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Comparison of Tomato Leaf Disease Detection Using Transfer Learning Architecture with the VGG19 Method

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ABSTRACT

Diseases in plants are often detrimental to agriculture, can be seen manually and require a very long time, which can lead to possible errors in disease detection. Detecting diseases in plants early can overcome these problems and reduce the risk of reduced crop production. The aim of this research is to make a comparison of quickly and accurately detecting tomato leaf diseases compared to previous researchers who used Deep Learning applications. Which can be applied effectively for image classification using the VGG19 method. The implementation of this model uses a dataset containing 2,694 images, including 3 different types of diseases. That the conclusion of this research is the fastest and most accurate way to detect tomato leaf diseases. To prove this research, results and necessary data will be presented in this paper. The accuracy obtained on the VGG-19 architecture was 91.85% with the best increase in accuracy compared to the previous journal which only produced 87% accuracy.

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1. INTRODUCTION

Tomato (Solanum lycopercism) is one of the most important and popular vegetable crops throughout the world. One of the main problems in the agricultural sector is the decline in plant performance due to attacks by various diseases that attack tomato leaves. Therefore, scientists are interested in developing efforts to prevent tomato leaf diseases in order to increase crop yields [1]. Tomato leaves are susceptible to various diseases which can result in a reduction in the quality and quantity of the harvest. The problem of tomato leaf disease has become a serious problem in the agricultural sector and currently its detection is increasingly difficult. Agriculture is the main pillar of the global economy. India ranks second in the world in tomato production [2].

Apart from disease, pests can also affect tomato growth. Therefore, learning how to identify tomato leaf diseases is very important. However, manual disease and pest detection is inefficient and expensive. Tomato leaf diseases have a significant impact on tomato yield. Recognizing diseases in agriculture is very important for the economy of the agricultural sector [3]. The spread of diseases caused by various pathogens such as fungi, bacteria and viruses has caused a decline in tomato production globally [4]. Infected plant leaves have varying characteristics in terms of color, texture,

shape, etc. Exploiting these features has been the focus of various computer vision-based studies, which aim to
automatically detect pests and diseases every year. This research plays an important role in the identification and classification of plants [5]. In this article, we propose an image processing-based low-temperature plant leaf disease detection technique, which mainly relies on traditional computer vision techniques such as filtering and edge detection. However, we also considered the use of neural networks, which have good nonlinear matching capabilities and have been proven to be successful in various image recognition tasks, resulting in higher accuracy [6].

Rapid advances in learning have enabled significant accuracy in image classification and object detection, even surpassing human capabilities, especially in accurately classifying large data sets in various contexts [7]. Various techniques have been used to overcome pest and disease problems in plants, one of which is Deep Learning (DL) which has become popular in the agricultural sector in recent years [8]. CNN (Convolutional Neural Network) is a class of DL system that is very useful for image processing [10]. When diseases are detected on tomato leaves, image classification approaches can improve diagnostic accuracy by identifying the symptoms and signs observed on tomato plants [11]. CNNs can be extended to handle various forms of image classification and plant disease identification problems. Several CNN architectures are built based on the VGG-19 model, which often uses the ImageNet dataset for model training and learning [12].

This architecture has a primary focus on improving accuracy. However, relevant research has been conducted to improve this architecture, which will be discussed in the next section. In this article, we use the VGG-19 architecture to compare this model with previous studies. This comparison allows faster and more accurate identification of infected tomato leaves. VGG-19 was trained and tested using transfer learning techniques on the Kaggle dataset to automatically detect and identify tomato leaf diseases. The Kaggle dataset contains images of three types of diseases. This article states that VGG-19 is the best model for detecting tomato leaf diseases, with results compared with previous research data conducted on the Google CoLab platform. The structure of this paper is organized as follows: Section II presents an overview of research related to plant disease detection using deep learning that has been published previously. The methodology used to analyze this paper is explained in Section III. Experimental results are presented in Section IV. Section V carries out a comparative analysis based on the results obtained. Finally, the conclusions of this research are presented in Section VI, which is targeted at improving its accuracy using adjustments so that the original function and data coverage can achieve the goal.

