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Paddy Disease Detection Using Machine Learning

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ABSTRACT

Rice is a staple food in our daily diet, and holds immense agricultural significance in India. Traditionally, farmers rely on visual examination or group discussions to identify leaf diseases, later resorting to time-consuming laboratory tests for confirmation. To address this, a model has been developed – A Deep Convolutional Neural Network (DCNN) combined with an Ensemble Model utilising AdaBoost and Bagging Classifier. This model proficiently classifies five paddy leaf diseases: Bacterial Leaf Blight (BLB), Hispa , Brown Spot (BS), and Leaf Blast (LS).Notably, it outperforms traditional models such as Combined Contrast Limited Adaptive Histogram Equalization (CLAHE), Gray Level Co-occurrence Matrix (GLCM) with Convolutional Neural Network (CNN).This innovation has the potential for extension into a practical rice plant disease identification system for real-world agriculture applications.

Keywords : Paddy leaf diseases, DCNN, Ensemble Model, AdaBoost, Bagging Classifier, Agriculture.

I. INTRODUCTION

As We Know, The Indian Population Gets 140 Crore People. In that Population Half Of the Population Are Consuming Rice as their Daily Food. In 2023,135 Million Tons Of Rice Produced In That 80% Of Rice Is Consumed By The Indian People. where 11.5 Million Tons of Rice Used As Operational Stock, Two Million Tons Are Used As Strategic Reserve and Remaining 13-14 Million Tons Of Rice Used As Exporting System[1]. The rice exported to other countries Like Iran, Iraq, Saudi Arabia, United States and Africa is Also a Significant Market For Rice. For This Huge Consumption and Exporting we Must be aware of Growth Of the Paddy Crop. It Will Impact On Survival and Economic Growth. For the huge Consumption we must be aware of Growth of paddy crops. Earlier the Farmers inspect the paddy Disease [2]Visually which leads to Loss Of crop and laboratory test results take more time to classify the disease. As the Years Evolved New Disease are raised and Lack of water/Rainfall and Scientific Methods.

Paddy, also known as rice, is one of the most important cereal crops globally and serves as a staple food for a significant portion of the world's population. Belonging to the grass species Oryza sativa (Asian rice) or Oryza glaberrima (African rice), paddy cultivation dates back thousands of years and holds immense cultural, economic, and nutritional significance in many regions[3].

Paddy cultivation is primarily practised in regions with abundant water resources, as rice plants require large amounts of water to thrive. The cultivation process typically involves flooding or irrigating fields to maintain a consistent water level, which helps control weeds and pests while providing essential nutrients to the growing plants. Rice is a highly versatile crop, with various types and varieties adapted to different growing conditions and culinary preferences. From long-grain to short-grain, aromatic to sticky, and brown to white, rice comes in many forms and serves as a staple ingredient in a wide range of dishes worldwide. Due to its importance as a dietary staple and its role in global food security, research and innovation in paddy cultivation techniques, disease management, and breeding programs are ongoing to enhance yield, resilience, and sustainability in rice production.

1.1 Paddy Disorders

Research in agriculture can grow effectiveness and sustenance quality at diminished utilisation with an extended advantage. A large portion of the individuals rely upon farming for their livelihood. So loss of harvests from plant sickness may bring about yearning and starvation. Paddy crops are throttled which affects their growth reasons being climatic changes, fertility changes of the soil and primarily by Paddy leaf diseases. This leaf diseases directly affects the plant growth, the leaves contain the chloroplasts which has pigments called the chlorophyll, which in turn stores the light energy[4] .The leaves have pores called the stomata through which they absorb carbon dioxide from the atmosphere which are the important factors for the production of food and energy needed for their growth and cellular respiration. Leaf diseases may block these pores causing a major loss in production in terms of quality and quantity of rice produced.

1.2 Problem Statement

A lot of crops are available in agricultural fields. Among them Paddy is one of the main crops in India and paddy is an everyday food of peoples. So, reducing the diseases in paddy is one of the main tasks. To predict the disease present in the leaf, the parcel of classifiers is used in particular,
support vector machine, artificial neural network, k-nearest neighbour, recurrent neural network, fuzzy logic system.

