Identification of Rice Plant Diseases Using Image Processing, Machine Learning & Deep Learning: A Review

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Abstract

Agriculture is the primary source of livelihood for about more than 50% of the Indian population and rice is one of the major food grains of India. It is observed that rice plant diseases are the major contributors to reduce the production & quality of food. Identification of such diseases may improve the production quality. This paper gives an idea about different methods such as image processing, machine learning & deep learning which are used to detect deadly diseases in rice plants. Much research has been done to automate the rice plant disease detection process using images of the leaf. This manuscript has compared different rice plant disease detection methods and it is found that deep learning methods are more promising than other two methods.

Keywords

Rice plant, image processing, machine learning, segmentation, deep learning

1. Introduction

Agriculture plays an important role in the economic growth of every country and so it is necessary to ensure its development. The spread of various diseases in rice plants has increased in recent years. There is a variety of plant pathogens such as viral, bacterial, fungal and these can damage different plant parts above and below the ground[1]. However, some abiotic factors such as water, light, radiation, temperature, humidity, atmosphere, acidity, and soil also affect the growth of the plant[2]. Crop diseases are creating problems for farmers due to low output and economic losses and industrial agriculture[3]. So, it is need of the hour to detect such diseases as earliest as possible. Much research is going on in this field using various techniques like image processing, machine learning and deep learning. We have made a survey for disease detection based on these techniques and approaches to different rice plant diseases. It is observed that deep learning is giving the best results as compared to the other two methods[4]. This paper is divided into different sections: section 2 presents different types of rice diseases along with symptoms, Section 3 describes the methodology for plant disease detection. Section 4 depicts a comparative study among several related research works in rice disease detection and finally, the paper is concluded in Section 5.

2. Types of Rice Diseases

Rice plant diseases can infect rice at all growth stages and at its all parts (leaf, neck and root). These are mainly caused by bacteria, viruses, or fungi. Though there exist several rice plant diseases, based on the survey some of the most prominent diseases affecting the rice plant are listed in table 1.

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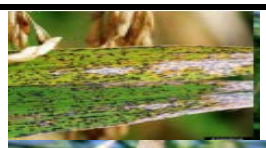
Table 1
Rice plant diseases and their symptoms

Disease	Caused due to	Image	Symptoms
Leaf Smut	Virus		small black linear lesions on leaf blades, leaf tips may turn grey and dry[5].
Bacterial blight	Bacteria		elongated lesions near the leaf tips and margins, and turns white to yellow and then grey due to fungal attack [5].
Brown spot	Fungi		dark brown colored and round to oval-shaped lesions on rice leaves[5].
Blast	Fungi		white to gray-green lesions or spots, with dark green borders. Older lesions on the leaves are elliptical shaped and whitish to gray centers with red to brownish or necrotic borders.
Sheath Blight	Fungi		Greenish grey spots on the sheath of leaf either in oval or elliptical are formed irregularly. The enlarged spots become grey combined with white with an outline border in purple brown or blackish brown can be seen[6].
Sheath Rot	Fungal & bacterial pathogens		The formation of small seized black lesions found on the sheath of the outer leaf close to the water line, which spread to the sheath of inner leaf resulting in the rotting of tissues[6].

3. Methodology Used

The basic steps of the rice plant disease detection system include different modules such as image acquisition, pre-processing, image segmentation, feature extraction, and classification.

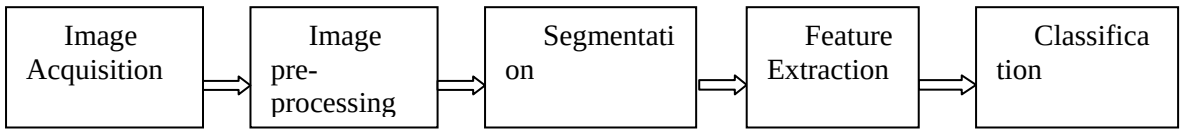


Figure1: Methodology for disease detection in rice plants

3.1 Image Acquisition

In image processing, it is defined as the retrieval of an image from some source which can either be manual capturing of images or some dataset. Most of the researchers have captured images using a

camera with high resolution in paddy fields and then resized the images into some definite number of pixels[7]–[9]. On the other hand, the dataset named UC Irvine Machine Learning Repository [1] and imageNet [10] is also used for image acquisition.

3.2 Image pre-processing

It includes resizing, cropping and removal of noise from the given image. The preprocessing step aims to enhance some image features that are required for further processing. This step includes the removal of some undesired features from the given image. For example, the background and an irrelevant portion of the image is discarded to reduce image processing time[11].

