



## **CLASSIFICATION OF COVID 19, PNEUMONIA AND NORMAL LUNGS BASED ON X-RAY IMAGES USING CONVOLUTIONAL NEURAL NETWORK**

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### **Abstract**

The RT-PCR (Real Time – Polymerase Chain Reaction) examination method is a type of Nucleic Acid Amplification Test (NAAT) method currently used by hospitals, laboratories and other facilities stipulated by the Minister of Health as the main standard for the diagnosis of Covid-19. . -19 19. It is this sensitivity and specificity in detecting genetic material that makes the PCR method quite important and is still the gold standard in detecting SARS-CoV. Although considered the best, not without flaws. The RT-PCR examination method requires two processes, namely extraction and amplification. which takes several days to find out the results of the RT-PCR examination. However, the positive rate for this method is reported to be around 30-60%, so there are still patients who are not diagnosed and can cause infection in healthy people. One of the alternatives used for the detection of Covid-19 is Chest Radiographic Imaging (X-Ray or Computed Tomography Scan) which is a tool that is often used periodically as a tool to easily and quickly diagnose pneumonia and Covid-19. The detection of Covid-19 by X-Ray Imagery has proven to be feasible as well as deep residual tissue studies. Detection of Covid-19 Disease Based on X-Ray Imagery and Results of Implementation of Corona Virus Detection on X-Ray Imagery Using Intelligence Algorithms. In this study a classification system for Covid-19, Pneumonia and Normal Lung will be designed using the CNN architectural model which uses three dataset sources to add (combine) Pneumonia, Normal Lung image data, and also Covid-19 image data. 19 so that it becomes one dataset. which aims to analyze the level of accuracy in the proposed model.

**Keyword:** RT-PCR1, Covid-192, Pneumonia3, Classification4, Convolutional Neural Network5

## **1. INTRODUCING**

Use this Coronaviruses are a large family of viruses that cause disease in humans and animals. In humans it usually causes respiratory tract infections, ranging from the common cold to serious diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). A new type of coronavirus that was discovered in humans since the extraordinary incident that first appeared in Wuhan China, in December 2019, was later named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2-) which causes Coronavirus Disease-2019 (COVID-19).

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is a new type of virus from Coronavirus Disease-2019 that is transmitted to humans. This virus can attack anyone, from the elderly (elderly group), adults, children and infants, to pregnant women and nursing mothers. The SARS-CoV-2 virus is thought to spread between people primarily through respiratory droplets produced during coughing. These sparks can also be generated from sneezing and normal breathing. In addition, this virus can be spread by touching contaminated surfaces and then touching someone's face. Coronavirus Disease-2019 disease is contagious people who have it have symptoms, but even so transmission may occur before these symptoms appear.

Each person has a different response to Coronavirus Disease-2019. Most people who are exposed to the virus will experience mild to moderate symptoms, and will recover without needing hospitalization. In many cases, this virus infects the respiratory system with the most common symptoms in patients suffering from flu, fever, cough, fatigue, loss of taste or smell. However, this virus can also cause severe respiratory tract infections, such as lung infections (pneumonia). Pneumonia itself is a lower acute respiratory infection (ARI) caused by inflammation of the tissues and air sacs in the lungs. The air sacs fill with fluid which can cause coughing up phlegm, fever, chills and difficulty breathing.

The disease caused by the Coronavirus is indeed spelled out with very similar symptoms to ordinary Pneumonia. Apart from that, this disease can also cause inflammation of the lungs which also includes pneumonia. However, pneumonia caused by the Coronavirus is slightly different from the usual pneumonia. Common pneumonia is also known as wet lung. This condition can cause inflammation of the air sacs in one or both lungs. This infection can cause air sacs in the respiratory tract in the lungs that become inflamed and filled with fluid. However, this disease can heal by itself if the person's immunity is good. Whereas Pneumonia in Coronavirus Disease-19, this disorder generally attacks the upper tract which can eventually spread to the lungs. The coronavirus can infect the upper respiratory tract and cause obstruction



in the respiratory organs. What's worse is that the Coronavirus can cause fatal damage to the lungs if it is not treated immediately.

