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Nematode detection and Management System in Rice Plant using Image Processing and Machine Learning

A Thesis by

Ms. Banuji Liyanwala

Supervised by

Mr. Nathindu Himansha

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Abstract

Rice is the staple food of over 22 million people and the main livelihood for more than 1.8 million farmers in Sri Lanka. However, the rice cultivation phase faces significant challenges, one of the most impactful being **Nematode infestations**. These microscopic soil-borne pests damage the roots of rice plants, causing stunted growth and significant yield reduction. In Sri Lanka, yield losses due to root-knot nematodes can reach up to 72%. Traditional methods for detecting such infestations are manual, time-consuming, and require expert knowledge, which may not always be accessible to farmers.

To address this issue, this research presents a mobile-based Nematode Detection and Management System using image processing and Convolutional Neural Networks (CNN). The proposed solution integrates two deep learning models: a **Root Classifier Model** that first validates whether the uploaded image is of a rice root, and a **Nematode Detection Model** that is triggered only if the image passes this validation. This layered approach improves the system's accuracy by ensuring only relevant images are analyzed for nematode infection.

A custom image dataset of both healthy and infected rice roots was used to train the models. The nematode detection model achieved high performance, with an accuracy of 91%, precision of 89%, recall of 90%, and an F1-score of 89%. The integration of the root classifier enhances the system's robustness by reducing false positives caused by unrelated images. The overall system provides timely feedback and actionable recommendations to farmers, contributing to more effective pest management, improved productivity, and sustainable rice farming practices in Sri Lanka.

Keywords

Nematode Detection, Image Processing, Machine Learning, Convolutional Neural Networks, Rice Cultivation, Agricultural AI.

Subject Descriptors

- Computing methodologies → Image processing
- Computing methodologies → Machine learning → Neural networks
- Applied computing → Agriculture → Pest detection and management
- Information systems → Decision support systems