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Prediction of Paddy Crop Diseases Using Transfer Learning

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***Abstract*— Because it meets a vital requirement for every living thing on this planet, agriculture serves as the backbone of human society. In terms of humanity, Paddy farming is significant, especially on the Asian continent. Since we humans are among the most intellectual animals, it is crucial that we preserve the value and productivity of agriculture. The productivity of agriculture has increased to some extent with the arrival of the IT sector. It has made significant contributions to agricultural healthcare. The term "deep learning" is popular in the IT industry. This trendy term has significantly increased agricultural output. The overuse of pesticides and chemicals created by humans has recently resulted in a rise in plant diseases. These plant diseases must be treated since they can develop into serious conditions. Additionally owing to a lack of technical understanding, it can occasionally be challenging to identify certain disorders. So, a model for identifying the disease that is with in paddy crop is presented in this study. The model employs transfer learning, a paradigm for effectively addressing deep learning issues.**

Keywords*— *Paddy crop disease, Deep learning, Transfer Learning, Convolutional Neural Network

I. INTRODUCTION

Agriculture development is seen as one of the most effective methods for reducing severe poverty and fostering shared prosperity. Agricultural production aims to support9.7 billion people globally by 2050. The global agriculture industry has a huge impact on earnings of all social strata [1]. However, there are significant hazards related to agricultural expansion, poverty alleviation, and food security. The production of the crops may be severely reduced due to continuous climatic fluctuations and other weather-related issues. In addition to slowing agricultural expansion, climate change also eliminates many farmer job options. A further significant factor in the decline of agriculture is human error, such as the overuse of insecticides and other herbicides. In addition to killing crops, these pesticides jeopardise biodiversity. Disease is one more aspect that has a highly negative impact on agriculture. A plant with a disease is justas serious as a person who has one. If not treated in a timely manner, the plant can eventually perish.

In Asia, the paddy crop has a significant impact on the number of farmers that are employed. In addition to creating jobs, it also contributes to the partial eradication of poverty. The Asian continent eats a lot of rice. In more than a hundred nations throughout the world, it is also regarded as a staple dish [2]. It is typically served with more than one meal each day in most families. It is extremely affordable and offers itself to everyone. It is starchy and heavy in calories. However, recent times have seen some difficulties with the paddy crop. Climate change, such as global warming, and illnesses including fungal, viral, and bacterial infections are making rice cultivation more difficult. The rice plant's potential health problem might lead to an early demise if it is not thoroughly investigated.

The suggested model determines what illness the plant has. There are three different types of ailments that the crop could contract: “Hispa”, “brown spot”, and “leaf blast”. The “Convolutional Neural Network” is used in the model to forecast and categorise the illnesses. “Convolutional Neural Network” was chosen because of how well it handles pictures. Four classifications make up the selected data collection, three of which are related to diseases and one to health. The suggested model enhances the image via image augmentation, then trains on it to get the desired outcome.

II. RELATED WORK

Suraksha et al [3] .'s approach employs “data mining” and “image processing” in order to forecast the illness that the rice crop will contract. In the publication, they provide a model that makes use of “feature extraction” and “data mining” methodologies to identify illnesses that the rice plant is experiencing.

A model for identifying ailments that the paddy crop is afflicted with is provided by K.Jagan Mohan et al. [4]. The features are extracted using the “Scale Invariant Feature Transform”. The characteristics are then used, and the model uses “K Nearest Neighbours” and “Support VectorMachine” classifiers to use the characteristics to detect the illness.

Anuradha B. [5] has provided a paradigm for identifying the illness the plant is carrying. The author's clever edge detection approach was applied. In order to anticipate the illness that the plant has, the author tracked the edge and obtained the histogram value using the clever edge detection technique. The cultivated field is also periodically observed by the model. Early illness detection

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is achieved by the model. Then, training is carried out using machine learning. The model then makes the appropriate choice and foresees the sickness the plant will contract. A method for Rice disease area detection via image processing has been presented by LipsaBarik [6]. The model that the author has suggested also pinpoints the disease that the paddy crop is experiencing, in addition to the area that is impacted. The author employed “machine learning” and “image processing” methods including “Support Vector Machines” and “Nave Bayes” for categorization. After the prediction is complete, the disease's severity is established, and then classified it into several groups.

Using image processing techniques, Jayanthi, G. et al. [7] established a model for the investigation of automated rice blight categorization. Their research provided a thorough analysis of the various picture categorization techniques.

