

# RICE LEAF DISEASES CLASSIFICATION USING CNN WITH TRANSFER LEARNING

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**Abstract** - Rice is one of the maximum critical plants in India and is liable to diverse illnesses at some point of extraordinary tiers of cultivation. It could be very tough for farmers with confined understanding to as it should be perceiving those illnesses manually. Recent traits in deep gaining knowledge of have proven that automated picture reputation structures the use of convolutional neural network (CNN) fashions are very beneficial for such problems. Since rice leaf ailment picture datasets aren't quite simply available, we created our very own small dataset. Therefore, I advanced a deep gaining knowledge of version the use of switch gaining knowledge of. The proposed CNN structure is primarily based totally on VGG-sixteen and is educated and examined the use of paddy subject and net datasets. The accuracy of the proposed version is 92.46%. Index Terms – Convolutional Neural Networks, Deep Learning, Fine Tuning, Rice Leaf Disease, Transfer Learning.

**Key Words:** Convolutional Neural Network, Deep Learning, Fine-Tuning, Rice Leaf Diseases, Transfer Learning.

## 1. INTRODUCTION

Rice is the staple delivery of food in India similarly to at some point of the world. It is attacked with the useful resource of the use of hundreds of ailments in numerous levels of its cultivation. Therefore, early detection and remedy of such ailments are beneficial to make certain immoderate quantity and quality quality, but this is very difficult due to the big expanse of land underneath individual farmers and the big kind of ailments similarly to the prevalence of more than one disorder withinside the identical plant. Agricultural expert knowledge isn't on hand in a way off areas, and its miles a time taking process. Therefore, the Automated Systems are required. To aid the plight of the farmers and provide advanced accuracy of plant disorder detection, research artwork using numerous gadgets learning algorithms such as Support Vector Machine (SVM) [1]- [3], Artificial Neural Networks [4] have been done.

However, the accuracy of such systems is highly relying on feature preference techniques. Recent researches on convolutional neural networks have provided tremendous bounce ahead in photograph based totally absolutely

recognition thru removing the need for photograph preprocessing similarly to imparting constructed in function selection. Another challenge is that it's miles very difficult to gain huge sized dataset for such problems. For times wherein duration of the dataset is specifically small, it's far more main to use a model this is pretrained on a huge dataset. This is called Transfer Learning and it can be implemented to create a model that can be used as a difficult and speedy function extractor disposing of the very last honestly associated layer or thru fine-tuning the last few layers a very good manner to artwork more unique to the involved dataset. Nowadays, mobileular phones are accessible to every body and so we've given you the idea of an automated device wherein the farmers can upload the diseased leaf image and post it to our server wherein the neural network may be used to find out the sickness and the sickness magnificence on the aspect of the remedy can be dispatched once more to the farmer. In those art work we have got proposed the shape for the sickness magnificence part of the automated device. Inspired thru the art work in [5]- [8] and [14] on convolutional neural networks, on those art work, we have got superior the deep mastering technique on our rice sickness dataset that we have got accrued over past several months. We have used the pre-professional VGG-16 version (Trained on the massive ImageNet data) and the use of Transfer Learning we have got finetuned the actually associated layers just so we're capable of accommodate our very own dataset and at the prevent we have got completed some errors assessment and tried to provide an cause of the reasons for the errors.

## 2. LITERATURE SURVEY

A lot of research were completed using traditional classifiers but the effects are relying at the characteristic desire techniques and photo preprocessing is a high step [9]. Therefore, CNN has attracted multiple researchers to take advantage of immoderate reputation accuracy.

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researcher to take benefit of immoderate recognition accuracy.

### B. Rice Disease Detection using CNN

Convolutional neural network classifier is used on a dataset of 227 photographs of snail-bitten, diseased and wholesome rice flowers in [8]. The classifier is transfer getting to know based definitely using Alex Net. Training the above shape an accuracy of 91.23% is achieved but it can maximum efficiently anticipate whether or not or now no longer plant is diseased or now no longer. In [13], the authors accumulated 500 photographs of 10 superb rice illnesses of leaf and stem. They developed a shape inspired with the useful resource of the usage of Le-Net and Alex Net and achieved 95.48% on the test set. Since the facts can be very a lot less, they used several preprocessing steps like image resizing to 512\*512, normalization, PCA and whitening. They used stochastic pooling in location of max pooling and stated that it prevents over fitting.

