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# A Morphological Change in Leaves-Based Image Processing Approach for Detecting Plant Diseases

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**ABSTRACT-** In recent years, rice production is mostly affected by rice plant leaf diseases due to the unawareness of suitable management strategies. The paddy leaves are regularly impacted by Brown spot and Bacterial blight diseases, which result in creating major loss to the farm owners. The naked-eye observation is used by the farmer to analyse the condition of paddy leaves, but, it takes more time and the accuracy of it is based on the observer. The naked-eye observation is generally difficult and it has a high possibility of human error. To overcome these drawbacks, a fast and suitable recognition system is required. Thus, appropriate methodologies are required for the determination of diseases in paddy leaf. The use of image processing is seen as a non-intrusive method that offers farmers a precise, economical, and trustworthy solution. Therefore, this research work, focused to provide the fast recognition system to detect leaf diseases in paddy crops.

**Keywords:** Morphological, Leaves, Image, Segmentation, Plant Diseases, Brown Spot.

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## 1. INTRODUCTION

The plant disease affects the plant physiological function and creates severe destruction to the field. Further, the plant diseases may propagate to other plants through several means. The occurrence of each disease in the plant is found by its symptoms, which may present in a variety of parts of the crops, such as roots, fruits, leaves, flowers and stem. Disease in plants can create unnecessary changes in appearance, size of fruits, leaves, flowers and stem.

The disease in plant leads to the reduction of crop production by affecting the quantity as well as eminence of the yield. The predominant food crop of Asian countries is rice. This is the major food source for south Indian people too. Many techniques are developed to increase the crop yield to satisfy the huge need for rice crops [1]. This food grain is grown in huge fields of paddy and hence the spread of any disease would severely affect the productivity.

Such harmful diseases infect the plant due to several biological reasons, which are discussed below.

**Bacterial Diseases:** If the plant diseases occur due to bacteria, it is referred to as bacterial disease. Bacterial leaf spot is known as the plant disease which is generally caused by bacterial infection. This bacterial leaf spot mostly affects the young leaves and the affected leaves look like dark, greasy, twisted, water-soaked - appearing lesions.

**Viral Diseases:** Both lives of plant and production are affected by viral-based diseases. In viral diseases, the symptoms prominently occur on the plant leaves, but, several viruses may affect the other parts of the plant such as roots, leaves and fruits [2]. The identification of symptoms of viral diseases is difficult compared to the symptoms of bacterial diseases. As a result of viral diseases, the growth of plants is affected, likewise, the leaves may appear as curled and wrinkled.

**Fungal Diseases:** Fungal disease can propagate from one plant to another plant by factors like water and wind. It affects the seed, yield and soil. The fungal disease affected plant appears as water-soaked, gray-green spots. After the formation of gray-green spots, white fungal is developed under the leaf of plant.

The productivity in agriculture is significantly affected every year because of the diseases, invasion of pathogens and climatic

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conditions. The weather conditions cannot be neglected, whilst, the propagation of disease and pathogens can be controlled. Some of the diseases which generally affect the paddy leaf are listed below. Sheath rot: Sheath rot minimizes the productivity by aborting or retarding panicle emergence and it also creates sterile panicles and unfilled seeds. This disease leads to reduction in quality and causes panicles to grains and rot with a change in original color [3]. The propagation of this disease is high in wet weather conditions than dry conditions. If the planting density is high, the propagation of this disease will be high. This disease enters into the plant through the wounds and injuries caused by insects like stem borers. Sheath rot is a fungal disease which creates young panicles, therefore, the rotting of leaf and the damaging can be controlled by spraying the fungicides at the time of emergence. The conditions such as temperatures (20-28ºC), high nitrogen fertilizer application and high relative humidity make the propagation of this disease easier. The paddy leaf affected by the sheath rot is shown in *figure 1(a).*

