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Utilization of Artificial Neural Network in Rice Plant Disease Classification Using Leaf Image

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Abstract:** Rice is the name of the type of plant that is needed by humans in the world. The plant is used as the main source of energy by Most people in the world, especially on the Asian continent. The importance of rice plants makes rice widely planted in various regions. Most humans use rice as a staple crop. Therefore, rice production needs to be considered to meet the need for enough food for most people in the world. The main thing that needs to be considered in maximizing rice production is that when guarding rice plants, many factors that inhibit rice plants can be the cause of food crises in various regions. Therefore, the care of rice production needs to be considered. In addition to the lack of nutrients in water and soil in decreasing rice production, plant diseases also need to be considered. Some types of diseases that often attack rice plants include bacterial leaf blight, brown spots, and left smut. Therefore, there is knowledge of prevention efforts or early treatment before the disease attacks rice plants more widely. The efficacy of technology can be used in solving this problem, we can take advantage of artificial intelligence in it. Artificial intelligence is implemented for the detection of types of diseases in rice plants using image images on the leaves of rice plants. If the disease in rice plants can be detected, it will make it easier for rice plant farmers to overcome the disease. The ANN (Artificial neural network) algorithm can be used in this problem from the results of research on identifying the type of rice disease using the algorithm obtained an accuracy of 83%. This shows the ability of artificial intelligence in disease identification can help farmers detect types of diseases.

***Keywords:** Rice, Identification, Crops, Artificial Intelligence, Diseases.*

1. INTRODUCTION

Rice plants or in Latin named Oryza sativa are plants that have an important role as a

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complement to food security in the world. Rice is the most important strategic crop for food and nutritional security globally [1], despite having an important role in food in the world, rice plants cannot be separated from various challenges, one of which is disease. Rice plant diseases are things that must be considered to stabilize the world's food needs.

Indonesia is an example of a country with a fairly high level of rice consumption. The need for rice plants in the country exceeds several other countries in Asia such as China, Korea, and Malaysia. With the high level of rice consumption in the country, the country must be able to produce high amounts of rice. Referring to statistics released by the Central Statistics Agency (BPS), it is known that rice production in 2021 in the country has decreased quite significantly, namely 54.42 million tons [2]. Very much different from the production level in the previous year, which reached 54.65 million tons. The impact of the decline is a serious concern and requires rapid handling to avoid negative consequences on food needs in the country.

Some types of diseases that often attack rice plants, namely leaf blight commonly known as Bacterial left Blight, are one of the most common types of diseases affecting rice cultivation in the world. The disease caused by Xanthomonas oryzae bacteria can spread quickly. This adversely affects the quality of rice crop harvest. It is reported that bacterial blight may damage seedlings and can cause grain yield loss of 4.5-29.1%[3].

Another disease that often attacks rice plants is also a Brown spot. The disease is caused by infection with the fungus Cercospora oryzae. The characteristic of plants infected with this disease is that there are brown spots in the middle of the leaves. In general, this disease arises due to an imbalance in soil fertility and easily develops in plants that are water-stressed. Brown spot is one of the deadliest rice diseases, which can lead to total yield loss [4].

In recent years, digital image technology has emerged with effective capabilities as a disease detector in plants. Artificial intelligence-based jobs with existing automation jobs provide trendy output for human convenience[5]. Leaf imagery provides visual data that can be computerized to identify changes in color, texture, and pattern associated with the presence of disease. By utilizing leaf image technology, research on rice plant detection is the main focus to improve precision and efficiency in identifying various diseases. This study aims to develop a rice plant disease detection system using leaf images that can produce predictions quickly and accurately. By using the ANN (Artificial Neural Network) algorithm.

2. RELATED WORKS

Similar research in classification using the ANN method in glass image images has also been carried out and obtained a satisfactory accuracy of 96.7% [6] in the study researchers classified the type of glass that functions as an assistant to assist investigators in identifying the type of glass found in the crime arena.

