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Disease detection on plant leaf using K-means segmentation with fuzzy logic SVM algorithm

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***Abstract*---**Detection of plant diseases requisite at its early stage to manage the large crop field. In plants existence of diseases result reduced yields of crops and therefore it is imperative to identify at its early stage. Leaf is the main part where the diseases symptoms are shown in the initial stage itself. Image processing techniques are used at the computing part whereas in this research a hybrid KMFLs (K-Means Fuzzy logics) and SVMs (Support Vector Machines) are implemented to identify and categorize diseased plants based on leaf disease grades. This work's proposed method is implemented by examining images of leaves for diseases including Alternaria alternates, Anthracnoses, Bacterial blights and Cercospora leaf spots. The input leaf image features are extracted which are subsequently used for categorizations into classes.

***Keywords*---**K-means, fuzzy logic, support vector machine, segmentation, classification.

Introduction

India is a farming nation here major part of the economy depends upon the crops and plants. Plant disease detection causes determination of crops and loss in terms of financial condition of the farmers. Crop leaves have to be inspected regularly for pests which normally does not occur. These crops need to be treated in a timely fashion to maintain food production qualities and quantities. When crop yields reduce it may lead to food insecurities and poverty effectively increasing mortalities [7]. Deterioration in plants causes diseases as well as financial loss. Quick detection and prevention of diseases within plants is the prime cause of concern with proposed system. Identification of diseases at the

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early stage, there are many more researches are made. This research involves the hybrid method of Support Vector Machine, Fuzzy logic and K-means algorithms.

Diseased plants can be identified by investigations of their parts including roots, leaves and stem. Initial stage of the disease in plant is identified with its leaf itself, such leaf are taken into consideration to disease detection. Diseases are categorised into various categories Viral, Bacterial and fungal. Most farmers investigate crops manually for pests according to H.Al-Hiary et al [6], which necessitates monitoring of crop's stems and leaves on a continual basis. This is a laborious, less accurate and costly affair specifically for large-scale farms. Furthermore even a small set of infected leaves can spread the disease throughout the fruits, crop or vegetables thus it really affects the crop yield and leads to a huge agricultural loss. Currently many species of plants are used by a wide range of industries making quality of agricultural goods imperative and a key concern in agriculture. IPTs (Image processing techniques) have been very helpful in achieving these objectives as they execute many operations on images and extract features relevant for classifications.

Related Work

- The paper "PLANT DISEASE DETECTION IN FUZZY LOGIC SYSTEMS ", explains to prevent agricultural loss the fundamental thing is to accurately detect and classify the leaf disease. Dataset for the proposed idea is set up with the plant leaf stand with diseases Bacterial Blight, Alternaria Alternata, Cercospora Leaf Spot and Anthracnose. This work used FSVMs (Fuzzy SVMs) for segmenting images to identify diseased leaves where their experimental result showed that accuracy was improved and In future, optimization mechanism like genetic approach can be used with the proposed mechanism for result enhancement.
- In the research paper "SVM-BASED DETECTION OF TOMATO LEAVES DISEASES", the suggested system worked in 3 phases of IPTs namely pre-processes, feature extractions, and categorizations. Image capturing, elimination of backgrounds and extractions of textural features were a part of the scheme. SVMs were subsequently used to classify based on retrieved features. Moreover, the model was evaluated using N -fold cross validations.
- Clustering using FCMs (Fuzzy C-Means) was proposed in the paper "PLANT LEAF DISEASE DETECTION USING FUZZY C-MEANS CLUSTERING ALGORITHM" [3] where survey on plant disease classifications/detections methods and image segmentations were presented. The study's proposed scheme was tested for its ability to detect diseases automatically in Jackfruits, Bananas, lemons, potatoes, mangos, beans and tomatoes. One major advantage of the study was its early detections of diseases as it used enhanced and hybrid techniques like ANNs (Artificial Neural Networks), NBs (naive Bayes) for classifications and achieved an accuracy rate of ninety percent.
- In the paper," LEAF DISEASE DETECTION AND GRADING USING COMPUTER VISION TECHNOLOGY &FUZZY LOGIC ",the authors segmented images using KMCs (K-means clustering) and Euclidean distances for successfully separating backdrops from disease affected areas.

