IoT - Based Multispectral Imaging System for Early Detection of Diseases, Pest Infestations in Kochchi (Dark Green Scotch Bonnet) Plants Using Deep Learning Algorithms

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A THESIS

SUBMITTED TO

SRI LANKA INSTITUTE OF INFORMATION TECHNOLOGY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY

December 2025

I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

Supervisor - Dr. Kalpani Manathunga

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Head of Graduate Studies, FoC, SLIIT

DECLARATION

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Sri Lanka Institute of Information Technology or to any other institution for assessment for any other purpose.

Sign:  .....

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Date: 31.12.2025

ABSTRACT

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Kochchi, also known as the Dark Green Scotch Bonnet, is a valuable chili variety that thrives in Sri Lanka. However, the yield and quality of this crop often suffer due to pests and plant diseases. Traditional detection methods rely on manual inspection, which is labor-intensive, subjective, and typically identifies symptoms only after visible damage occurs. This study proposes a multispectral imaging (MSI) framework combined with deep learning algorithms to achieve early and accurate disease detection under greenhouse conditions. A DJI Mavic 3 Multispectral drone was used to capture synchronized RGB and multispectral bands (Green, Red, Red-Edge, NIR). Preprocessing involved band alignment, vegetation index computation (NDVI, NDRE, GNDVI), and reduce noise, all aimed at spotting early signs of distress before they become severe. A convolutional neural network (CNN) was trained for binary classification of healthy versus infected plants, achieving high accuracy across cross-validation. For plants classified as infected, severity mapping was performed using advanced instance segmentation models, YOLOv11 and Mask R-CNN, followed by HSV color transformation and K-means clustering to quantify lesion area as a percentage of total leaf surface. Evaluation using Accuracy, Precision, Recall, F1-score, Intersection over Union (IoU), and Dice Coefficient confirmed the robustness of the system. The proposed approach demonstrates the potential of multispectral imaging combined with deep learning for early disease detection and severity quantification in Kochchi cultivation, reducing reliance on pesticides and supporting sustainable agriculture.

ACKNOWLEDGEMENT

It is with great pleasure that I express my deepest gratitude to all those who supported me throughout the course of this research.

First and foremost, I would like to extend my heartfelt appreciation to Dr. Hasitha Wegiriya, Chief Technology Officer of Permia Sensing Lanka (Pvt) Ltd., for providing me with the DJI Mavic 3 Multispectral drone used in this study, and for his continuous encouragement and guidance. I also owe my sincere thanks to Mr. Jonathan Rowell (Sri Lankan Operations Lead | Precision Farming and Drone Piloting) and Mr. T. B. Kasun Hasitha Neranjana (Senior Agronomist - Research and Development, Permia Sensing Lanka (Pvt) Ltd.) for their invaluable domain expertise and assistance in the agricultural aspects of this research.

I wish to express my deepest gratitude to my supervisor, Dr. Kalpani Manathunga, for her consistent guidance, constructive feedback, and encouragement throughout this journey. I am equally thankful to my co-supervisor, Mr. Samitha Vidhanarachchi, for his expert insights, critical comments, and support that greatly strengthened this work.

I would also like to acknowledge Prof. Dilshan De Silva, Prof. Prasanna Sumapthipala, Dr. Mahima Weerasinghe, Dr. Dinuka Wijendra, and Dr. Junius Anjana for their valuable feedback, suggestions, and guidance that contributed significantly to improving the quality of this research.

Finally, I extend my heartfelt gratitude to my family and friends for their constant support, encouragement, and understanding during this academic journey.

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