It utilises of a Deep Convolutional Neural Network (DCNN) combined with an Ensemble Model comprising AdaBoost and Bagging Classifiers for enhanced accuracy in detecting paddy leaf diseases

II. Literature survey

This section examines various research efforts conducted on paddy diseases across different rice fields, repositories, websites, and institutes.

2.1 Related Work

A hybrid approach for rice disease identification employs a deep convolutional neural network to extract leaf features and a support vector machine for classification. The system achieves 98.9% accuracy, utilising a dataset sourced from universities and international rice research institutes to classify nine diseases, including brown spot, false smut, bacterial leaf blight, and others, using SVM with a kernel trick[1]

Introduces Deep Neural network(DNN) with crow search algorithm(CSA).The features are Extracted by the Gray level Co-occurrence Matrix. which will detect the three rice diseases : bacterial leaf blight, brown spot, leaf smut. It will be captured from the rice fields for prediction diseases. It provide an accuracy of 96.4% on the disease classification[2]

It creates Deep neural network with Jaya optimization[3] can classify four type of diseases such as Bacterial leaf blight, Brown spot, Sheath rot, Blast. The dataset consists of 650 real images captured by the cameras and taken from the rice field . 95 normal images, 125 bacterial blight images, 170 blast images, 110 sheath rot images and 150 brown spot images. We used k-means clustering for segmentation and gray level co-occurrence matrix(GLCM) Feature extraction. It provides an accuracy 98.9%.it completely optimization system my Jaya Optimization which will provide higher Accuracy[3]

They uses the cascade classifier for disease classification[4] it combines the weaker classifier and updates the weights continuous for better performance.it uses the dataset consists the images of paddy leaves manually from the fields of Maharashtra, and we have also used online repositories of images such as Kaggle for the training of machine learning algorithms in initial phases. Additionally a Genetic algorithm is used.

It uses Deep convolutional Neural network by altering the architectures of the Convolutional Neural network by Using Deep Learning methods. the dataset consists of Four types of classes such as Brown spot, Leaf smut ,Bacterial Leaf Blight can be extracted from Kaggle. A paddy leaf15 model[5] is created to classify the Disease of a Leaf at an Earlier Stage.

A Deep convolutional neural network with comprises of ADAM(Adaptive moment Estimator) optimizer for classifying the disease .it uses the dataset from GitHub and Kaggle having 5 types of disease such as Bacterial leaf blight, Brown spot, leaf smut, narrow for these pretrained AlexNet is used and ADAM optimizer is used to reduce the error rate and improve the performance[6].

S. No	Method	Dataset	Remarks	Reference
1	Deep Convolutional Neural Network (DCNN), Support Vector machine (SVM)	Data set has1080 images having nine different classes taken from varsity rice research field under the supervision of a professor the various rice institutes IRRI[13], BRRI, BRKB [14], Plantix [15].	It does not enhance patterns and forms by the classifier	1

2	Deep Neural network(DNN), Crow Search algorithm(CSA)	Dataset consists of 120 images from the active agricultural environment in rainy July to December season of 3 disease classes	It reduced computational workload but deep feature extraction is less.	2
3	Deep Neural Network(DNN), Jaya optimization	Dataset prepared from farm field in real world circumstances totally 5 Classes with 650 images which include 95 normal images, 125 bacterial blight images, 170 blast images, 110 sheath rot images and 150 brown spot images	It shows low in complex and noise data and vary with performance and accuracy	3
4	Adaboost and Bagging ,Nearest Neighbour algorithm(NNA)	Dataset comprises of 520 images of 4 classes of diseases from various fields in maharashtra and repository from kaggle	The genetic algorithm is not sufficient to make the best classification and requires additional techniques to classify the diseases.	4
5	Paddy Leaf 15,Adam Optimizer	The dataset from the Kaggle that includes four different rice plant diseases	Lack of deep feature extraction results with accuray reduction	5
6	Classification of Diseases in Paddy using Deep Convolutional Neural Network	A unique dataset has been created, which contains 1,260 images for five different classes, Taken From repository of github and kaggle.	Classification Of leave Diseases Lacks	6