3.3 Segmentation

Segmentation is an important step in object recognition tasks. It transforms images into a form that is more meaningful and less complex to analyze. Here, an image can be divided into some regions based on the desired feature[12]. Several segmentation techniques are the Otsu segmentation method, K-Means Clustering, region segmentation, contours, etc.

3.4 Feature Extraction

The feature extraction process extorts the features from the segmented based on shapes, colors, and textures[13]. Some shape-based features are area, axis, and angle[14].

3.5 Classification

Classification is an important module in plant disease detection systems. It is defined as a process of categorizing plant leaf images based on identified diseases. There are two main classification techniques namely supervised and unsupervised. In Supervised classification, we have pre-trained data that helps to predict outcomes for some unforeseen data. The trained classifier is used to group different pictures. The Unsupervised order utilizes the properties of the pixels to bunch them, these gatherings known as a group, and process called clustering[15]. Some supervised classification algorithms like Logistic Regression, K-Nearest Neighbor, Decision Tree, Naive Bayes were applied for classification[16]. Also, the artificial neural network is one of the emerging methods of classification.

4. Comparative Analysis

In this section, the most recent proposed solutions that are performing best for different types of disease identification of paddy crops are presented along with their performance measure (Table II). Most researchers have identified four major diseases of rice plants: blast, bacterial blight, spot, and leaf smut. Different segmentation and classification techniques are used for detecting these diseases. K-means clustering and Otsu's method are giving significant results for segmentation. Further, it is observed that deep neural network and decision tree classifiers are giving the highest accuracy of >=97% for identifying rice plant diseases. Several researches have been done to find the optimum solution to identify most prominent diseases in the rice plant[17].

Table 2
Comparative study of methodologies applied on rice plant diseases

Author & year	Aim	Dataset/ Images	Methodology used	Diseases detected	Accuracy
Suresha M	Recognition of	330 images:	Global threshold	Blast and	76.59%

et.al(2017)	Diseases in Paddy Leaves Using kNN Classifier	out of these 60% of images are used for training and 40% of images are used for testing.	method and kNN classifier to classify data	Brown Spot diseases.	
S.Ramesh et al. (2018)	Rice Blast Disease Detection and Classification using ML	300 images	K-means clustering for segmentation and ANN for classification	Blast	90%
Taohidul Islam et al. (2018)	A faster technique on rice disease detection using image processing of affected area in agro-field	60 images	RGB for segmentation and Gaussian Naive Bayes for classification	brown spot, bacterial blight, and blast	Blast: Above 89% Bacterial Blight & Brown Spot: Above 90%
Kawcher Ahmed et al. (2019)	Rice Leaf Disease Detection Using Machine Learning	Training and Test dataset contains 432 and 48 instances respectively	KNNJ48 (DecisionTree), Naive Bayes and Logistic Regression. Decision tree algorithm, after 10-fold cross validation	leaf smut, bacterial leaf blight and brown spot	Decision tree algorithm: 97.9%
S.Ramesh et al. (2019)	classification of paddy leaf diseases using optimized deep neural network with jaya algorithm	450 images for training and 128 for testing	deep neural network with Jaya algorithm	Bacterial leaf blight, Brown spot, blast & sheath rot	97%
Minu Eliz Pothen et al. (2020)	Detection of Rice Leaf Diseases Using Image Processing	UC Irvine Machine Learning Repository	Otsu's method for segmentation and SVM for classification	Bacterial leaf blight, Leaf smut and Brown spot	94.6%
Md. Ashiqul Islam et al. (2021)	An Automated Convolutional Neural Network Based Approach for Paddy Leaf Disease Detection	984 images	CNN	leaf smut, leaf blast, bacterial leaf blight, and brown spot	Inception-ResNet-V2 is 92.68%.

5. Conclusion & Future scope

Rice plant diseases can reduce the production of the crop. So, it is the need of the hour to find an optimum solution for this problem. Different techniques are applied on diseased rice images so that further research can be made in this area to improve the overall performance of the rice disease detection system. This paper reviewed and summarized techniques of image processing, machine learning and deep learning that have been used in disease identification.

It is found that extraction of the affected region from the leaf image is the utmost important step, for which we have studied different segmentation techniques. A comparison between different methodologies for rice disease detection has been made and it can be concluded that deep neural network and decision tree classifiers are giving highest accuracy of >=97% for identifying diseases in rice crop. Still there is a need to work to identify more rice plant diseases other than the four major diseases which are discussed in this paper.

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