain associated with the swab. An infection or not in a way that saves less time and effort, in addition to the speed of detection that limits the prevalence of the disease; reduces it and treats it faster [4]. Figure 1 represents spread COVID-19 from during Touching or sneezing directly [5].

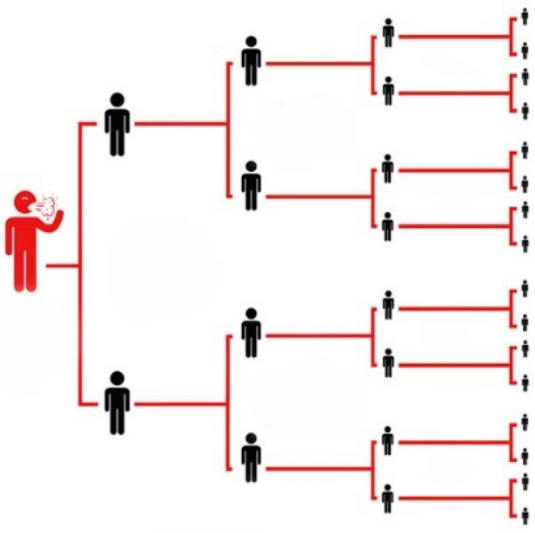


Figure 1. The spread of COVID [5]

Diseases are usually diagnosed in patients through the may have similar symptoms, but differ in the method of treatment, so a method must be used to correctly identify the disease. Therefore, it is based on taking CT-Scan images or X-rays of the body organ that contains pain in the patient. Such pictures provide the internal parts of an organ, whether it contains a disease or not. A part may appear completely different from the rest, the parts of the organ, so it represents the disease. These images can be diagnosed by special computer programs.

These images are used as part of image processing and computer vision through the use of programs in different languages that work to determine the features of symptoms experienced by them. However, many diseases normal images and images infected with diseases. Then training these programs on these features. Each image can be tested depending on training. The best field of use within medical image processing is deep learning [6, 7, 8]. We will discuss the details of the methods used in diagnosing COVID and the work that was done in this field. There are many algorithms and methods used in the process of classifying medical and other images as shown in Figure 2. Deep learning algorithms are the most developed and used at the present time [9]. In addition, Figure 3 shows medicine images that used in classification.