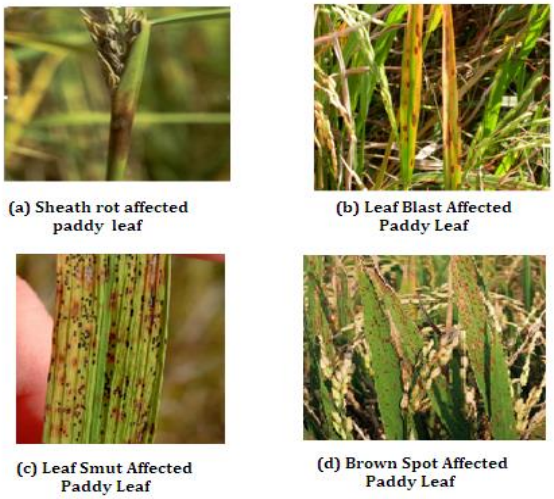


**Figure 1:** Paddy leaf affected by various diseases

**Leaf blast:** The fungus named as Magnaporthe oryzae creates the Blast. The parts of rice plant exist above the ground surface such as the neck, collar, and parts of panicle, node, sometimes leaf sheath and leaf are mostly affected by this disease. The factors like minimum temperature in the daytime, low soil moisture, prolonged and frequent rain showers creates more damage. The dew formation is happening on the rice plants, in upland, due to the temperature difference created between the night and day [4]. This cooling condition is favourable for this disease to spread. The blast disease influences the plant at both growth and primary stage. Nevertheless, the impact of the blast is low in the adult plant because it has more resistance to the disease. The *figure 1(b)* shows the paddy leaf which was affected by the leaf blast.

**Leaf smut:** If the plant leaves have the appearance such as angular patches, minute and sooty dull and the presence of leaf smut disease could be confirmed. The leaf smut is created by the fungi. This disease influences the entire leaf surface. The teliospores that are light brown in colour, smooth-walled and angular to globose in the paddy leaf are caused by entylomaoryzae. The disease is spread *via* sori that exists in the infected plant. The infection may be propagated by spore that exists near the leaves. One of the major conditions for this disease is the presence of high nitrogen. The *figure 1(c)* shows the example of leaf smut affected paddy leaf.

**Brown Spot**: Brown spot is considered as one of the prominent and common rice diseases and it reduces the productivity of rice highly. It is known as a fungal disease, affecting the parts of plants such as spikelets, panicle branches, leaves, glumes, leaf sheath and coleoptile. The numerous big spots that exist in the plant leaf denote the influences of brown spot which can destroy the whole plant. In rice plant, discoloured or spotted seeds or unfilled grains are formed by the infection of brown spot. The conditions such as temperature (16-36ºC) and high relative humidity (86-100%) create the propagation of this disease. The toxic substances are generally accumulated on nutrient-deficient soil and unflooded soil. The wet condition in the duration of 8-24 hours is mandate for the occurrence of this infection. The life duration of this fungus is more than four years and can propagate via wind to various plants. The paddy leaf with the brown mark is seen in *figure 1(d*).

## 2. LITERATURE REVIEW

To enhance the contrast of an input image the preprocessing step is essential. The cameras and sensors are used to acquire the input images which have more noises. In addition to the poor back ground, noises usually affect the accuracy. Compared to the captured image the preprocessing makes the diseased regions of an image more visible [5]. Image Segmentation refers to partition the image into different parts. To detect disease region present in the image, segmentation is employed. In the segmentation, the region of interest is achieved by combining the similar pixel [6]. The leaves and fruits are affected by many diseases in agriculture. To overcome these issues various segmentation methods are included in the literature survey thereby easily detects the diseased region of the image. The authors of [7] provided a way to gauge the extent of spider mite damage to leaves. The segmentation technique used in this study is a two-stage thresholding approach. At first, the separation of background from leaf is performed and in the second stage discriminating the infected regions from healthy regions is carried out. Then these results are compared with the other methods. Then the authors are concluded that their method provided superior results than the leaf damage index and chlorophyll fluorescence techniques. The different causes of plant diseases are listed in the *figure 2*.

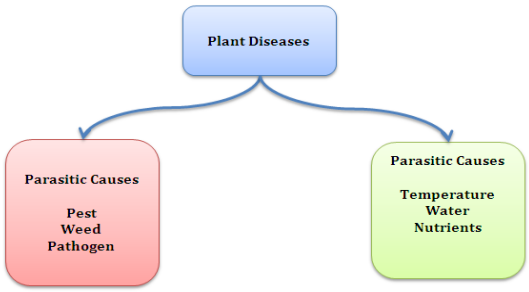


**Figure 2:** Causes of Plant Diseases

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In [8] author's described a method to predict sugar cane leaves fungi-related disease severity level. The two-segmentation process is carried out. Binarization is computed using Triangle thresholding method and then using the binary image the infection ratio is determined. In [9] authors presented a Fuzzy logic based technique for the quantification of disease symptoms. The authors used pomegranate leaves for testing. In this technique first L*a*b* color space conversion is applied for input image. Then, K-means clustering is employed to cluster the group of pixels. The authors concluded that the diseased areas are identified using one of the groups by using Fuzzy Inference System to achieve the final evaluation of the disease rating. The information of how much a system is applied were also absent.

