International Journal of Electrical and Computer Engineering (IJECE)
Vol. 10, No. 4, August 2020, pp. 3568~3575
ISSN: 2088-8708, DOI: 10.11591/ijece.v10i4.pp3568-3575

Bacterial foraging optimization based adaptive neuro fuzzy inference system

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Article Info

Article history:

Received Aug 19, 2019
Revised Dec 25, 2019
Accepted Jan 11, 2020

Keywords:

Bacteria foraging algorithm
Feature extraction
Image segmentation
Plant disease
Soft computing

ABSTRACT

Life of human being and animals depend on the environment which is surrounded by plants. Like human beings, plants also suffer from lot of diseases. Plant gets affected by completely including leaf, stem, root, fruit and flower; this affects the normal growth of the plant. Manual identification and diagnosis of plant diseases is very difficult. This method is costly as well as time-consuming so it is inefficient to be highly specific. Plant pathology deals with the progress in developing classification of plant diseases and their identification. This work clarifies the identification of plant diseases using leaf images caused by bacteria, viruses and fungus. By this method it can be identified and control the diseases. To identify the plant leaf disease Adaptive Neuro Fuzzy Inference System (ANFIS) was proposed. The proposed method shows more refined results than the existing works.

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1. INTRODUCTION

Indian Economy is necessitous in the role of agriculture. India is an agriculture based country, where more than 50% of population depends on agriculture. Like human being plants also get affected from diseases, to prevent this farmers must use suitable pesticides for crops. Both the quantity and quality of crops get affected due to diseases. Visual observation of a plant is done by plant pathology. Computer devices act as a consequential role in numerous applications such as defense, agriculture, medical and engineering. Huge number of research has been reported [1-35]. In early days, the expertise person in the field manually analyses and diagnosis the plant disease which are too difficult to be monitored and also it required more time. Plant serve as a backbone in all aspects of life, plants also suffer from diseases which affects the normal growth of the plant.

In this article, it has been presented an automatic soft computing approach named ANFIS to identify and classify diseases of plant leaves. Image segmentation is done to split the leaf images into smaller parts for clear identification of affected parts of leaf. Image segmentation is done with the texture, color and shape of an image. Segmentation is the preprocessing technique which comprises of soft computing and traditional method. Soft computing is an automatic method which is used for complex task (i.e. image segmentation) without human knowledge.

2. RELATED WORK

In this technique [36] plant diseases symptoms was identified and it was tested using algorithm to achieve better accuracy. Conduct an investigation [37] in classification methods to get rid of errors and also discussed the models to extract information in infected leaf. In [38] proposed a methodology in four different phases to support accurate differentiation of leaf diseases and classify the detection. Comparison was made for segmentations using automated tool and leaf symptoms were identified [39]. An inventive technique elicited from OCM [40] was introduced to analyze the leaf mechanism and the leaf spots provide stability in the framework of hybrid algorithms. In this work [41] a new approach was considered to emulate the results and the portions of leaf are combined to address the image analysis. It is widely used to adapt the segmentation in a general measure of bias. The images were automatically classified [42] in a training set to facilitate accuracy in deep learning models. Approaches involved have the potential to identify the species of perspective models. Evaluation was made for running time and accuracy also guidelines were given to overcome the problems in future research works [43]. In [44], bacterial spot was assessed and also evaluated the severity of diseases which are inaccurate causing lesions on leaves. Using some modifications visual methods quantify the potential risk of infection. The diseased areas of each leaf are collected to facilitate digital scanning. The author proposed an algorithm [45] to identify the results of maize disease in the detection of plant leaf. A data point in same class is a prime technique to enhance colour analysis in favor of feature extraction. In this research work [46, 47] depicts a prototype called eAGROBOT to detect the crop disease.

3. RESEARCH METHOD

In this paper the plant leaf disease is analyzed and predicted by using Adaptive Neuro Fuzzy Inference System. Basically human beings calculate the characteristics of a particular thing by comparing the predetermined value obtained by other authors. Similarly system analyses the same predetermined values to obtain the expected result. Feature extraction is related to dimensionality reduction. With the help of ANFIS, the proposed algorithm achieves higher accuracy.

