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# PARTICLE SWARM OPTIMIZATION BASED RECOGNITION AND CLASSIFICATION OF RICE LEAF DISEASES

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## Abstract
Soft computing combines a set of computational techniques and algorithms to find solutions for real world complex problems. In this paper, the recognition and classification of rice leaf diseases by using particle swarm optimization algorithm to segment the disease affected portion of a plant leaf and extract the features for better classification of different disease patterns. In the proposed system, image segmentation is done using Particle Swarm Optimization (PSO) and disease identification is done using a minimum distance classifier. The proposed system conducted experiments on six types of diseases bacterial leaf blight, brown spot, leaf smut, blast, sheath rot and leaf scald with the 98.28% average accuracy of classification.

**Keywords**: rice leaf diseases, image segmentation, soft computing techniques, swarm intelligence, particle swarm optimization, and minimum distance classifier.

## I. Introduction
Rice is an important source of food for the people of our country and also major revenue generator to the farmers as well as the Indian Agro-economy. Plant diseases are one of the main causes for the reduction in quality and quantity of rice production agriculture crops. Bacterial blight, bacterial leaf streak, brown spot, leaf scald, sheath rot and blast diseases are the most common diseases that affect the yield of rice crops[1]. Hence, effective measures should be taken to identify diseases in the early stages of the crop to improve crop yield.

Monitoring the diseases, their occurrences and frequencies are very important for early detection of the affected plants, their timely treatment, and most importantly, for planning future strategies to prevent the diseases to minimize the losses. So it is essential to recognize and categorize diseases in crops as early and as accurately as possible. Disease detection by farmers manually on small scale form size is easy. But on a large scale, disease detection manually is a tedious job. So it is essential to recognize and categorize diseases in crops as early and as accurately as possible.

The advancement in the field of object recognition provides an opportunity for a more robust and accurate disease recognition. Recent enhancements in the field of machine learning and deep neural networks have provided fast and more accurate results. As one of the most acknowledged and widely-used Evolutionary Computing algorithms, PSO has been adopted in various optimisation problems, owing to its simplicity, fast convergence speed, as well as effectiveness and robust generalization capability. In PSO, each particle adjusts its search trajectory by learning from two historical best experiences, i.e., its own best position and the global best solution.

#### Particle Swarm Optimization (PSO)

Swarm Intelligence [2] is the study of collective intelligence behaviour of complex, self-organized and decentralized systems with social structure. Examples of SI include the group foraging of social insects, cooperative transportation, nest-building of social insects, and collective sorting and clustering. Particle swarm optimization algorithms are population-based optimization algorithms which are modeled after the simulation of social behaviour of bird flocks. PSO is an automatic unsupervised algorithm[3] which is used for better feature extraction. PSO is easy to implement and there are few parameters to adjust. PSO performs better than the GA with respect to computational efficiency[12].

PSO is initialized with a population of random particles (swarms) and then searches for optimal solution by updating generations. Each particle is being associated with position vector present[ ] and velocity vector v[ ]. The size of these vectors is equal to the dimension of the search space. In each iteration, each particle updates its trajectory towards its own best fitness solution as pbest and global best or swarm's best fitness value gbest. After finding the two best values, the particle updates its velocity and positions with the following equations.

v[ ] = v[ ] + c1* rand( ) * (pbest[ ] – present[ ]) + c2* rand( ) * (gbest[ ] – present[ ])
present [ ] = present [ ] + v [ ]

Where v [ ] is the particle velocity, present[ ] is the current particle (solution), pbest[ ] and gbest are their local and global best, rand ( ) is a random number between (0,1) and c1, c2 are pre-specified constants.
According to empirical studies [4] for standard PSO the value of parameters (w, c1 and c2) are considered as w should be about 0.7 to 0.8, and c1 and c2 around 1.5 to 1.7. In our study an experimental results show that the value of w and (c1 and c2) should be 0.9 and 1.2 respectively for image segmentation problem.

#### Minimum Distance Classifier

The minimum distance classifier[5] is used to classify unknown image data to classes which minimize the distance between the image data and the class in multi-feature space. The distance is defined as an index of similarity so that the minimum distance is identical to the maximum similarity. Euclidian distance, normalized Euclidian distance and mahalanobis distance are often used in this classifier.
On any plant, diseases are caused by bacteria, fungi, and virus. For rice plants, most common diseases are Brown spot, Leaf blast, Bacterial leaf blight, Leaf scald, Leaf smut, Sheath Rot, and Sheath blight. This article attempts to apply concepts of Machine Learning and Image Processing to solve the problem of automatic detection and classification of diseases of the rice plant, which is one of the important foods in India.

## II. Related Works

Some of the recent researches related to the recognition and classification of rice plant diseases are given as below.

D. Nidhis et al. [6] proposed a method using image processing techniques for detecting the disease type affected by the rice leaves. The severity of the disease infection was calculated by calculating the percentage of diseased area.

