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Identifying Nutrition Deficiency in Paddy Leaf using Neural Network

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ABSTRACT

Agriculture is the primary source of livelihood for majority of India's population, with paddy serving as a staple food for a large segment of people. However, paddy cultivation is affected by several challenges that vary with climate, location, and farming practices. Among these, nutrient deficiencies in paddy leaves significantly impact crop yield and quality, making early detection crucial for effective farm management. The following study presents a novel approach to identifying nutrient deficiencies using neural networks and also provides a solution for their early detection in paddy leaves . A diverse dataset of paddy leaf images showing different types and severity levels of nutrient deficiencies is collected, and a Convolutional Neural Network (CNN) is used in order for image classification. The model is trained and tested on diverse dataset, demonstrating strong performance in accurately detecting nutrient deficiencies in paddy leaves.

Keyword: Bacterial blight, Brown spot, Convolutional Neural Network, Image Processing, Inception v3 model, Leaf smut.

INTRODUCTION

Nutritional deficiencies in rice crops can lead to stunted growth, reduced yields, and poor grain quality. These deficiencies are typically caused by imbalances in essential nutrients such as nitrogen, phosphorus, potassium, iron, and zinc, all of which are critical for healthy plant development. Any imbalance, whether deficiency or excess, disrupts key physiological processes such as photosynthesis and nutrient uptake, thereby negatively affecting overall crop health. Traditionally, the identification of nutrient deficiencies in paddy plants relies on visual inspection by farmers or agricultural experts. This approach is subjective, time-consuming, and dependent on individual experience, often leading to delays in diagnosis. With recent advancements in technology, machine learning offers an effective alternative to overcome these limitations. In particular, artificial intelligence and neural networks enable precision farming by automating the detection process. Using computer vision and deep learning techniques, models can be trained to recognize subtle visual symptoms of nutrient deficiencies in paddy leaves, allowing for fast and accurate identification. This approach provides farmers and agricultural experts with a reliable, automated, and scalable tool for monitoring crop health, thereby improving crop management, increasing yields, and supporting food security in rice-dependent regions. Early detection of nutrient deficiencies also reduces excessive fertilizer use, lowers production costs, and minimizes environmental impact. Furthermore, improved crop health and productivity contribute to global food security and economic stability, especially in regions heavily reliant on rice cultivation. This study demonstrates the potential of artificial intelligence in addressing real-world agricultural challenges. The objective is to utilize neural networks to detect nutrient deficiencies in paddy leaves, thereby enabling precision agriculture and promoting sustainable rice farming practices.

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Here are the descriptions for the leaf diseases:

1) Leaf Smut: Manifests as small black linear lesions on leaf blades, with affected leaf tips often exhibiting a gray and dry appearance.
2) Bacterial Blight: Characterized by elongated lesions near leaf tips and margins, with affected areas transitioning from white to yellow and ultimately gray due to fungal invasion.
3) Brown Spot: Identified by dark brown, round to oval lesions on paddy leaves.

Objectives:

1. Early Detection
2. Precision in Diagnosis
3. Reduction of waste and cost
4. Improved Crop Yields
5. Sustainable Farming

METHODOLOGY

The study uses a deep learning convolutional neural network model-based target detection and positioning method, and proposes an improved Inception v3 model. The trained Inception v3 network is used as a pre-trained model of this model. By fine-tuning the transfer learning method, the parameters of the pre-trained model optimize the model parameters of the convolution layer and solve the classification problem of paddy leaf disease detection. The main operation process is as follows:
(1) Enter a sample pictures of paddy diseases .
(2) Pre-processing: In order to improve the training efficiency, the input image is standardized to a resolution of 224*224.
(3) Construct new and improved model using the Inception v3 model
(4) Micro-transfer learning: Using the parameters of the convolutional layers and pooling layers of the Inception v3 pre-trained model, the parameters of the detection model were optimized by transfer.

SYSTEM DESIGN

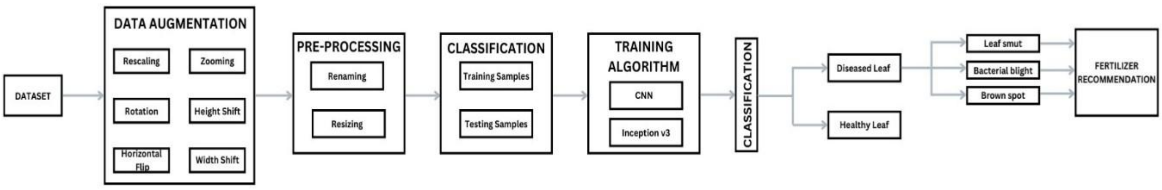

Fig 1:System design

The system starts by collecting images of paddy leaves, which are used to create the dataset. This dataset includes both healthy leaves and leaves affected by different diseases or nutrient deficiencies. In order to improve the accuracy of the model, data augmentation is applied, which increases the number and variety of images. After this process, the next step is to pre-process the images, the images are pre processed to improve their quality and make important features more visible. This includes steps like removing noise, resizing, cropping, normalizing, changing color format, enhancing contrast, and detecting edges. Once preprocessing is completed, the dataset is divided into training and testing sets. The training set is used to teach the model, while the testing set is used to check how well the model performs on new, unseen data. Next step is to extract the important features from the images. This is a key step because it helps the system understand the differences between healthy and unhealthy leaves. For this purpose, the Inception V3 model is used. It is a deep learning model already trained on a large image dataset called ImageNet. This model has learned to identify general image patterns like shapes, textures, and edges. Since paddy leaf images are different from ImageNet images, transfer learning is used. This means the pre-trained Inception V3 model is reused and further trained using paddy leaf images. This process is called fine-tuning, where the model is adjusted to learn specific features like leaf color changes, spots, and other signs of nutrient deficiency. After training, the model classifies paddy leaf images into different nutrient deficiency categories. The final layer uses a softmax function to give probability values for each class, and the highest value is selected as the final prediction. Once the model is ready, it can analyze new leaf images and detect whether there is any nutrient deficiency. It also helps farmers by suggesting possible treatments or fertilizer recommendations based on the detected problem. This helps improve crop health and increases yield through better decision-making.

FUTURE SCOPE

The application of neural networks for identifying nutrient deficiencies in paddy leaves presents significant potential for improving agricultural practices. Future research can focus on enhancing model performance by increasing accuracy, sensitivity, and specificity in detecting various nutrient deficiencies. Integration with sensor technologies and remote sensing systems can enable continuous, real-time monitoring of paddy fields, allowing early detection of nutrient stress conditions. Additionally, the development of user-friendly mobile applications can empower farmers to capture and analyze leaf images directly using smartphones, making the technology more accessible and practical in field conditions. Such systems can support precision agriculture by enabling targeted fertilization strategies based on real-time analysis of crop health. This approach can improve nutrient use efficiency, reduce excess fertilizer application, lower production costs, and minimize environmental impacts such as soil degradation and water pollution.

CONCLUSION

The use of Convolutional Neural Networks (CNNs) for identifying nutrient deficiencies in paddy leaves represents a significant advancement in precision agriculture. The developed model demonstrates high efficiency in automating the detection and classification of nutrient deficiencies, thereby providing farmers with a reliable and timely tool for monitoring crop health.Beyond its immediate technological benefits, this system contributes to the broader goal of sustainable agricultural practices. By integrating advanced deep learning techniques such as CNNs, it supports more informed decision-making in crop management, ultimately promoting efficient resource utilization.This approach aligns with the vision of a more resilient and secure global food system. It highlights the critical role of technological innovation in addressing contemporary agricultural challenges and enhancing productivity in a sustainable manner.

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