The RT-PCR (Real Time – Polymerase Chain Reaction) examination method is a type of Nucleic Acid Amplification Test (NAAT) method currently used by hospitals, laboratories and other facilities determined by the Minister of Health as the main standard for confirming the diagnosis of Covid-19. RT-PCR converts RNA into DNA with the help of the reverse transcriptase enzyme, so that it can become an amplification in the PCR process. SARS-CoV-2 is a virus with genetic material in the form of RNA, so it must first be changed using the reverse transcription method to confirm DNA so that it can be amplified in the PCR process. The PCR process in the detection of genetic material is very important, this process functions to multiply copies of specific target DNA in order to reach the detection threshold of Real-Time PCR instruments (increase sensitivity). It is this sensitivity and specificity in detecting genetic material that makes the PCR method quite important and is still the gold standard in detecting SARS-CoV-2.

Even though it is considered the best, it is not without drawbacks. The inspection method using RT-PCR requires two processes, viz extraction and amplification, which takes several days to find out the results of the RT-PCR examination. However, the positive rate of this method is reported to be around 30-60%, so that there are still patients who are not diagnosed and can cause infection in healthy people. One of the alternatives used for the detection of Covid-19 is Chest Radiography Imaging (X-Ray or Computed Tomography Scan) which is a tool that is often used periodically as a tool to easily and quickly diagnose pneumonia and Covid-19.

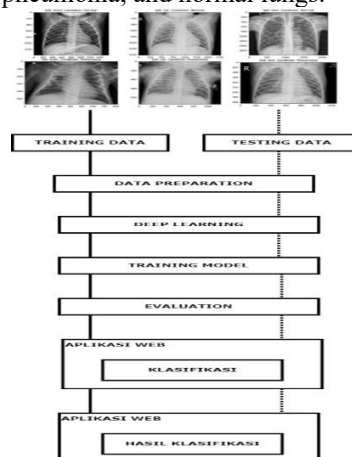
In several cases the researchers found lung scans of patients with indications of Covid-19 who had dark spots compared to patients who were not infected. CT-Scan has high sensitivity for the diagnosis of Covid-19. This method is another alternative in detecting SARS-CoV-2 through X-Ray images of a patient who is indicated to be infected with the SARS-CoV-2 virus. Several studies have shown that this method can be useful in detecting viruses with good results. The advantage of this method compared to RT-PCR is that it quickly analyzes several images at once, and can be used in hospitals that have quite limited RT-PCR kits.

The detection of Covid-19 with X-Ray Imagery has been shown to be feasible as in research with a deep residual network. Detection of Covid-19 Disease Based on X-Ray Imagery and on the results of applying Corona Virus Detection in X-Ray images Using Intelligence Algorithms. The two studies have proven that detecting Covid-19 with X-ray imagery can be an option..

## 2. RESEARCH METHODS

The method used to classify the three types of disease consists of several stages. These stages start from collecting x-ray image data of Covid-19, pneumonia, and normal lungs which will be used as data or images to be trained and tested. The x-ray image data will then go through the Data Preparation stages. At this stage resizing the x-ray image to determine the appropriate size for the input image. Then proceed with converting it into a numpy array.

The next stage is Deep Learning, this stage creates a model and analyzes the Convolutional Neural Network with the EfficientNet Pretrained model which has a higher accuracy value than the others. After the model has been created, in the next stage is the Training model, in the Training stage the learning process model and create an artificial intelligence that will be formed .h5 file then in the next stage is the evaluation of the results of the Training model which we can see how high the accuracy obtained from the Training model. When finished, the file is transferred to the web application to start classifying x-ray images of covid-19, pneumonia, and normal lungs.



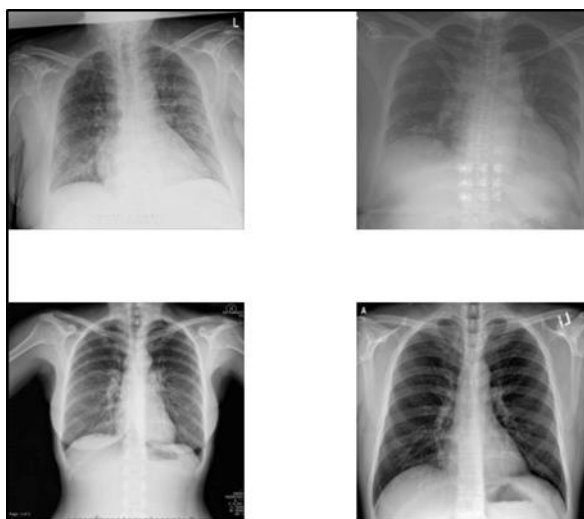
**Fig. 1** Convolutional Neural Network Architecture Design

## 2.1 Dataset

In this study, the first step that needs to be prepared is a data collection that contains x-ray images of Covid-19, pneumonia, and normal lungs. The dataset serves as input which is processed by the system at a later stage. The data used in this research is data obtained from the Kaggle platform. With 3 types of disease namely Covid-19, Pneumonia, and normal Lungs. These data sources include T1 and T2 Weighted images and total Covid-19 3,616 files, Pneumonia 1,345 files, and Normal Lungs 4,990 files.

