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LEAF DISEASE CLASSIFICATION AND SEVERITY ESTIMATION USING GA BASED BPNN ALGORITHM

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ABSTRACT

Agriculture is the main source of food for living beings. One of the reasons for the decreased productivity yield is due to the disease in plants. Few of the research works are focused on leaf disease classification, but there is no standard technique for estimating the severity of the leaf disease. In this paper, proposed Genetic Algorithm based Back Propagation Neural Network algorithm is proposed for the classification of plant leaf diseases by using papaya leaf dataset. Genetic Algorithm is used to optimize the weights and value of the back propagation neural network algorithm. This performs better on identifying the severity than the usual BPNN algorithm. The real-time dataset is captured from the region of Telangana, India that contains 109 images from the papaya tree. The dataset consists of four types of leaves such as blackspot, brownspot, powdery mildew, and healthy leaf.
Keywords – BPNN, Carica papaya, GA, leaf disease.

I. INTRODUCTION

Carica papaya is widely distributed in the tropical region, and it comes under the herbaceous succulent plant variety. Especially, Carica papaya spreads widely and it is beneficial in many areas such as food products, cosmetics, pharmacy, etc. Still scientific researchers are in a process to identify the usage of a different part of papaya that covers leaves, fruits, seeds, shoots, rinds, roots, or latex [1]. Especially papaya is rich in nutrients and vitamins; available all the time. It is well suitable to get recover from abdomen and digestive disorder. It is treated as good medicine for indigestion, constipation, acidity, dysentery. Additionally, medical values include the prevention of colon cancer and prostate cancer, anti-inflammatory effects, rheumatoid arthritis, promote lung health, anti-sickling activity, anticoagulant effect [17].

Papaya leaf diseases significantly impact the growth and its yield. The primary diseases are peduncular rot, anthracnose, malaria, postharvest, and papaya ringspot virus. Foliar diseases, such as black spot, greasy spot, leaf spot also leads to main damage in papaya fruits. These diseases minimize the fruits yield when it is not controlled properly [3] and leaf disease has various symptoms. Inexperienced farmers face more difficulties in identifying the disease in the field. Therefore, the fast and accurate detection of papaya leaf disease detection is needed for prior prevention and treatment.

Leaf diseases can be identified automatically using generative adversarial network, multiple linear recognition, multi-support vector machine algorithms. The threshold of multiple linear recognition is automatically adjusted by the medium filtering operation. The regression extracts a total 11 features from color, texture, and shape [4]. Generative adversarial network produce the high resolution images by the dual attention and fusion of topology process. Deeper trainable structures in residual and dense connections are produced by reducing the number of network parameters [5]. Multi-Support Vector Machine algorithm classifies the apple leaf diseases, optimizing the feature extraction process by genetic algorithm. Hybrid method classifies the leaf disease which is designed from the combination of 3D median filter, de-correlation, 3D box filtering and 3D-Gaussian filter [6]. Since its accuracy varies for a different kind of disease identification and poor in rust identification.

In order to address the above problems, GA based BPNN algorithm is proposed for papaya leaf disease classification with severity estimation. Generally, BPNN slows the training process by encountering the local minimum frequently. The collected papaya leaf is preprocessed for the training stage using the GA based BPNN algorithm. Next, the GA based BPNN algorithm is processed with better performance on estimating the severity of the papaya leaf disease. Finally, the confusion matrix is used to analyze the dataset to predict the accuracy.

II. RELATED STUDY

Generative Adversarial Networks (GANs) are utilized to maximize the accuracy of the tomato leaf diseases identification. The input image is retrieved from the GoogLeNet input which is augmented using the Deep Convolutional Generative Adversarial Networks (DCGAN). This process attained a good accuracy rate of 94.33%. The hyper-parameter adjustment, modifying the design and selecting different generative adversarial networks are carried for the framework enhancement. On the other hand, generated images from DCGAN result in good generalization effect by maximizing the size of the dataset. DCGAN images have different characteristics, enlarge the data size.

