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Transfer Learning Based Paddy Leaf Disease Detection Using Deep Learning & Fertilizer Recommendation

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ABSTRACT

Paddy farming is particularly vulnerable to a number of leaf diseases, which, if left untreated, can drastically lower productivity. This study presents a system that uses transfer learning techniques and Convolutional Neural Network (CNN) algorithms to identify rice leaf damage and propose fertilizer. The suggested model ensures strong performance even with sparse training data by correctly identifying and classifying leaf diseases from photos using pre-trained CNN architectures. To help farmers take prompt and efficient action, the system offers tailored fertilizer recommendations based on the disease that has been identified. Farmers with little technological knowledge can also use the system since it incorporates an intuitive user interface for simple image uploads and real-time analysis. The model achieves great accuracy while lowering computational needs by utilizing transfer learning, guaranteeing scalability across various agricultural contexts. By applying fertilizer precisely, this all-inclusive method avoids crop losses, encourages proactive disease management, and lessens its negative effects on the environment. In the end, it promotes sustainable farming methods, strengthens crop health, and raises paddy farmers general production.

Keywords: Paddy Leaf Disease Detection, Convolutional Neural Network(CNN), Transfer Learning, Bacterial Leaf Blight, Fertilizer Recommendation.

I. Introduction

In Agriculture Plant diseases, pests, and ineffective fertilizer use are just a few of the many issues facing agriculture, a vital industry that can result in lower food yields and environmental damage. One of the most extensively grown crops, paddy, is especially vulnerable to a number of illnesses that can have a major effect on its quality and growth. For efficient crop management and yield maximization, paddy leaf diseases must be identified early. By automating disease identification using picture analysis, recent advances in deep learning (DL) present a promising option that allows for quicker and more precise results. Particularly, transfer learning has become quite popular, enabling the effective use of pre-trained models to identify paddy leaf diseases with less data.

Manual inspection is usually necessary for traditional disease detection techniques, which can be laborious and prone to mistakes. Proper fertilization is essential for maximizing paddy growth and increasing yield, in addition to disease detection. While inadequate fertilization may impede crop growth, excessive or inappropriate fertilizer application can result in resource waste and environmental damage. Fertilizer recommendations are typically based on soil tests and general guidelines, but these approaches do not always account for the specific needs of different crops or regions. To address this, the integration of Convolutional Neural Networks (CNN) for fertilizer recommendation offers a more precise and adaptive solution. By analyzing soil and crop data, CNN models can recommend the optimal fertilizer combination based on real-time conditions, improving crop health and minimizing resource wastage.

Paddy is a staple crop for over half of the world's population, yet it is susceptible to several diseases that can significantly reduce crop yields and jeopardize food security. Early detection and diagnosis of paddy leaf diseases is essential for timely intervention and disease control. Traditional disease detection methods, on the other hand, rely on manual inspection by experts, which can be time-consuming, labor-intensive, and prone to human error. Recent advances in computer vision and deep learning have enabled automated disease detection systems. Plant disease identification is one of the image classification problems where transfer learning, a method that uses pre-trained models and refines them for particular tasks, has shown a lot of potential.

II. Methodologies of Paddy Leaf Disease Detection

Paddy Leaf Disease Detection can have more Methodologies they are

- Input Data Collection
- Data Labeling and Data Splitting

- Pre-processing
- Disease Detection
- Remedies and Suggestion

1 Input Data Collection

Gathering a large and huge number of high-resolution photos of maize plants is crucial to producing a trustworthy dataset. Both healthy plants and those afflicted with common diseases including leaf blast, bacterial leaf blight, brown spot, and tungro should be included in these photos. Every picture requires thorough annotations that either identify the particular illness or show that it is in a healthy state.The quality and diversity of the dataset are guaranteed by this painstaking procedure, which makes it easier to train and assess illness detection models. For the study on rice illness diagnosis using CNN, the dataset—which began with roughly 5932 samples—was acquired from Mendeley Data via Google.

