PADDY LEAF DISEASE SYMPTOMS DETECTION THROUGH ARTIFICIAL NEURAL NETWORK

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Abstract. Changing from one disease control strategy to another presents significant challenges for farmers. It can be costly to diagnose and categorize diseases just by naked-eye observation. By shortening the life of the plants, numerous plant diseases represent a serious threat to the agricultural industry. The goal of the current work is to provide a straightforward system for paddy disease detection. Usually, the leaves, stems, or fruit are examined to identify the attack signs. The effective method for diagnosing plant diseases by inspection of leaf features is included in this suggested system. To assess the health of the rice plants, experiments are performed on the set of leaves according to the classified form. Diagnosing plant diseases requires both science and art. Inherently visual, the diagnosis process (i.e., identifying symptoms and indications) calls for both intuitive judgement and the use of scientific principles. The first step in the process is input as image. From the segmentation output, color features like hue saturation value (HSV) features are retrieved, and an ANN is then trained by selecting the feature values that can accurately distinguish between healthy and diseased samples. According to experimental findings, symptoms detection performance using ANN with accuracy is better. In the current study, a method for early and precise detection of paddy leaf diseases employing a variety of image processing techniques and ANN is the more accurate approach for this.
Keywords: *paddy disease, feature extraction, ANN, HSV, performance, accuracy*

Introduction

In many nations, including the most populous ones like China, India, Pakistan, and others, rice is the main component of the diet, making it one of the most consumed foods worldwide. In the east of India and Pakistan, rice is mostly produced. A total of 2.6 million acres are used to grow the country's 7.5 million metric tonnes of rice. Rice exports generated $1.677 billion in revenue for Pakistan in 2017–2018, accounting for 0.6% of the country's GDP and 3.1% of services with value added. With a total yield of 7.442 million metric tonnes, rice was produced on 2793 thousand hectares of land (Ali et al., 2021). There has been a dramatic decline in rice production recently for several reasons. The diseases or ailments that affect rice plants are one of the key causes. The identification of plant disease is one of the crucial study areas in the agricultural industry (Yusof et al., 2018). Recently, it has become difficult to identify and classify plant diseases. Asian nations deliver and consume 91.05% of the world's rice, according to the Food and Agriculture Organization of the United Nations (FAOSTAT) overview. The remaining rice generation is distributed across various regions of the globe (Varma

et al., 2017). Machine learning is currently being used extensively in the fields of computer vision, object recognition, and plant health monitoring, in particular (Fuentes et al., 2017; Qin and Zhang, 2005). In terms of image identification, speech recognition, and natural language processing, neural networks and deep learning now offer the greatest answers (Nielsen, 2015). Researchers still use powerful computer technology in almost every field of study.

A disease is the occurrence of a shift from the normal to bad operation of the paddy or the part that can be affected by the producing agent such as nematodes, fungi, bacteria, or viruses (Narmadha and Arulvadivu, 2017). The farmer's difficulty that results in significant injury is the illness that develops in the plant during the growth of the paddy (Ramesh and Vydeki, 2018). Every portion of the plant, including the paddy throughout all its developmental stages, is susceptible to disease. There are claims that four primary paddy diseases, including leaf blast, brown spot, bacterial leaf blight and tungro, can attack rice fields in Indonesia (Asfarian et al., 2013). Blast, sheath blight, and brown spot are three significant diseases that were detected in Sri Lanka (Anthonys and Wickramarachchi, 2009). Research in India has identified a wide range of rice leaf diseases, including bacterial blight, brown spot, leaf scald, and leaf blast (Sethy et al., 2019). Experts typically use their own eyes to observe plants to manually identify plant diseases, which takes more time and is more expensive on large farms (Mohanty et al., 2016). It is challenging to process, and occasionally it results in a mistake when determining the disease type (Mahlein, 2016). The production of rice has decreased in recent years because of inadequate management to correct rice plant leaf defects (Pinki et al., 2017). A suitable and quick detection system for rice leaf disease is required to combat this. As a result, this paper suggests a novel technique for identifying rice plant illnesses from their images. The four most prevalent diseases of rice plants such as brown spot, leaf blast, bacterial blight, and sheath rot are the main subject of this study.