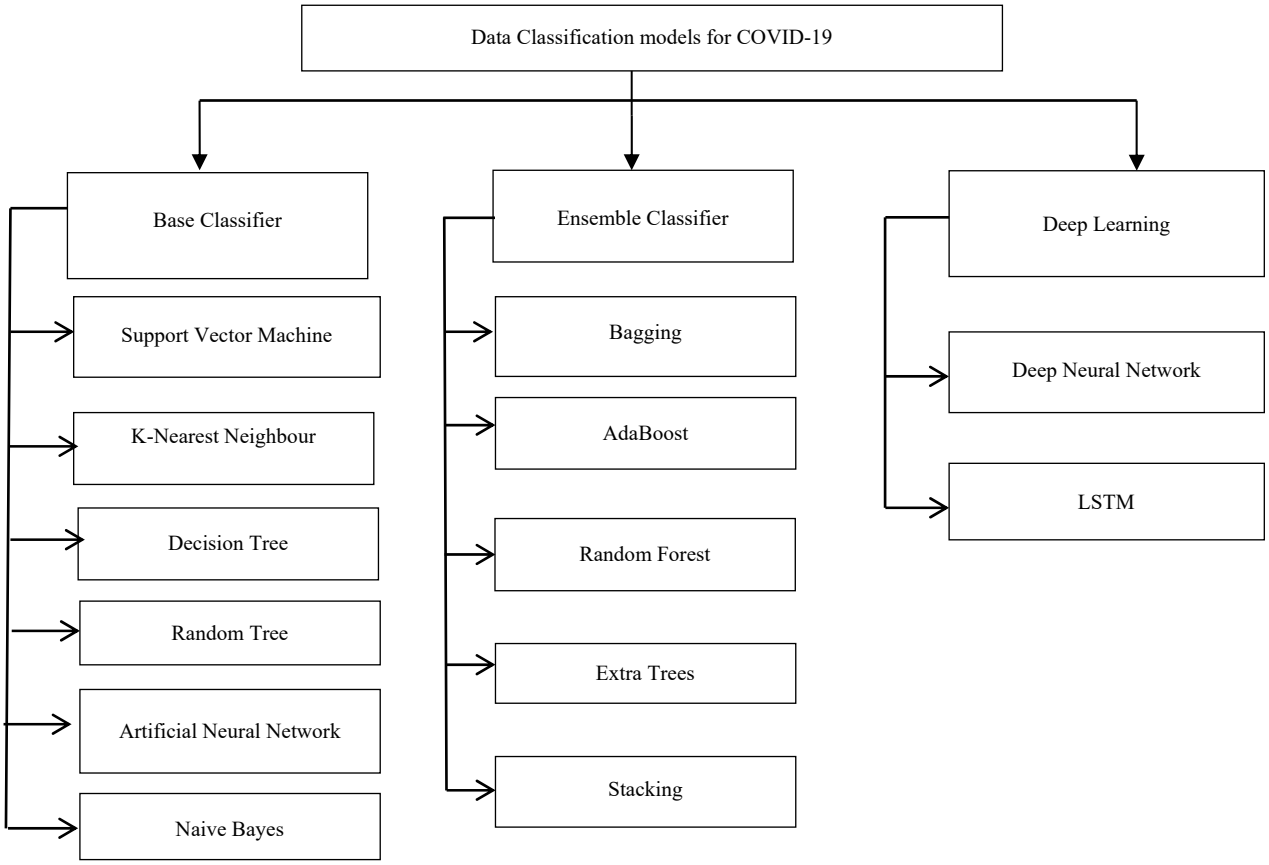
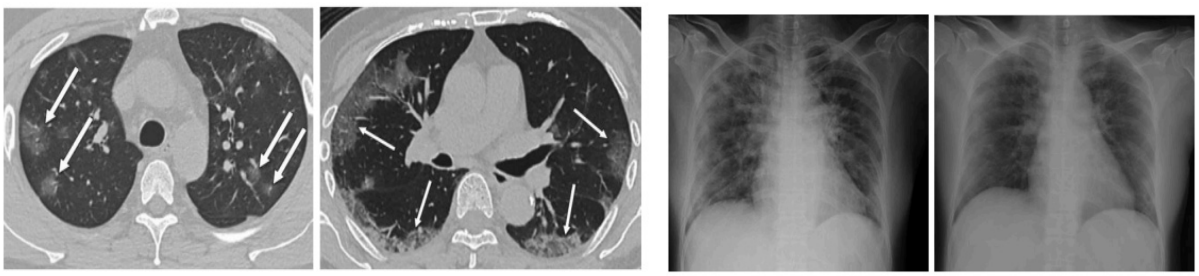


Figure 2. Classification of using AI in COVID-19 [9]



(a) CT-Scan from dataset

(b) X-ray from dataset

Figure 3. Lung Images for patient's using two types X-ray and CT scan from Dataset

2. RELATED WORKS

A lot of research has been conducted within this field, but with a specialization either using CT-Scan or X-ray, we will address some of the works:

Hou wang, et al., 2020 Introduced a fully automated system based entirely on deep learning. Their proposed system is based on diagnosing a lung with Covid or pneumonia. The base consists of 1,266 photos of different people, 924 with COVID-19 and 342 with other pneumonia. The lung was segmented from chest computed CT images using Dense Net 121 and FPN, and (19 Net) was utilized for diagnostic and prognostic analysis. A database of 5372 patient photographs was used to test the system. The proposed system achieved 0.87 in order to diagnose COVID-19 infection from another pneumonia [10].

Lin le, et al., 2020 They proposed a system that would distinguish between three types of disease, either Covid, pneumonia, or another long-term illness. The model used is called 3DDL (COV NET). COV NET achieved a sensitivity of 90% and a specificity of 96% on the used database, which amounted to 4,356 images from 3,322 difference patients [11].

Xiaowei Xu, et al., 2019 Whenever the base contains large data and different types, the diagnosis becomes accurate. But this does not mean that the small base size does not show results, the base size used consists of 618 images. Classifies it as infected with COVID-19 or LAVP. System after performing the automatic extraction of the characteristics of the excised area from the images used for the cheese. Accuracy of system was 98% [12].