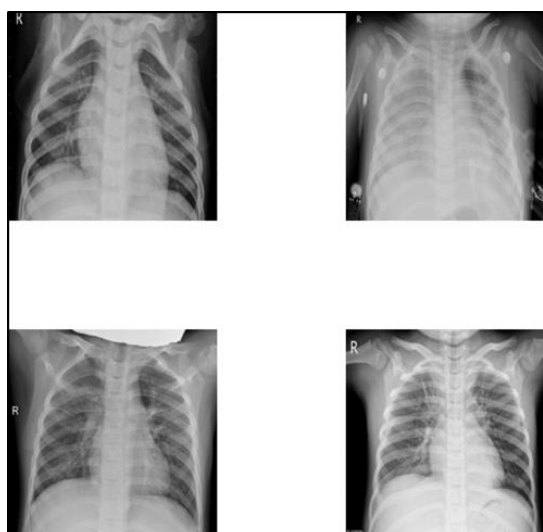
An example of the data used can be seen in the following figure:

Covid-19



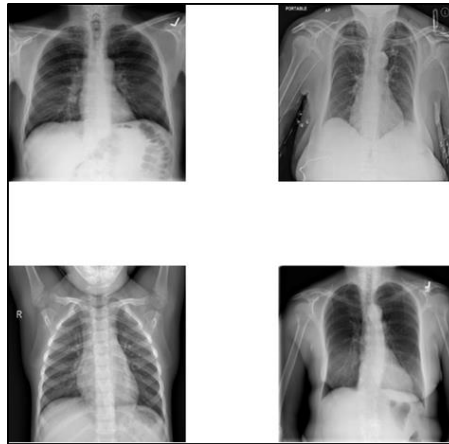
**Fig. 2 X-Ray Covid-19**

Pneumonia



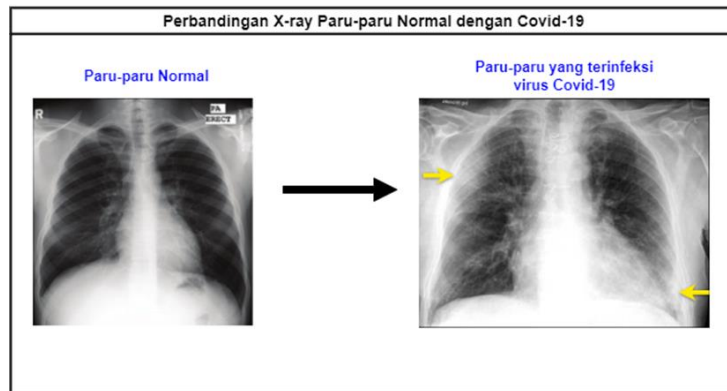
**Fig. 3 X-Ray Pneumonia**

Normal Lungs



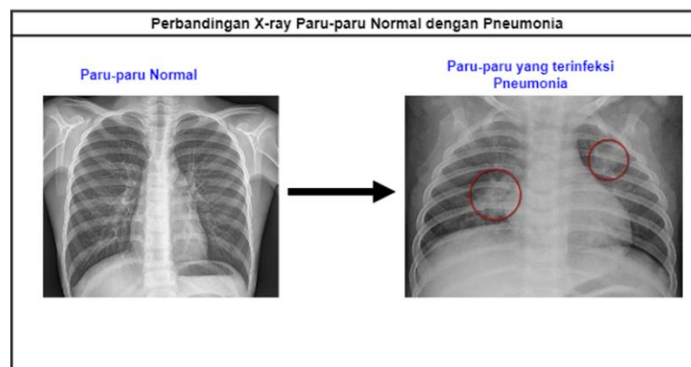
**Fig. 4 X-Ray Normal Lungs**

The following is a comparison of normal lung x-ray results, covid-19, and also pneumonia:



**Fig. 5 Comparison of Normal Lung X-Ray with Covid-19**

In the comparison results shown in the figure 5, you can see the comparison in the image of the normal patient's lungs which appear black in all parts, indicating that the patient has lungs that are not infected or affected by any disease. But different from the picture of the lungs of a patient infected with the Covid-19 virus shown in the arrow there is a white layer covering part of the lung.