The study emphasized the importance of using IPTs in place of manual leaf disease detections and thus aid agriculturalists in determining appropriate pesticides with quantity for effectiveness.

- The paper,” LEAF DISEASE DETECTION USING FUZZY LOGIC”, detailed on IPTs used by the study to segment required parts of images. The study’s scheme used the values of Otsu's threshold, means, standard deviations, entropies along with feature’s standard deviations, kurtosis, and skewness for feature extractions. The study tested the suggested scheme’s Fuzzy Logic on 57 leaf images for achieving an accuracy rate of 88% in detecting diseased leaves.

Methodology

The suggested system in this paper uses a new hybrid algorithm that combines KMC algorithm, FLCAs (Fuzzy logic classification algorithms)), and SVMs to identify leaf illness and assess the severity of the leaf.

KMC algorithm

Clustering datasets without knowledge of tagged classes is the main goal of KMCs. They are unsupervised machine learning examples and iteratively partition data. KMCs assign observations to k groups specified by centroids. These centroids can be resolved using MATLAB’s heuristic techniques. The algorithmic steps of KMCs is detailed below:

Step 1: Determine the number of initial centroids (k).
Step 2: Calculate the point-to-cluster distance for each centroid using the centroid distances of all observations.
Phase 3: Batch and online updates can be used to complete this step.

1) Allocate each observation to the cluster with the closest centroid in a batch update.
2) Online update – Assign observations to a different centroid if doing so reduces the total of the within-cluster, sum-of-squares point-to-cluster centroid distances.

Step 4: To get k new centroid positions, take the average of the data in each cluster.
Step-5: Repeat steps 2–4 until the cluster assignments remain the same or the maximum number of iterations is achieved.

SVMs

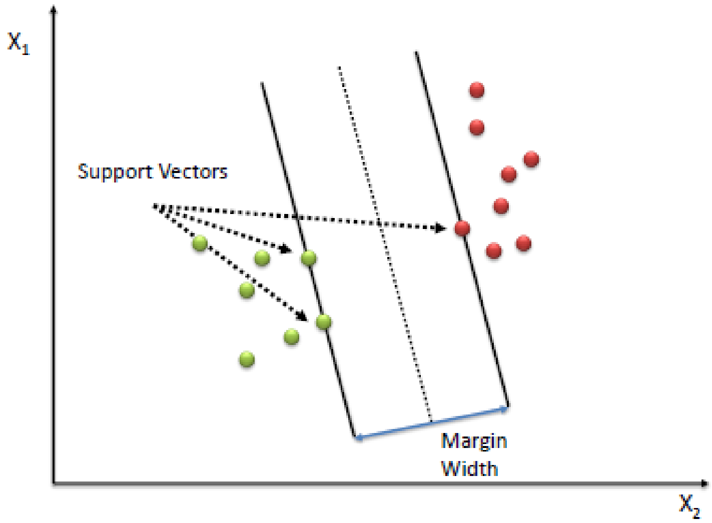

Fig 1. Separating hyperplane created by SVM

SVMs are a type of supervised machine learning that are widely employed. To evaluate supervised learning methods, training data with labelled classes are used. SVMs are similar to discriminating classifiers, but differ in their generation of maximum margin separators leading to higher generalizations than discriminating classifiers. Linear separating hyper planes are built in SVMs for linearly separating data collections. Original data that are not linearly separable are projected onto higher or lower dimensional spaces for demarcations. SVMs use kernel techniques, mathematical procedures that change original dimensions into higher-dimensions. Hence, SVMs are referred to as non-parametric techniques. Despite the fact that vast datasets are utilised to train algorithms, trained algorithms stores only particular characteristics or data sets [8]. The basic notion of SVMs operate on two dimensional data is shown in Fig. 1.

FLCAs

The goal of this procedure is to determine if the condition on the leaves is caused by iron deficiencies or fungal infections. There are five inputs to this method. Two of the inputs are related to iron deficiencies where the first is green pixel counts in images, and the second is matched pixel counts between red and green pixels after gaps are filled. The final three inputs are about fungal infections where first is image's green pixel counts, second are leaves' hole areas, and third are matched pixels between red pixels and leaves' holes. Fuzzy logic-based algorithms output two numbers that denote disease types when they are infected. Fuzzy logics enhance classification efficiencies in terms of accuracies and execution times and their approximations of results are equivalent to human vision.

