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Paddy Leaf Disease Prediction Using Transfer Learning

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ABSTRACT

Plant disease diagnosis is very critical for agriculture due to its importance for increasing crop production. Recent advances in image processing offer us a new way to solve this issue via visual plant disease analysis. However, there are few works in this area, not to mention systematic researches. In this paper, we systematically investigate the problem of visual plant disease recognition for plant disease diagnosis. Compared with other types of images, plant disease images generally exhibit randomly distributed lesions, diverse symptoms and complex backgrounds, and thus are hard to capture discriminative information. To facilitate the plant disease recognition research, we construct a new large-scale plant disease dataset with 271 plant disease categories and 220,592 images. Based on this dataset, we tackle plant disease recognition via reweighting both visual regions and loss to emphasize diseased parts. In the proposed method, five disease ware classified which are, Bacterial leaf blight, Brown spot, Leaf smut, tungro and blast. The algorithms such are Xception, inception, VGG19 are used in the proposed method. Proposed an automated leaf disease recognition system. Extensive evaluations on this dataset and another public dataset demonstrate the advantage of the proposed method. We expect this research will further the agenda of plant disease recognition in the community of image processing.

Keywords: Paddy Leaf Disease, Classification, Transfer Learning, Image Processing, SVM.

I. INTRODUCTION

Agriculture has always been the mainstay in economy of most of the developing countries, especially the ones located in South-Asia. The purpose of agriculture is not only to feed ever growing population but it's a solution to solve the problem of global warming and it is an important source of energy [1]. India is an agricultural country wherein most of the population depends on agriculture. Research in agriculture is aimed towards increase of productivity and quality of the food at reduced expenditure, with increased profit [2]. Therefore, detection and classification of diseases is an important and urgent task.

Paddy is a globalized staple food. It is one of the three leading food crops in the world which makes it a more significant food item worldwide [3]. Paddy is

considered as the main crop in the east India and believed to be the second central crop after wheat, in the world. In a third world country like India where the major staple food is “Paddy” where life of many people, economy of the country is related to the production of paddy [4].

One of the main diseases of paddy is leaf disease. Generally, it is very time-consuming and laborious for farmers of remote areas to identify paddy leaf diseases due to unavailability of experts. Though experts are available in some areas, disease detection is performed by naked eye which causes inappropriate recognition sometimes [5]. An automated system can minimize these problems. In this paper, an automated system is proposed for diagnosis three common paddy leaf diseases (Brown spot, Leaf blast, and Bacterial blight) and pesticides and/or fertilizers are advised according to the severity of the diseases [6].

Paddy is an important crop worldwide and over half of the world population relies on it for food. Many people in the world including Malaysia eat paddy as staple food. However, there are many factors that make paddy paddy production become slow and less productive. One of the main factors is paddy disease [7]. An abnormal condition that injures the plant or leads it to function improperly is called as a disease. Diseases are readily recognized by their symptoms. There are a lot of paddy disease types which are Bakanae, red disease virus, brown spot disease and many more. Image processing and computer vision technology are very beneficial to the agricultural industry. They are more potential and more important to many areas in agricultural technology [8].

II. RELATED WORKS

Paddy is the staple food of Asia and part of the Pacific. Over 90 percent of the world’s paddy is produced and consumed in the Asia-Pacific Region. With growing prosperity and urbanization, per capita paddy consumption has started declining in the middle and high-income Asian countries like the Republic of Korea and Japan [9].Detection of plant disease is an essential research topic. Studies show that relying on pure naked-eye observation of expert to detect such diseases can be prohibitively expensive, especially in developing countries [10].

In the work [11], an automated system has been developed to classify the leaf brown spot and the leaf blast diseases of paddy plant based on the morphological changes of the plants caused by the diseases.Blasts in paddy leaves are the most predominant disease which appears as brown spots on the leaves [12]. If not treated on time, it may cause the great loss. Excessive use of pesticide for treatment of plant diseases increases the cost, environmental pollution and decreases the production.

To ensure healthy and proper growth of the paddy plants it is essential to detect any disease in time and prior to applying required treatment to the affected plants [13]. Since manual detection of diseases costs a large amount of time and labour, it is inevitably prudent to have an automated system.Bacterial Leaf Blight and Brown Spot are a major bacterial and fungal disease respectively in rice (Oryza sativa) crops, it causes yield loss and reduce the grains quality [14].

There are various diseases that affect food crops and cause huge damages to crops, frightening the livings of helpless farmers and the food and nutrition security of masses [15].In this study [16], firstly, used convolution neural networks (CNNs) to extract the rice leaf disease images features. Then the SVM method is applied to classify and predict the specific disease.

As nearly half of the people in the world live on rice, so the rice leaf disease detection is very important for our agricultural sector [17]. Many researchers worked on this problem and they achieved different results according to their applied techniques.Rice is a staple food feeding more than half of the world’s population. Rice disease is one of the major problems affecting

rice production [18]. Machine Vision Technology has been used to help develop agricultural production, both in terms of quality and quantity.