By analyzing data and results obtained from the Google CoLab platform, this paper states that the comparison results of the VGG-19 model can detect tomato leaf diseases more quickly and accurately. The remainder of this paper is organized as follows: Section II presents previously published related works on deep learningbased plant disease detection. The methodology adopted in the paper. The main text format consists of a nalysis of the results [2]. If the manuscript was written really have high originality, which proposed a new method or algorithm, the additional chapter after the "Introduction" chapter and before the "Research Method" chapter can be added to explain briefly the theory and/or the proposed method/algorithm [4].

2. RESEARCH METHOD

The dataset used in this research comes from Kaggle, to detect tomato leaf diseases using the VGG-19 method. The concept or description of the research to be carried out is called the research flow, and the research flow is described in Figure 1 as follows.

Deep Learning Networks can be applied for image classification in many fields based on the large size of the data set with around 60 million parameters and 650,000 neurons. In practice, a network architecture can have five convolutional layers and three fully connected layers with different roles. There are the first two convolution layers (standard layer and max pooling layer), the 3rd and 4th convolution layers (directly connected), the final convolution layer (max pooling layer), and the output layer (softmax layer). Additionally, some networks have specific architectures for unique applications. For example, GoogleNet is a network with about 7 million parameters, 9 initial modules, 4 convolutional layers, 4 max pooling layers, 3 average pooling layers, 5 fully connected

layers, and 3 softmax layers. All convolutional and dropout layers use ReLU (activation function) with a reduction ratio parameter of 70% applied to all fully connected layers.

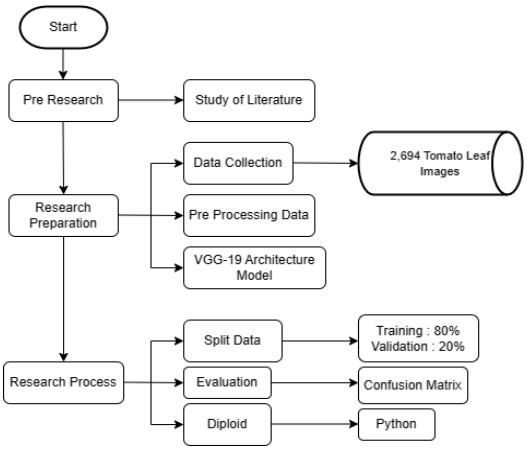

Figure 1. Research Flow Chart

Additionally, ResNet is similar to VGG-19 and has been adapted many times to produce ResNet-18, ResNet-34, ResNet-50, ResNet-101, and ResNet-152. Here we apply VGG-19 to train on a dataset of tomato leaf images. Basically VGG has a CNN network architecture, and VGG-19 is a VGG-based architecture. VGG-19 is a deep learning neural network with 19 connection layers, including 16 convolution layers and 3 fully connected layers. The convolution layer will extract the input image features, and the fully connected layer will classify the image leaves for those features. Additionally, the max-pooling layer will reduce features and avoid overfitting (Nguyen et al., 2022).

$$\text{Akurasi} = \frac{TP+TN}{TP+FN+TN} \times 100 \quad (2.1)$$

Accuracy is a testing technique that is based on the degree of closeness between predicted values and actual values. By knowing the amount of data that is classified correctly, we can know the accuracy of the prediction results (Trivusi, 2022).

$$\text{Recall} = \frac{TP}{TP+FN} \quad (2.2)$$

Recall adalah teknik pengujian yang membandingkan jumlah informasi relevan yang diterima sistem dengan total jumlah informasi relevan yang ada dalam koleksi informasi (baik yang diambil atau tidak diambil sistem) (Trivusi, 2022).

$$\text{Recall} = \frac{TP}{TP+FP} \quad (2.3)$$

Presisi adalah metode pengujian yang membandingkan jumlah informasi relevan yang diterima sistem dengan jumlah total informasi yang diambil sistem, baik yang relevan maupun tidak relevan (Trivusi, 2022). Persamaan ketepatan ditunjukkan di bawah ini.