**Fig. 6 X-Ray Comparison of Normal Lungs with Pneumonia**



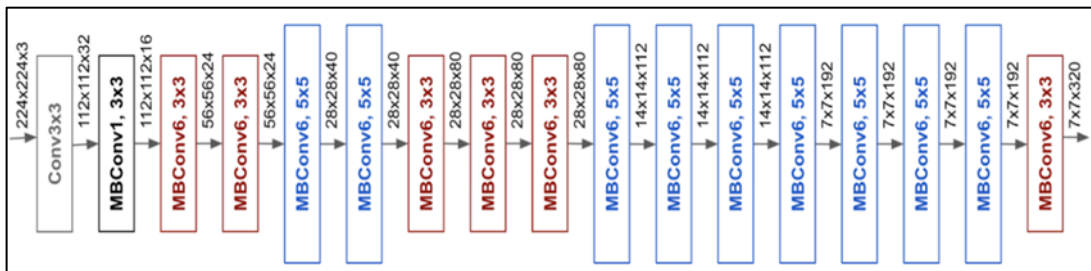
In the next comparison results shown in Figure 6, you can see the comparison in the image of a normal patient's lungs which looks black in all parts, which indicates that the patient has lungs that are not infected or affected by any disease. However, in contrast to the image of the lungs of a patient infected with pneumonia which is circled in red, it can be seen that the area has a gray-white color.

**2.2 Data Preparation**

The data used is in .png or .jpg format so that the resulting image can be as expected. Then before the image can be inserted into the proposed structure the next step is to change the initial pixels of the image from 512 x 512 to 224 x 224. This is done to help the performance of the model so that it can do more precise work in a relatively low time and equalize or equalize the dimensions between the images. Then the data in the form of images that have been grouped according to the type is divided randomly into training data and testing data with a total percentage of 90% training data and 10% testing data that has been prepared.

**2.3 Deep Learning**

The deep learning model that will be used for the classification applied in this research is EfficientNet.



**Fig. 7 Model EfficientNet CNN**

The above architecture has the following steps:

Started by adding all the images from the directory and then turning it into a numpy array after resizing it to 150x150 pixels

**Table 1 Resizing**

Preparation	Input Layer
	Rescalling
	Normalization
	ZeroPadding
	Convolutional 3 x 3
	Activation ReLu
Block 1	Batch normalization
	Depth Wise Convolutional
	Activation ReLu
	Global Average Pooling
	Reshape
	Convolutional 3 x 3
Block 2	Batch normalization
	Convolutional 3 x 3
	Activation ReLu
	ZeroPadding
	Depth Wise
	Global Average Pooling
Block 3	Reshape
	Multiply
	Batch normalization
	Dropout
	Convolutional 5 x 5



	Activation ReLu ZeroPadding Depth Wise Global Average Pooling Reshape Multiply Batch normalization Dropout
Block 4	Convolutional 3 x 3 Activation ReLu Depth Wise Global Average Pooling Reshape Multiply Batch normalization Dropout
Block 5	Convolutional 5 x 5 Activation ReLu Depth Wise Global Average Pooling Reshape Multiply Batch normalization Dropout
Block 6	Convolutional 5 x 5 Activation ReLu Depth Wise Global Average Pooling Reshape Multiply Batch normalization Dropout
Block 7	Convolutional 3 x 3 Activation ReLu Depth Wise Convolutional Global Average Pooling Reshape Multiply Batch normalization
Finished	Convolutional 1 x 1 Batch normalization Activation ReLu Global Average Pooling Dropout Dense

Followed by doing the Flatten process which gets the output in the form of a one-dimensional array. After the next stage Flatten process is inserted into the neural network. After the neural network stage is completed and gets the weight value and is classified by softmax activation. After the EfficientNet Convolutional Neural Network Build Model is complete, it will generate Total Parameter values, Trainable Parameters and Non-trainable Parameters.