Hassantabar, et al. (2020b**)** A system based on deep learning has proposed two algorithms in this regard. The first algorithm one of them is a deep neural network (DNN). The second algorithm convolutional neural network (CNN) for a set of thorax X-ray images. The first is a deep instruction, but for normal neural networks that take characteristics from images. As for the second model, the network used to take the complete images as an input. Performs of the CNN rendered with large accuracy that equal (93.2%) and sensitivity with the value (96.1%). Performs of the DNN with the value 83.4% for accuracy and 86% for sensitivity [13].

Wang, et al. A system based entirely on convolutional neural networks. The system distinguishes between normal lungs and lungs infected with Covid. Accuracy present for system 93.3 [14].

Ali, et al., in three databases made up of four categories-healthy lungs, lungs infected with COVID-19, viral pneumonia, and bacterial pneumonia - he presented five convolutional neural network models (ResNet50, ResNet101, ResNet152, InceptionV3 and Inception-ResNetV2), and the findings were as follows: Chest X-ray pictures from the Dataset are accurate to 96.1 percent [15].

3. MATERIALS AND METHODS

The proposed work to detect corona virus in human lungs includes three basic steps. The first step represents the pre-processing stage of medical images to remove noise or other effects from medical devices such as darkness or fog. As for the second stage, it is represented by using a deep learning CNN algorithm that ensures the feature extraction and classification step with high accuracy. The final stage includes segmentation of lungs. The chart below shows the proposed system, starting with inserting medical images and ending with segmentation.

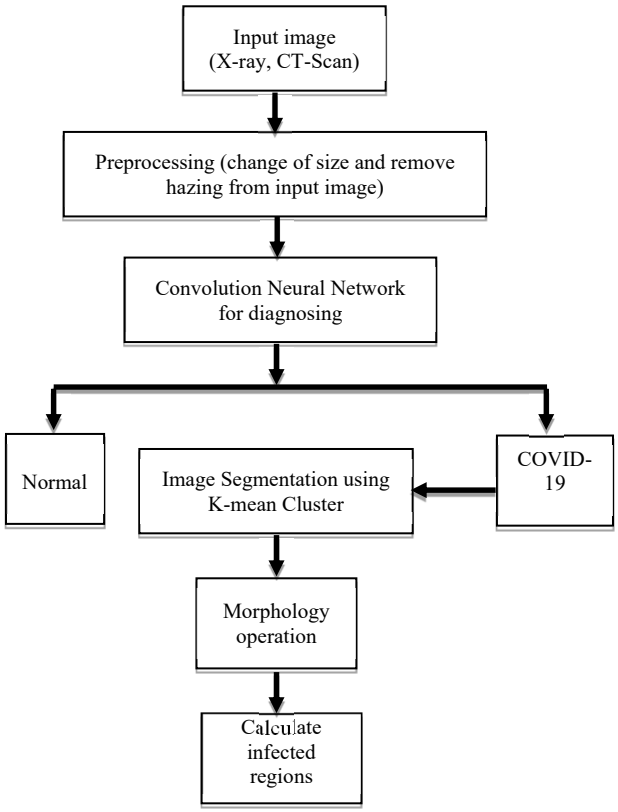


Figure 4. Flowchart of the proposed method

3.1. Pre-Processing

This is an essential step for processing images before entering them into the training stages. Because the images taken from medical devices contain blur, they must be removed because they greatly affect the final results in the diagnosis process. The algorithm below shows Image Enhancement.

A1gorithm 1. Pre-processing of input image

Input: Input Image.
Output: enhancement image.
Began:
1. Read CT-Scan or X-ray gray image.
2. resize of images to same size.
3. Convert RGB image to Ycbcr color space.
4. Separate the first layer (Y) representing lighting from two layers representing color (CbCr).
5. Working on layer Y in order to unify the luminance values and make them close to the average, the dispersion in the values is caused by hazing.
6. Each value within the luminance layer is subtracted from the smallest value in the layer and divided by the difference between the largest and smallest value.
7. Convert the image to RGB space to show the image features as they were without hazing.
End

After the process of pre-processing medical images to improve their appearance and remove noise from them, this image enters the second stage, which is a diagnosis using CNN. This algorithm consists of three preprocessing steps which include resizing the database images to make them the same size and this is an essential part of the algorithm training process. It also includes changing the type of images from gray to color if the images are not colored.

