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A Novel IoT and Machine Learning-Based Architecture for Real-Time Paddy Crop Disease Detection and Monitoring

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Abstract: *The growing impact of crop diseases in paddy cultivation has led to significant losses in yield and farmer income across India and other rice-producing regions. This study proposes a novel architecture integrating Internet of Things (IoT) sensors and Machine Learning (ML) algorithms for the real-time detection and monitoring of paddy crop diseases. The system comprises environmental sensors (temperature, humidity, soil moisture, and leaf wetness) and an image capture module deployed on a low-cost ESP32-based edge device. Sensor data and leaf images are preprocessed locally and transmitted via MQTT protocol to a cloud-based server for analysis and model refinement.*

A Convolutional Neural Network (CNN) model was trained using a dataset of 5,000 annotated images representing common paddy diseases such as Sheath Blight, Bacterial Leaf Blight, and Rice Blast. The model achieved a classification accuracy of 94.7% on a validation set, demonstrating its potential for accurate early-stage disease identification. In addition, a lightweight TensorFlow Lite version of the model was deployed on the edge device, achieving an inference time under 1.2 seconds with an accuracy of 91.3%, enabling real-time alerts even in low-connectivity environments. The proposed architecture emphasizes modularity, low power consumption, and affordability, making it suitable for rural agricultural deployment. By automating disease detection, this system aims to empower farmers with timely insights and interventions, ultimately enhancing paddy crop health and productivity.

Keywords: Paddy Crop Disease Detection, Smart Agriculture, Internet of Things (IoT), Machine Learning, Convolutional Neural Network (CNN), Real-Time Monitoring, Edge Computing, TensorFlow Lite, Precision Farming, Agricultural Automation

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