In [10] authors developed an enhanced K-means clustering algorithm. Based on the time complexity and the diseased region experimental analyses are made on the test image samples. The authors suggested the methods of detecting plant diseases and also gave solutions to rescue from these diseases. In [11] authors proposed the system for recognizing the diseases in plant leaves. The results revealed that their method was superior the detection of diseased leaf. Automatic techniques were used to identify the infected region of input leaf image. Then using K-means algorithm was used to obtain the clustering of images. This technique paved the way for farmers from huge loss. In [12] author's reviewed different kinds of image segmentation technique details and made a comparison between those techniques. The detailed segmentation techniques in this work are suitable for medical image applications, object detection and identification. These techniques are used to detect cancer in a medical field and detect roads and bridges in satellite images. From this survey authors concluded that for every image no single method is enough and for a specific image all methods are not suitable. The picture segmentation method was selected based on the application. That is a herculean task in segmentation method selection. In [13] authors presented the image segmentation system based on genetic algorithm which adopts the image characteristics change with respect to the different environmental changes. The author's main objective of this work is to provide an efficient adaptation for the dynamic environment. From the experimental results they have demonstrated that their system provides the better segmentation performance for the outdoor colour image establishment. In [14] authors described the system to find the K-means clustering algorithm effects with various computation parameters. The object is categorized to its relevant class through feature extraction. In agriculture, the different feature extraction techniques are employed to extract the features. In [15] author's described methods, which helps for an early and accurate detection of diseases in pomegranate leaf. After capturing the image, they used median filtering for preprocessing. From the results the authors extracted the colour and texture features. Then, the classifications are performed. The authors proved that their system providing instant analysis of the product quality by detecting the diseases of pomegranate leaf. In [16] authors proposed an involuntary system for the organization of fungal diseases present in the vegetable crops using Local Binary Pattern (LBP). The disease severity leave are computed using pixel's average the leaf. Further the manual and obtained results are compared. Also, they compared the results based on the capturing device type. In [17] authors described a local binary pattern feature extraction method for the detection of healthy and diseased leaves. The segmentation of this work involves the segmentation techniques such as Global thresholding. Otsu method. Then the classification of plant leaves is achieved using KNN classifier. The disease recognition accuracy is obtained as 84.43%. In [18] authors exposed, an advance computing technology for the classification of cotton leaf spot images captured from mobile. The authors proposed the HPCCDD classification algorithm for classification, which is trained to provide an intelligent farming. This proposed work is utilizing ranging values to identify the diseases. First the enhancement was performed after that the disease spots are obtained using color image segmentation. Then to extract the edge features Homogenize methods of Sobel and Canny filter are used. Then the classification is done using the extracted features. Finally, pest suggestions also provided to the farmers to rescue from yield loss. In [19] authors proposed the method for quantifying the symptoms of yellow starthistle disease. A flatbed scanner is used to capture the images and the diseased regions (pustules) are emphasized by applying simple operations. To extract particularly the diseased regions, a shape-based selection is performed. Finally, the diseased regions are counted. In [20] authors proposed the six categories of mineral deficiencies occurred in rice crops rice. The texture and color features were extracted using the proposed algorithm. Then each type of feature was given to respective MLP neural network. Then the results obtained by both networks were combined to provide the final classification. The obtained results are cross-validated using other classification methods. According to the authors, their method effectively discriminates between diseased and healthy parts for various conditions and species of plants. The authors tested some species such as Grape, Paddy, okra, etc. They obtained the optimum results with very less computational efforts which also showed the disease detection efficiency. In [21] authors portrayed the various algorithms that are used to achieve the thigh accuracy in an automated system. In this work, the authors have analyzed different rice plant leaf disease using distinct classifier combinations. In [22] authors portrayed an image processing system for recognizing unhealthy region of the plant. In this work the authors efficiently utilized the neural networks and ayes theorem to detect the infected leaf and categorized the disease. But neural network computation complexity of is very high. In [23] authors analysed and described the different research works based on various classification algorithms for the disease detection. Classification algorithms had a variety of applications like Marketing, Disease Diagnosis in medical field, Social Networks, and artificial Intelligence *etc*.

