

UNIVERSITI TEKNOLOGI MARA

**IMAGE PROCESSING
IMPLEMENTATION IN *CITRUS*
MICROCARPA DISEASES
DETECTION SYSTEM**

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Image Processing Implementation in *Citrus Microcarpa* Diseases Detection System

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This thesis was prepared under the supervision of the project supervisor, Dr Lee Yee Ann. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science (Hons.).

Approved by

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Dr Lee Yee Ann

Project Supervisor

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ABSTRACT

Manual inspections are insufficient to detect outbreak of leaf disease in traditional *Citrus microcarpa* (Calamansi) farming, which are subjective in nature and take time to get results. This study is designed to develop and prototype a low-cost, portable, edge-AI based system that can be used in field for real-time, non-destructive localization and diagnostic assessment of anomalies in the leaf. A structured Waterfall Software Development Life Cycle (SDLC) methodology was followed and a single-stage YOLOv11 Nano deep learning architecture was optimized and trained. In order to remove data representation bias, an imbalanced baseline dataset (1,556 raw images) was extended to 3,288 highly optimized images through an Albumentations pipeline combining photometric and geometric transforms. The image was converted to 640×640 pixels resolution and all the pixel intensities were fully normalized. The scope of this project is limited to three diseases including Citrus Greening (Huanglongbing), Citrus Canker and Citrus Black-spot and the Healthy control classifications. The optimized weights were then tested on a stand-alone edge-computing device composed of a Raspberry Pi 4 Model B (4GB RAM), 8MP Camera Module V2, 7" touchscreen LCD display and asynchronous background cloud logging to Google Drive. The DL model has been able to reach smooth mathematical convergence at epoch 65. The analytical metrics confirmed the good results obtained, with mAP₅₀ between 0.75 and 0.78, a precision score of 0.85 and 0.88, overall accuracy around 79.95%, and a diagnostic recall score of 0.68 and 0.72. A panel of 10 experts confirmed the consistency of the diagnostic tool and usability of the tool in the field but highlighted an on-chip CPU bottleneck that limited the continuous processing to 1.7-2.2 frames per second (FPS). This one-stage AI edge integration gives a low-cost, very accurate architecture for the diagnostic system suitable for precision pruning and smart farming practices. For Market Readiness, it is recommended to use INT8 Model Quantization to reduce Latency to computation and software Controlled LED ring lighting to combat ambient daylight variations.

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