Big data is used in the model proposed by S. Nithya et al. [8]. They developed a paddy crop disease-based recommendation system based on symptoms. Information about illnesses is gathered from a variety of websites and blogs. Through the use of HiveQ, hive tools, and Hadoop the information has been examined.

A model that uses predictive modelling is proposed by Arumugam, A. [9]. This model uses “data mining techniques” to increase the productivity of the rice crop. Their research intends to offer a predictive modelling strategy that would assist farmers in producing rice crops with a high yield. They have employed machine learning methods like decision trees and clustering. They have used the weather data to apply them.

III. Background Study

Predicting the sort of sickness the rice plant is experiencing is the goal of this study. The illnesses that affect the paddy plant are outlined below.

A. Brown Spot

The rice plant's leaves develop black patches, which are indicative of this illness. The signs of this illness, such as the mortality of seedlings, the death of substantial portions of the leaf, and the presence of brown or black spots, can be used to identify it. It belongs to the class of fungi. It results in a loss of both quantity and quality. All throughout South and South East Asia, it results in a 5% yield decrease. By giving the crop the proper quantity of nutrients and preventing water stress, it can be made sure that paddy plant is not afflicted with this illness [10].

B. Leaf Blast

The most severe and devastating disease that affects rice plants is thought to be leaf blast. It may have an impact on the neck and leaves, among other leaf sections. In areas withsporadic rainfall, chilly temperatures, and little soil moisture, this illness is highly common. Leaf explosion can occur in a rice plant at any stage. It is distinguishable because the dots have dark green edges. They can be mistaken for brown patches with ease. It can completely destroy the leaf if it grows. They can be mistaken for brown patches with ease. If the field is flooded as frequently as feasible, it can be controlled. It can also be controlled by dividing the use of nitrogen fertiliser into two or more treatments [11].

C. Hispa

If the grub mining is evident on the leaves, this disease can be detected. The rice fields seem burned if the land is highly infected. The injured leaves of a badly afflicted rice plant wither away. Young plants are typically affected by this disease. A field should not be overfertilized in order to control this disease [12].

D. Sheath Blight

It is a sickness that is classified as a fungus. The main paddy farming regions in tropical and subtropical nations typically experience it. It is present in all regions of rice cultivation and is reducing rice yield, particularly in systems with intensive production. Studies reveal that it reduces tropical Asia's overall production by 6% [13].

E. Bacterial Leaf Blight

The rice plant's leaves can develop bacterial leaf blight, which is easily identified by looking at the yellow and white stripes on the paddy leaf. We can tell whether a plant has bacterial leaf blight by examining the newly grown leaves, which will have a faint yellow colour. By applying less nitrogen fertiliser and tilling straw and stubble into the soil after the crop has been harvested, this disease can be prevented [14].

F. Grassy Stunt

If the leaves are thin, pale green in colour, or yellow in colour, this disease is present. It is a kind of virus. It can also be identified if leaves develop sporadic dark brown patches. It can spread by leaf hoppers. In South, Taiwan, Southern Japan, Southern China and South East Asia, the illness is widespread [15].

These are the several diseases that the rice plant may contract. We have considered Hispa, Leaf Blast and Brown Spot illnesses out of all of these ailments. These disorders can be properly categorised by our approach. The rice plant would be categorised as healthy if it was free from any diseases.

IV. Methodology

A. Dataset

The dataset we used is custom dataset which consists of 9000 images collected from various Bing Search API and Kaggle Datasets. A Python script was used for Bing Search API to find pictures with multiple queries related to “brown spot”, “leaf blast” and “hispa” which aids us in data collection. Hence our dataset consists of three classes with 3000 images per each class.

B. Proposed Method

Neural Networks are a collection of intricate algorithms that, by simulating how the human brain functions, identify the main relationship among a group of facts. Neural networks are frequently utilized in business trading, planning and business analysis, as well as for product and medical maintenance purposes. They have succeeded in achieving wide adoption in corporate applications and also

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has a significant part in identifying diseases like diabetes, breast cancer, and brain tumor [16].

Out of all the many variations of neural networks, CNNs are the optimal option for use with photographs. Convolutional neural networks come in a variety of designs, some of which include DenseNet, ResNet, Inception, VGG 16, LeNet-5 and Alexnet. These builds work as a powerful "feature extractor" that may be applied to a variety of sophisticated tasks, including object identification, picture segmentation, and image classification [17].