III. METHODOLOGY

In the proposed methodology, the process of detecting and classifying rice diseases is meticulously divided into two primary phases: feature extraction utilising deep convolutional neural network (DCNN) and subsequent classification employing ensemble classifiers such as Adaboost and bagging. Initially, the DCNN serves as a powerful feature extractor, capitalising on its ability to autonomously extract intricate features from images without the necessity for handcrafted algorithms. A specialised variant of the Inception-V3 architecture is adopted, wherein a transfer learning strategy is implemented to leverage pre-trained weights partially, thereby mitigating computational complexity [6]. Through this approach, the active layers of the Inception-V3 model undergo retraining using rice plant disease images, with the number of training iterations determined through a specified equation. Post-extraction, the features are funnelled through a global average-pooling layer, flattening them for subsequent processing. A portion of the extracted features is separated for future Utilisation [7], while the remainder undergoes training using Support Vector Classifier (SVC) with the RBF kernel and a one-vs-one method for multi-class classification. Fine-tuning of SVC hyperparameters, including 'gamma' and 'C', is conducted using the grid-search algorithm. Finally, the classifier's performance is evaluated on the segregated features, yielding a sophisticated model capable of accurately predicting unseen data. This approach amalgamates the proficiency of deep feature extraction with the robustness of ensemble learning techniques, aiming to attain superior classification accuracy for rice disease detection [8].

Classification

Following feature extraction, the classification phase is initiated, wherein ensemble classifiers like Adaboost and bagging classifiers come into play. Extracted features are fed into the classification framework, wherein they undergo rigorous processing to categorise rice diseases accurately. Ensemble classifiers, known for their ability to combine multiple weak learners to produce a strong classifier, are leveraged to enhance classification accuracy further. Adaboost and bagging classifiers complement the deep feature extraction capabilities of DCNN by aggregating predictions from multiple base classifiers[9], thereby smoothing out individual biases and improving overall robustness. Through this synergistic integration of feature extraction using DCNN and classification employing ensemble classifiers, the proposed methodology aims to achieve superior performance in rice disease detection, offering enhanced precision and reliability[10].

IV. RESULT AND DISCUSSION

In the proposed study, a dataset of 1494 paddy leaf images, stored in both *.png and *.jpeg formats, was utilised for training a deep convolutional neural network (DCNN) to extract features such as colour, texture, and regions[11]. Performance evaluation involved calculating various metrics including entropy loss, True Positive Rate (TPR), True Negative Rate (TNR), False Discovery Rate (FDR), False Positive Rate (FPR), and Accuracy Rate through digital image processing techniques such as segmentation, filtration, and K-means clustering. Additionally, the DCNN was combined with ensemble classifiers like Adaboost and bagging classifiers to enhance classification accuracy for paddy disease detection[12]. Comparison with existing methods was performed to assess system performance, aiming to provide insights into the effectiveness of the proposed approach in accurately detecting and classifying paddy diseases[13].

V. Conclusion

Combining deep convolutional neural networks (CNNs) with ensemble classifiers like Adaboost and bagging represents a robust approach for paddy disease detection. CNNs excel at extracting intricate features from paddy plant images, capturing subtle patterns indicative of various diseases. By leveraging their hierarchical architecture, CNNs can discern complex disease-related features with remarkable accuracy. However, to further enhance classification performance and address potential limitations like overfitting, the integration of ensemble classifiers becomes pivotal. Adaboost and bagging classifiers complement the deep feature extraction capabilities of CNNs by aggregating predictions from multiple base classifiers, effectively smoothing out individual biases and increasing overall robustness. Adaboost emphasises the importance of misclassified instances, iteratively adjusting classifier weights to focus on challenging samples. Meanwhile, bagging generates diverse training subsets through bootstrap sampling, leading to more stable and generalised predictions. Together, this hybrid approach combines the superior feature representation power of CNNs with the ensemble's ability to mitigate weaknesses, yielding a comprehensive solution for accurate and reliable paddy disease detection.

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