Table 1. Comparison Table

Activation	Optimizer	Epoch	Accuracy
Softmax	Adam	18	91,85%
Softmax	SGD	17	82,59%
Softmax	Adagrad	17	89,26%
Softmax	RMSProp	17	89,07%
ReLu	Adam	17	33,33%
ReLu	SGD	17	33,33%
ReLu	Adagrad	17	33,33%
ReLu	RMSProp	17	33,33%

(a) (b) (c)

Figure 2. Some sample leaf images from the dataset representing ten different diseases, (a) Bacterial spot, (b) Early blight, (c) Late blight

2.1 Experimental Data

In this section, data is needed to support the research objectives of detecting tomato leaf diseases. To get good and fast accuracy, it can be presented in the form of images, graphs, table.

2.1.1 Graphics

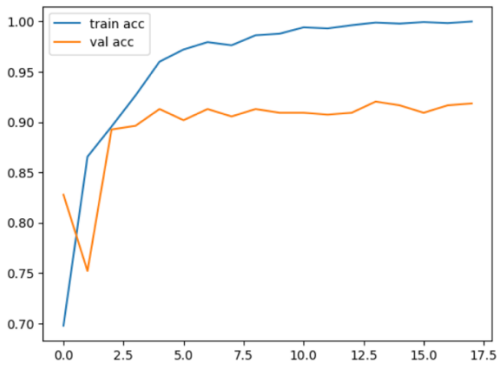

Figure 3. Graphic of Epoch 18 Activation Modification Results Softmax and Optimizer Adam

In the graph below, the accuracy of the training data is 0.10000, then for the validation data it is 0.9185. Model accuracy from training data and test data when viewed from epoch 1 to 18 predominantly increases, but there is also a decrease at certain epochs, increases and decreases in model accuracy occur because the data that is predicted correctly at each iteration is always different or fluctuates.

2.2.1 Confusion Matrix and Comparison Table

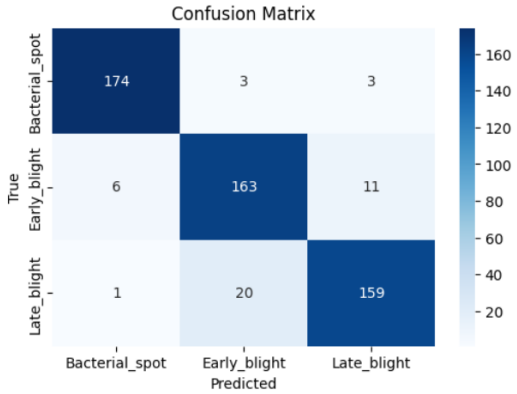

Figure 4. Confusion Matrix

Table 1. Comparison Table

Activation	Optimizer	Epoch	Accuracy
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ReLu	Adam	17	33,33%
ReLu	SGD	17	33,33%
ReLu	Adagrad	17	33,33%
ReLu	RMSProp	17	33,33%

Demonstrated significant performance improvements in the developed model, with increased accuracy in every aspect evaluated. By using Softmax activation, using the Adam optimizer and increasing the epochs to 18 new models, we managed to achieve the highest accuracy of 91.85%.

3. CONCLUSION

In this paper, a comparative analysis has been presented tomato plant disease detection using transfer learning architecture namely VGG-19. The theoretical background and methodology used to carry out the analysis have been explained in the previous section of this paper. In the experimental results and comparative analysis section, it can be seen that the VGG-19 model obtained the most satisfactory average validation accuracy in detecting tomato leaf diseases. This can be analyzed from previous researchers who only got an accuracy of 87%, after making modifications the accuracy obtained was 91.85%. Therefore, it can be concluded by considering. The overall most accurate aspect in detecting tomato leaf diseases in this study was compared with detecting tomato plant diseases with high efficiency in previous researchers.

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