Deep learning approach with enhanced convolutional neural networks identifies the apple leaf disease. Initially, the apple leaf was collected from the real time environment. The input image is processed using data augmentation and image annotation. The proposed framework is the combination of Rainbow concatenation and Google Inception network. Finally, 26,377 apple leaf disease images were used to evaluate the Inception network and Rainbow concatenation with SSD model under the hold-out testing dataset. The INAR-SSD model evaluates the performance detection of 78.80% mAP on ALDD, 23.13 FPS of high detection speed.

Radial basis neural network with bacterial foraging optimization algorithm is proposed for the detection of apple leaf disease. Optimizing the weight of neural network algorithm improves the speed and accuracy. Searching and grouping of grid points are maximize the performance of region growing algorithm. The grid points are same in attributed for feature extraction process. The proposed work is evaluated using fungal diseases such as leaf curl, rust, late blight, early blight, leaf spot, cedar apple rust. This work attains higher accuracy on identification of diseases.

LeafGAN from generative adversarial networks (GANs) is proposed for generating four different types of grape leaf disease for learning process. The image generating channel is designed with degressive channels. The combination of dense connectivity strategy and instance normalization is used to detect real and fake disease images from the feature extraction for grape leaf lesions. Finally, the deep regret gradient method stabilizes the learning process. The LeafGAN model generates totally 8124 grape leaf diseases from the 4062 grape leaf disease. The grape leaf disease images results in improved performance than DCGAN and WGAN by Fréchet inception distance.

k-means algorithm is proposed for a rule-based semi-automatic system to differentiate as good leaves from infected leaves. The diseased leaves are classified into three types as Septoria leaf spot, frogeye leaf spot, and downy mildew leaf spot. Color features, texture features separately and combining these two based on support vector machine algorithm are used for evaluation. The dataset is collected from the PlantVillage that contains thousands of images. This model performs better for Soybean leaf disease detection and provides better accuracy. This also performs well for detecting the severity of leaf disease, and it also further suitable for detection, classification, and severity calculation.

Principle Component Analysis (PCA) based classification method is used to detect the disease in greenhouse bell peppers. Two diseases are detected using PCA are powdery mildew and tomato spotted wilt virus. PCA and coefficient of variation detect the powdery mildew disease various PCA with leaf vein removal provides good accuracy on detecting the tomato spotted wilt virus. Robotic system is designed for disease detection that includes robotic manipulators, sensors, and end effectors. Images are collected from 32 plants for both powdery mildew and tomato spotted wilt virus in greenhouse during day time.

Multilayer Convolutional Neural Network detects the mango leaves disease. The dataset contains 1070 images

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of infected and healthy leaves. The images are preprocessed by the histogram equalization that balances the invariability in images. Then the images are cropped by central square method. This has number of preprocessing layers where information is retrieved from raw input to final output. This model is connected by two layers for image classification based on feature set. This uses the SoftMax for the activation function.

III. PRBLEM DEFINATION

BPNN algorithm is processed with the Generalized Delta Rule (GDR). Gradient descending search method is utilized to propagate the training error in backward to acquire the gradient. Later the parameters in the network are modified based on the gradient. Though the training process is at high speed, the error reduction process still encounters the local minimum. So these results in a smaller gradient and the network parameters can't be modified properly and trapped in the local minimum. In this paper, first dataset is collected. After preprocessing of collected dataset GA-BPNN algorithm is used for obtaining the best solution (Fig.1).

3.1 PREPROCESSING

At first, the dataset is separated into two sets as training and testing sets with the same pixel size. Histogram equalization is utilized to enhance the image contrast and the images are cropped as central square for the entire dataset. In histogram equalization process, same intensity value is fixed for the entire pixel to improve the image contrast.