Because it is highly convenient to deal with a big number of photos, we have chosen the Transfer Learning methodology out of all of these designs. Transfer learning is a machine learning methodology that emphasizes on applying the model's previous experience with other issues to address a new difficulty. In other words, it is a well-known methodology that utilizes a model that has previously been trained on a comparable problem and that addresses issues in a variety of fields which include natural language processing, computer vision, and image processing. Transfer learning may be used in two ways: pre-trained model approach and developed model method [18]. The four crucial phases of the developed model approach are the selection of the source task, the development of the source model, the reuse of the model, and the tuning of the model.

C. Architecture

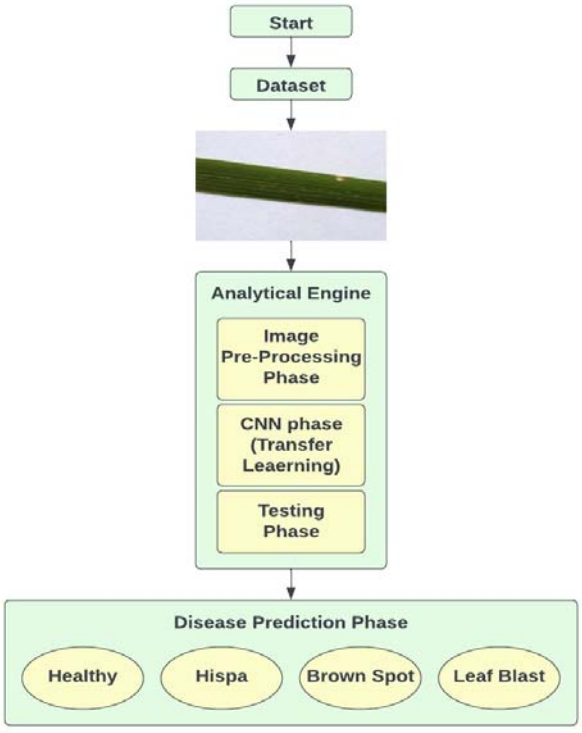

Fig. 1. Architecture of the proposed system

Firstly, we collect the dataset as shown in the architecture diagram in Fig. 1. The Analytical Engine phase of our architecture consists of three main sub phases. The first sub phase is the image pre-processing phase where several pre- processing methods like brightness corrections, segmentation and geometric transformations are applied. In the second sub phase, we train our CNN model coupled with transfer learning which results in faster train times and higher accuracy. In the testing sub phase, we test the performance of our model with other CNN models in order to obtain a comparison among various models. Finally, we employ the best performing model among all the compared models for our Disease Prediction Phase.

V. Experiments

We employed the VGG16 architecture for our CNN model with transfer learning. Which means we have 16 layers that have weight. The average pooling technique was used in the pooling layers. We used ReLU and Softmax activation functions were used for the convolutional layers and the dense layer respectively as we have to perform predictions of 4 classes at the end.

A. Results

We put our model to the test using several Convolutional Neural Network topologies. We employed a single layer of CNN, two levels of CNN, and the 16-layer VGG-16. Our model has a 91.7% accuracy rating, which is its highest. Compared to the previous models we have employed, the one layer CNN and the two layer CNN—the loss in our model is likewise relatively low. Utilizing transfer learning, we were able to achieve 94.4% training accuracy and 91.7% testing accuracy.

TABLE I. Comparison among Different Models

Model Name	***CNN one layer***	***CNN two layers***	***Transfer Learning with VGG-16***
Test Accuracy	71.8%	76.1%	91.7%

B. Performance Evaluation

The model effectively identified the illnesses that the rice plant could have after being put to the test using the test data. We were able to get an accuracy of 91.7% employing the transfer learning methodology. It is a powerful technique for solving complex deep learning problems, especially those that use image-based data. This set of architectures may be quite helpful when we have a difficult problem to solve.

VI. Conclusion

In people's life, cultivation is essential. It also offers food for both humans and animals, as well as sources of work for people. Agriculture must be safeguarded and kept since it is necessary for both people and other creatures to exist. Lack of technical expertise and understanding in the agricultural sector may seriously affect the health of plants. The procedure of detecting and diagnosing different lethal illnesses has altered as a result of the substantial involvement of the IT industry in agriculture during the past several years.

Transfer learning, a technique for gracefully and successfully addressing difficult image processing problems, is used in this model. This model uses the transfer learning VGG-16 architecture to forecast illness in rice crops. It takesthe features out of the leaves and determines what kind of sickness the plant is experiencing. The classification and

detection concept is closely adhered to in this model. This approach has many promising applications and a bright future. It may be implemented in a website and turned into an app. The website or developed app is used by the farmer or individual to submit a carefully taken picture of the plant leaf, and it promptly detects what sort of disease the plant is facing. It will let us know whether the plant is likely to have a disease.

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