

DEEP LEARNING MODEL FOR THE DETECTION AND CLASSIFICATION OF BANANA DISEASES BASED ON LEAF IMAGES

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Bogor, June, Year 2024
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SUMMARY

SHABAN NASSOR SHABAN. Deep Learning Model for The Detection and Classification of Banana Disease Based on Leaf Images, supervised by KARLISA PRIANDANA and MUSHTHOFA.

Fungal diseases are among the main reasons for low productivity in banana farming. Black Sigatoka and fusarium wilt race 1 are the major fungal diseases that threaten banana production. black Sigatoka is a fungal disease caused by a wind-bone fungus, *Mycosphaerella fijiensis* Morelet. On the other hand, fusarium wilt is another fungal disease originating from soil caused by a fungus named *Fusarium oxysporum* f. sp. *cubense* (Foc). The spread of these diseases is accelerating in many countries and threatens the production of bananas globally. Early detection of fungal diseases is essential and one of the possible approaches is using machine vision. Due to its high accuracy, deep learning is the most widely used algorithm in machine vision for many solutions. Its ability to model the data into multiple levels of abstraction makes it suitable for many agricultural solutions. Furthermore, deep learning can be trained with a vast amount of data. However, deep learning requires a high computational resource, challenging many agricultural solutions implemented on low-computing devices such as edge, mobile, and IoT devices. Therefore, this research proposes deep-learning models for detecting and classifying banana diseases based on leaf images. The study proposes the use of lightweight deep learning algorithms instead of off-shelf algorithms. Lightweight deep learning algorithms have a small architecture which make them suitable for low computing resources devices.

The research is conducted in two stages: the first stage focuses on identifying the diseases using deep learning where default algorithms are trained. In this stage, four lightweight deep learning utilized namely mobileNetv2, mobileNetv3-small, ShuffleNetv2, and SqueezeNet. The choice of algorithms is based on the popularity of the algorithm in the research community. The second stage focuses on modification of the algorithms to increase the performance of the models. Modifications introduced include the addition of a convolutional block attention module (CBAM). CBAM is a lightweight attention module that enhances both channel and attention features. In both stages, sequential model-based optimization (SMBO) is used for automatic hyperparameter tuning (HPO). SMBO is a variant of Bayesian optimization that selects the parameters sequentially. This makes SMBO to be faster than other optimization algorithms.

The study used a dataset of images representing three classes: healthy, black Sigatoka, and fusarium wilt race 1. The dataset was collected in Northern Tanzania for a period of six months by the Mandela African Institution of Science and Technology (NM-AIST) and the International Institute of Tropical Agriculture (IITA). The preprocessing conducted after acquiring the dataset includes resizing, removing the stem images, splitting, and augmentation. The model's performance is measured by calculating accuracy, precision, recall, and f1-score as well as measuring model complexity.

The results indicated that for stage one, mobileNetv2 outperforms all other models with 97,73% accuracy, 97,74% precision, 97,73% recall, and 97,73% f1-score, while shuffleNetv2 had poor performance with an accuracy of 84,21%,

precision of 84,76%, recall of 84,21%, and f1-score of 84,03%. SqueezeNet is a light model with a size of 2,78 MB, while mobileNetv3-small is the heaviest model with a size of 8.74 MB. However, all models had trouble distinguishing between black sigatoka and fusarium wilt race 1. This indicates generalization ability of the models is poor. For lightweight deep learning with CBAM (stage two), shuffleNetv2 outperforms all other models with 99,07% accuracy, 99,07% precision, 99,07% recall, and 99,07% f1-score. SqueezeNet is a light model with a size of 2,09 MB, while mobileNetv2 is the heaviest model with 14,40 MB. SqueezeNet took a short time, with an estimated 558.0961, equal to 9.301 minutes. Generally, the classification capability of all models increased significantly compared to stage one. Also, the CBAM module helps to increase the generalization capability of the models by reducing the number of misclassified images as well as increasing the performance of the models. However, the classification is still not 100% for all classes.

Overall, the lightweight deep learning proposed by this research showed a good performance and can be used to overcome computational challenges. Also, classification and detection of banana diseases can be done based on image leaf, which can be a solution for early detection of the diseases and destruction method. Furthermore, the improvement of light-weight deep learning can be achieved by enhancing feature extraction ability. The approach proposed by this study can also be applied to other banana diseases and other plant species.

Keywords: banana, CBAM, deep learning, HPO, SMBO.