## 3. MACHINE LEARNING TECHNIQUES USED IN AGRICULTURE

In order to maximize productivity, strengthen agricultural sustainability and minimize post-harvest processing, different types of modern technologies have arisen. In the detection of plant disease, techniques such as thermography and mass

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spectrometry are used. These techniques are consuming low cost, but, more time to detect the diseases [24]. In recent days, mobile and server-based approaches are also used for the determination of plant diseases. To detect the plant disease automatically, some special features such as extensive built in accessories, high-resolution camera and high-performance processing are combined with the above-mentioned approaches. For enhancing both accuracy and recognition rate in those approaches, deep learning or machine learning algorithm are implemented [25]. Based on the different criteria such as application domain, representation of knowledge and underlying learning strategy, the machine learning methods are categorized. ML is used in application domains such as chemical formula optimization, airline seating allocation, marketing analysis, credit card fraud detection, speech recognition, quality control in manufacturing, automatic classification of celestial objects, food and handwritten character recognition. At present, machine learning techniques are also deployed in agriculture sector for recognition of medicinal plants, classification of grains, recognition of objects, detection of weeds and grading of fruits etc.

SVM is considered as one of the major classification algorithms which can solve variety of classification tasks. Both nonlinear and linear data can be classified by using SVM. In the beginning, with the help of kernel functions, the data is mapped by SVM nonlinearly into a high-dimensional space. The linear optimal hyper plane divides the data with high margin, in which, the hyper plane is found by high-dimensional space. The advantages of SVM include the ability to handle high dimensional data, higher accuracy and robustness even in the presence of distortion in the training samples. However, the mapping of data to produce higher dimensional data and the selection of both kernel parameters and kernel function are very critical and it consumes much time. Artificial neural networks may be referred to as the combination of many classification techniques. ANN works on the principle of operation human biological nervous system, and its robustness is high at the interpolation of large amounts of ambiguous data. Artificial neural networks are popular among the commonly used techniques for identification and detection of plant diseases. It is used with various image pre-processing techniques for the extraction of useful information. ANN has the advantage of being robust and providing better accuracy even with complex and noisy data. Nevertheless, the high accuracy could be achieved through repetitive training, which might take longer duration. It also suffers with scalability issues.

The data present near to closest k neighbours is categorized. KNN algorithm employed in diseases recognition system as a classifier to categorize the leaves according to perimeter and area values, shape roundness value and mean colour values.

KNN has the advantage of implementation is very simple, and robust, few parameters to tune (distance metric and k) and some of the disadvantages are less sensitivity to irrelevant and noisy data. In both regression and classification, random forest (RF) is mostly utilized. It has an ability to classify a large number of the dataset. According to the forest and randomly sampled values, the tree is working. The input direction is from the top to bottom of tree.

## 4. PROPOSED MODEL

In India, farmers produce agricultural products and there is increased consumption of agriculture products due to the high population growth. In south India, rice is the main ingredient in all the food items prepared on a daily basis. Hence, it is cultivated in more agricultural field, than other crops. Huge loss in rice cultivation is incurred due to diseases than the other challenges like environmental conditions and pests.

In any stage of rice crop, like the nursery stage and main field stage, the crop may be infected by either fungal or bacterial based diseases. Brown spots, tungro, and blast are known as the several fungal and bacterial vectors-based diseases. Among those diseases, the blast disease creates grain losses in rice cultivation, nearly 72% to 85%. The blast disease may only harm a relatively tiny portion of paddy leaves at the nursery stage before it spreads to the whole rice crop, resulting in significant crop loss. This paper is focused to provide a machine learning technique to find the blast disease by using the KNN and ANN classifiers. Eventually, an appropriate confusion matrix is employed to analyses the performance of both classifiers.