Ramesh and Vydeki[7] proposed a recognition and classification of rice leaf diseases using optimized DNN with Jaya Algorithm. Classification of diseases is carried out by using optimized deep neural network with Jaya optimization algorithm.

Rehman et al[8] reviewed statistical machine learning technologies current application of statistical machine learning techniques in machine vision systems, such as Naive Bayes (NB), discriminant

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analysis (DA), k-nearest neighbour (kNN), support vector machine (SVM), etc. in agriculture (Rehman, Mahmud, Chang, Jin, & Shin, 2019).

yangLu et al[9] proposed detection approach based on deep convolutional neural network feature maps to classify ten common rice diseases. Under the 10-fold cross-validation strategy, the proposed CNNs-based model achieves an accuracy of 95.48%.

Amrita A. Joshi et al. [10] extracted color and shape as feature vector of diseased rice input images. These extracted features are fed as input to two different classifiers namely Minimum Distance Classifier (MDC) and k-Nearest Neighbor classifier (kNN) and compared and accuracy obtained by KNN is 87.02 percent and by MDC is 89.23 percent that shows accuracy of finding disease of MDC is better than KNN.

Taohidul Islam et al. [11] recognized and classified three main types of rice plant diseases by using only one feature. They detected and identified the diseases by employing image processing techniques on the basis of percentage of RGB value of the diseased part and Naïve Bayes classifier for classification.

A new framework for classifying and automatically detecting diseases in rice crops through image segmentation using particle swarm optimization has been proposed to resolve the existing issues such as the speed of detection of disease, feature optimization, achieving high accuracy in classification. In the proposed system, population based swarm intelligence is used for image segmentation and disease detection is done using a minimum distance classifier.

## III. Proposed System

The proposed methodology shown in figure 1 involves a series of steps explained below:

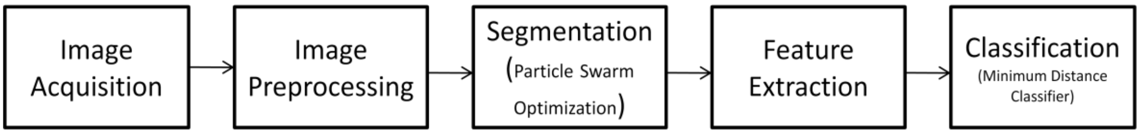


Figure1. Process steps

Step 1: Image Acquisition

Infected rice leaf images were collected using high resolution digital camera for the data set from the farms. Leaf images with above 400 pixels are considered and automatically adjusted to 256 X 256 using a python script to decrease training time. By using a comparing procedure that is written in a python script, all the duplicated images taken from different sources are removed. The python script removes the duplicated images using images metadata like name, size, and date. Finally, a database containing 40880 images for training and 3589 images for validation has been created. Appropriate data sets are created to get better and accurate results. To achieve good results one more class was added to the dataset to identify the healthy leaves from disease infected ones. Few images collected from regional rice farms are given inFig.2.

Fig2.(a)Bacterial leaf blight(b)Brown Spot(c) Leaf Smut(d) Blast(e) Sheath Rot(f) Leaf Scald

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Step 2: Image Preprocessing

The input images are preprocessed to remove distortion and to improve image quality to get better and accurate results. To retain the original quality of the image, the median filtering method is applied and green-colored pixels are masked. The masked pixels are cleared in the bounds of infected clusters.

Step 3: Image segmentation:

In this step, the segmented image is obtained by using particle swarm optimization A size of p x q color image was taken and every identified pixel has RGB (Red, Green, Blue) components. A chromosome is represented by a set of related K cluster centers. The swarm is randomly started and the current particle is updated with a new particle in each round and a new chromosome is used for next round processing.

Particle Swarm Optimization based partition of rice leaf images is illustrated in Fig. 3.

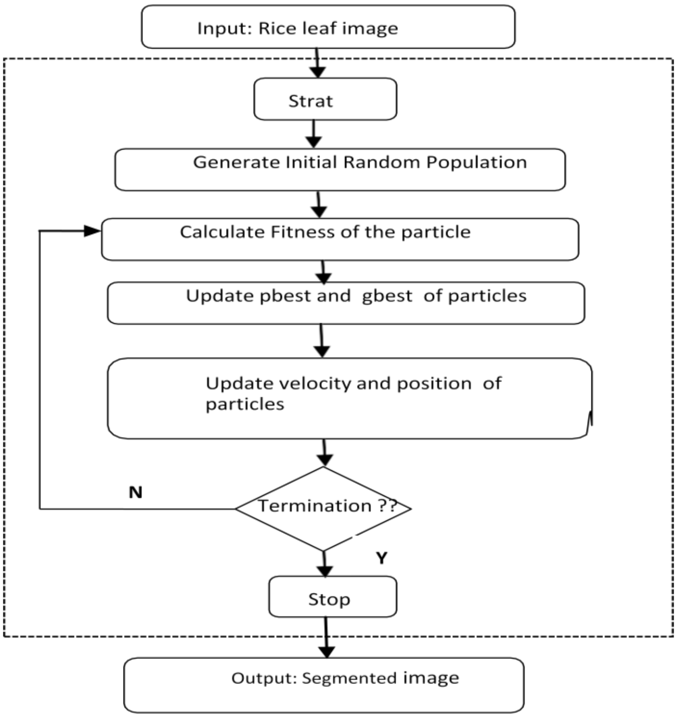


Fig 3: PSO based Image segmentation process

Using the following equation velocity of each particle ‘p’ in the swarm is updated.