Previous research has also been conducted in the classification of nemun rice plant diseases

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using the CNN (Convolutional Neural Network) method. In the study, the pre-processing process was carried out as data standardization, and this study considered several parameters to obtain the greatest accuracy, including carnal size, learning rate, epoch, type of optimizer, and batch size. The results showed a high accuracy rate of 91.7% [7]. In the next study [8] there was a classification of brain tumors that are usually performed before brain surgery. This study proposes the use of convolutional nerve tissue (CNN) for calcification of brain tumors without invasive biopsy. The best results achieved 96.56% accuracy with the 10-fold validation method, demonstrating the potential of CNN as a decision support tool for radiologists in diagnosing brain tumors non-invasively.

References [9] refer to research that uses the CNN method to classify leaf images with a focus on identifying different types of medicinal plants. The study involved analyzing data from images of medicinal leaves in different regions of India using 34,123 images as training data. The final results showed that the system developed succeeded in classifying types of medicinal plants with an accuracy rate of 71.3%. In addition, in reference [10], other studies use the Recurrent Neural Network (RNN) method to classify skin cancer with the final results of the RNN model showing 0.5740 for loss value, 0.7150 for accuracy, 0.5807 for validation loss and 0.8003 for validation accuracy. A similar occurrence is contained in reference [11], which includes research on image classification with a focus on classifying herbs and spices using the Convolutional Neural Network (CNN) method. In this study, researchers used 2 layers of convolution, with each layer having 10 and 20 filters, and the final results showed that the system managed to achieve an overall accuracy rate of 88.89%.

3. RESEARCH METHODOLOGY

The method in this research using ANN (Artificial Neural Network) has a superior ability to process complicated and inappropriate data and can solve unstructured problems. The way ANN or artificial neural networks work is by simulating indicators with various characteristics such as different geometries, entanglement strands, core materials, waveforms, and others [12]. This shows that ANN can be used in designing and simulating inductors with a variety of parameters, enabling high adaptability in producing inductor components that suit specific needs.

In this study, we used secondary data in the form of images that we obtained through the UCI Machine Learning Repository, which is a data source for Machine Learning and Intelligent Systems projects. We searched for rice leaf disease image data using the keyword "Rice Leaf Diseases Data Set" on the website. This dataset consists of three categories of rice leaf diseases, namely Bacterial Leaf Blight, left smut, and Brown Spot, each consisting of 40 images so there are a total of 120 images in JPG format. In Figure 1, we show the architecture of the model used in the study.

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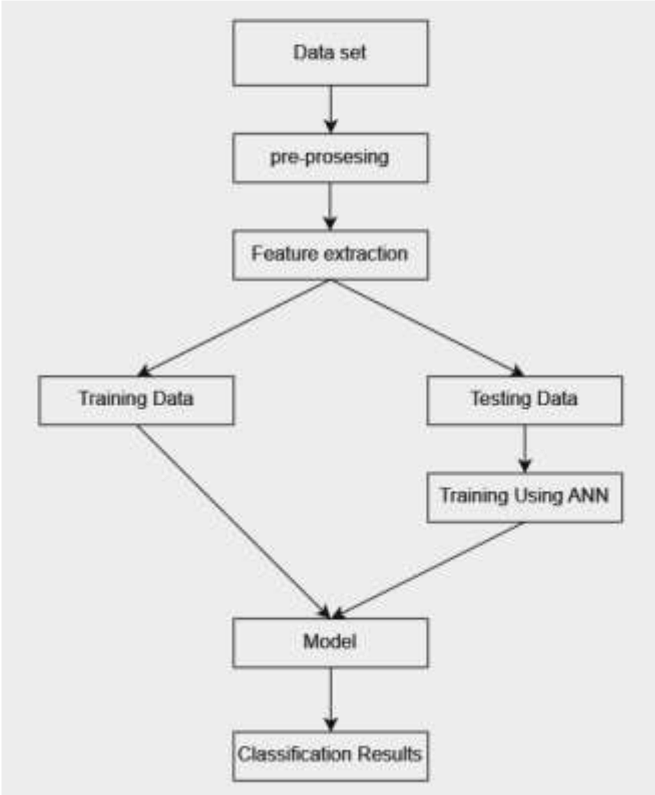

Figure 1 Model Architecture in research

a. System Manufacturing Process

The system creation process begins with pre-processing to produce a uniform input image, given the elemental variations in each image. Pre-processing aims to clarify image features, using the Keras package for classification. The size of all images is uniform to 256 x 256 pixels for easy training. The next stage involves category labeling, where each image is labeled with training and testing data. Labeling is done according to categories, allowing machines to make predictions. The number of training data is 56 and the testing data is 24, with the value 1 representing "true" and the value 0 representing "false".