KNN algorithm is the most utilized and simplest machine learning algorithm, for the purpose of classification. The KNN classifier is used in the database for dividing the data into several classes to predict the classification of a new sample point. According to a similarity measure, the KNN classifier can classify the new cases and store all available cases. The suggested model's flow diagram is shown in *figure 3*.

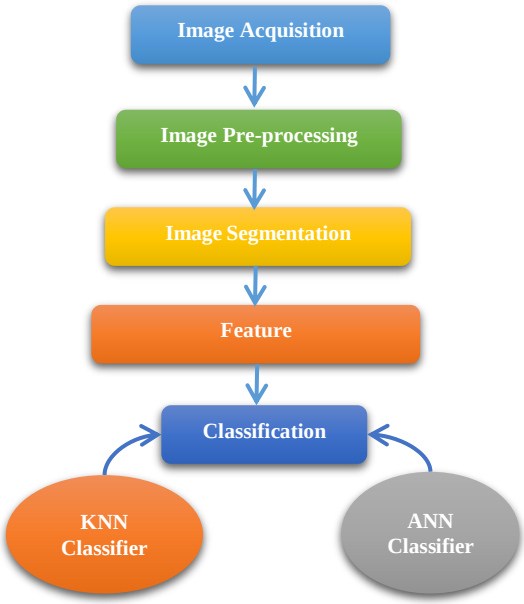


**Figure 3:** Proposed Model

An ANN is known as a computational model which works according to the functions and structure of biological neural networks. The relationship between the outputs and inputs are

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modelled with the help of non-linear statistical data modelling tools that exist in the ANN. ANN Classification is considered as a Supervised Learning method. The performance of the system is indicated by the known class labels. ANN classifier is required to differentiate the various cases present in the system. In this research work, 550 images are used to train the classifier, in which, 250 images consist of the normal paddy leaf images, whilst, 220 images consist of the blast affected paddy leaves. In the 130 images, employed for testing, the number of blast affected paddy leaf images are 80, and, normal images are 60.

In spite of the better performance of hybrid algorithm, the time consumption is higher in the stage of classification. Hence, the corresponding performance gained could be achieved by the utilization of single enhanced alternative classifier for minimizing the overall classification time. Human vision-based approaches are earlier used to detect leaf diseases. However, it takes more time and provides less accuracy and also suffers many limitations. The research work presented in this article is improving the causes of several plant diseases, different paddy diseases which appear in the farm field and the procedural steps of image processing techniques are discussed.

In the step of pre-processing, reduction of image dimensions and the background removal takes place.

