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ERFORMANCE ANALYSIS OF ALEXNET CONVOLUTIONAL NEURAL NETWORK (CNN) ARCHITECTURE WITH IMAGE OBJECTS OF RICE PLANT LEAVES

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Abstract— *Rice is a staple food consumed by Indonesian people, even 75% of the world's population consumes rice and it is mostly found in Asia. Rice derived from pounded rice is a staple food so it can be consumed. In the process of planting rice, pests and diseases are not spared so that it can affect crop yields. Pest and disease attacks need fast, accurate and precise handling so that crop failures. In this paper, we will discuss the classification of leaf diseases of rice plants using the Convolutional Neural Network (CNNN) algorithm, especially the Alexnet architecture. There are 4 types of disease, namely Brown spot, Leafblast, Hispa and Healthy. Models built based on the Alexnet architecture may have differences in the level of accuracy and loss compared to other architectures due to the different stages in the sequential model formation. The dataset used is public data from Kaggle consisting of 4 classes with a total of 1,600 images. In each class the dataset is divided for training, testing and validation datasets with a ratio of 70:20:10. As for tools in the process of training datasets using Google Colab from Google. After going through the stages of the research, the research results obtained are accuracy worth 99,22%, mean average precision worth 0,24 and loss worth 0,05.*

Keywords: *Alexnet, CNN Classification, Convolutional Neural Network, , Rice leave image,*

Intisari— *Beras merupakan bahan makanan pokok yang dikonsumsi masyarakat Indonesia bahkan 75 % penduduk dunia mengkomsumsi beras dan sebagai besar terdapat di Asia. Beras yang berasal dari padi yang ditumbuk menjadi bahan makan pokok supaya bisa dikonsumsi. Pada proses penanaman padi tidak luput dari serangan hama dan penyakit sehingga bisa mempengaruhi terhadap hasil panen. Serangan hama dan penyakit perlu penanganan yang cepat, akurat dan tepat supaya kegagalan panen. Pada penelitian kali ini akan membahas klasifikasi jenis penyakit daun tanaman padi dengan algoritma Convolusional Neural Network (CNNN) khususnya arsitektur Alexnet. Jenis penyakit pada daun tanaman padi ada 4 kelas yakni Brownspot, Leafblast, Hispa dan Healthy. Model yang dibangun berdasarkan arsitektur Alexnet dimungkinkan terjadinya perbedaan pada tingkat akurasi dan loss daripada arsitektur yang lain dikarenakan adanya perbedaan tahapan pada pembentukan sequential model. Dataset yang digunakan merupakan data publik dari kaggle terdiri dari 4 kelas dengan total citra sebanyak 1.600 citra. Pada setiap kelas dataset dibagi untuk dataset training, testing dan validasi dengan perbandingan 70:20:10. Adapun sebagai tools pada proses men-training dataset menggunakan google colab dari google. Setelah melewati tahapan-tahapan penelitian didapatkan hasil penelitian yakni akurasi senilai 99,22%, presisi rata-rata senilai 0,24 dan loss senilai 0,05.*

Kata Kunci: *Alexnet, Convolutional Neural Network, Klasifikasi CNN, Citra Daun Padi.*

INTRODUCTION

Indonesia is an agricultural country with the majority of the population working as farmers [1] either as landowners or as farm laborers. So far, the main crops grown by farmers are rice and corn [2] because they are staple foods. In addition, the staple foods grown are sweet potatoes, cassava, vegetables and tubers. Various crops grown by farmers show that Indonesia is dependent on the agricultural

sector and plays an important role in the national economy. In the rice planting process, pests and diseases are not spared which can interfere with rice growth and can even cause crop failure. Regular monitoring must be carried out by farmers to find out the progress of growth from the planting season to entering the harvest period. There are various types of pests that attack rice plants including insects, leafhoppers, mammals, and invertebrate animals [3].

Detection of rice plant diseases requires a fast, accurate and precise time because to prevent rice damage which results in a decrease in rice yields. The speed of rice disease detection using the deep learning convolutional neural network (CNN) method. CNN can achieve a high degree of accuracy by using leaf images with controlled lighting and background conditions [4]. Even though the presence of AI helps in the rapid detection of rice diseases, the presence of experts is still needed as a comparison in the process of determining the results of the disease detection process.