## 2.4 Training Model

The training model is used by the neural network algorithm to form a classifier model which is a knowledge representation that will be used to measure the extent to which the classifier succeeds in correctly classifying. The results



of this training process will form files that can be used for classification without having to repeat the data training process continuously.

Training data that will be created using Callback functions can help fix bugs more quickly, and can help visualize how the training model is going, and can even help prevent overfitting by implementing early termination or adjusting the learning rate at each iteration. By definition, “A callback is a set of functions that will be applied at a certain stage of the training data procedure. You can use callbacks to get a view of the model's internal state and statistics during data training.”

Dicode that will be created using the CallBack function:

- a. TensorBoard  
Visualize information on the training data process that is currently running.
- b. CheckPoint model  
Automatically saves training results in the form of .h5 extension
- c. ReduceLROnPlateau or reduce\_lr  
Reduces the learning rate as the stop metric increases

## 2.5 Evaluasi

This stage will evaluate the experiments that have been set in the form of evaluation of accuracy. This analysis is carried out from the accuracy value for several predetermined experiments. The final analysis is in the form of predetermined accuracy and is one of the final conclusions of the research. The evaluation stage for accuracy is carried out using a classification matrix, namely the confusion matrix, by evaluating accuracy, precision, recall, and F1-Score.

## 2.6 Interface Application Design

In the design of the application to be built there are four sections, namely the main page menu, the X-Ray Image Check Page, the After the image is input, and the Image page after it has been processed.

- a. Main page  
In this section, the main page is the page that will appear when the system is opened, via the URL here the buttons for Check X-Ray and Help are displayed.

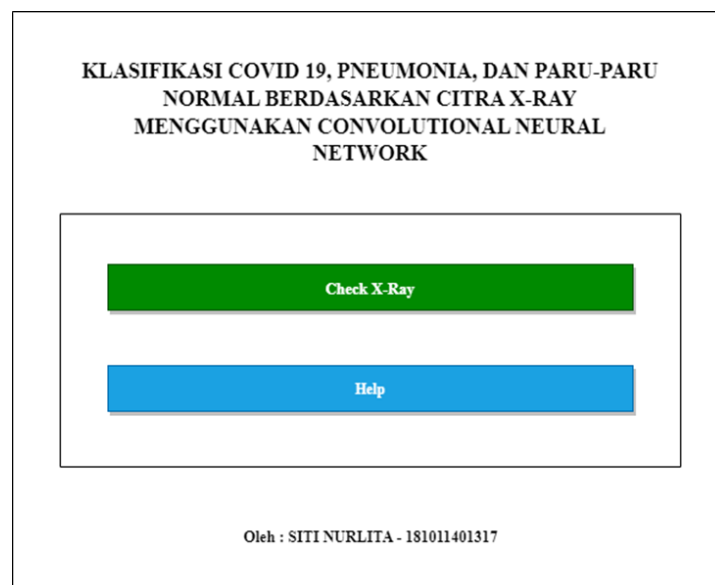
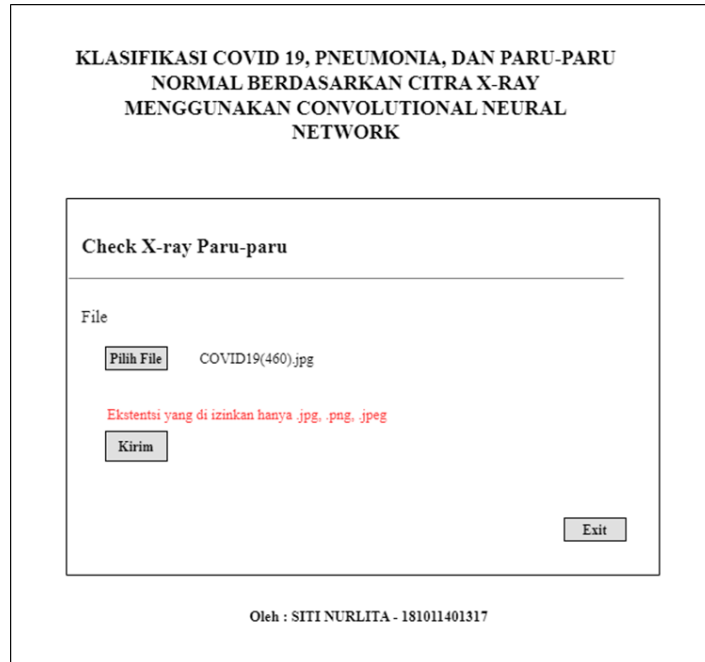