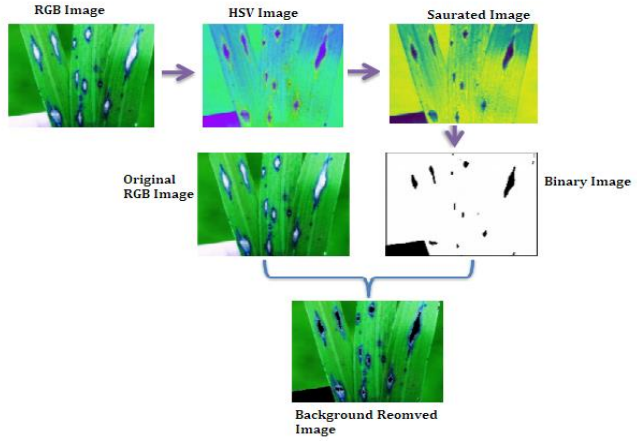


**Figure 4:** Image Pre-processing

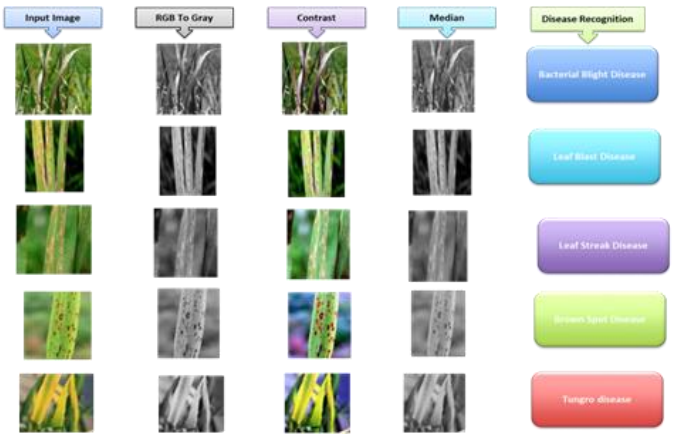


**Figure 5:** Pre-processing Results for the sample images

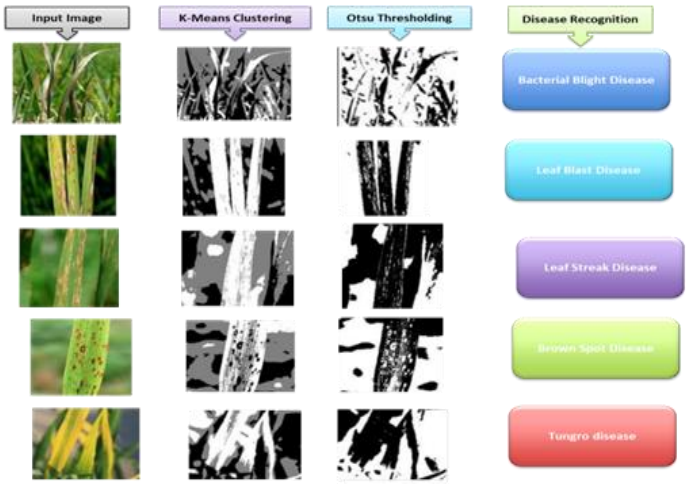


**Figure 6:** Segmentation Results for the sample images

The process of collection of images for this research is called as image acquisition. A high-resolution digital camera is used for capture the leaves of rice plant and then the captured images are allowed to computer for disease detection. In the stage of pre-processing, dataset images are cropped and resized into 300x450 pixel dimensions for reducing the memory necessities and power computation. The background elimination of image is a superior aim of this phase and it is carried out by the application of hue value-based fusion. The image gets converted into binary image in accordance with the threshold value. A mask is then created due to the fusion of binary image and original image of RGB. The pre-processing steps involved in eliminating the background portion is visualized in *figure 4*.

It is the fundamental step, in which, the static or movement of a particular object is captured with the help of various devices such as camera or scanner. Mostly, the images are captured in the form of digital. If the acquired image is not in the form of digital, the ADC conversion process applied to the acquired image. Based on the type of application, the image sensor is selected. Typically, CMOS is mostly utilized, for instance, Scanner, Digital camera and Video camera. Digital computers are used in the stage of pre-processing (*figure 5*). Prior to pre-processing, the images must be converted into the digital format. The operation such as formatting of the data, correction and enhancement are performed in image processing for creating the picture with superior quality. The steps that follow pre-processing in digital image processing are segmentation of the images, feature extraction and classification of images.

In image segmentation, each image is split as a large number of parts or regions (*figure 6*). The number of parts mostly depends on the application and requirements of the user. As a result of image segmentation, the image is divided efficiently for further processing. The requirement such as editing, compression of image and recognition of objects are achieved in the segmentation step. Thresholding methods are also used in the image segmentation for enhancing the quality of the image.

Terminally, ANN and KNN method is applied as classifier to detect the diseases from the images. In this work, complete

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stability of the proposed system is obtained by sending feedback from classification to the segmentation phase. After the pre-processing of paddy leaf images, k-means clustering is employed for various k values for Image segmentation. *Figure 7* exhibits the sample result of the k-Means clustering implemented images affected by blast disease.

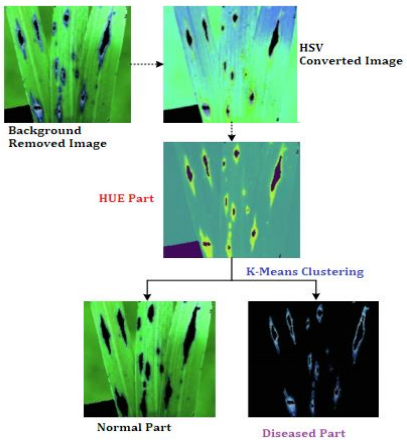


**Figure 7:** K-means clustering image

The features corresponding to the disease infection is extracted from the segmented images. The disease affected portion is calculated by the GLCM texture feature. The features such as mean value, standard deviation, energy, contrast, and homogeneity are extracted in the GLCM algorithm to determine the blast effects. A classifier uses these extracted features to define the sort of image, whether it is uninfected or infected. In KNN classifier, the value of k is fixed as 4, since the accuracy of KNN cluster is high when the value of k as 4. The leaf part with the background appears in the image, while the k value is 4. The accuracy of KNN classifier is 96% for normal images and 85% for blast affected images, at the selected k Values. The standard layered architecture is used in ANN Classifier, in which the extracted features are used in the input layer. ANN classifier produces more accurate value when five neurons are present in one hidden layer. The characteristics of paddy leaf indicated by the output layer. The working of ANN is based on the initialization of weights, updating of the weights, and feed forward back propagation. The accuracy of ANN classifier is 100% for blast infected images and 99.9% for a normal image.