Pest and disease attacks on rice plants can be seen, one of which can be identified through the color of the leaves because the leaves will have certain characteristics according to the type of pest and disease. According to Ramesh [5] in 2020 there are 4 types of leaves based on the disease (Brownspot, Leafblast, Hispa and Healthy). These types of infected leaves can be identified and classified using deep learning algorithms to look for certain characteristics to distinguish one from another. The algorithm used is a Convolutional Neural Network (CNN). This paper specifically uses the CNN Alexnet architecture because Alexnet was the winner of the Imagenet Competition in 2012 [6]. Alexnet itself has 8 convolutional layers and 25 layers and 60 million parameters [7].

CNN is a development method for Multi-Layer Perception (MLP) which has few parameters because it does not require pre-processing, segmentation and feature extraction values [8]–[12]. The Alexnet architecture itself has 5 conv layers, 3 pooling layers, 2 dropout layers, and 3 fully connected layers. CNN can classify an image based on a predetermined class. In addition, CNN has high accuracy because it has the number of feature extractions from the results of the convolution process and the number of neurons used. The iteration weight also influences the image classification results. The CNN architecture develops with various methods and certain features, these architectures include GoogleNet, Resnet, VGG-16, VGG-19, SqueezeNet, MobileNet [13], [14].

Research conducted by Sibiya et al in 2019, they conducted research using 3 classes of classification of diseases in corn plants with 3 categories and using the CNN 50 hidden layer architecture consisting of a convolution layer with a kernel filter having a median of 24, ReLU and a pooling layer. Research conducted using 100 images per class with a ratio of 70% for training and 30% for testing with research results showing an accuracy rate of 92.85% [15].

Another research is research on corn leaf diseases with 8 classes of classification of leaf types.

This study uses the CNN architecture, namely googleNet or Inception-V1 with a total of 3,672 images used, 80% for training data and 20% for test data [16]. The results of the research conducted by Zhang et al resulted in an accuracy of 98.9%.

The final goal of this paper is to classify the image of rice plant leaves with 4 classes. Image classification uses the Alexnet architecture and the training process uses google colab. Analysis of the classification training process using a confution matrix consisting of accuracy, precision, recall, F1-score and loss.

MATERIALS AND METHODS

The research stages applied are using the CNN architecture, especially the Alexnet architecture. The Alexnet architecture chart can be seen in Figure 1. The Alexnet architecture is used to obtain feature extraction by training datasets which are first grouped into training and testing datasets as well as validation. The comparison of the three dataset groups is 70:20:10.

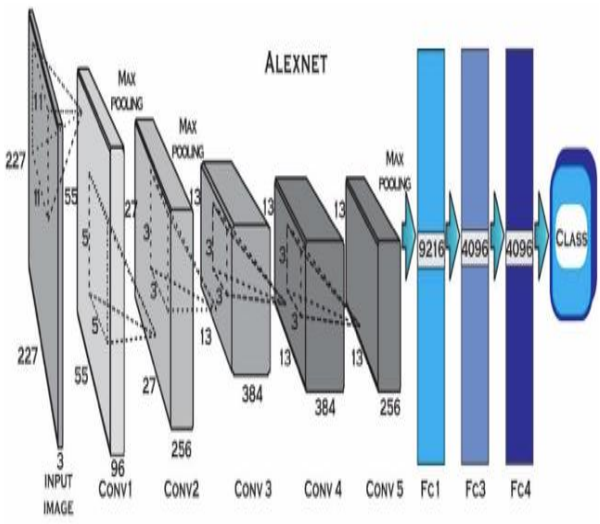

Figure 1 Architecture of Alexnet [17].

The alexnet architecture has 5 stages of layer convolution as shown in Figure 1. This architecture applies max pooling as an approach in determining feature extraction. After passing through the

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convolution layer, the next stage is fully connected for 3 stages before heading to the classification process according to the class on the input. The kernel used in the alexnet architecture consists of 11x11, 5x5, 3x3 contained in the covolution layer.

The dataset used is images of rice plant leaves obtained from public data on kaggle.com as many as 2,150 images of rice plant leaves. The image of rice plant leaves is divided into 4 classes namely Brownspot, Leafblast, Hispa and Healthy.