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SHABAN NASSOR SHABAN

Thesis

as one of the requirements for obtaining a Master degree in
Computer Science Study Program

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TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	viii
LIST OF ATTACHMENTS	ix
I INTRODUCTION	1
1.1 Background	1
1.2 Problem formulation	3
1.3 Research Purpose	3
1.4 Research Benefit	3
1.5 Research Scope	3
II LITERATURE REVIEW	4
2.1 Banana Diseases	4
2.2 Object Detection and Deep Learning	4
2.3 Two Stages Object Detection	5
2.4 One Stages Object Detection	6
2.5 Object Detection with Transformer	8
2.6 Light Weight Deep Learning	8
2.7 Common Deep Learning Light-Weight Architecture	8
2.8 Model Performance Evaluation	9
III METHOD	11
3.1 Research Stages	11
3.2 Data Acquisition	12
3.3 Pre-Processing	13
3.4 Identification of the Disease Using Deep Learning	14
3.5 Modification of the Algorithms	14
3.7 Fitting the Models with the Best Hyperparameters	19
3.8 Model Evaluation and Analysis	20
IV RESULTS AND DISCUSSION	21
4.1 Identification of Diseases Using Deep Learning (Stage One)	21
4.2 Modification of the Algorithms (Stage Two)	23
4.3 The Effect of Attention Layer (CBAM) on the Performance of the Models	26
4.4 Hyperparameters Optimization Analysis	29
V CONCLUSION AND SUGGESTIONS	30
5.1 Conclusion	30
5.2 Suggestions	30
REFERENCES	31
ATTACHMENTS	36

LIST OF TABLES

1	Comparison of lightweight deep learning and heavy-weight deep Learning	12
2	Description of the original dataset	13
3	Final dataset after pre-processing	13
4	Pseudocode of SMBO algorithm	17
5	Hyperparameters space used in this study	18
6	Optimization parameters, image size, and dataset size	19
7	Training configuration	20
8	Summary of the Classification Reports of Light Weight Deep Learning	21
9	Summary of the Model Performance of Light Weight Deep Learning	21
10	Overall summary of the model's complexity of Light Weight Deep Learning	23
11	Summary of the Model Performance of Light Weight Deep Learning with CBAM	24
12	Summary of the Classification Reports of Light Weight Deep Learning with CBAM	24
13	Overall summary of the model's complexity of Light Weight Deep Learning with CBAM	25

LIST OF FIGURES

1	Fusarium Wilt Race 1 disease	4
2	Black sigatoka disease	4
3	Multi-scale object detection model	5
4	Basic architecture of two-stage detector	5
5	The basic idea of YOLO	7
6	YOLO grid system processing	7
7	The basic architecture of YOLO network	7
8	Research stages for this study	11
9	Results of the literature search	12
10	Image sample from the dataset: healthy, Black Sigatoka, Fusarium Wilt Race 1- Leaf and Fusarium Wilt Race 1- Stem, respectively	13
11	CBAM attention module	15
12	Channel attention module	15
13	Spatial attention module	16
14	Intergration of CBAM module for mobileNetv2, shufflenetv2 and squeezeNet	16
15	MobileNetv3-small architecture	16
16	MobileNetv3-small with CBAM module	16
17	Confusion matrix of each model for Light Weight Deep Learning (a) mobileNetv2,(b)mobileNetv3-small, (c) shufflenetv2, (d) SqueezeNet	22

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18	Confussion matrix of each model for Light Weight Deep Learning with CBAM (a) mobileNetv2, (b) mobileNetv3-small, (c) shuffleNetv2 and (d) sqyeezeNet	25
19	The size of the models (a) Lightweight deep learning only (b) Light Weight Deep Learning with CBAM	26
20	Comparison of evalution metrics for Light Weight Deep Learning only and Light Weight Deep Learning with CBAM (a) accuracy (b) recall	27
21	Comparison of evalution metrics for Light Weight Deep Learning only and Light Weight Deep Learning with CBAM (a) precision (b) fl-score	28
22	Misclassified Of Images by Light Weight Deep Learning and Light Weight Deep Learning with CBAM	29

LIST OF ATTACHMENTS

1	The graph of train-validation accuracy and loss of Light Weight Deep Learning Models.	36
2	The graph of train-validation accuracy and loss of Light Weight Deep Learning with CBAM.	37
3	The plots of optimized parameters of Light Weight Deep Learning Models.	38
4	The plots of optimized parameters of Light Weight Deep Learning with CBAM.	39