## 5. RESULTS AND DISCUSSION

The analysis of various classification techniques to detect different types of rice crop diseases is presented in this work. Data set of images are acquired and processed by image processing techniques.

**Table 1: Performance of Classifiers – Blast**

| Classifiers | Accuracy (%) |
|---|---|
| ANN | 99.8 |
| KNN | 88 |
| DNN | 90 |
| DNN with Jaya algorithm (Agricultural environment) | 98.5 |
| DNN with Jaya algorithm (Greenhouse environment) | 98.8 |

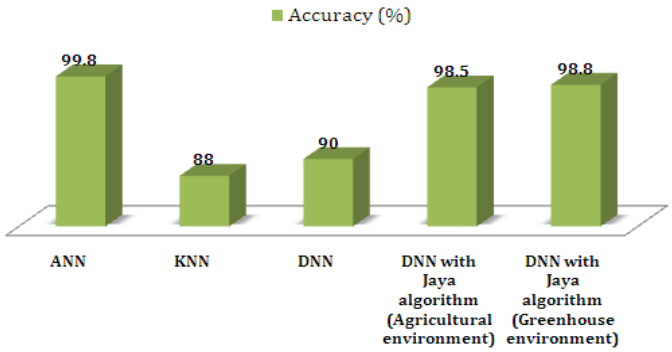


**Figure 8:** Comparative Analysis of Classifiers in Blast Affected Leaves

The performance of the classification algorithms are measured by the parameters such as are accuracy, precision, NPV, TPR, TNR, f1 score, FDR, FPR and FNR. Among these output performance metrics of classification, we mainly focus on the attained accuracy level of different classifiers. The classifiers perform more effective in image processing for identifying the appearance of several diseases. The performance of different classifiers with its corresponding diseases of images are categorized in the following portions. The accuracy performance of different classifiers when detecting the blast disease are listed in *table 1*. *Figure 8* shows the comparison of different classifiers accuracy level for blast disease detection. The ANN classifier presents optimal level of accuracy output with 99% while detecting the blast disease of rice plant and KNN classifier promotes less accuracy output. The accuracy performance of different classifiers are listed in *table 2* when detecting the normal portion of the leaves. *Figure 9* represented the comparison of different classifiers accuracy level for the normal leaves of rice plant. A potential method for 3D image-based plant disease diagnosis is emerging: hyperspectral imaging. Deep learning-based diagnosis of plant diseases is a natural match because to the substantial and sometimes redundant information that hyperspectral data cubes contain. New 3D, DCNN that directly incorporates the hyperspectral data for 3D images for the detection of Paddy diseases.

**Table 2: Performance of Classifiers – Normal**

| Classifiers | Accuracy (%) |
|---|---|
| ANN | 100 |
| KNN | 88 |
| DNN | 98 |
| DNN with Jaya algorithm (Agricultural environment) | 92 |
| DNN with Jaya algorithm (Greenhouse environment) | 97 |

**Table 3: Performance of Classifiers**

| Classifiers | Leaf Diseases | Accuracy (%) |
|---|---|---|
| DNN | BB | 95 |
| | BS | 95 |
| | SR | 94 |
| DNN with Jaya algorithm (Agricultural environment) | BB | 96 |
| | BS | 95 |
| | SR | 93 |