4. PLANT DISEASE

Similar to human beings and animals reveal symptoms of suffer from diseases. The entire plant gets affected by the diseases including flower, root, leaf, stem and fruit. Most of the time it is difficult to identify the plant under various factors which may cause leaves drop, flower and fruit. Well-defined treatment and identification of plant diseases is required for growth of certain factors and appropriate diagnosis. The aspects for diagnosis of diseases depends on

- Glancing for symptoms or signs: the appearance of some unwanted spots, curls and dead areas are visible to the naked eyes.
- Awareness of the normal characteristics of host plant: it is easier for one to diagnosis the plant disease if one should know the inheritances and assets of the host plants.
- The occurrences of symptoms: it depends upon two factors (i) the Disorder, (ii) Diseases some environmental problems lead to disorders, it happens suddenly like within a day or week and does spread over the parts of the plants.
- Detecting the diseases of the host plant in nature pattern is of two types uniform and non-uniform. Non-living factors are the cause for uniform pattern whereas non-uniform pattern is caused by some disease or insect. The disease classification and its effect, symptoms of fungal plant are explained in Table 1.

Table 1. Fungal plant disease classification

Leaf Image	Diseases name	Effect	Suitable Climatic Condition	Symptoms/Cause
	Common rust	Roses, hollyhocks, snapdragons get affected	Low temperature	Appears primarily on the surface of lower leaf, reddish orange spore mass

Table 1. Fungal plant disease classification *(Continue)*

Leaf Image	Diseases name	Effect	Suitable Climatic Condition	Symptoms/Cause
	Late blight	entire plants get infected	temperature below 70degree Fahrenheit	resemble on the lower, older leaves as water soaked, grey green spots
	Cedar apple rust	infect junipers	spore over winter appears as a reddish brown gall	moisturized weather
	Leaf curl	reduce fruit production	temperature above 70degree Fahrenheit	leaf shape changes in to spring, reddish area on developing needs
	Leaf spot	as spots become more numerous, entire leaves may yellow and leaf drop will takes place	warm and cool temperature	Leaf spot, brown blotches on the leaf
	Early blight	stem, fruit and upper position of the plant get infected	moderate temperature	small brown spot appears on the lower side of the leaves with concentric rings which forms a bull-s eye pattern

5. PROPOSED WORK

In the proposed work, it has been spirited on identification and classification of plant diseases using a few computational and intelligence advance. The perfection research area is emerging for the development of an automated system for identifying and classifying the adulterated plants with different diseases. To prevent the qualitative and quantitative loss of agricultural yields identification of diseases is the only way. The limitation of human vision can be overcome by the accurate and timely detection of diseases with the help of image processing techniques. The leaf image is pre-processed initially. Using adaptive k-means diseases part is segmented. Texture and statistical technique are also included to obtain high pass version of feature extraction.

5.1. Image acquisition

The acquired image is enhanced by using UN sharp filter, by filtering a UN sharp version in dark image from the original image. It filters the edges. When compared with negative of the Laplacian filter the parameter alpha is used for unsharp filter and the alpha value is selected as 0.2, by the 'fspecial'. K-means method is used for image segmentation and flowchart for the proposed approach is shown below in Figure 1.

