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Implementation of Machine Learning Model for Pneumonia Classification Based on X-Ray Images

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A B S T R A C T

This study applies a Machine Learning learning model for Pneumonia classification based on x-ray images. This study uses two classes, namely Pneumonia Class and Normal Class, and uses Epoch 10, Epoch 50, Epoch 250 and Epoch 700, Learning Rate 0.001, and Batch Size 16. Learning carried out using Epoch 10 to get accuracy results per class is Pneumonia Class 0.97 and Class 0.95. While learning using Epoch 50 gets accuracy results per class, namely Pneumonia Class 0.97 and Normal class 0.97, and for learning, using Epoch 250 gets accuracy results for Pneumonia Class 1.00 and Normal Class 0.97. By using Epoch 700, the accuracy results were obtained for Pneumonia Class 1.00 and Normal Class 1.00. From the results of tests carried out using Learning Rate 0.001, Batch Size 16 and Epoch 10 received an accuracy of 64%. For Learning Rate 0.001, Batch Size 16 and Epoch 50 obtained 86% accuracy, and for Learning Rate 0.001, Batch Size 16 and Epoch 250 got 87% accuracy, while for Learning Rate 0.001, Batch Size 16 and Epoch 700 get 92% accuracy. From this study, the results show the highest precision using Epoch 700.

1. Introduction

Lung diseases are common worldwide, including those associated with chronic obstructive pulmonary disease, asthma, tuberculosis, fibrosis, and pneumonia [1], [2]. Pneumonia or also known as the wet lung, is an infection that causes inflammation of the air sacs in one or both lungs [1], [3], and is a lower acute respiratory tract infection (ARI), [4]. Early diagnosis of Pneumonia has a significant impact on a patient's life. Diagnosis of Pneumonia is generally made clinically (physical symptoms by a doctor). In addition, Pneumonia can also be diagnosed through chest radiographs, CT scans, and MRI [5]. Chest X-ray images have an essential role in the process of diagnosing Pneumonia. Chest X-rays can increase the accuracy of the diagnosis, explain the presence of anatomical abnormalities, and influence the management of frail patients [6].

Several studies have been conducted to classify Pneumonia using different methods and results, including using Convolutional Neural Networks, Artificial Neural Networks, Feature Extraction, and Deep Learning. Some of the latest studies that have been carried out are, in research [1] using the CNN method to classify Pneumonia with variations in the Size of the input image; the results of this study provide important information that the Size of the input image has a significant influence on the performance of pneumonia classification, both classification using the CNN method and CNN-ELM. Research [6] used an Extreme Learning Machine Artificial Neural Network to introduce Pneumonia in children. This study used the parameters of all angles (0°, 45°, 90°, 135°) in the GLCM feature extraction resulting in a total accuracy of 0.9728 with a sensitivity of 0.9886 and specificity of 0.9574. In research [7] using Support Vector Machina in classifying Pneumonia, the proposed method can classify lung images with 600 testing datasets using the GLCM feature with an overall accuracy of 62.66%, SVM can classify lung images with a total of 62.66%.

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750 dataset testing using the GLCM feature with an overall accuracy of 59.2%. Research [8] used GLCM and LVQ to classify Pneumonia. The results obtained with the best train data accuracy of 89.714% and the best test data accuracy of 74,000% were obtained in testing with a learning rate = 0.4. While in research [9] using Local Binary Pattern Feature Extraction Using Support Vector Machine in classifying Pneumonia by getting the best accuracy results of 65.63%.

From several studies that have been carried out, few researchers use Machine Learning methods in classifying Pneumonia by utilizing the results of X-Ray images. As for this research, the implementation of the learning model on Machine Learning is to classify Pneumonia based on the results of X-Ray images. Before the learning model stage, the datasets were first grouped into two classes: the Pneumonia class and the Normal class.

2. Method

The stages in this research can be seen in Figure 1.

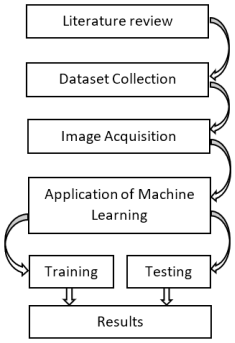

Fig 1. Research Stages

a. Literatur Review

A library study is carried out at this stage to find references relevant to machine learning and classification in Pneumonia. The Literature Study used in this study uses the library study from 2015-2021.

b. Data Collection

At this stage, the data collection was carried out to find data related to Pneumonia. The data used in this study was taken on a dataset-sharing website, namely Kaggle. The dataset is the result of X-Ray images [10] that have been shared on dataset-sharing websites such as Kaggle. The dataset used in this study is an image with a . JPEG extension. In contrast, the total dataset used in this study is 600 images, with details on pneumonia images 300 and Normal images 300. The number of images for training is 600, while there are 90 images for testing. Figure 2 is an example of Pneumonia and a Normal Image.

