Faculty of Cognitive Sciences and Human Development

Hybrid Pepper Plant Disease and Nutrition Deficiency Diagnosis with UNet and CNN

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A thesis submitted

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Signature

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ABSTRACT

Black pepper is an essential commodity in Malaysia, which not only adds flavors to local dishes but also financially supports the local community and the country's economy. However, black pepper plants are susceptible to various diseases and nutrient deficiency, which affect their growth and peppercorn production, and it is costly for the farmers and the officers from the Malaysian Pepper Board to provide timely aid. In the meantime, even though various methods have been attempted to support the local farmers, there are still difficulties for black pepper farmers in accurately diagnosing the problems in their crops. Besides that, many computational tools and convolutional neural network (CNN) models are available for plants in the PlantVillage dataset, excluding the black pepper plant. Therefore, this study aims to design a CNN model that accurately diagnoses both single and hybrid cases of black pepper diseases and nutrient deficiencies which enhance detection accuracy and robustness, then to develop and to test a robust hybrid detection model that identifies the most commonly co-occuring symptom, red rust disease, using UNet segmentation and fine-tuned CNN models, and to test the new CNN model with other existing models. The result shows that EfficientNet is the best performing black pepper plant disease and nutrient deficiency classification model, followed by ResNet, MobileNet, and DenseNet. For the custom CNN with five convolutional pooling layer blocks with 0.2 dropout performed almost as well as the state-of-the-art model. Besides that, UNet was also utilized to segment the regions with the secondary disease, red rust disease, from the images, and the segmented results again fit into EfficientNet to cross-check if they were red rust or not. Therefore, the whole project involves CNNs classifying the pictures of the leaves into their respective classes, whereby UNet and EfficientNet are used to identify and check the presence of red rust in those images.

Keywords: Black pepper, convolutional neural network, plant disease, nutrient deficiency, classification