The second step involves extracting the image properties by generating filters with random weights at first and then updating them to reach the ideal weights. A roll is made between filters and images. The number and size of filters are determined by the programmer [17-19]. This step in our proposed system consists of four layers as the following:

1. Convolution layer: create 32 filters with size 3×3 is employed to construct 32 feature maps if gray image or 96 feature maps if color image where 32 feature maps for each layer. In remain layer 64, 128, 256 filters.
2. Activation Function (ReLU) that use for return positive values of image and convert negative values to zero.
3. Max Pooling layer: the main purpose in this layer reduces size of image to reach in to important features. Size of max filter 2×2 the optimal size of proposed method.

The third and final step involves the classification process using a normal neural network with multiple hidden layers [17]. The entrance to this layer is the most important features that were extracted from the previous layer, so the number of features is determined, which is approximately 512 features that were taken in our system. Using the neural network, the images are classified as whether they have Covid or not. The proposed convolutional neural network in Table 1 was used on X-ray and CT-scan images, including preprocessing.

Table 1. Proposed CNN Layers

Layers	Details
First L.	Conv. (32 filter, size 3, padding 'same') ReLU Maxpooling (size 2×2)
Second L.	Conv. (64 filter, size 5, padding 'same') ReLU Maxpooling (size 2×2)
Third L.	Conv. (128 filter, size 3, padding 'same') ReLU Maxpooling (size 2×2)
Fourth L.	Conv. (256 filter, size 5, padding 'same') ReLU Maxpooling (size 2×2)

The size of the images entered into the network is 250×250 after resizing the images.

The last step is to calculate the efficiency of the system in diagnosing through numerical ratios that show its accuracy. There are several metrics used within this field, including:

1. Accuracy: The accuracy is a most reliable performance measure and calculates as a ratio of correctly predicted observation to the total observations. When a model achieves high accuracy, it is not necessary to assume that the model performs its function optimally. Other parameters need to be looked at in order to test the results because when the dates are symmetrical the false positive and false negative values are similar.

$$\text{Accuracy}=[(TP+TN)/(TP+TN+FP+FN)\times 100] \quad (1)$$

2. Precision: Precision is calculated as the ratio of correctly positive predicted observations to the total positive predicted observations.

$$\text{Precision}= [TP/(TP+FP)\times 100] \quad (2)$$

3. Recall: Recall or sensitivity is calculated as the ratio of correctly positive predicted observations to the all observations in actual class true.

$$\text{Recall}=[TP/(TP+FN)\times 100] \quad (3)$$

4. F-score: F1 score is calculated as a weighted mean of precision and recall.

$$F1=2\times(\text{Precision} \times \text{Recall})/(\text{Precision} + \text{Recall})\times 100 \quad (4)$$

3.2. Diagnosing Using CNN

The proposed system is primarily based on neural networks but form other type. CNN has become a broad concept and is of great use in the field of imaging and diagnostics, primarily [16, 18]. CNN consists of several layers as in the Figure 5.

3.3. Segmentation of Image

It is necessary to extract the lungs from an image in order to determine the incidence of infection. The K-mean Clustering algorithm and morphology operation was used, which separates the lungs from a background.

Algorithm 2. Segmentation of Image

Input: enhancement Image.
Output: Segment image.
Began:
1. Choose two cluster one for the object and the other for the background.
2. Apply K-mean cluster to extraction features.
3. convert image into binary image.
4. apply morphology operation to delete small object and save on size of lung.
5. extraction region of Covid from lung.
End