III. PROPOSED METHODOLOGY

In the proposed method, the transfer learning based architecture is used to improve the overall performance of the system. In the proposed method, five disease ware classified which are, Bacterial leaf blight, Brown spot, Leaf smut, tungro and blast. The algorithms such are Xception, inception, VGG19 are used in the proposed method. Proposed an automated leaf disease recognition system. Leaf disease can recognize using PYTHON. Here it detects the diseases of leaf through image processing where we will give images of the disease affected crops. The image will go through several levels of processing to detect and identify the disease. System has concentrated on recognizing the paddy leaf diseases which assists the farmers to take a proper measurement and increases the production of paddy. The K-means clustering segmentation algorithm is used to segment the image and visual-based features i.e. color, texture, and shape features are extracted. At the end, SVM classifier is applied to classify paddy leaf diseases. This system provides a proper guidance containing instantaneous remedies based on the severity of the disease.

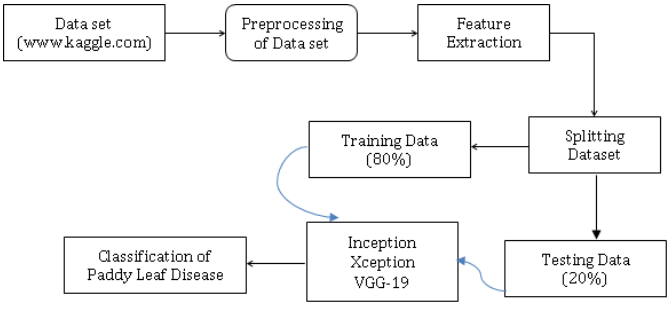

Figure 1. System Architecture

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

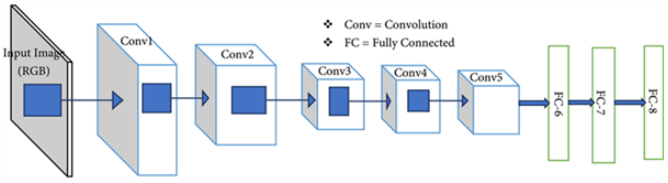

Figure 2. Architecture of AlexNet Neural Network

3.1 Modules Description

Data Collection

The data has been collected from the website called data world.org. The data set has 5 classes.In this process to collect a data from Kaggle. This Kaggle data collection has an only numerical value and in this data using multiple purpose.Kaggle supports a variety of dataset publication formats, but we strongly encourage dataset publishers to share their data in an accessible, non-proprietary format if possible. Not only are open, accessible data formats better supported on the platform, they are also easier to work with for more people regardless of their tools.

Preprocessing

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MODEL DEVELOPMENT

The use of Machine Leaning (ML) has increased substantially in enterprise data analytics scenarios to extract valuable insights from the business data. Hence, it is very important to have an ecosystem to build, test, deploy, and maintain the enterprise grade machine learning models in production environments. The ML model development involves data acquisition

from multiple trusted sources, data processing to make suitable for building the model, choose algorithm to build the model, build model, compute performance metrics and choose best performing model.

MODEL SELECTION

Model selection is the process of selecting one final machine learning model from among a collection of candidate machine learning models for a training dataset. Model selection is a process that can be applied both across different types of models (e.g. logistic regression, SVM, KNN, etc.) and across models of the same type configured with different model hyper parameters (e.g. different kernels in an SVM).

IV. RESULTS AND DISCUSSIONS

4.1 Dataset Description

Paddy, being one of the most important staple crops worldwide, is susceptible to various diseases that can significantly impact its yield and quality. Disease classification in paddy plants plays a crucial role in identifying and managing these diseases effectively. Here are some common diseases that affect paddy plants:

Bacterial Leaf Blight (BLB): Caused by the bacteria Xanthomonasoryzaepv. oryzae, BLB results in the development of water-soaked lesions on the leaves, eventually turning them yellow and causing wilting. It is a major disease in many paddy-growing regions.

Paddy Blast: Caused by the fungus Magnaportheoryzae, paddy blast is one of the most devastating diseases of paddy. It leads to the formation of lesions on leaves, stems, and grains, which can be oval-shaped and grayish or have a blast-like appearance.

Sheath Blight: Caused by the fungus Rhizoctoniasolani, sheath blight affects the sheaths of paddy plants. It results in the development of elongated lesions that initially appear water-soaked and later turn brown. This disease can cause lodging and reduce yield.

Brown Spot: Caused by the fungus Cochliobolusmiyabeanus, brown spot causes oval or diamond-shaped lesions on leaves. These lesions start as small brown spots and gradually enlarge, leading to premature senescence and yield reduction.

Tungro Disease: Tungro is a viral disease caused by the Paddytungro bacilliform virus and Paddytungro spherical virus. It causes stunting, yellowing of leaves, and reduced tillering. This disease is transmitted by insect vectors like leafhoppers.