2 Data Labeling and Data Splitting

The gathered information, which comes from internet sources, is carefully labeled after collection in case to categorize each picture based on type of ailment or state of health. After that, the dataset will be divided into three different parts: The proportion of training to testing to validation is 80%. The model is trained using this, the largest section of the dataset. With the help of this data, the model discovers trends and connections and modifing its parameters to reduce errors. 10% trained model's performance is assessing using this set.

3 Pre-Processing

The first step is pre-processing, which involves removing extraneous noise from the supplied image of an infected paddy leaf. To make it easier to train the CNN network, the entire image is resized to 50 by 50 pixels. It to enable effective training of a Convolutional Neural Network (CNN), pre-processing of infected paddy leaf photos include eliminating noise and reducing images to on a consistent size. One of the more better steps in picture analysis is pre-processing.

4 Disease Detection Module

When comparing to conventional approaches, disease identification is carrying out with greater accuracy using the collected evaluation parameters. The model's ability to recognize and categorize rice diseases is assessed by examining the performance metrics obtained from the assessment process, which eventually advances disease detection methods in agriculture.

5 Remedies and Suggestion Module

Customized treatments are recommended based with the findings of the disease detection. In case to effectively treat and mitigate the detected rice plant illnesses and optimize crop health and yield, these remedies include a variety of choices such as botanicals, bio-pesticides, and chemical solutions. Remedy recommendations are informed on disease detection results. Chemical solutions, botanicals, and bio-pesticides which can be the examples for remedies.

III. SYSTEM ANALYSIS

3.1 Existing System

The majority of paddy leaf disease detection systems now in use rely on shallow machine learning models or conventional image processing methods, which frequently ask for human feal volumes of labeled data. These systems may have issues with scalability and accuracy, especially when it comes to identifying a variety of illnesses in different environmental settings. The accuracy and scalability of current rice leaf disease detection systems, which rely on conventional image processing or superficial machine learning, are problematic. Systems for recommending fertilizer frequently rely ature extraction and substantion generic recommendations and simple soil testing, which are not very flexible.

3.1.1 Disadvantage

The main disadvantages of Existing System are

- **Dependency on Quality Data:** It might be difficult to get high-quality, labeled data, which is necessary for accurate disease detection and fertilizer recommendations.
- **Scalability Issues:** Conventional approaches frequently have trouble scaling efficiently in a variety of settings or with big datasets.
- **High Dependency on Soil Tests:** Recommendations for fertilizer based on soil tests might not take current crop and environmental variables into consideration, which would limit accuracy.

3.2 Proposed System

A CNN algorithm for fertilizer recommendation is combined with transfer learning-based deep learning (DL) for paddy leaf disease diagnosis in the suggested system. Using pre-trained models, the system analyzes photos to detect prevalent diseases in paddy leaves, guaranteeing precise and effective identification. In order to offer the best nutrients for crop growth, the CNN model examines soil and crop conditions. The suggested approach employs a CNN algorithm for fertilizer recommendation and transfer learning-based deep learning for paddy leaf disease diagnosis.

3.2.1 Advantage

The Advantages of Proposed System are

- **Resource Efficiency:** By precisely detecting diseases and recommending fertilizer, advanced systems maximize resource utilization and minimize waste.
- **Faster Implementation:** Decision-making is streamlined by deep learning models and automation, which allow for faster disease identification and fertilizer recommendations.
- **Scalability:** These data-driven systems are easily scalable to many crop varieties and locales, accommodating a range of conditions and requirement.