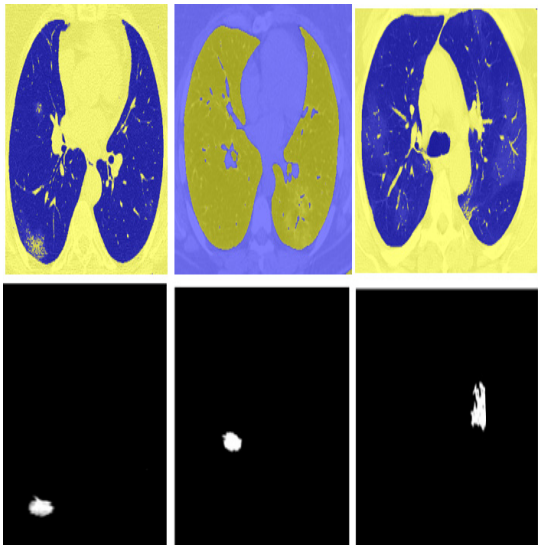


Figure 6. explain segmentation of K-mean

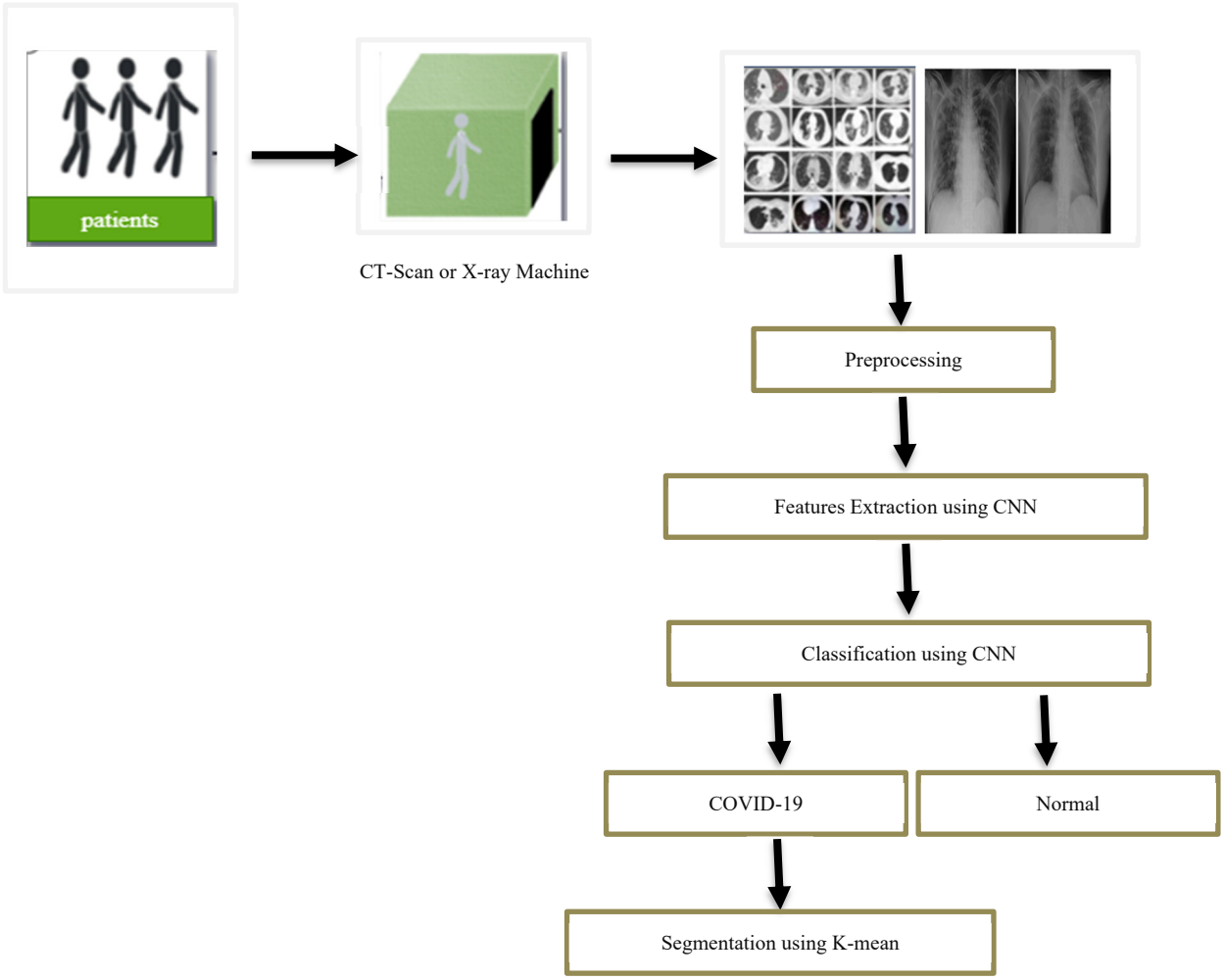


Figure 5. Structure of CNN for Diagnosing

4. PERFORMANCE EXPERIMENT

In this section, the rule used and the results are discussed that were reached.