Related work

The diseases of the rice plant have been found to be the main causes of the decline in food output and quality. Dr. Kavita Bhosle and Shweta Ghorpade describe a 6-layered Convolutional Neural Network (CNN)-based model for diagnosing illnesses of the rice leaf. They make use of the Kaggle dataset for photos of rice leaf disease in addition to a fresh collection of field data (Hossain et al., 2020). A. Sony applied a CNN using the R-programming language to identify rice diseases using photos of diseased leaves. The three different disease types which are bacterial leaf blight, brown spot, and leaf smut, represented in the illness photos gathered from the UCI Machine Learning Repository (Sony, 2019). An architecture for the fully connected CNN that was developed for automatic feature extraction, detection, and classification was proposed by Santosh Kumar Upadhyay and Avadhesh Kumar. Using images of rice plant leaves with early-stage brown spots, developed-stage brown spots, and healthy leaves, the CNN-based classification model is trained and verified. The suggested model is shown to have a 99.20% classification accuracy (Upadhyay and Kumar, 2021). The researchers described four different diseases and one healthy leaf class of the paddy has been the focus of research. Their top priority was to produce the most accurate results for paddy leaf disease identification using an automated detection strategy with deep learning CNN models. It has examined four models: VGG-19, Inception-ResNet-V2, ResNet-101, and Xception. The accuracy of Inception-ResNet-V2 was found to be 92.68% (Liang et al., 2019).

An efficient approach for identifying rice leaf disease is the suggested methods, the input image is pre-processed, the paddy plant disease type is identified using the gray-level co-occurrence matrix technique, and ANNs are utilized as classifiers for greater detection accuracy (Kiruthika et al., 2019). Furthermore, another recent research which achieved high accuracy of 98.9% for the affected blast, 95.78% for the bacterial blight, 92% for the sheath rot, 94% for the brown spot, and 90.57% for the normal leaf image is (Ramesh and Vydeki, 2020). An automated method for detecting rice leaf disease using SIFT (SVM classifier analysis), features are retrieved for the examination of paddy blast and brown spot disease. A 95% accuracy rate was attained (Pavithra et al., 2015). The researchers provided a methodology for identifying the illness that affects the paddy plant. The transfer learning paradigm, which was created to successfully solve the difficulties of deep learning, is utilized by the model (Rautaray et al., 2020). Plant diseases can seriously jeopardise the safety of food production while also having a devastating impact on the quantity and quality of agricultural products. Numerous techniques have been developed for the purpose of identifying plant diseases; however, deep learning is the preferred technique because of its greater performance (Daniya and Vigneshwari, 2022). The CNN method was created to detect paddy crop illness using an image and deliver the appropriate treatment. Regarding the use of pesticides or insecticides to treat the condition, the medicines offer the necessary information (PrajwalGowda et al., 2020). The CNN weights were then applied to new rice leaf images to test their performance. Utilizing transfer learning, the Inception v3 model is used to determine the best weights for testing and validation of the suggested technique. The proposed model beats existing models in terms of detection performance, according to the results, which show that the model's accuracy is 94.48% (Poorni et al., 2022). Paddy disease detection through edge detection methods applied with its processing time and calculation of the time described in the Khan et al. (2023).

Materials and Methods

Proposed system

The researchers proposed a method that helps detect diseases in rice leaves, which will help farmers detect disease and put the required precautions in place to boost rice production. The leaf boundary was eliminated from the photos by the researchers using several pre-processing techniques. Researchers photographed rice leaves with damage. The main objective is to locate the disease-causing leaf spot in rice crop leaves. This indicates that leaf spot disease accounts for about 80–90% of the diseases affecting rice harvests. Therefore, areas that involve distinguishing between the rice leaf and the whole grain are important. Researchers used an ANN as the classifier to compare the input test image to the database image in order to detect the proper ailment. The major objective of the proposed research is to identify diseases in rice leaves. As a result, ANN can recognise infected rice crop leaves with great speed and accuracy. It is already well established that the field of computer science known as artificial intelligence (AI) is devoted to the creation of software capable of complex, intelligent computations identical to those that the human brain does frequently. It encompasses techniques, tools, and systems designed to mimic how people acquire knowledge logically and inductively and use their brains to reason through difficulties. AI developments fall into two primary groups. The first category consists of techniques and programmes, such as expert systems, that imitate human experience and derive conclusions from a set of

rules. The second has ANN-based systems that simulate how the brain functions which described with their properties in *Table 1*.