IV. LITERATURE SURVEY

1 Sustainable Application Rice Feedstock in Agro-Environmental and Construction Sectors: A Global Perspective

AUTHOR: Sabry M. Shaheen a b c, Vasileios Antoniadis d

YEAR: 2022

Rice is second only to maize among the world's most important cereal crops, with a global harvested area of approximately 158 million hectares and an annual production of more than 700 million tonnes as paddy rice. At this scale, rice production generates vast amounts of waste in the form of straw, husk, and bran. Because of high cellulose, lignin, and silica contents, rice biowaste (RB) can be used to produce rice biochar (RBC) and rice compost (RC). Furthermore, RB can be used as sorbents, soil conditioners, bricks/concrete blocks, flat steel products, and biofuels, all of which make significant contributions to meeting United Nations Sustainable Development Goals (UNSDGs). Although previous reviews have explored individual applications of rice feedstocks, inadequate attention has been paid to multifunctional values and potential multi-utilities. Here, we offer a comprehensive review of RBC and RC with respect to: (1) preparation and characterization; (2) applications as soil conditioners and organic fertilizers and their effects on soil-carbon sequestration; (3) remediation of toxic element–contaminated soils and water; (4) removal of colors, dyes, endocrine-disrupting chemicals, personal-care products, and residual pesticides from water; and (5) applications in the construction industry. Specifically, we describe the opportunities for the sustainable use of RBC and RC in the management of contaminated soils and water as well as the construction industry. Overall, this review is expected to lengthen the list of possible multifunctional applications of RBC and RC.

2 Smart Farming through Responsible Leadership in Bangladesh: Possibilities, Opportunities, and Beyond

AUTHOR: Nahina Islam

YEAR: 2021

Technologies Smart farming has the potential to overcome the challenge of 2050 to feed 10 billion people. Both artificial intelligence (AI) and the internet of things (IoT) have become critical prerequisites to smart farming due to their high interoperability, sensors, and cutting-edge. Extending the role of responsible leadership, this paper proposes an AI and IoT based smart farming system in Bangladesh. With a comprehensive literature review, this paper counsels the need to go beyond the simple application of traditional farming and irrigation practices and recommends implementing smart farming enabling responsible leadership to uphold sustainable agriculture. It contributes to the current literature of smart farming in several ways. First, this paper helps to understand the prospect and challenges of both AI and IoT and the requirement of smart farming in a nonwestern context. Second, it clarifies the interventions of responsible leadership into Bangladesh's agriculture sector and justifies the demand for sustainable smart farming. Third, this paper is a step forward to explore future empirical studies for the effective and efficient use of AI and IoT to adopt smart farming. Finally, this paper will help policymakers to take responsible initiatives to plan and apply smart farming in a developing economy like Bangladesh.

3 Cucumber Leaf Diseases Recognition Using Multi Level Deep Entropy-ELM Feature Selection

AUTHOR: M Munawwar Iqbal Ch

YEAR: 2023

Agriculture has becomes an immense area of research and is ascertained as a key element in the area of computer vision. In the agriculture field, image processing acts as a primary part. Cucumber is an important vegetable and its production in Pakistan is higher as compared to the other vegetables because of its use in salads. However, the diseases of cucumber such as Angular leaf spot, Anthracnose, blight, Downy mildew, and powdery mildew widely decrease the quality and quantity. Lately, numerous methods have been proposed for the identification and classification of diseases. Early detection and then treatment of the diseases in plants is important to prevent the crop from a disastrous decrease in yields. Many classification techniques have been proposed but still, they are facing some challenges such as noise, redundant features, and extraction of relevant features. In this work, an automated framework is proposed using deep learning and best feature selection for cucumber leaf diseases classification. In the proposed framework, initially, an augmentation technique is applied to the original images by creating more training data from existing samples and handling the problem of the imbalanced dataset. Then two different phases are utilized. In the first phase, fine-tuned four pre-trained models and select the best of them based on the accuracy. Features are extracted from the selected fine-tuned model and refined through the Entropy-ELM technique. In the second phase, fused the features of all four fine-tuned models and apply the Entropy-ELM technique, and finally fused with phase 1 selected feature. Finally, the fused features are recognized using machine learning classifiers for the final classification. The experimental process is conducted on five different datasets. On these datasets, the best-achieved accuracy is 98.4%. The proposed framework is evaluated on each step and also compared with some recent techniques. The comparison with some recent techniques showed that the proposed method obtained an improved performance.