4.1. Databased

The diagnosis of COVID disease through computer-generated programs is based on images taken of the lung area. The images are either taken with x-ray or CT-Scan devices. Usually, the most diseases to difficult diagnose use CT-scan for detection it for several reasons. X-rays take a single snapshot of a specific area of the body. And when you take the lung area, the rib cage appears in the area, and it is not possible to detect early infection with "Covid" disease only after the disease has progressed above 40%. As for CT-scan, it takes several snapshots of the same part and in different directions to be able to determine the injury [20, 21]. It shows the entire lung area, so the disease is clear even if it is in its early stages. In this study, we employed a CT-Scan database comprising 5000 images of COVID-19-infected lungs and 5000 images of healthy lungs free of infection. We used an X-ray database consisting of 1500 images of lungs infected with Pneumonia and 1500 images of normal lungs without infection.

4.2. Applying the Proposed System

This part explains the results obtained by applying the proposed system to databases. Various cases were taken to measure the accuracy of the system. Table 2 shows the results of applying X-rays to the proposed system with different layers:

Table 2. Difference cases for the proposed method

Number of Layer	Epochs	Size of filter	Accuracy	Precision	F-score	Recall
1	3	3*3	90.11	90.11	90.11	90.11
1	3	5*5	91	91	91	91
1	7	5*5	92	92	92	92
2	3	3*3	94.33	94.33	94.33	94.33
2	5	5*5	95.22	95.22	95.22	95.22
2	10	5*5	93.15	93.15	93.15	93.15
3	3	3*3	94	94	94	94
3	5	5*5	96.33	96.33	96.33	96.33
3	10	5*5	95.66	95.66	95.66	95.66
4	3	3*3	96.1	96.1	96.1	96.1
4	4	5*5	96	96	96	96
4	5	5*5	96.4	96.4	96.4	96.4

Table 3 shows the results of applying CT-Scan to the proposed system with different layers.

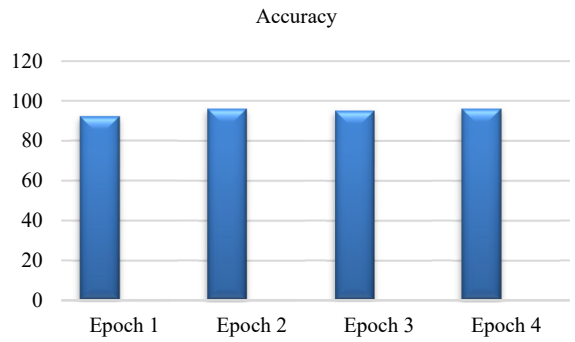


Figure 7. Appear Accuracy of CNN for training X-ray image

Table 3. Represent difference cases for proposed method

Number of Layer	Epochs	Size of filter	Accuracy	Precision	F-score	Recall
1	3	3×3	95	95	95	95
1	3	5×5	96	96	96	96
1	7	5×5	96	96	96	96
2	3	3×3	98	98	98	98
2	5	5×5	98.9	98.9	98.9	98.9
2	10	5×5	97	97	97	97
3	3	3×3	99	99	99	99
3	5	5×5	99	99	99	99
3	10	5×5	99	99	99	99
4	3	3×3	99	99	99	99
4	4	5×5	99	99	99	99
4	5	5×5	99	99	99	99