### 3. PROPOSED METHOD

In proposed system, we advise a Deep Learning generation that automatically apprehend pics using Convolution Neural Network (CNN) models can be very beneficial in such problems. By using the ones techniques, we are able to results easily discover and select out out the diseases.

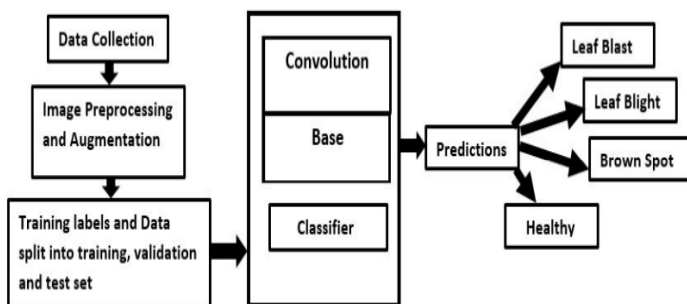


Fig.1. Overview of the steps of the proposed model

### 4. RICE DISEASE TYPES AND DATASET DESCRIPTION

The rice image graph dataset has been amassed throughout the previous few months withinside the principal from the cultivation fields of Maharat village (District: South 24 Parganas) in Baruipur, Dharana village District: Pura Medinipur) in Tamluk and Basi hat (District North 24 Parganas), belonging to the dominion of West Bengal, India similarly to from the Internet. The pics were taken the usage of Motorola E4 Plus and Redmi 5A molecular camera. The symptoms and symptoms and statistics about the illnesses

were gathered from the International Rice Research Institute (IRRI) Rice Knowledge Bank website. There were constrained huge sort of images for schooling our system, so we've were given used a few statistics augmentation techniques with the help of Kera's Documentation to get a substantial huge sort of images. The dataset consists of 1649 images of diseased leaves of rice which incorporates three most common location illnesses mainly Rice Leaf Blast, Rice Leaf Blight, and Brown Spot. There are 507 images of Healthy leaves. We have now not accomplished any step to dispose of noise from the raw statistics. There were a number of issues faced at the same time as amassing the statistics like horrible illumination and more than one illness withinside the same plant. We have tried to conquer them thru manner of method of the usage of picture graph preprocessing steps like resizing and zooming. The huge sort of images that could be gathered from the fields are very a whole lot much less for schooling CNN so we have got were given used a number of augmentation techniques like zoom, horizontal and vertical shift, and rotation which is probably stated withinside the Implementation Section later. The beneath Neath sections describe the commands of Rice Leaf illnesses on which we have got were given worked.

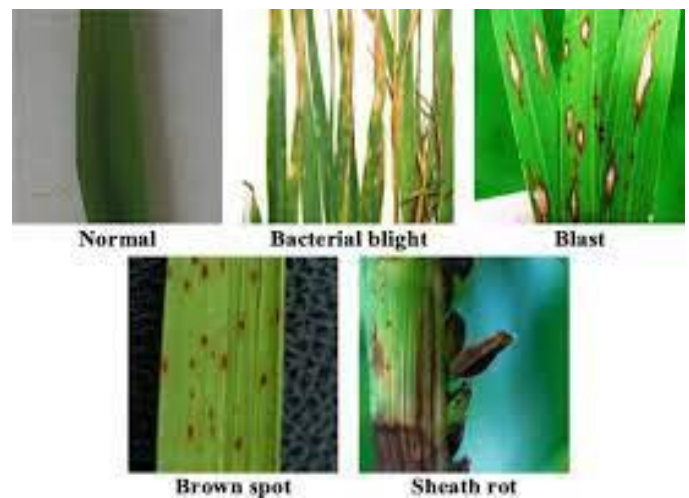


Fig. 2. Types of Rice Leaf Disease

#### A. Leaf Blast

It is a fungal illness because of Magnaporthe Oryza. The initial symptoms and symptoms and signs are white to grey-green spots which might be elliptical or spindle-fashioned with dark pink to brownish borders. Some have diamond shape with extensive centers and pointed ends. In the Figure 2 (a) the spindle fashioned lesions with white spots and dark brown border can be seen.