Table 1. *Comparison of cenventional computing and ANNs in the form of special properties.*

Properties	Conventional computing	ANNs
Examples	Expert systems	Networks
Learning method	By rules	By examples
Phases	Didactically	Socratically
Functions	Logically	Perceptual pattern
Processing style	Sequential	Parallel

Artificial Neural Network (ANN)

The ANN is a reliable data treatment system that can capture intricate, non-linear relationships between inputs and outputs. Each neural network consists of three levels: an input layer, an output layer, and one or more hidden layers. Neurons serve as the connecting elements between the layers. The formula illustrates a common architecture with lines connecting the neurons. A numerical value called "weight" is assigned to each link. The output, h_i, of neuron “i” in the hidden layer is:

$$h_i = \sigma\left(\sum_{j=1}^{N} V_{ij} x_j + T_i^{\square id}\right) \qquad \text{Eq. (1)}$$

Where, N is the number of input neurons, V_{ij} is the weight, x_j is the input to the input neurons, and $T_i^{\square id}$ is the threshold term of the hidden neurons. This function is known as the "activation" (or "transfer") function σ(). In addition to adding non-linearity to the neural network, the activation function aims to constrain the value of each neuron so that the network is not paralysed by divergent neurons. A frequent example of the activation function is the sigmoid (or logistic) function. The architecture of the ANN along its layers is shown in *Figure 1*.

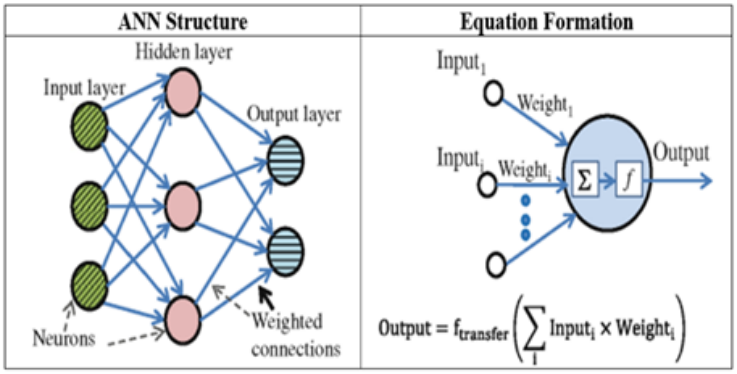

Figure 1. *The ANN structure with its equation formation.*

System architecture

The study follow certain procedures to diagnose paddy illnesses using rice leaves. First, the incoming image will go through pre-processing to extract features like color. These characteristics will be compared with the input image using ANN to find

diseases. *Figure 2* illustrated all the steps of the proposed framework to detect the paddy disease. It consists of the seven steps listed below. This research began with ANN training for several diseases of rice leaves. The ANN is then given the features of the input test image, which it compares to the features of the database image and outputs correctly.

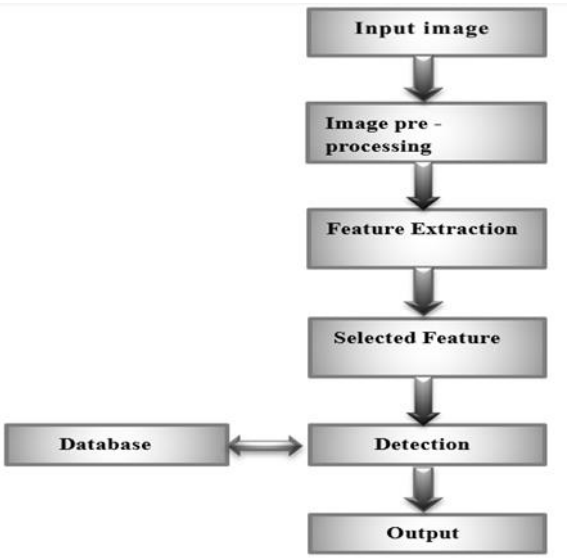

Figure 2. *The proposed framework.*

Input image

The ANN that researchers have trained can test any image of rice leaves for paddy disease, whether it is present in the database or not

Image preprocessing

The term "image pre-processing" refers to operations on images at the lowest level of abstraction whose goal is an improvement of the image data that suppresses unwanted distortions or enhances some image features crucial for further processing and analysis. This task does not increase the amount of image information, however.

Feature extraction

This phase's goal is to identify and extract characteristics that can be used to interpret a particular sample. The RGB image will be converted into a grayscale image and assigned a value to obtain features.

Detection

The input image will be compared by the classifier to database entries that contain sick leaves. For the purpose of identifying the paddy disease in rice leaves, the researchers are using an ANN as a classifier. *Figure 3* described the step-by-step database creation for feature extraction of paddy disease.

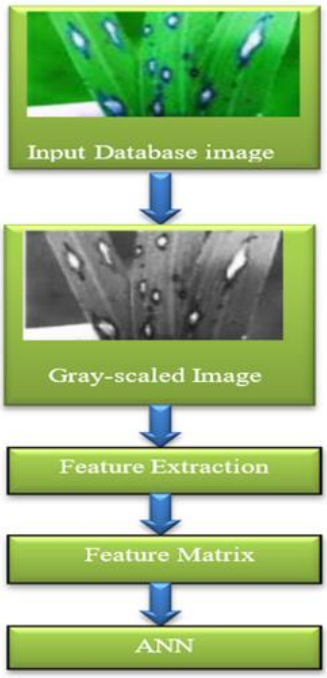

Figure 3. *The flowchart for database creation.*

Results and Discussion

Disease types

Only insects and diseases can account for the loss of several grains of food. All across the world, research is being done to obliterate these rice-related problems. Twenty rice diseases were reported in Bangladesh, out of a total of more than 30 rice diseases, according to the 1979-1981 study (Miah et al., 1985). However, 13 ailments are widespread throughout the year. With their symptoms and descriptions, only the diseases that have been addressed in this research are briefly explored further.