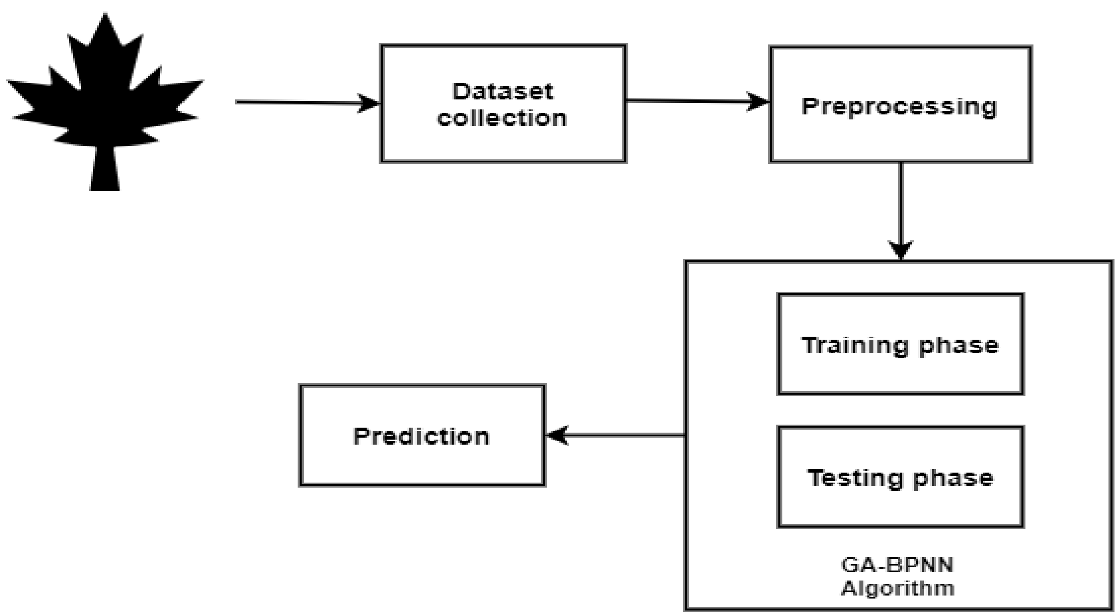

Fig.1. Architecture of the proposed work with the working of GA-BPNN algorithm.

A. GA ALGORITHM

Genetic algorithm is biologically inspired search algorithm from genetics and selection. It is also described from Darwin's principle "Survival of the fittest". This contains the bit strings in binary format which are mentioned as the population. The number of input data is called as population. The population is not related to parameters in the algorithm. The binary bit strings are nothing but ones and zeros. The relationship between the binary strings is found using the evaluation process that results in fitness value for the specific string. It consists of three phases such as Selection, Crossover, and Mutation.

The selection of the chromosomes with good fitness value is called as the selection used to form a new population. The probability of selecting the good chromosomes for the next generation is based on the highest fitness value. The selection is based on various categories such as rank-based selection, roulette wheel selection, tournament selection, etc. After selecting better chromosomes, the process will obtain a good population. A new string is created by the crossover operator which combines chromosome bits. New strings are not created in the selection process, but it created in crossover process. A probability of crossover range varies between 0.3 to 0.9. The mutation is the process of changing the value of selected chromosomes from one position to another position. The mutation rate changes from 0.1 to 0.09. Once the creation of a single generation is completed then the evaluation of fitness function is continued.