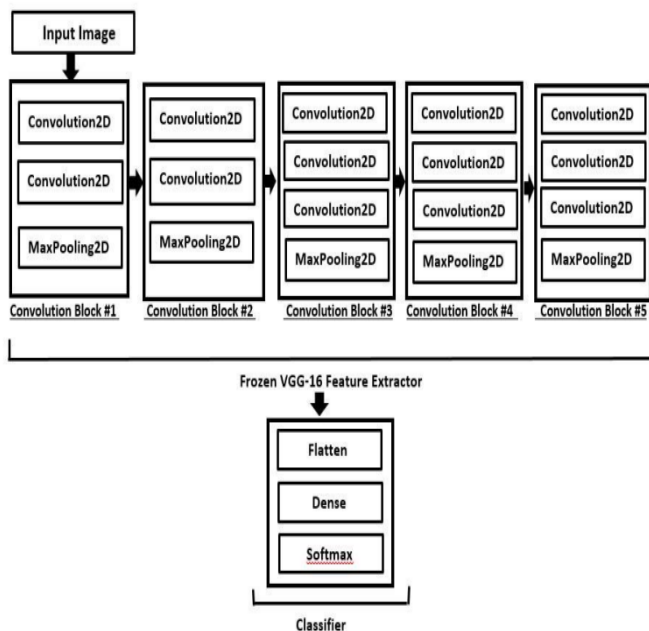


Fig. 3. VGG-16 Architecture fine-tuned with the last two layers with 128 Dense FC Layer and 4 Dense SoftMax Layer as the output.

### b. Leaf Blight

It is a fungal illness because of *Magnaporthe oryzae*. The initial symptoms and symptoms and signs and symptoms are white to grey-green spots which might be elliptical or spindle-shaped with dark crimson to brownish borders. Some have diamond shape with extensive centers and pointed ends. In the Figure 2 (a) the spindle shaped lesions

#### B. Brown Spot

It is a fungal disease. The inflamed leaves have several massive spots at the leaves that can kill the entire leaf. At the preliminary stage, small, round, darkish brown to purple-brown lesions may be located within the leaves. Fully evolved lesions are round to oval with mild brown to grey center, surrounded with the aid of using a reddish-brown margin because of the toxin produced with the aid of using the fungi are the small darkish brown lesions of the Brown Spot affected leaves.

## 5. METHODOLOGY

Convolutional neural networks (CNNs) are multi-layered networks whose shape determines the general overall performance of the network. It consists of three additives namely, convolution layer, pooling layer and absolutely associated layer. The first together office works the feature extractor and the 0.33-layer acts as a classifier. Convolutional neural networks (CNNs) are multi-layered

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Since we've small dataset and it is unique from the ImageNet dataset, our model falls within the 1/3 scenario, so we have got steady the layers of the VGGNet to use it as feature extractor until the ultimate absolutely associated layers which we have got fine-tuned in keeping with the style of commands in our dataset. In Figure 2 the shape of proposed model is depicted. We have moreover superior a CNN model without transfer learning with 4 Convolution layers each of it's determined via ReLU, Maxpooling and dropout layer determined via 2 Fully Connected Layer and SoftMax. But the general overall performance was now not as nicely due to the fact the above-said model. The assessment of the identical has been said within the stop ends result section.

## 6. IMPLEMENTATION

### A. Experimental Setup

The take a look at come to be achieved on a Windows 10 PC organized with GPU card P4000, 64-bit Operating System. The CNN-based completely model come to be accomplished within the Keras 2.2.4 deep analyzing framework with TensorFlow 1.13.1 backend and python 3.7.2

### b. Image Acquisition

The pictures are collected from the cultivation fields similarly to from internet. As referred to within the dataset description, statistics encompass 4 schooling mainly Leaf Blast, Leaf Blight, Brown Spot and healthful plant pictures

### c. Image Preprocessing and Augmentation

The images amassed are resized to 224\*224 pixel and a number of augmentation techniques like zoom, rotation, horizontal and vertical shift are achieved using Image Data Generator in Keras to generate new images.

