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CLASSIFICATION OF RICE LEAF DISEASES USING TRANSFER LEARNING WITH CNN

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Abstract : One of the most widely grown crops in India is rice, which is afflicted by a number of illnesses at different phases of its development. With their limited understanding, farmers find it extremely challenging to manually detect these diseases effectively. Recent advancements in deep learning demonstrate how Convolutional Neural Network (CN N) model-based automatic image recognition systems can be quite helpful in solving such issues. Since there aren't many image datasets available for the rice leaf disease, we developed our own, small dataset and utilised Transfer Learning to build our deep learning model. The dataset gathered from rice fields and the internet was used to train and test the suggested CNN architecture, which is based on VGG16.

IndexTerms - Convolutional Neural Network, Deep Learning, Fine-Tuning, Rice Leaf Diseases, Transfer Learning

INTRODUCTION

In India as much as the rest of the globe, rice is a basic food. Different diseases attack it at different phases of its cultivation. Therefore, early diagnosis and treatment of such illnesses are advantageous to ensuring high quantity and highest quality, but due to the vast areas of land under individual farmers, the enormous variety of diseases, and the incidence of several diseases in the same plant, this is highly challenging. It takes a long time to access agricultural expert knowledge in remote locations. As a result, automated systems are necessary. Research employing various machine learning algorithms is being conducted to better the accuracy of plant disease diagnosis and alleviate the burden of farmers.Artificial neural networks, such as Support Vector Machines (SVM), have been developed.

However, the methods used in feature selection have a significant impact on how accurate such algorithms are. Convolutional neural networks have made significant advances in image-based recognition recently by removing the requirement for image pre-processing and by supplying built-in feature selection. Another difficulty is that obtaining huge datasets for these situations is exceedingly difficult. It is better to employ a model that has been pretrained on a large dataset when the dataset size is relatively small. By eliminating the final fully connected layer or fine-tuning the model's parameters, this technique known as Transfer Learning can be used to generate a model that can be used as a fixed feature extractor.the final few layers, which will work more specifically with the relevant dataset.

Since everyone can now access mobile phones, we came up with the concept of an automated system where farmers could upload images of the sick leaves and post them to our server, where the neural network would be used to identify the disease. The disease classification along with the treatment could then be sent back to the farmer. In this paper, we have put forth an architecture for the automated system's disease classification component. In this study, we created the deep learning approach using our dataset of rice sickness that we have gathered over the previous few months, drawing inspiration from the work on convolutional neural networks. We've employed theIn order to suit our own dataset, we have adjusted the fully connected layers of the pre-trained VGG16 model (trained on the massive ImageNet data). Finally, we have performed some error analysis and attempted to identify the causes of the errors.

1.1 Plant Disease Detection using CNN

With 58 classifications and 25 plant species, including healthy plants, CNN taught using 87,848 photos. Various model types were trained, and the top model offered 99.53% accuracy in the right identification. 54306 photos of 14 different crop varieties with 26 different illnesses and healthy leaves were utilised to train CNN. When evaluated using a different dataset gathered from a real-world scenario, the success percentage of 99.35% dropped to 31.4%. It is highlighted why disease severity is a more difficult topic to solve than disease classification. The difficulty in identifying it is increased by the considerable intra-class resemblance among the several photos that belong to the same class.

1.2 Rice Disease Detection using CNN

Using 227 photos of healthy, damaged, and snail-bitten rice plants as a dataset, a convolutional neural network classifier is used to categorise the data. The classifier uses Alex Net and is based on transfer learning. Training the aforementioned architecture yields an accuracy of 91.23%, but it simply determines whether a plant is infected or not. The scientists gathered 500 photos of ten distinct leaf and stem diseases in rice. They created an architecture using Le-Net and AlexNet as inspiration, and they scored 95.48% on the test set. They employed a variety of pre-processing steps such image downsizing to 512*512, normalisation, PCA, and whitening because there was so little data. They claimed that stochastic pooling, as opposed to max pooling, reduces overfitting.

1.3 Rice disease types and dataset description

The rice image dataset was primarily gathered over the past few months from the fields of the West Bengal, India, states of Madarat (District: South 24 Parganas), Dharinda (District: Purba Medinipur), Tamluk, and Basirhat (District: North 24 Parganas), as well as from the Internet. The photos were captured with a smartphone camera called a Redmi 5A and a Motorola E4 Plus. From the website of the Rice Knowledge Bank of the International Rice Research Institute (IRRI), the illnesses' signs and symptoms have been gathered. There weren't many images available for our system to train on, so we used some data augmentation methods and the Keras Documentation to obtain a large number of images.