Bacterial Leaf Streak (BLS): Caused by Xanthomonasoryzaepv. oryzicola, BLS results in the development of long, water-soaked lesions on leaves. The lesions turn yellow or straw-colored as they age, and severe infections can cause yield loss.

Paddy Grassy Stunt Virus: It is a viral disease transmitted by the planthopper insect. It causes stunting, reduced tillering, and yellowing of leaves. The plants also exhibit excessive vegetative growth and may produce few or no grains.

These are just a few examples of paddy plant diseases. There are several other diseases and disorders that can affect paddy plants, and each has its unique symptoms and management strategies. Proper disease classification helps in implementing appropriate control measures, such as the use of resistant varieties, cultural practices, chemical treatments, or biological control methods, to minimize the impact of these diseases on paddy production.

4.2 Experimental Setup

This paper investigates the use of transfer learning of deep CNN for paddy disease classification. We have used AlexNet for extraction of features and SVM for classification. The MatConvNet toolbox is used for implementation of Xception, inception, VGG19 model. The considered dataset has been randomly partitioned into training and testing set.

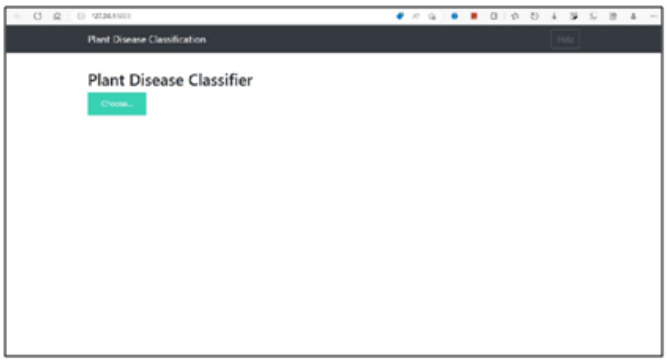

Figure 3. Front End of Paddy plant disease classifier

Figure 4. Input image

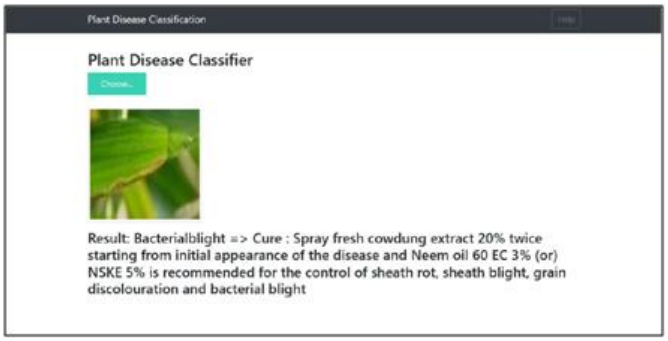

Figure 5. Disease Classification using Proposed Model

To analysis the effect of partitioning, three sets of training-testing partition has been done: (i) 60%-40%; (ii) 70%-30%; and (iii) 80%-20%. The experiment was carried out for 10 trails (10 times) by choosing samples randomly for each partition from whole dataset. Further, the classification accuracy was calculated by averaging the accuracy for 10 trails. The results are shown in Table 1. All of our experiments were performed on Intel Core i5-6200U CPU @2.40 GHz with 8GB RAM and NVIDIA GeForce 940M GPU. The classification accuracy of 93.24% has been achieved with training-testing partition of 80%-20%.

Table 1. Classification Accuracy with Different Training / Testing Partition.

Training / Testing (%)	Classification Accuracy (%)
60 / 40	89.53
70 / 30	91.25
80 / 20	93.24

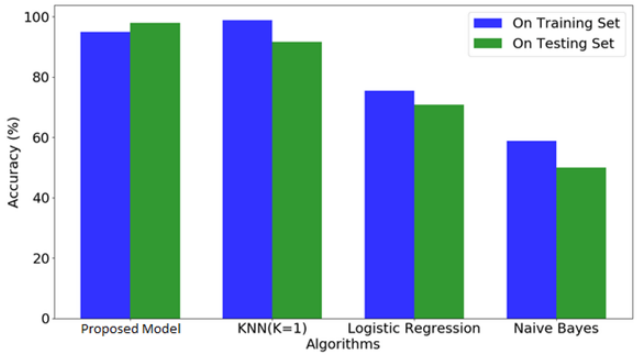

Figure 6. Accuracy Comparison

V. CONCLUSION

In this study, we demonstrated a pre-trained deep convolutional neural network of InceptionResNetV2 with transfer learning approach for the detection of paddy leaf diseases. The three major attacking diseases of paddy plant like leaf blast, bacterial blight and brown spot and healthy class are considered for this research. The simple CNN model was fine-tuned using different hyper parameters and achieved the accuracy of 84.75% by running 15 epochs. InceptionResNetV2 has attained an optimized accuracy of 95.67% using 10 epochs and by fine-tuning several hyper parameters. Future work will be the exploration on convolutional neural network for categorizing further types of paddy diseases and other plant leaf diseases. Additionally, we like to utilize nature inspired algorithms for selecting the best hyper parameters automatically for fine-tuning the CNN.

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