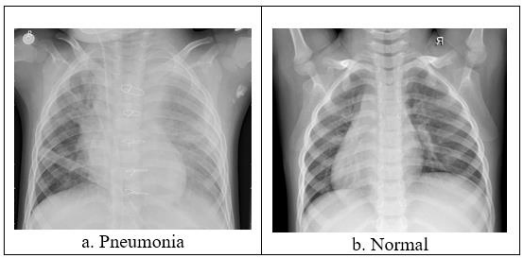

Fig 2. Pneumonia and Normal

c. Image Acquisition

At this stage, the images that have been taken are then selected and grouped into two polders, namely the Pneumonia polder and the Normal polder. The purpose of this image acquisition is to facilitate the training and testing carried out.

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d. Application of Machine Learning

At this stage is the application of Machine Learning; the total data used is 600 images. Learning is carried out to provide a learning model on Machine Learning, while testing is carried out to test the accuracy of the learning model that has been formed previously. At this stage, the model is given two classes: the Pneumonia class and the Normal class, and the application used in this study is Google's Teachable Machine [11]. Figure 3 is an example of Testing on Machine Learning being carried out, while Figure 4 is an example of Testing on Machine Learning.

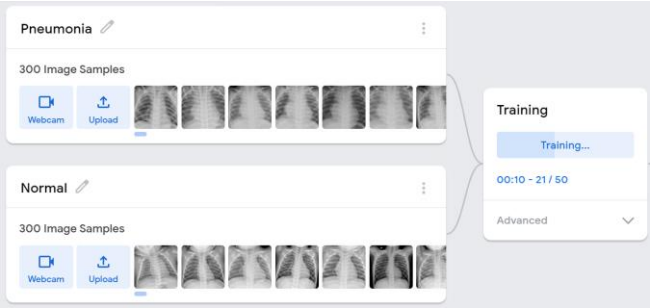

Fig 3. Machine Learning Training

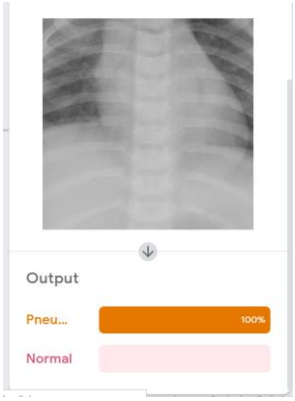

Fig 4. Machine Learning Testing

3. Result and Discussion

3.1 Application of Machine Learning

In this study, the Machine Learning model was used to obtain the classification results for Pneumonia and Normal. This test uses Epochs 10, 50, 250, and 700 with a Learning Rate of 0.001 and Batch Size = 16.

3.2 Machine Learning Model

At this stage of learning the machine learning model, the Epoch used is 10, the learning rate is 0.001, and the batch size is 16. Figure 5 is a lesson from the pneumonia class and the regular class. The accuracy results obtained are Pneumonia Class of 0.97 and Normal Class of 0.95. For accuracy, results per Epoch can be seen in Figure 6.

CLASS	ACCURACY
Pneumonia	0.97
Normal	0.95

Fig 5. Accuracy Result

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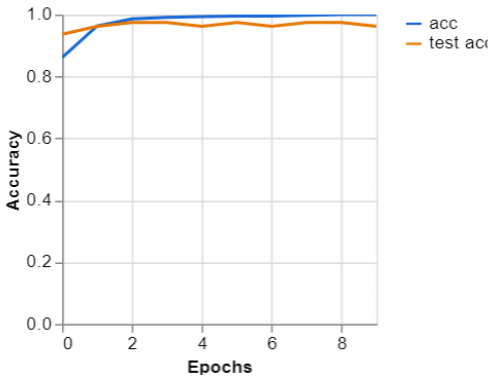

Fig 6. Accuracy Results Per Epoch

The following learning uses Epoch 50, Learning Rate 0.001, and Batch Size 16. Figure 7 shows accuracy resulting from the learning process carried out, using two classes, namely the Pneumonia class and the Normal class. From the picture, it can be seen that there is an increase in accuracy from the previous one using Epoch 10. Figure 8 is the result of accuracy based on Epoch