Fig. 8 Main Page

- b. The page after the image is input  
In this section, click Select File and then successfully enter the file directory to select the dataset to be trained:

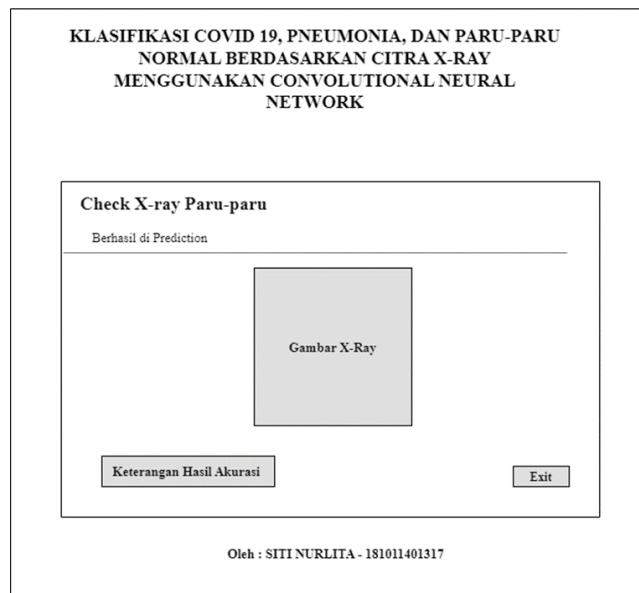




**Fig. 9** Image Input

c. Page After Data Is Processed

In this section Successful Data is used to predict and display the results of the selected dataset



**Fig. 10** X-Ray Image Classification Result Page

### **3. RESULT AND DISCUSSIONS**

The program implementation stage is the implementation stage which is carried out after the Analysis and Design of the application that has been made before. The implementation stage of the program must be in accordance with the





application needs so that the application made can run properly. At this stage it discusses how the results of a model that can classify x-ray images of a disease using one of the Deep Learning methods, namely the Convolutional Neural Network.

In making this model, data is needed in the form of images from x-rays or chest x-rays of humans who have one disease and will be classified. In this case the diseases in humans that will be classified are Covid-19, Pneumonia, and Normal Lungs. The steps carried out in this study consisted of collecting image data, preprocessing data, selecting the right parameters to get the best model, training the classification model and testing new image data using an application built using the covid-19, pneumonia and lung classification models. normal.

### 3.1 Trial Step

#### a. Training Process

Where at this stage training will be carried out on data that has been previously prepared using the CNN model. The trained model will later be used to measure how good the algorithm is at identifying

```
keluaran atau output
Model: "sequential"

Layer (type)                Output Shape                Param #
-----
conv2d (Conv2D)              (None, 148, 148, 32)       896
max_pooling2d (MaxPooling2D) (None, 74, 74, 32)         0
conv2d_1 (Conv2D)            (None, 72, 72, 64)        18496
max_pooling2d_1 (MaxPooling2 (None, 36, 36, 64)         0
conv2d_2 (Conv2D)            (None, 34, 34, 128)       73856
max_pooling2d_2 (MaxPooling2 (None, 33, 33, 128)         0
dropout (Dropout)            (None, 33, 33, 128)         0
flatten (Flatten)            (None, 139392)             0
dense (Dense)                 (None, 64)                 8921152
dropout_1 (Dropout)          (None, 64)                 0
dense_1 (Dense)               (None, 3)                 195
-----
Total params: 9,014,595
Trainable params: 9,014,595
Non-trainable params: 0
None
****
```

Fig. 11 Parameter

#### b. Testing Process

This stage is quite an important stage because at this stage the program that has been built and previously trained is tested. The data that has been prepared for testing is then tested using a model that has been previously trained.