1649 photos of sick rice leaves from the three most prevalent diseases, rice leaf blast, rice leaf blight, and brown spot, make up the dataset. Healthy leaves are depicted in 507 pictures. We didn't take any action to clean out the noise in the raw data. Poor lighting and many diseases in the same plant were only two of the challenges encountered when gathering the data. By applying image pre-processing techniques like resizing and zooming, we have attempted to get around them. Since there were not enough images from the fields to train CNN, we used a variety of augmentation techniques, including zoom, horizontal and vertical shift, and rotation, which are covered in the Implementation section.later. The classes of rice leaf diseases that we have studied are described in the sections below.

Fig. 1. (a)-(c) From Left to right. (a) Leaf Blast (b) Leaf Blight and (c) Brown Spot

A. Leaf Blast

It is a fungus-related illness brought on by Magnaporthe oryzae. The first signs are elliptical or spindle-shaped white to grey-green patches with dark red to brownish edges. Some have pointy extremities and broad centres in the shape of a diamond. Spindle-shaped lesions with white dots and a dark brown border can be seen in Figure 1(a).

B. Leaf Blight

Xanthomonas oryzae is the bacterium that causes it. The affected leaves roll up and turn a greyish green, then start to yellow, turn straw-colored, and eventually wilt to death. The lesions advance towards the base and have wavy edges. Bacterial slime that resembles a morning dew drop can be seen on new lesions. Leaf blight-affected leaves are depicted in Figure 1(b).

C. Brown Spot

It is a bacterial infection. The afflicted leaves have a lot of large spots that can harm the entire leaf. Small, circular lesions on the leaves that range in colour from dark brown to purple-brown are visible in the early stages. Fully formed lesions have an oval or circular shape, a light brown to grey centre, and a reddish brown edge brought on by the toxin that the fungi generate. The tiny, dark-brown lesions on the Brown Spot-affected leaves are depicted in Fig. 1(c).

D. Healthy:

Despite the fact that the image is clear and contrast is good, it is nevertheless categorised as a Brown Spot.

LITERATURE SURVEY

[1] R. R. Atole, D. Park, "A Multiclass Deep Convolutional Neural Network Classifier for Detection of Common Rice Plant Anomalies," International Journal Of Advanced Computer Science And Applications,vol. 9,no. 1,pp. 67–70,2022.

This study examines the use of deep convolutional neural network in the classification of rice plants according to health status based on images of its leaves. A three-class classifier was implemented representing normal, unhealthy, and snailinfested plants via transfer learning from an AlexNet deep network. The network achieved an accuracy of 91.23%, using stochastic gradient descent with mini batch size of thirty (30) and initial learning rate of 0.0001. Six hundred (600) images of rice plants representing the classes were used in the training. The training and testing dataset-images were captured from rice fields around the district and validated by technicians in the field of agriculture.

[2] P. Konstantinos Ferentinos, "Deep Learning Models for Plant Disease Detection and Diagnosis," Computers and Electronics in Agriculture ,vol. 145,pp. 311–318,2020

In this paper, convolutional neural network models were developed to perform plant disease detection and diagnosis using simple leaves images of healthy and diseased plants, through deep learning methodologies.Training of the models was performed with the use of an open database of 87,848 images, containing 25 different plants in a set of 58 distinct classes of [plant, disease] combinations, including healthy plants. Several model architectures were trained, with the best performance reaching a 99.53% success rate in identifying the corresponding [plant, disease] combination (or healthy plant). The significantly high success rate makes the model a very useful advisory or early warning tool, and an approach that could be further expanded to support an integrated plant disease identification system to operate in real cultivation conditions.

[3] Y. Lu, S. Yi,N. Zeng,Y. Liu, and Y. Zhang, "Identification of Rice Diseases Using Deep Convolutional Neural Networks," Neurocomputing, 267, pp. 378-384,2021.

An accurate and timely detection of diseases and pests in rice plants can help to reduce economic losses substantially. It can help farmers in applying timely treatment. Recent developments in deep learning based convolutional neural networks (CNN) have allowed researchers to greatly improve the accuracy of image classification. In this paper, we present a deep learning based approach to detect diseases and pests in rice plants using images captured in real life scenerio with heterogeneous background. We have experimented with various state-of-the-art convolutional neural networks on our large dataset of rice diseases and pests, which contain both inter-class and intra-class variations. The results show that we can effectively detect and recognize nine classes of rice diseases and pests including healthy plant class using a deep convolutional neural network, with the best accuracy of 99.53% on test set.