The steps of creating an ANN model are carried out to achieve optimal accuracy of the design of the model created. In this process, experiments are conducted to evaluate the capabilities of the model using the most suitable ANN architecture to obtain the best results. During this stage, comparisons are made against several parameters in the ANN architecture, such as epoch values, optimizer types, and dataset scenarios. It aims to find the best model by considering the variety of these parameters.

The first comparison is made on the epoch parameters to find the best architecture. Epochs are a critical part of neural network learning, where a set value affects the learning process, and learning stops after reaching a specified epoch value. Epoch is a hyperparameter that determines the number of iterations when a deep learning algorithm works through the entire dataset. The epoch values to be compared in this study are 50, 100, and 150.

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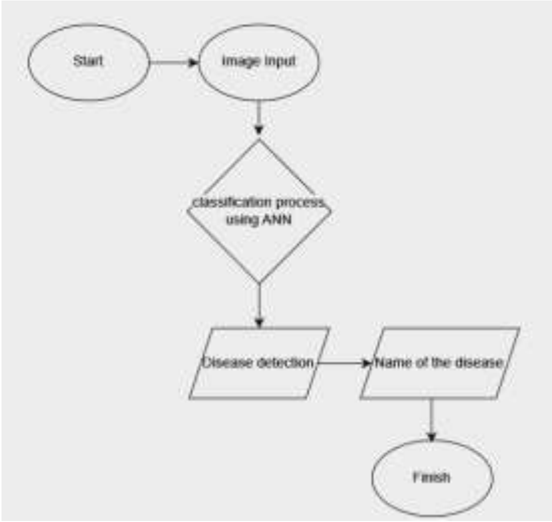

Figure 2 System Flow

Figure 2. The description above details the operational design of the application to be made, starting from the data entry step which is then processed by the system to classify or classify according to predetermined training data. The result is an output of disease names identified by the system based on the characteristics of the images entered.

b. ANN Modeling

The process of developing an Artificial Neural Network (ANN) model involves a series of stages to achieve an optimal level of accuracy. At this stage, experiments are conducted to find the ANN architecture that best suits the research objectives. In this process, comparisons are made against several key parameters in the ANN architecture, such as the number of epochs, the type of optimizer, and the variation of the dataset, to obtain the most effective model.

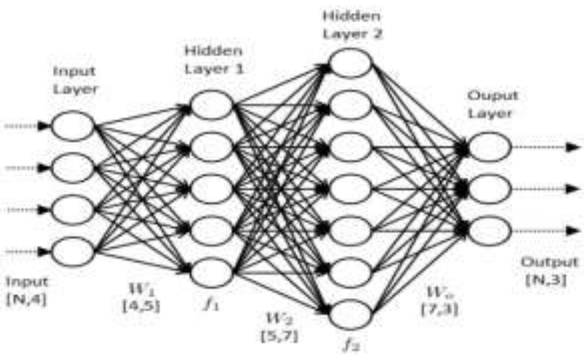

Figure 3 Artificial Neural Network

In the training process, the training data is fed to the network for forward propagation (feedforward), resulting in an output that is compared to the training target. The testing process involves a comparison between the test target and the output produced when performing feedforward on the test data.

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The first parameter that will be compared to get the best architecture is the number of epochs. Epochs are a key element in the neural network learning process, where the epoch value determined will affect how the learning process progresses, and training will stop once it reaches a predetermined number of epochs. Epoch is a hyperparameter that controls how often deep learning algorithms go through the entire dataset in forward and backward processes. In this study, we will compare epoch values of 50, 100, and 150 in the research data.

c. Research Data

The data used in this study came from secondary data sources found in the UCI Machine Learning Repository, which is an archive that can be accessed through the archive.ics.uci.edu website. The site provides a variety of data used in Machine Learning and Intelligent Systems projects. Data search is done by using the keyword "Rice Leaf Diseases Data Set" to search for image datasets related to rice leaf disease. The dataset consists of two main categories: Bacterial Leaf Blight and Brown Spot, each with 40 images. The total number of images in this dataset is 120 images in JPG file format. Images of rice leaves are taken on a white background and placed in direct sunlight. This data was collected by Dharmsinh Desai University through the Department of Information Technology in Gujarat, India, as seen in Figure 4.