4 Image Processing System based Identification Classification of Leaf Disease: A Case Study on Paddy Leaf

AUTHOR: Karuna J Gowda Manohar N

YEAR: 2023

Paddy is the main nourishment in the south sections of India. It straightforwardly influences the country's infrastructure. Bacterial leaf blight, brown spot and leaf smut were its main illnesses found in paddy field crops, which also significantly affect its profitability. This work presents an image processing system based automatic identification and classification of various paddy leaf diseases by affecting the cultivation of paddy namely bacterial leaf blight, brown spot, and leaf smut. The key phases of proposed methodology are pre-processing of images, segmentation, feature extraction and classification. The technique used in the proposed work to identify paddy leaf disease involves Otsu threshold method for segmentation, grey level co-occurrence metrics for feature extraction and k-nearest neighbors algorithm for classification. The proposed system aims at achieving rapid and accurate identification of disease and classification of the disease type and also helps in classifying the various paddy leaf diseases by utilizing the texture and shape features that majorly contributes in leaf disease recognition.

5 An IOT Based System with Edge Intelligence for Rice Leaf Disease detection using Machine Learning

AUTHOR: S. M. Shahidur Harun Rumy Forji Jahan

YEAR: 2021

Bangladesh is one of the top five rice-producing and consuming countries in the world. Its economy dramatically depends on rice-producing. Rice leaf disease is the biggest problem in the agriculture sector. This is the main reason for the reduction of the quality and quantity of the crops. The spread of the disease can be avoided by continuous monitoring. However, manual monitoring of diseases will cost a large amount of time and labor. So, it is a good idea to have an automated system. This paper presents a rice leaf disease detection system using a lightweight Artificial Intelligent technique. We are applying the edge computing concept here. Our edge device is Raspberry Pi. We have processed all our data in Raspberry Pi. We consider three rice plant diseases, namely Brown Spot, Hispa, and Leaf Blast. They are the most common type of rice leaf disease in Bangladesh. We have used clear images of healthy and infected rice leaves with white background. After applying the necessary preprocessing, we have extracted the necessary features from the images. Then we have made an image classification model with various machine learning algorithms by feeding these features. We have learned that the Random Forest algorithm performed the best. By using our image classification model, we have achieved 97.50% accuracy on our edge device.

V. CONCLUSION

This study used Convolutional Neural Networks (CNNs) to identify four significant rice diseases: brown spot, leaf blast, leaf blight, and tungro. According to the study's findings, the assignment was finished effectively. Following a rigorous test process that used parameters including accuracy, precision, recall, and F1 score, the model demonstrated remarkable performance, attaining an incredible 98% overall accuracy with little loss (0.0669). Additionally, we expanded the detection model's functionality by integrating it into a user-friendly web application developed with Streamlit. By submitting images of the diseased rice leaves to this portal, farmers may promptly diagnose the leaves. The software also offers treatment suggestions that can be implemented and are broken down into three groups: biopesticides, conventional fertilizers, and botanicals. By using these data, farmers may make more educated decisions and better manage the effects of crop diseases. The technique improves rice disease detection and encourages sustainable farming methods by fusing state-of-the-art machine learning with user-friendly web tools. This integrated technology increases the resilience and productivity of rice farming by assisting farmers in preserving crop health and optimizing yields.

VI. FUTURE ENHANCEMENT

Future improvements might incorporate soil and climate data for individualized fertilizer recommendations, add real-time farmer feedback, and broaden disease detection to cover additional pests and illnesses. The solution would be available in faraway locations with the help of a mobile app that has offline capabilities. Accuracy, scalability, and sustainability in farming would all rise with these advancements. To enable real-time monitoring and paddy leaf disease detection, integrate the disease detection system with Internet of Things devices like drones, sensors, and cameras. Hyperspectral imaging with GIS (Geographic Information System) integration.

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