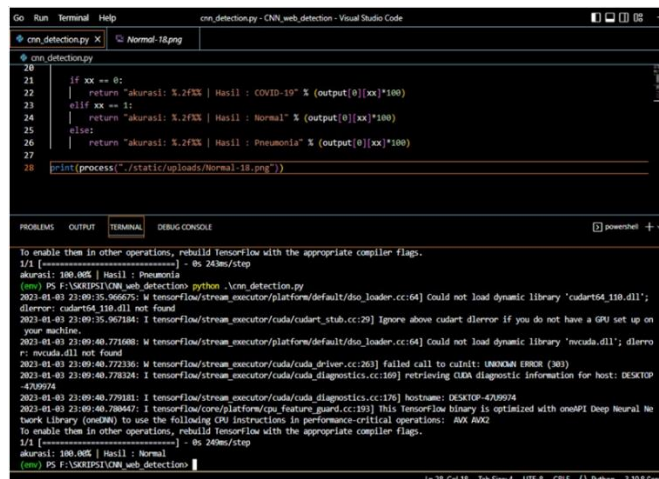


Fig. 12 Running Program



## 3.2 System Implementation

At this stage, an interpretation of the CNN model that has been built using images of undetected disease is carried out, and the accuracy obtained during the classification is measured. In testing the model the researchers used a web-based application to test x-ray images of covid-19, pneumonia and undetected normal lungs. After that, call the model via the newCNNModel.py source code in Visual Studio Code, the Input Size for the image is 255 x 255 pixels because the Input Size is the same as the Input Size when training the data.

```
for imgpaths in tqdm(imgpath): #tqdm is used to make terminal progress bar
    label=imgpaths.split(os.path.sep)[-2]
    image=cv2.imread(imgpaths)
    image=cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    image=cv2.resize(image, (resize, resize)) /255 #resizing the image
    #updates the respective data and target label lists
    data.append(image)
    target.append(dic[label])
```

To run the model that has been built based on the web, the researcher must run the Command Prompt to be able to import the converted model into Visual Studio Code, then point the source code to the models directory.

```
C:\Windows\system32\cmd.exe - python -m flask run
(env) F:\SKRIPSI\CNN_web_detection>python -m flask run
2023-01-04 03:34:38.050797: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library
not found
2023-01-04 03:34:38.051089: I tensorflow/stream_executor/cuda/cudart_stub.cc:29] Ignore above cudart dlerror if you do not
2023-01-04 03:34:57.274279: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library
2023-01-04 03:34:57.274509: W tensorflow/stream_executor/cuda/cuda_driver.cc:263] failed call to cuInit: UNKNOWN ERROR (38
2023-01-04 03:34:57.353504: I tensorflow/stream_executor/cuda/cuda_diagnostics.cc:169] retrieving CUDA diagnostic informat
2023-01-04 03:34:57.353937: I tensorflow/stream_executor/cuda/cuda_diagnostics.cc:176] hostname: DESKTOP-47U9974
2023-01-04 03:34:57.354729: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with
use the following CPU instructions in performance-critical operations: AVX AVX2
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
1/1 [=====] - 10s 10s/step
akurasi: 100.00% | Hasil : Normal
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:5000
Press CTRL+C to quit
```

Fig. 13 cmd -python -m flask run

When finished, we can directly access the Ip Address by running it on a Web Browser. On the start page we can see the initial appearance of the web face.



Fig. 14 Page Classification Results Figure 3 dataset



The start page is the page that will appear at the start of the system opened via the next URL On Check X-ray clicked, successfully entered the file page to select the dataset to be trained then select file clicked after successfully entering the file directory to select the dataset to be trained after being selected the data that will be used click the send menu after that a display will appear as below which indicates the program has been successfully used to predict and display the results of the selected dataset:

#### 4. CONCLUSION

From the results of research conducted to classify covid-19, pneumonia and normal lungs based on x-ray images using the Convolutional Neural Network (CNN) method, the following conclusions can be drawn: Basically the CNN algorithm is an algorithm capable of classifying objects without the need for additional feature extraction. Because the algorithm already has features of the stages or learning process. However, during the research, the amount of data held was too little and the quality of the data obtained was not good, making researchers add additional feature extraction to facilitate the algorithm in extracting features from the image to be processed. By changing the RGB image to a grayscale image, the researchers succeeded in sharpening the image to simplify the extraction process. In this method the Convolutional Neural Network method can be used to extract and differentiate x-ray image results and can produce a fairly high accuracy value with a level of 80-90%. The research conducted is still said to be not optimal. Therefore, future research is to improve the model that has been proposed with various approaches, such as proposing a fine tuning method by trying several types of optimizing variables, experimenting with more than one pre-processing technique, increasing the number of datasets used, using a preserved model, which is on CNN.

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