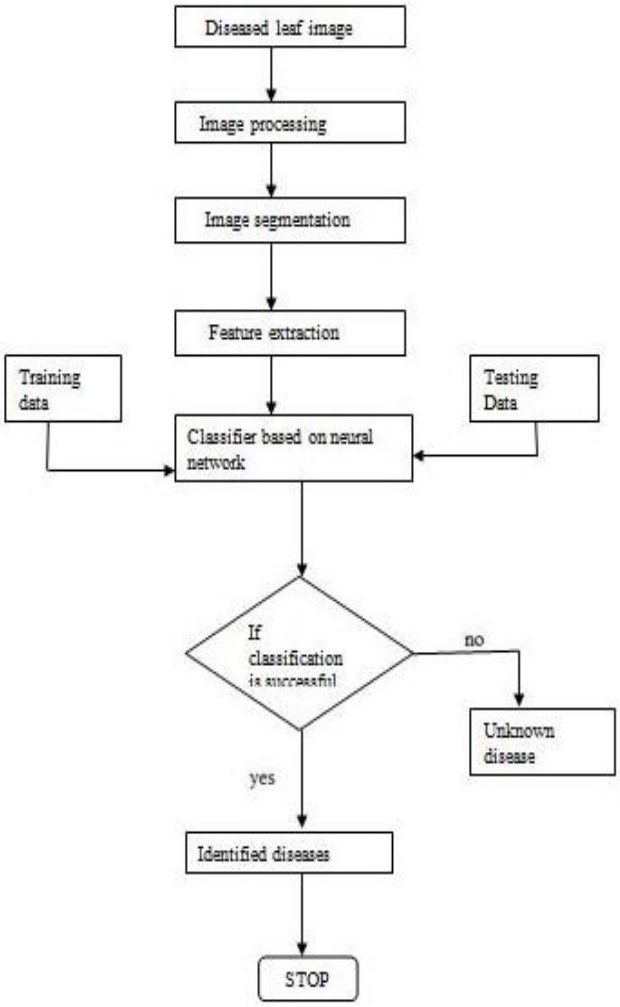


Figure 1. Flowchart for proposed approach

6. RESULTS AND ANALYSIS

The proposed work was implemented on MATLAB 2014a. For justifying the success of this work we have taken two set of images. First we have taken 6 set of images as an input images which are affected by diseases caused by fungi and second step we have finally two hundred and seventy images. The affected region of the leaf part is identified by segmentation of pixels. The proposed work is done successfully with the accurate value that is the diseases are classified perfectly. For classification the parameters are required are specificity and Sensitivity. The affected area of leaf part are observed and presented in Table 2 with their classifications.

Table 2. Results for ANFIS, (a) Original image, (b) Segmented grayscale image, (c) Mask image, (d) Results for segmented leaf disease

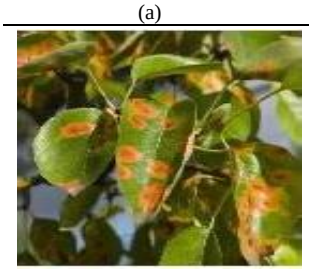
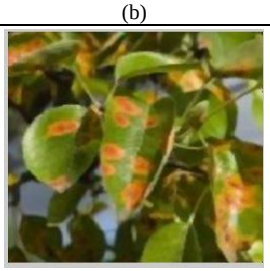
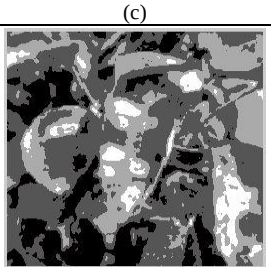
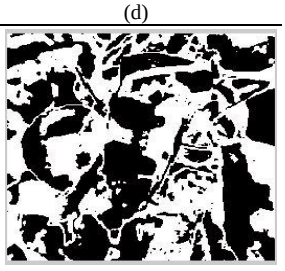
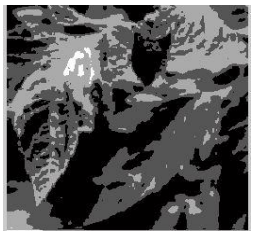
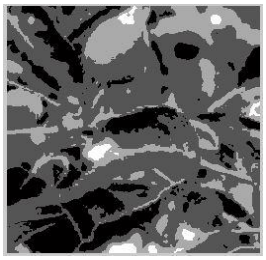
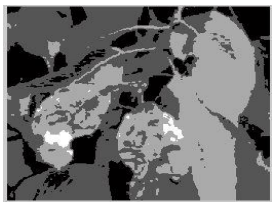
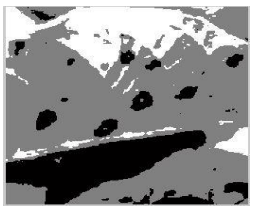
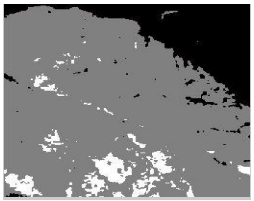
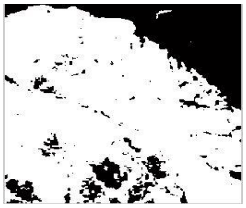
(a)	(b)	(c)	(d)
			
Common rust			

Table 2. Results for ANFIS, (a) Original image, (b) Segmented grayscale image, (c) Mask image, (d) Results for segmented leaf disease *(Continue)*

(a)	(b)	(c)	(d)
			
Late blight			
			
Cedar apple rust			
			
Leaf curl			
			
Leaf spot			
			
Early blight			

Plant leaf diseases depends on its own feature refers to symptoms. Features like shape, color and size can be determined by feature extraction. To search seed points and to group them region growing method is used in feature extraction. For well-defined examination defined the input image is converted into segmented gray scale image. Specificity and Sensitivity validation parameters used in the proposed work. Adaptive K-means is used for evaluating the segmentation process. Table 3 shows the report of specificity for the proposed algorithm along with the comparison of existing algorithms. Table 4 shows the report of sensitivity for the proposed algorithm along with the comparison of existing algorithms. The pictorial representation of detected leaf diseases for proposed and existing algorithms with specificity results is shown in Figure 2. The pictorial representation of detected leaf diseases for proposed and existing algorithms with sensitivity results is shown in Figure 3.