$$X_m^t = 0.9 * X_m^t + 1.2 * R1 * (pbest - present) + 1.2 * R2 * (gbest - present)$$

Position and pbest and gbest are computed based on the standard PSO equations. Initially, the algorithm partitions the data set into comparatively large number of clusters in order to reduce the complexity in the initial conditions. Clustering is an unsupervised technique for image segmentation. The PSO is used for assigning each pixel to a cluster. The fitness function used here is the Euclidean distance between the pixels and their respective cluster. In the first step of fitness computation the dataset of pixel is clustered according to nearest respective cluster centres such that each pixel xi of colour image is put into the respective cluster with cluster center. In the next step new cluster centres are obtained by calculating the mean of each pixel of the assigned clusters. Now the fitness function is computed by calculating Euclidean distance between the pixels and their respective cluster

Step 4: Feature Extraction

For the extraction of the colors, the color co-occurrence approach is used. In this approach, texture and color are the two variables that are taken into account to identify unique features in the image.

The color co-occurrence method has three mathematical processes. Firstly, HIS color space representation is obtained by converting the RGB images of leaves. Following this process, each pixel mapping produces the color co-occurrence matrix resulting in three color co-occurring matrices, one for each H, S & L. For the H image, features consisting of local homogeneity, contrast, energy and entropy are calculated. Every H-image then includes all the characteristics such as local homogeneity, contrast, energy and entropy. This vector is then labeled with a Minimum distance Classifier.

Step 5: Disease Discovery

In this step, leaf co-occurrence characteristics are extracted and compared with their corresponding functional values and stored in the data set. The unknown image data is labeled with a minimum distance classifierin multifunctional areas. The classifier is evaluated using test images for each class following the formulation parameters. The images of the leaf are split into training and testing. The test samples are taken as the input and the minimum Euclidean distance is determined between the test sample and the known feature set. The minimum value of Euclidean distance is considered for classifying the disease or for displaying the output. After the Minimum Distance principle has been used for the classification, the accurate measurement of classification is calculated by using the classification gain.

Accuracy = (number of correctly categorized results/Total number of test results)*100

## IV. Results and Discussion

We implemented the proposed method of image segmentation based on PSO for detection of diseases in rice leaf in Python platform. Dataset is prepared totally with 790 captured images that include 110 normal images, 100 leaf scald images, 110 bacterial blight images, 120 blast images, 120 sheath rot images 110 leaf smut and 120 brown spot images. From the dataset 70% of images are used for training, 20% are used for testing and remaining 10% are used for validation. The performance of our methodology has been successful in recognizing and classifying the diseases. It does not require any prior information regarding number of segments as required for other existing methods. From the segmented results, the particular disease affected portion in the leaf can be easily identified. With very less computational efforts, the optimum results were obtained. It effectively shows the efficiency of proposed algorithm in recognition and classification rice leaf diseases.

Experimentation results reveal that only few samples were misclassified. The average accuracy of classification of proposed algorithm is 98.28%

| Leaf Disease | Leaf scald | Bacterial Blight | Blast | Sheath Rot | Leaf Smut | Brown Spot | Normal | Accuracy |
|---|---|---|---|---|---|---|---|---|
| Leaf scald | 19 | 1 | 0 | 0 | 0 | 0 | 0 | 98.73 |
| Bacterial Blight | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 96.2 |
| Blast | 0 | 1 | 22 | 0 | 0 | 1 | 0 | 96.83 |
| Sheath Rot | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 98.73 |
| Leaf Smut | 0 | 0 | 0 | 0 | 22 | 0 | 0 | 100 |
| Brown Spot | 0 | 1 | 2 | 0 | 1 | 20 | 0 | 97.47 |
| Normal | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 100 |
| Average | | | | | | | | 98.28 |

## V. Conclusion

Identification and classification of diseases from the leaf images of a plant is an important key in agriculture. This paper presents particle swarm optimization based image segmentation along with minimum distance classifier for identification of diseases in rice leaf. The efficiency of the proposed algorithm in the classification of rice leaf diseases is demonstrated effectively. Just a few samples during the analysis tests were misclassified. The proposed algorithm's average accuracy is 98.28%.

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