Table 1 Image of Rice Plant Leaves

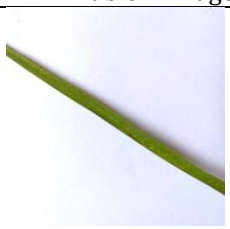
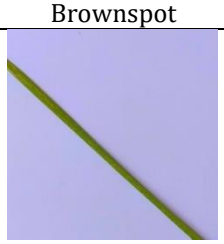
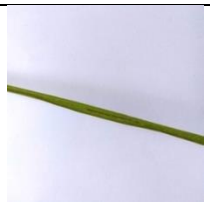
 Brownspot	 Leafblast
 Hispa	 Healthy

Table 1 explain the image of a rice plant leaf. The 4 dataset classes are based on the diseases suffered on rice leaves including healthy leaves. Differences in leaf patterns in each class indicate differences in pixel colors in each leaf so that feature extraction on each leaf can be identified.

Research stage starts with collecting datasets in the form of images of rice plant leaves then the second stage is dividing the image dataset into 4 classes. Data acquisition was carried out by the publisher on Kaggle by listing classes according to the characteristics of the rice leaves. Class division consists of brownspot, hispa, leafblast and healthy. Third stage is training process on the Alexnet architecture with google colab. The dataset training process for building models is carried out using Google Colab because it is open source, but if additional features are needed you can use Google Colab Pro or Google Colab Pro+.

Dataset training process involves various epoch combinations that function to determine the best model. Evaluation of the model uses the dataset testing then as a determination of the best model using the validation dataset. The next stage is the stage of calculating the training results using the convolution matrix to calculate accuracy, recall, precision and F1-Score. The stages of conducting the research are presented in Figure 2.

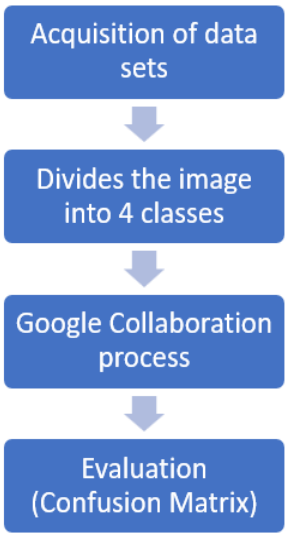


Figure 2. Research Stages

Evaluation of the performance of the CNN model built using a confusion matrix involving TP (True Positive), TN (True Negative), FP (False Positive), FN (False Negative). Several parameters are calculated using the confusion matrix, namely accuracy, precision, recall, F1-Score. The existence of a dataset in the CNN learning process greatly determines the results of the classification, therefore the success of the classification of the model built depends on the comparison between the actual value and the predicted value. There are several parameters whose values need to be known to determine model performance. The size of the confusion matrix depends on the number of classes used because the comparison between actual and predicted must be balanced.

$$Accuration = \frac{TP+TN}{TP+TN+FP+FN} \quad \text{..... (1)}$$

$$Presicion = \frac{TP}{TP+FP} \quad \text{..... (2)}$$

$$Recall = \frac{TP}{TP+FN} \quad \text{..... (3)}$$

$$Specification = \frac{TN}{TN+FP} \quad \text{..... (4)}$$

$$F_1 = 2\,x\,\frac{Precision\ x\ Recall}{Presicion+Recall} \quad \text{..... (5)}$$

In the CNN algorithm, to overcome the lack of datasets in the training data or dataset imbalances that are not evenly distributed with each other, the analysis uses the traditional transformation data augmentation analysis method which is commonly applied to the CNN algorithm. The performance or performance of CNN is also influenced by the number of datasets, meaning that the more datasets used, the better the classification results.

RESULTS AND DISCUSSION

The Alexnet architecture used in this study consists of several stages starting from the convolution process, max pooling to flaten. Complete Alexnet architecture can be seen in Figure 4. The CNN network is used to extract features from the input image because the CNN network has a strong ability to search for image features. The input image dataset will be subjected to a convolution operation on each layer to look for the most important features of the image. The earliest layer has low spatial information or no image features can be found, while the high layer will have more spatial information so that features will be found in the image. Finally, the pooling layer is used as the most important feature and is defined as an image feature. The results of image feature extraction with CNN are used as input in making a graph of classification result (Figure 3).

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 54, 54, 96)	34944
max_pooling2d (MaxPooling2D)	(None, 26, 26, 96)	0
conv2d_1 (Conv2D)	(None, 22, 22, 256)	614656
max_pooling2d_1 (MaxPooling2D)	(None, 10, 10, 256)	0
conv2d_2 (Conv2D)	(None, 8, 8, 384)	885120
conv2d_3 (Conv2D)	(None, 6, 6, 384)	1327488
conv2d_4 (Conv2D)	(None, 4, 4, 256)	884992
max_pooling2d_2 (MaxPooling2D)	(None, 1, 1, 256)	0
flatten (Flatten)	(None, 256)	0
dense (Dense)	(None, 1024)	263168
dense_1 (Dense)	(None, 1024)	1049600
dense_2 (Dense)	(None, 4)	4100

Total params: 5,064,068
Trainable params: 5,064,068
Non-trainable params: 0

Figure 3. Architecture of Alexnet

Some of the parameters used in the Alexnet training model can be seen in Table 2. The tools used are Google Colab with GPU runtime type. It takes 2 hours for the training process to produce a classification model for the image of rice plant leaves.