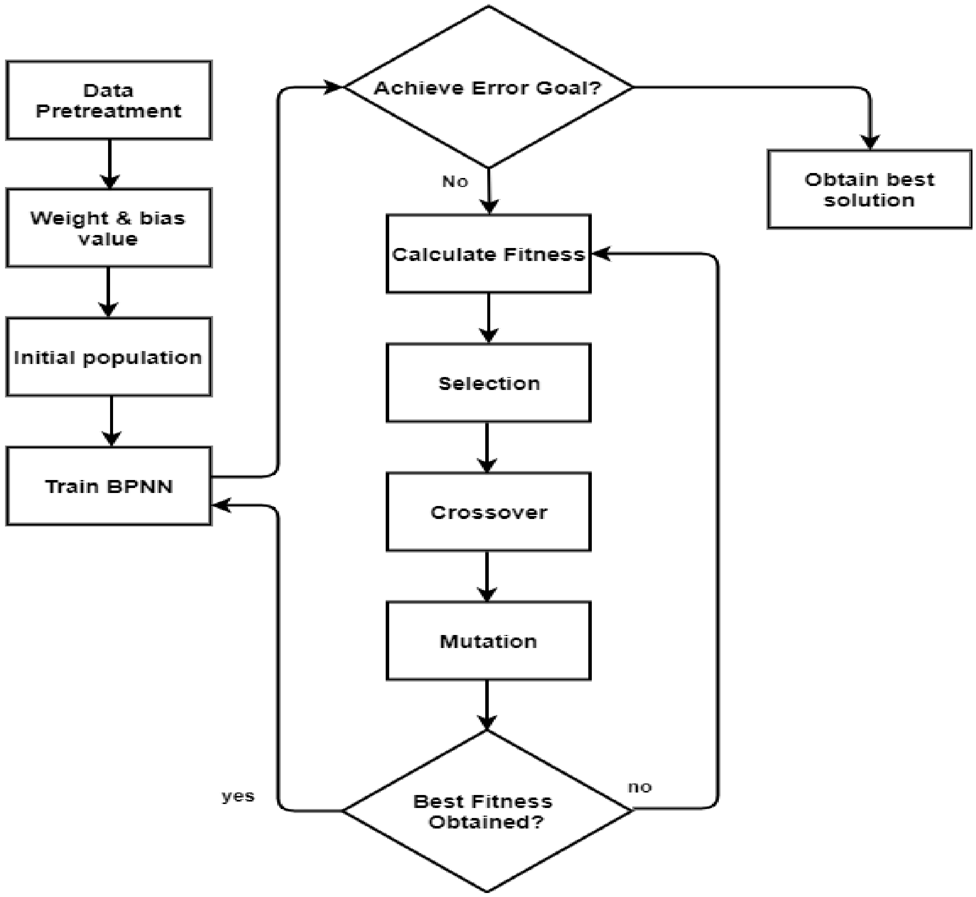

Fig.2. Working mechanism of GA-BPNN algorithm

B. GA BASED BPNN ALGORITHM

The important parameters in BPNN algorithm is hidden layer count, nodes count, activation function count in the hidden layer, epochs count, training rate, momentum term, etc. Genetic algorithms optimize the parameters in the BPNN network for the training process. A neural network is constructed with the numerous neurons required for each and individual hidden layer with a suitable activation process for it. Usually, the weight and biases are assigned randomly. Once BPNN training process is started, genetic algorithm generates the fitness value. In the selection phase, the input is taken as the highest fitness value, and it is iterated to obtain the best fitness value. In the crossover phase, the recombination of input bits produces the new population. Finally, bit value positions are changed randomly in the mutation phase. Iterating the last fitness values, the best fitness value are retrieved, later it is assigned as new values for weights and biases.

The size of the population is considered as 40 to 100 generations, where mutation and crossover vary between 0.3 to 0.7. The BPNN network contains two layers (hidden layers) where the first one contains six neurons and the next one contains single neuron. Tangential Sigmoid is used to perform activation function. The epochs

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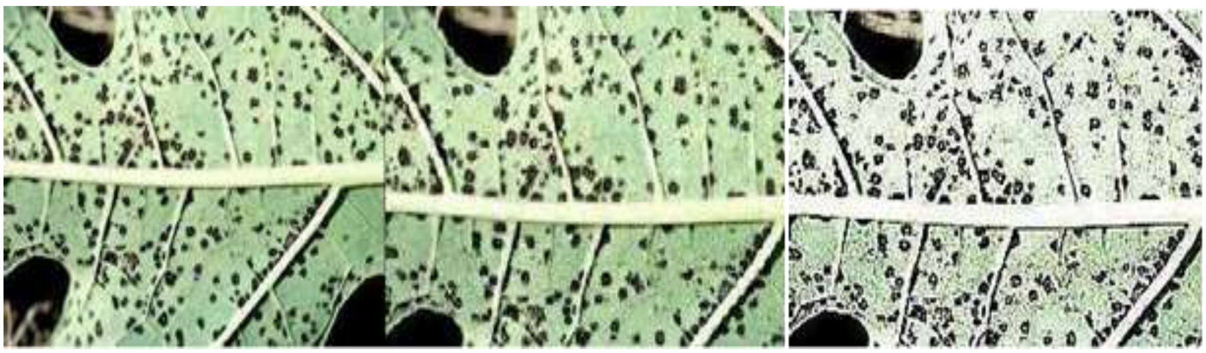
count is limited to 15000, momentum term to 0.005 with 10 as step increment. Additionally, the training rate is assigned as 0.15.