CLASS	ACCURACY
Pneumonia	0.97
Normal	0.97

Fig 7. Accuracy Results per Class

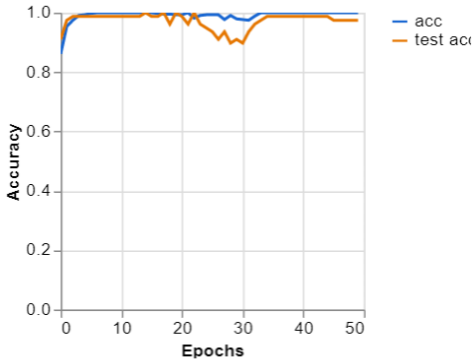

Fig 8. Accuracy Results Per Epoch

The following learning is a learning model using Epoch 250; this learning shows a significant increase in results from previous learning using Epoch 10 and Epoch 50. Significant results can be shown in Figure 9, where the accuracy results in the Pneumonia Class is 100, and the Normal Class is 97. Figure 10 shows the accuracy results based on Epoch.

CLASS	ACCURACY
Pneumonia	1.00
Normal	0.97

Fig 9. Accuracy Results per Class

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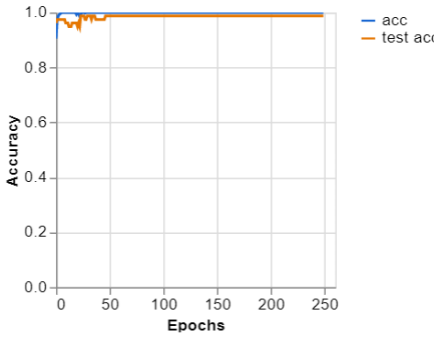

Fig 10. Accuracy Results Per Epoch.

The next lesson is learning using Epoch 700; Learning Rate is 0.001, and Batch Size is 16. Learning using Epoch 700 can give excellent accuracy results, shown by accuracy results from Pneumonia Class 100 and Normal Class 100. Figure 11 shows the results of the accuracy per class, and Figure 12 is the result of the accuracy that is carried out on a per epoch basis. From several lessons that have been carried out using different epochs, the Epoch that shows excellent accuracy results is epoch 700 for learning in pneumonia class and standard class using machine learning.

CLASS	ACCURACY
Pneumonia	1.00
Normal	1.00

Fig 11. Accuracy Results per Class

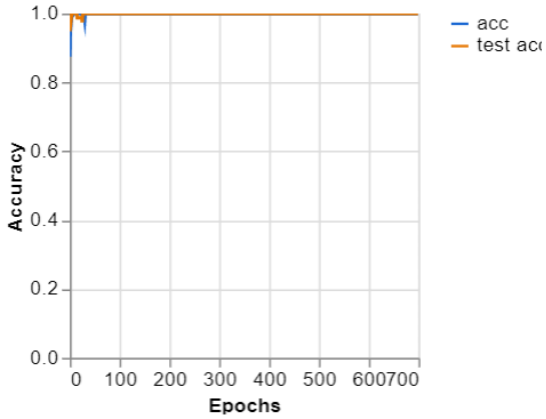

Fig 12. Accuracy Results Per Epoch

3.3 Testing Machine Learning Models

Testing this learning model is a stage to conclude the learning outcomes of Machine Learning in image classification in Pneumonia and Normal. In this testing phase, the data used is 15% of the total learning data. The amount of data used as test data in this study is 90 image data with details 45 from the Pneumonia Class and 45 from the Normal Class. Table 1 shows the classification test results carried out using Epoch 10, Learning Rate 0.001, and Batch Size 16. The test results using Epoch 10 show that the classification accuracy obtained is 64%, and the accuracy error rate is 36%.