Table 3. Comparison of specificity results for detection of leaf diseases

Disease	K-means	Genetic algorithm	BRBFNN	ANFIS
Common rust	0.7817	0.8096	0.8213	1.0000
Late blight	0.8014	0.8205	0.8326	0.8571
Cedar apple rust	0.7801	0.7854	0.8196	1.0000
Leaf curl	0.7517	0.7889	0.8879	0.8571
Leaf spot	0.8124	0.8318	0.8836	1.0000
Early blight	0.8211	0.8374	0.8897	0.8571
Average specificity	0.7914	0.8139	0.8558	0.9285

Table 4. Comparison of sensitivity results for detection of leaf disease

Disease	k-means	Genetic algorithm	BRBFNN	ANFIS
Common rust	0.8078	0.8117	0.8311	1.0000
Late blight	0.8189	0.8339	0.8497	1.0000
Cedar apple rust	0.7809	0.7996	0.8407	0.8571
Leaf curl	0.7729	0.8279	0.8938	1.0000
Leaf spot	0.8111	0.8315	0.9078	1.0000
Early blight	0.8201	0.8471	0.8999	1.0000
Average sensitivity	0.8020	0.8244	0.8705	1.0000

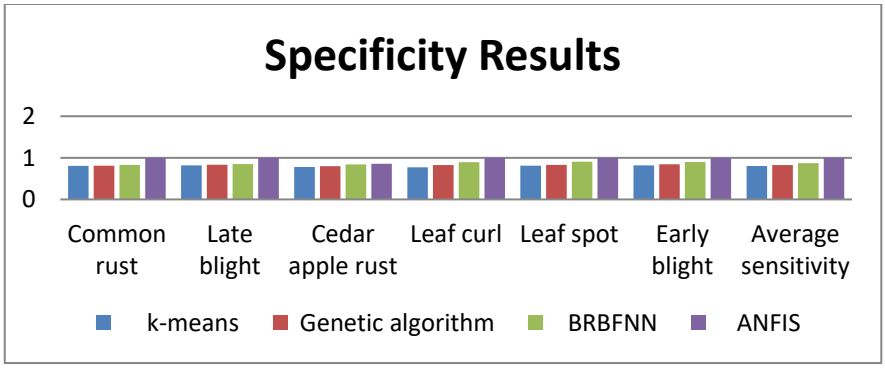


Figure 2. Inference for specificity interpretations

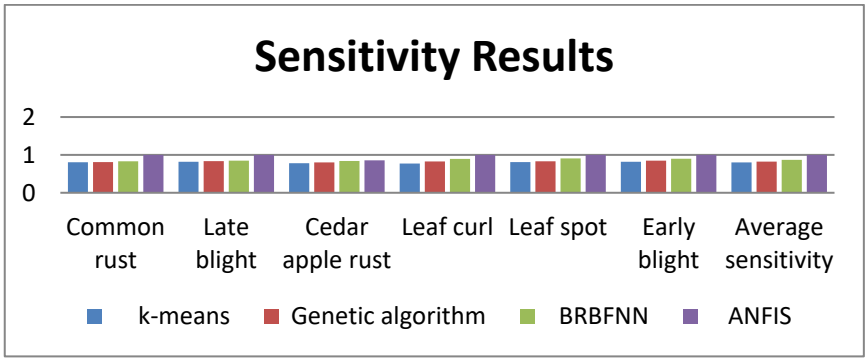


Figure 3. Inference for sensitivity interpretations

7. CONCLUSION

If human beings get affected by diseases, it has been cured by itself consulting a doctor, but plants should be observed by human beings to prevent the diseases. But human observation for a prolonged time is impossible and it is difficult. To overcome this, an automatic approach was designed which helps to monitor the plant leaves and identify the leaf disease. This automatic approach clearly identifies the disease and disease can be cured at earlier stage. For identifying the plant leaf diseases ANFIS has been used. While comparing to the existing algorithm results, the proposed algorithm shows 90 percent results. Proposed work shows higher accuracy and effectiveness. Proposed work has been successfully done on fungal diseases, in future it can be expected to work on bacteria and viruses.

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