IV. EXPERIMENT EVALUATION

In order to assess the performance of GA-BPNN classification algorithm, 109 papaya leaf images were collected from the region of Tamilnadu, India. This contains black spot, brown spot, powdery mildew leaf. We split total images into two as, 92 training images and 17 testing images. The experimental part is carried out in java language in netbeans tool. The entire trained sets of images are processed using the GA based BPNN algorithm. Then the feature selection is carried out with the training process. Later, testing process is performed in all sets of disease.



63.412

42.129

49.678

3.897

Fig.3. Represent the original image, preprocessed image, classified image and severity estimation in order for four types of images such as blackspot, brownspot, powdery mildew and healthy image.

Confusion matrix is used to calculate the accuracy, precision, sensitivity, specificity from the terms true positives (TP), true negatives (TN), false positive (FP), and false negatives (FN). After that GA based BPNN algorithm is evaluated using test data set. FP, FN, TP, TN are not directly calculated, instead, n x n is constructed for it (Confusion matrix).

Accuracy = $\frac{TP+TN}{n}$ * 100% = 95.41%

Sensitivity = TP/TP+FN * 100 = 96.93%

Specificity = TN/FP+TN * 100% = 81.81%

Precision = TP/TP+FP * 100% = 97.93%

Table 1. Accuracy level of detecting papaya leaf diseases such as blackspot, brownspot and powdery mildew.

Types of disease	**Value**
Blackspot	0.9482
Brownspot	0.8648
Powdery mildew	0.9285

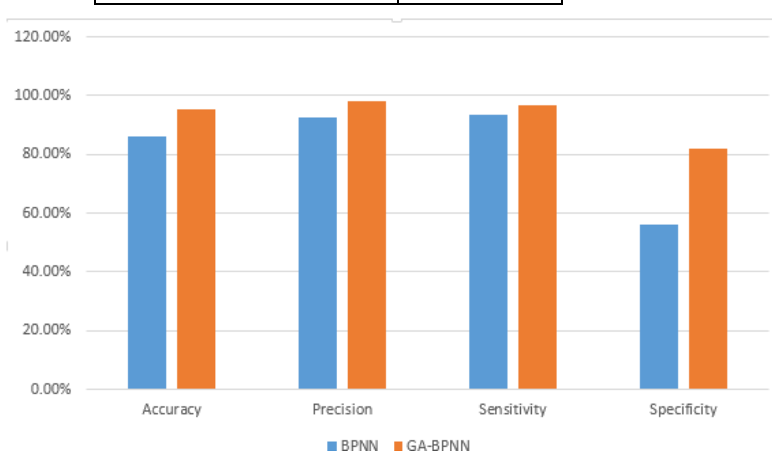


Fig.4. Graph represents the comparison between the BPNN algorithm and GA-BPNN algorithm.

For validating the performance of GA based BPNN algorithm, traditional BPNN has been considered. Since the accuracy of GA based BPNN algorithm is higher than the traditional BPNN and three different kinds of diseases also evaluated individually to check its accuracy. The blackspot of 58 images, brownspot of 37 images, powdery mildew of 14 images evaluated in confusion matrix which results in 0.9482, 0.8648, 0.9285 respectively.

V. CONCLUSION

In this paper, GA based BPNN algorithm is proposed for the classification of papaya leaf. Three different kinds of papaya leaf disease were analyzed and its severity is estimated. Proposed algorithm performs better than the usual BPNN for the leaf disease identification by overcoming the local minimum iteration. It results in an accuracy of 95.41%, which is better than the usual BPNN algorithm performance. In future work, large dataset is covered with more number of papaya diseases. Besides this, optimizing the algorithm is performed to get better accuracy than GA based BPNN algorithm.

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