TABLE 1
CLASSIFICATION RESULT USING EPOCH 10

No	Testing Class	Accuracy	Classification Results
1	Pneumonia Testing 1	100%	Succeed
2	Pneumonia Testing 2	100%	Succeed

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No	Testing Class	Accuracy	Classification Results
3	Pneumonia Testing 3	100%	Succeed
4	Pneumonia Testing 4	100%	Succeed
5	Pneumonia Testing 5	100%	Succeed
6	Pneumonia Testing 6	100%	Succeed
7	Pneumonia Testing 7	100%	Succeed
8	Pneumonia Testing 8	94%	Fail
9	Pneumonia Testing 9	100%	Succeed
10	Pneumonia Testing 10	100%	Succeed
…			
90	Normal Testing 90	100%	Succeed

Subsequent testing using Epoch 50, Learning Rate 0.001, and Batch Size 16, From testing using Epoch 50 getting better results than using Epoch 10, the classification results can be seen in Table 2. The accuracy results from the classification obtained are 86%, with an accuracy error rate of 14%.

TABLE 2
CLASSIFICATION RESULT USING EPOCH 50

No	Testing Class	Accuracy	Classification Results
1	Pneumonia Testing 1	100%	Succeed
2	Pneumonia Testing 2	100%	Succeed
3	Pneumonia Testing 3	100%	Succeed
4	Pneumonia Testing 4	100%	Succeed
5	Pneumonia Testing 5	100%	Succeed
6	Pneumonia Testing 6	100%	Succeed
7	Pneumonia Testing 7	100%	Succeed
8	Pneumonia Testing 8	84%	Fail
9	Pneumonia Testing 9	100%	Succeed
10	Pneumonia Testing 10	100%	Succeed
…			
90	Normal Testing 90	100%	Succeed

Table 3 shows the results of the tests carried out using Epoch 250, Learning Rate 0.001, and Batch Size 16. The results of this test show significant results; namely, the accuracy level of the classification is 87%, and the accuracy error rate is 13%.

TABLE 3
CLASSIFICATION RESULT USING EPOCH 250

No	Testing Class	Accuracy	Classification Results
1	Pneumonia Testing 1	100%	Succeed
2	Pneumonia Testing 2	100%	Succeed
3	Pneumonia Testing 3	100%	Succeed
4	Pneumonia Testing 4	100%	Succeed
5	Pneumonia Testing 5	100%	Succeed
6	Pneumonia Testing 6	100%	Succeed
7	Pneumonia Testing 7	100%	Succeed
8	Pneumonia Testing 8	100%	Succeed
9	Pneumonia Testing 9	100%	Succeed
10	Pneumonia Testing 10	100%	Succeed
…			
90	Normal Testing 90	100%	Succeed

The next test uses Epoch 700, Learning Rate 0.001, and Batch Size 16, getting excellent accuracy results compared to Epoch 10, Epoch 50, and Epoch 250. The level of accuracy obtained using Epoch 700 is 92% and has an accuracy error rate of 8 %. Table 4 is a table of classification results using Epoch 700.

TABLE 3
CLASSIFICATION RESULT USING EPOCH 700

No	Testing Class	Accuracy	Classification Results
1	Pneumonia Testing 1	100%	Succeed
2	Pneumonia Testing 2	100%	Succeed
3	Pneumonia Testing 3	100%	Succeed
4	Pneumonia Testing 4	100%	Succeed
5	Pneumonia Testing 5	100%	Succeed
6	Pneumonia Testing 6	100%	Succeed
7	Pneumonia Testing 7	100%	Succeed

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8	Pneumonia Testing 8	100%	Succeed
9	Pneumonia Testing 9	100%	Succeed
10	Pneumonia Testing 10	100%	Succeed
…			
90	Normal Testing 90	100%	Succeed

4. Conclusion

This study uses a machine learning model to classify Pneumonia images based on X-Ray images. This study used two classes, namely the Pneumonia class and the Normal class, the use of Learning Rate 0.001, Batch Size 16 and the Epoch used were Epoch 10, Epoch 50, Epoch 250, and Epoch 700. The accuracy results per class were obtained from the learning carried out using Epoch 10. Are Pneumonia Class 0.97 and Class 0.95? While learning using Epoch 50 gets accuracy results per class, namely Pneumonia Class 0.97 and Normal class 0.97, and for learning, using Epoch 250 gets accuracy results for Pneumonia Class 1.00 and Normal Class 0.97. By using Epoch 700, the accuracy results were obtained for Pneumonia Class 1.00 and Normal Class 1.00. From the tests carried out using Learning Rate 0.001, Batch Size 16 and Epoch 10 got an accuracy of 64%, and for Learning Rate 0.001, Batch Size 16 and Epoch 50 got 86% accuracy. For Learning Rate 0.001, Batch Size 16 and Epoch 250 get 87% accuracy, while for Learning Rate 0.001, Batch Size 16 and Epoch 700 get results

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