Table 2. Parameter Training Model Alexnet

Parameter	Value
Epoch	50
Step Per Epoch	8
Val_Steps	8
Verbose	1

The accuracy of the classification model using Alexnet on leaf images of rice plants can be seen after a 2-hour dataset training process with 100 epochs and 8 steps per epoch resulting in an accuracy of 99.2%. While the loss in the training process is 0.05. Figure 4 shows a graph of model accuracy and loss. From the graph shown, it is known that loss decreases throughout the epoch and the accuracy of the longer the training process shows an increasing trend up to close to 1 or 99.2% to be exact.

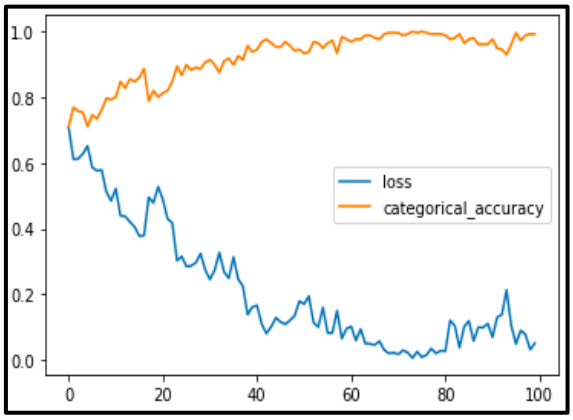


Figure 4. Graph of Accuracy and Loss

The performance measurement of the alexnet model is calculated based on the confusion matrix which shows the comparison between *true labels* and *predicted labels.* The confusion matrix from the results of the Alexnet training model is presented in Figure 6. The measurement results of accuracy, precision, recall, f1-score are known from the confusion matrix and the results are presented in Table 3.

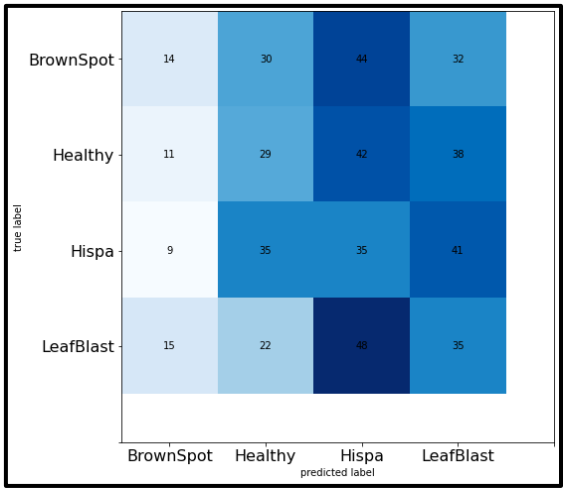


Figure 6. Matrix of Alexnet Performance Confusion

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The Score of accuracy, precision, recall and F1-Score are calculated based on the confusion matrix and using equations (1), (2), (3), (4), (5). The score of several calculated parameters are used as evaluation material for the performance of the mode being built.

Table 3. Evaluation Material Table

No Label	Presisi	recall	f1-score	support
0	0,29	0,12	0,17	120
1	0,25	0,24	0,25	120
2	0,21	0,29	0,24	120
3	0,24	0,29	0,26	120

While the accuracy score of the model in the classification of rice leaf imagery shows a value of 99.22% and loss in the Alexnet model is 0.05.

CONCLUSION

The Alexnet architecture used in this study consists of several stages starting from the convolution process, max pooling to flatten. Complete Alexnet architecture can be seen in Figure 4. The CNN network is used to extract features from the input image because the CNN network has a strong ability to search for image features. The input image dataset will be subjected to a convolution operation on each layer to look for the most important features of the image. The earliest layer has low spatial information, or no image features can be found, while the highest layer will have more spatial information so that features will be found in the image. Finally, the pooling layer is used as the most important feature and is defined as an image feature. The results of image feature extraction with CNN are used as input in making a graph of classification results.

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