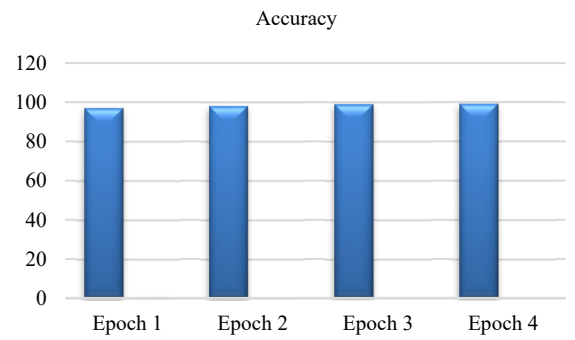


Figure 8. Appear accuracy of CNN for training CT-Scan image

We note from the tables that there are differences between x-rays and CT-Scans. Since the CT-scan images are more efficient and more accurate in imaging the lung, the results were higher, as they show the injury completely. By comparing both types of medical images with different layers, the figure below shows that CT-Scan images are more accurate in diagnosis because they highlight the internal features of the lung area. It can also determine the area of injury that can be detected in the x-ray images.

5. CONCLUSION

The proposed system works greatly in diagnosing images taken by computed tomography. This is because the lung features are clearer and more accurate, so deep learning requires accurate and clear images to extract the features better.

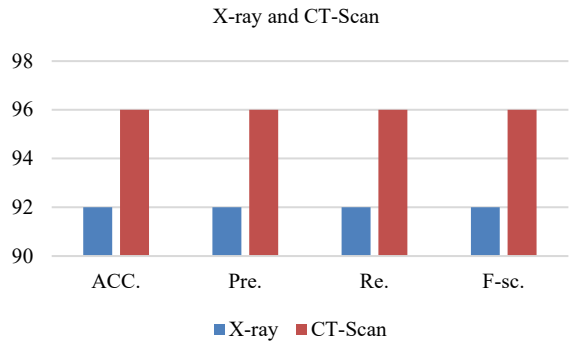


Figure 9. Measures of one layer

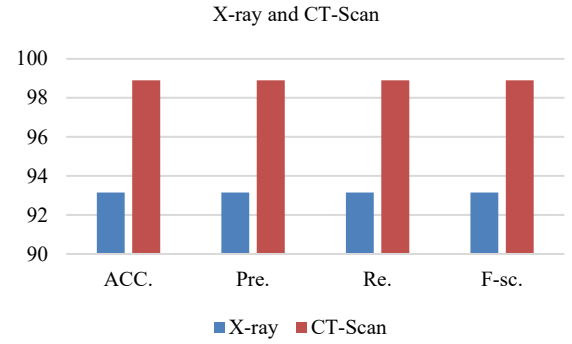


Figure 10. Measures of two layer

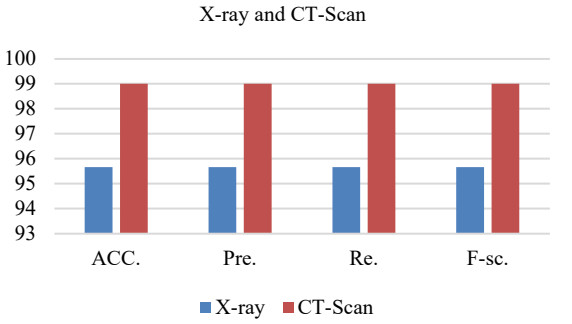


Figure 11. Measures of third layer

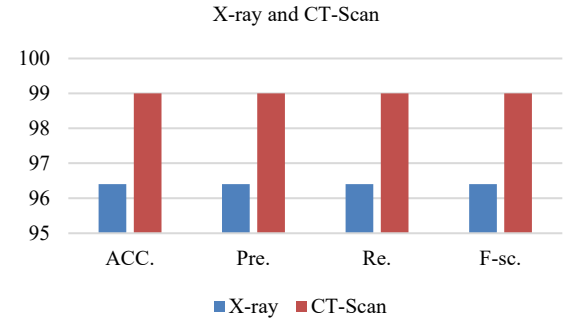


Figure 12. Measures of Four layer

The process of optimizing images prior to diagnosis has a role in improving outcomes. In addition, determining the rate of infection depends on the amount of Covid in the lung, which makes it easy to determine the appropriate treatment for infected people without referring to a medical consultation.

It is possible to add this work in future work after obtaining sufficient information from the approved health centers. Therefore, may be determining the percentage, from through it can determine the drug according to age, gender, or according to people, whether they have chronic diseases or not. Such a system reduces the fatigue of doctors, saves time, facilitates and speeds up work, and makes treatment time-consuming.

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