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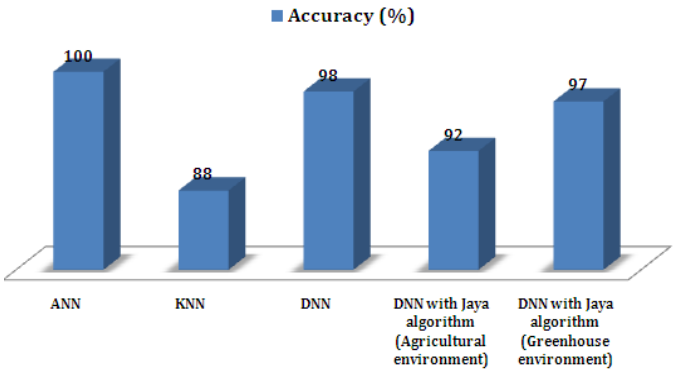


**Figure 9:** Comparative Analysis of Classifiers in Normal Leaves

The ANN classifier achieves 100% accuracy while detecting the blast disease of rice plant and KNN classifier promotes less accuracy output. The accuracy performance of different classifiers are listed in *table 3*. When identifying three diseases namely Bacterial blight, Brown spot and sheath rot. *Figure 10* shows the comparison of different classifiers accuracy level for detection.

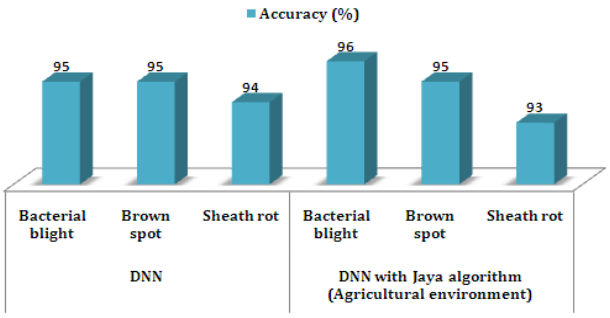


**Figure 10:** Comparative Analysis of Classifiers in Leaves

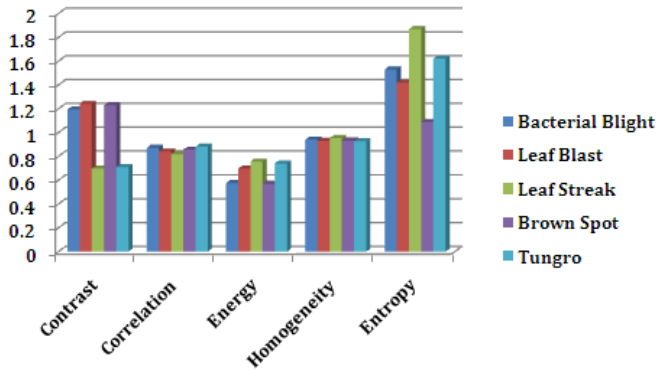


**Figure 11:** Feature vectors Extracted

The features for the sample pictures from the GLCM Method are shown in *figure 11*. Following that, the classifier will input the retrieved attributes to categories the images. DNN and DNN with Jaya algorithm are facilitated for the detection of remaining three diseases of rice plant such as, Bacterial Blight, Brown Spot and Sheath Rot. From the comparison, both the algorithms provide better performance in the detection of bacterial blight. As comparison, the DNN algorithm provides 95% of accuracy and optimized DNN with JOA classifier provides 96%. It also seems that, the optimized DNN with JOA provides better performance than the DNN type classifier. The precision and accuracy in human vision approach are based on the expert hired or the eyesight of the person. Machine learning-based methods have the ability to determine the types of diseases, to select proper treatment as well as make the right decision. The performance of machine learning is more consistent compared to other human experts. The requirement of new machine learning based classification approach is developed to eliminate the difficulties of previous manual methods. Existing models shown very less recognition accuracy in plant leaf disease detection especially, in paddy leaf.

## 6. CONCLUSION

In the precision agriculture, one of the evolving research area is an automation in system development for identification and the classification of several rice crop diseases. It may result in the improvement of quality and quantity of the agricultural product. The manual disease identification provides lack of accuracy for the farmers. Hence, it requires the method of image processing for the accurate timely disease detection of plants in several cases as it minimizes the application of human vision. The contribution of different types of classifiers in the disease identification scheme in the paddy crops are viewed from this research work. ANN classifier provides better accuracy outcomes, when detecting the blast disease of the plant. The remaining available diseases such as bacterial blight, sheath rot and the brown spot, are detected with better accuracy using optimized DNN with Jaya classifier. Finally, it was proved that, the paddy crops which cultivated in green house environment was more effective than the crops which cultivated from the agricultural environment.

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