Figure 4 Dataset

4. RESULT AND DISCUSSION

The study used as many as 40 test data for each type of disease. The dataset is obtained by taking images of leaves, then the data is fed into the system to identify the type of disease. Training data is taken from the UCI Machine Learning Repository which can be accessed through the archive.ics.uci.edu website, which is the data source for Machine Learning and Intelligent Systems projects. The rice leaf disease image dataset was found by searching for the keyword "Rice Leaf Diseases Data Set".
The dataset will be converted into training data through a pre-processing process, which involves labeling each object for identification purposes. Each image is labeled according to its category, allowing the machine to make predictions. Labeling is done based on the amount of data, with 56 records for training and 24 data for testing, using values of 1 as "true" and 0 as "false". Once pre-processing is complete, the dataset is trained using Google Colabotary with 100 epoch layers.

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Figure 5 Diagnosis of rice disease

In Figure 5 above, the prediction stage of the input image is carried out. The system will detect based on the training data inputted to provide the prediction results obtained. The system will produce output in the form of the name of the type of disease predicted by the system.


Figure 6 Image Entry

Furthermore, in Figure 6 the user enters the image that will detect the type of disease and after that, the user presses the "predict!" button to run the system to classify the input image.

Figure 7 Result

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Figure 7 shows the results of predicting what type of disease attacks the plant using this system classification, in the above detection the results of the classification found that the system detects the disease that attacks as Bacterial leaf blight disease.

a. Model Making

In conducting experiments to produce models with high accuracy, namely by conducting several experiments

Effect on the Number of Convolution Layers

Table. 1 Influence of the number of epochs

Epoch	**Train**		**Test**	
	Acuracy	Loss	Acuracy	Loss
50	0,8667	0,3103	0,8500	0,4218
100	0,7333	0,1782	0,8533	0,1466
150	0,7833	0,4357	0,8500	0,4654

Table 1 shows that the higher the epoch value does not affect the good accuracy produced. But it affects the time needed to process.

Effect Optimizer

Table. 1 Effect Optimizer

optimizer	**akurasi**	**loss**
Adam	0,8667	0,31
SGD	0,48	0,69
RMSprop	0,51	0,49

Table 2 of the statement above can be concluded that the best optimizer is Adam with an accuracy of 0.86.

Effect of Learning Rate

Table. 2 Effect of Learning Rate

Learning Rate	**Accuracy**	**Loss**
0.001	86%	0.313
0.006	74%	0.3710
0.007	76%	0.3592

In table 3 above, it can be concluded that the best learning rate is 0.001 where the smaller learning rate has the potential to make processing better.

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b. Model Evaluation

In Figure 8 there are several values generated from the confusion matrix for each class. Overall, accuracy reached 83%, while precision reached 84%. The recall score also reached 84%, and the f1 score reached 83%.

```
1/1 [==============================] - 0s 99ms/step
                       precision    recall  f1-score   support

Bacterial leaf blight       0.77      0.91      0.83        11
           Brown spot       0.91      0.77      0.83        13

             accuracy                           0.83        24
            macro avg       0.84      0.84      0.83        24
         weighted avg       0.84      0.83      0.83        24

Accuracy  : 0.8333333333333334
Precision : 0.844988344988345
f1Score : 0.8333333333333334
```

Figure. 8 Confution Matriks

5. CONCLUSION

In the analysis stage, several key conclusions have been obtained. First, the implementation of Artificial Neural Network (ANN) in the image classification of diseased rice leaves involves finding the best architecture by comparing epoch parameters. The results of this comparison guide in determining the optimal parameters for the ANN model. The best architecture was found with 128x128 pixel imagery, 3x3 kernel size, 0.001 learning rate, Adam type optimizer, epoch 100, batch size 32, and 75%:25% dataset scenario. The image used is an RGB image. Furthermore, the accuracy rate of testing using the best model for the classification of leaf diseases in rice plants reached 83.33%. This shows that the developed model can classify the type of disease with good accuracy.

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