### D. CNN Model Training

The picture information set is loaded for the education and checking out. The elegance labels and the corresponding

photos are saved in respective arrays for education. 70 percentage of information is used for education and 30 percentage of information is used for checking out the usage of teach take a look at cut up feature. The 70-percentage information is similarly cut up and 20% of its miles used for validation. The elegance labels are encoded as integers and then, one-warm encoding is executed on those labels making every label represented as a vector in place of an integer. Next, the VGG-sixteen version is loaded from keras and the remaining absolutely related layers are removed. The closing layers are made non-trainable. We have flattened the output of characteristic extractor part, accompanied through absolutely related layer and output layer with SoftMax. Then we've got compiled our version the usage of the Adam optimizer with categorical\_crossentropy because the loss feature for type. We have stopped at 25 epochs considering after this the consequences had been stable. Figure three suggests the stairs we've got finished for the type process.

**E. Justification for the Chosen Model**

Transfer getting to know refers back to the state of affairs wherein what has been discovered in a single placing is exploited to enhance generalization in some other placing. Transfer getting to know has the advantage of reducing the education time for a neural community version and as a consequence could be very beneficial considering the fact that maximum real-global troubles normally do now no longer have hundreds of thousands of categorized information factors to teach such complicated models. Usually, a number of information is wanted to teach a neural community from scratch however get admission to to that information isn't constantly available. With switch getting to know a strong device getting to recognize model can be built with quite little schooling records because of the reality the model is already pre-professional. Hence, we've used the pre-professional VGGNet and fined tuned it to classify the use of our non-public small dataset.

**7. RESULTS**

**A. Calculations**

The proposed version is completed for 25 epochs over 1509 education information observed with the aid of using 647 check information and the accuracy of education set is 97% and the check accuracy of 92. four%. We have additionally completed the equal information the use of the equal cut up ratio into train, validation and check set on every other CNN version without switch mastering. The batch size, variety of epochs, optimizer became fine-tuned and 16, 30, rmsprop respectively together with dropout 0. four supplied the exceptional end result but the exceptional accuracy became 74%. The CNN version without switch mastering has four Convolution layers every of that is observed with the aid of using ReLU, Maxpooling and dropout layer observed with

the aid of using 2 Fully Connected Layer and SoftMax. Table I in Figure four suggests the evaluation in accuracy of the proposed CNN version with Transfer Learning and CNN without Transfer Learning. Figure five illustrates the Training and validation accuracy as opposed to the variety of epochs for the CNN with Transfer Learning.

**TABLE I. PERFORMANCE OF COMPARISON OF CNN WITH AND WITHOUT TRANSFER LEARNING**

<i>Model</i>	<i>Test Accuracy</i>
<b>CNN With Transfer Learning</b>	<b>92.46%</b>
CNN Without Transfer Learning	74%

Fig.4. Performance comparison of CNN model with and without Transfer Learning

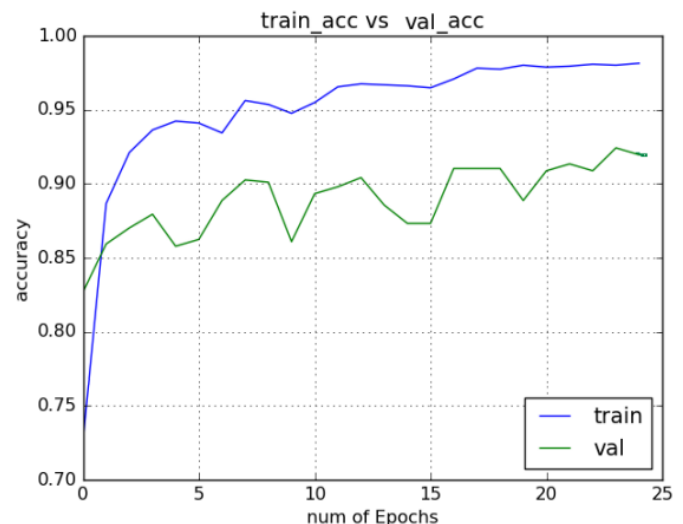


Fig. 5. Plot of Accuracy versus Epochs

**TABLE 2. PERFORMANCE OF COMPARISON OF CNN WITH AND WITHOUT TRANSFER LEARNING**

<i>Model</i>	<i>Test Accuracy</i>
<b>CNN WITH TRANSFER LEARNING</b>	<b>93.46%</b>
CNN WITHOUT TRANSFER LEARNING	75%