Disease symptoms

To determine whether a pattern is emerging in the issue, the distribution of afflicted plants in an area of research is examined. An accurate diagnosis of the field issue can be made using the symptoms of impacted plants. The symptoms of rice diseases that have already been identified have been very precisely defined and documented (Mueller, 2008). These symptoms are listed in the *Table 2*, along with all their conditions.

Table 2*. The symptoms for each type of disease along its appearance on the leaf's.*

Disease type	Image	Symptoms
Bacterial leaf blight		Water-soaked stripes, elliptical form, pale yellow, yellow to white lesions, edges, vascular system

Brown spot		Oval spots, dark brown dots, spots are small, circular brown with gray/ whitish, blackish lesions
Leaf smut		Mass of spores, greenish outside, yellow orange inside, sticky material

Dataset description

Three paddy leaf diseases are brown spot, bacterial leaf blight, and leaf smut have been selected for this study. There are 598 images in the dataset. Data was gathered from a variety of online sources, including Kaggle and the UCI machine learning repository. *Table 3* lists the number of data points in the dataset and provides a detailed breakdown of the data for training, validation, and testing. The classifications of the dataset are described in *Figure 4*.

***Table 3**. Count check for training, validation and testing the images for each disease.*

Disease type	No. of image	Training & validation	Testing
Bacterial leaf blight	216	188	28
Brown spot	166	138	28
Leaf smut	216	188	28
Total	598	514	84

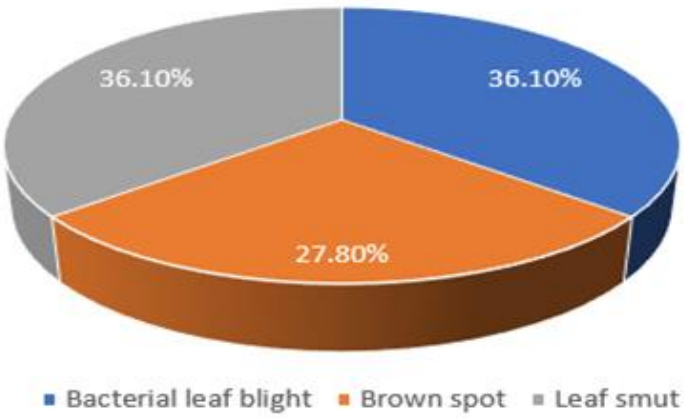

***Figure 4.** Data share percentages of types in the datasets.*

The features of the input image are retrieved by converting the RGB image to a grayscale image, and then several blocks of 10*10 size are produced. To identify blocks of various illnesses, researchers have given them distinct colours, such as red for bacterial leaf blight, green for brown spot, and blue for leaf smut. The researchers also display the proportion of leaf area affected by illness in the output. To do this, researchers divide the total number of blocks in the image by the number of blocks in

the diseased area. The pre-trained ANN model is implemented in the present investigation to classify and identify the leaf diseases. The model's study revealed that it showed good accuracy when evaluated against validation and testing datasets. The number of epochs that all training procedures anticipate being 100. *Table 4* provides each of these details.

***Table 4**. Accuracy measurement of the disease on validation and testing datasets.*

ANNs model on disease type	No. of images	Accuracy on validation	Accuracy on testing
Bacterial leaf blight	216	90%	90%
Brown spot	166	81%	84.6%
Leaf smut	216	85%	89.2%

Conclusion

The major goal of the suggested approach, which can identify leaf illnesses with little computing effort, is to identify the disease. This method can be applied to agricultural applications, such as the classifier-appropriate disease detection of plant parts like leaves. This project will outline a potential method for extracting basic image features like color. This essay discusses how disease analysis can be used to identify illnesses that affect rice leaves (paddy). By analyzing the several diseases that can affect rice leaves, it is feasible to identify them early before they harm the entire plant. Due to the proposed work's efficiency, which is around 80%, the offered model can identify the disease more precisely than other classifiers. Future work can focus on developing and implementing more accurate and efficient methods for paddy disease detection.

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Conflict of interest

The authors declare that there is no conflict of interest involve in this research study.

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