[4] V. Singh, A. Misra, "Detection of Plant Leaf Diseases Using Image Segmentation and Soft Computing Techniques," Information Processing in Agriculture,vol. 4 ,no. 1,pp. 41–49,2022

Agricultural productivity is something on which economy highly depends. This is the one of the reasons that disease detection in plants plays an important role in agriculture field, as having disease in plants are quite natural. If proper care is not taken in this area then it causes serious effects on plants and due to which respective product quality, quantity or productivity is affected. For instance a disease named little leaf disease is a hazardous disease found in pine trees in United States. Detection of plant disease through some automatic technique is beneficial as it reduces a large work of monitoring in big farms of crops, and at very early stage itself it detects the symptoms of diseases i.e. when they appear on plant leaves. This paper presents an algorithm for image segmentation technique which is used for automatic detection and classification of plant leaf diseases. It also covers survey on different diseases classification techniques that can be used for plant leaf disease detection. Image segmentation, which is an important aspect for disease detection in plant leaf disease, is done by using genetic algorithm.

[5] Y. Es-saady,T. El Massi,M. El Yassa,D. Mammass, and A. Benazoun, "Automatic recognition of plant leaves diseases based on serial combination of two SVM classifiers," International Conference on Electrical and Information Technologies (ICEIT) pp. 561-566, 2016.

This paper presents a machine vision system for automatic recognition of plant leaves diseases from images. The proposed system is based on serial combination technique of two SVM classifiers. The first classifier uses the color to classify the images; it considers, at this phase, that the diseases with similar or nearest color belonging to the same class. Then, the second classifier is used to differentiate between the classes with similar color according to the shape and texture features. The tests of this study are carried out on six classes of diseases including three types of pest insects damages (Leaf miners, Thrips and Tuta absoluta) and three forms of pathogens symptoms (Early blight, Late blight and Powdery mildew). The results of the study show the advantages of the proposed method compared to the other existing methods.

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III PROPOSED SYSTEM

Convolution Neural Network (CNN) models are used in the suggested system as a Deep Learning technology that automatically recognises photos and can be very helpful in solving such issues. These methods make it simple to find and recognise diseases.

3.1 Advantages

- It takes less time to identify and detect the disease.
- Results are accurate.
- Easy to handle.

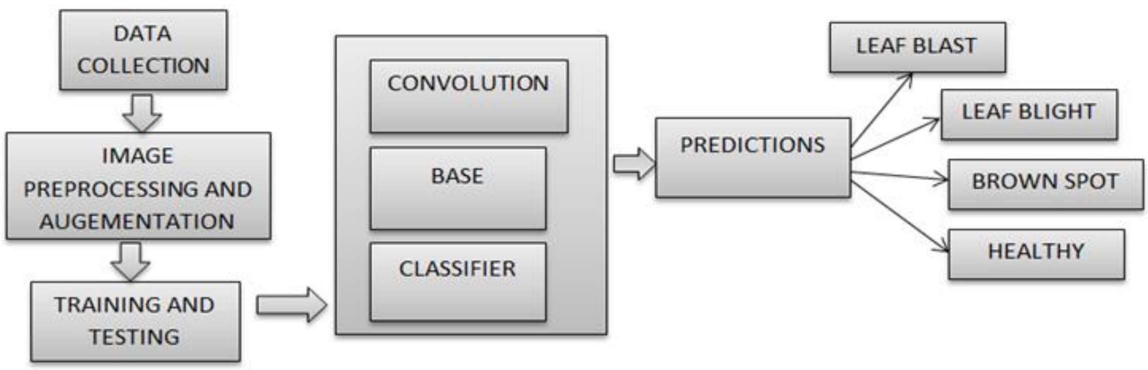

Fig 3 Proposed System

3.2 Implementation Details

1. Install the required packages
2. Defining the custom model.
3. Loading the dataset.

4. Pre-Processing the dataset.
5. Training the custom model.
6. Loading the pre-trained VGG16 models.
7. Training the pre-trained model with our own dataset.
8. Performing prediction.
9. Create a Flask based User Interface.

IV CONCLUSION

In this study, we propose a deep learning architecture that successfully classifies 92.46% of the test photos when trained on 1509 photographs of rice leaves and tested on 647 other images. The model's performance has been considerably enhanced by the use of Transfer Learning to fine-tune the predefined VGG16, as this would not have otherwise produced sufficient results on such a tiny dataset. We obtained a cut point after which the accuracy was not improving and the loss was not lowering on both training and validation data, thus we stopped using epochs at 25.

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[3] P. B. Padol and A. A. Yadav, “SVM classifier based grape leaf disease detection,” Conference on Advances in Signal Processing (CASP), pp. 175-179, 2021.

[4] L. Liu and G. Zhou, “Extraction of the rice leaf disease image based on BP neural network,” International Conference on Computational Intelligence and Software Engineering ,pp. 1-3,2020.