Fig.6. Performance Comparison of CNN model with and without Transfer Learning

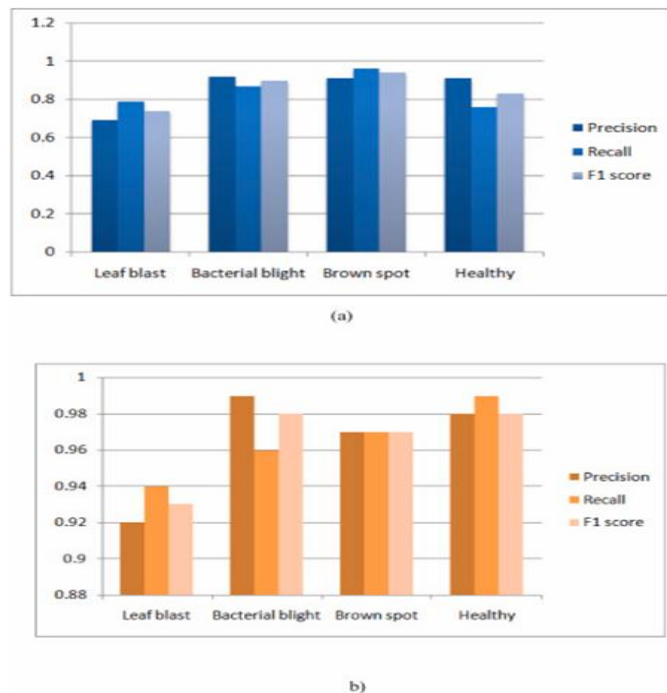


Fig.6. (a). (b). Comparison of diseases in rice leaf prediction

### B. Error Analysis

The Figure 6 (a)-(f) illustrates **pictures which are misclassified with the aid of using** the proposed CNN model. The misclassifications are **defined in information withinside the underneath segment for every of the sickness type**. Rice Blast: Image (a) belongs to Rice Blast but (a) **is classed as Brown Spot because the photograph is blurred**. The **purpose may be the presence of small brown spots withinside the identical rice leaf**.

**Leaf Blight:** Images (d) and (e) are categorized as Healthy however they belong to Blight category. The cause will be bad illumination and blurring of image.

**Healthy:** Image (f) is **healthful however it's far labeled as Brown Spot probable due to the fact the picture is blurred and comparison is poor**.

**Brown Spot:** Images (b) and (c) belong to Brown Spot **however are categorized as Blast**. One **purpose will be the presence of small blast lesions at the leaf**. In (d) the brown spot lesions resemble the blast lesion.



Fig. 6. From left to right (a)-(f) Rice disease images that are misclassified by the model. (a) Rice Blast disease (b) and (c) Brown Spot (d) and (e) Leaf Blight (f) Healthy

### 3. CONCLUSIONS

In this paper we've got proposed a deep gaining knowledge of structure with education on 1509 pictures of rice leaves and trying out on one of a kind 647 pictures and that successfully classifies 92.46% of the take a look at pictures. Transfer Learning the use of fine-tuning the predefined VGGNet has significantly advanced the overall performance of the version which in any other case did now no longer produce high-quality consequences on such small dataset. The variety of epochs used turned into stopped at 25 due to the fact we had acquired a reduce factor and then the accuracy turned into now no longer improving, and the loss turned into now no longer reducing on each education and validation data. In destiny work, We **would really like to accumulate more pics** from agricultural fields and Agricultural Research institutes **simply so we are able to decorate the accuracy further**. We **would really like to characteristic cross-validation approach in future a great manner** to validate our consequences. We **could additionally like to apply higher deep getting to know fashions and different state-of the artwork works and examine it with the outcomes** obtained. The **evolved version may be utilized in destiny to locate different plant leaf diseases, that are crucial vegetation in India**.