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Convolutional Neural Network (CNN) EfficientNet-B0 Model Architecture for Paddy Diseases Classification

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***Abstract*— Rice stands as a pivotal food commodity in Indonesia, contributing significantly to food security while witnessing a consistent rise in demand. The susceptibility of rice leaves to diseases threatens this critical role, underscoring the imperative for early and accurately automated disease identification. In this study, we employ Convolutional Neural Networks (CNN) as a deep learning methodology to classify various types of rice leaf diseases. The approach comprises distinct stages, encompassing preprocessing, modeling, and evaluation. The primary objective of this research is to achieve the classification of rice leaf diseases with both acceptable accuracy and runtime efficiency. The experimental outcomes highlight an impressive peak accuracy of 98.93% when employing data augmentation, layer normalization, and the RMSProp optimization function with a learning rate of 0.001. These results underscore the significance of diligent data preparation and model optimization in the rice leaf disease classification process.**

Keywords—Convolutional Neural Network, image processing, image classification, EfficientNet, paddy diseases.

I. Introduction

Rice is a crucial agricultural commodity in Indonesia, playing a vital role in maintaining national food security [1]. In 2022, Indonesia produced a staggering 55.67 million tons of rice from 10.61 million hectares of cultivated rice fields, marking a significant increase of 1.25 million tons compared to the previous year's harvest [2]. This continuous rise in rice production is closely tied to the growing market demand for this staple crop. However, this success is threatened by diseases that affect rice plants, posing a significant risk to food security [3].

One effective method for detecting diseases in rice plants is by examining the characteristics of the diseases through the leaves of the rice plant [4]. Furthermore, one observable characteristic is the discoloration of small microorganisms around the infected leaves [5]. In order to achieve a higher level of accuracy in disease identification than humans can provide, it requires a system capable of analyzing the texture of digital images, as well as deducing patterns through computational calculations [6].

The most promising approach to develop such a system is through the use of deep learning methods, renowned for their structured learning, and the ability to classify various disease types, yielding more accurate results [7]. One class in the deep learning method that can perform texture recognition through images is the Convolutional Neural Network (CNN) [8]. This method is designed to perform image processing using the workings of the human nervous system by performing feature extraction and classifying data in images [9]. Previous research using this method has demonstrated notable success, achieving high accuracy rates of 95.24% for rice disease classification [10], 92.46% [11], and 96.08% [12] in other studies.

However, one common challenge encountered when employing this method is excessive runtime and memory usage due to the model's complexity and a large number of parameters. To address and mitigate this issue, previous researchers have implemented various techniques, which will also be applied in this study. These techniques include preprocessing methods, model optimization, optimization of functions, configurations of learning rate hyperparameters, and comprehensive model evaluations [13].

II. Related Work

In a study conducted by [8], CNN outperforms both RCNN and CLSTM in multi-label classification, achieving an average accuracy of 88.54%. This superiority is attributed to CNN's ability to effectively differentiate supervised data. Substantiating this assertion is research by [10], which employed the CNN method with the VGG19 architectural model for classifying rice plants, achieving an accuracy rate of 95.24%. This research underscores the impact of architectural models on CNN in enhancing classification accuracy.

A comprehensive discussion of architectural models is presented in [14], covering the various layers and types of architectural models in CNN. CNN architecture is categorized into two main types: classical and modern architectural models. The primary distinction between these models lies in their number of layers and parameters. Classical models tend to have more layers and parameters than their modern counterparts. However, it's important to note that a higher number of layers and parameters does not guarantee superior accuracy.

During the modeling process, it is crucial to pay attention to the loss function since it will impact the model's