Approximate result for iron deficiency (ARID) = $\frac{\mathrm{ID}(2)}{\mathrm{ID}(1)}$ (1)

ID (1) is a variable that is determined by the number of green pixels in the image.

$$\mathrm{ID}(1) = \mathrm{I}_1 \times \mathrm{input}(1) \quad (2)$$

ID (2) is a variable that is determined by input (2), which is the number of matched pixels between the red pixel of the picture and the green pixel after the holes have been filled.

$$\mathrm{ID}(2) = \mathrm{I}_2 \times \mathrm{input}(2) \quad (3)$$

where, $\mathrm{I}_1$and I_2 are the tuning parameters of fuzzy logic algorithm. $\mathrm{I}_2 > \mathrm{I}_1$
Three factors influence the choice to infect diseased leaves with fungus.

Approximations of fungal infections (ARFI) $=\frac{\mathrm{F1(2)+F2(3)}}{\mathrm{F1(1)}}$ (4)

FI (1) is a variable that is determined by the number of green pixels in the image(3).

$$\mathrm{FI}\ (1) = \mathrm{F}_1 \times \mathrm{input}\ (3) \quad (5)$$

FI (2) is a variable that is dependent on the value of input (4), which is the area of the leaves' holes.

$$\mathrm{FI}\ (2) = \mathrm{F}_2 \times \mathrm{input}\ (4) \quad (6)$$

FI (3) is a variable that is dependent on input (5), implying that the pixels between the red pixels and the holes in the leaves are matched.

$$\mathrm{FI}\ (3) = \mathrm{F}_3 \times \mathrm{input}\ (5) \quad (7)$$

where F1, F2, and F3 are fuzzy logic’s tuning parameters.

$$\mathrm{F2} + \mathrm{F3} > \mathrm{F1} \quad (8)$$

It's worth noting that the aforementioned settings were fine-tuned once the best results were obtained.

Experimental Results

The Proposed system analyse the leaf diseases and its severity. This process describes the grade system for each infected leaf. In the first step of process the infected leaf is converted into its binary image. Figure 2 depicts the pre-processing stage, in which the original picture is transformed to a binary image and the backdrop is removed.

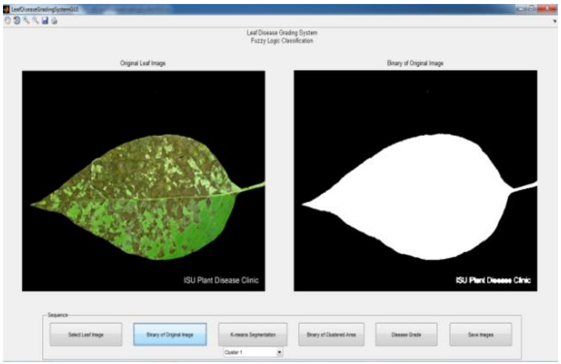

Fig 2 : Binary image of the infected leaf

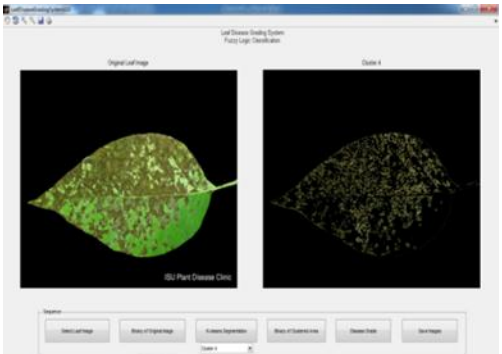

Fig 3: Segmented cluster using K-Means clutering

Next process implements the K-Means clustering algorithm for segmentation process. An infected leaf is segmented into n number of clusters. The cluster with more number of infected parts is chosen Fig 3.Then the selected cluster is converted into its binary image Fig4. Taking the binary image as input the proposed hybrid classification algorithm is implemented to draw a graph which describes the disease grade of how much it is infected in percentage Fig5.This proposed algorithm provides a better accuracy and the computation speed.

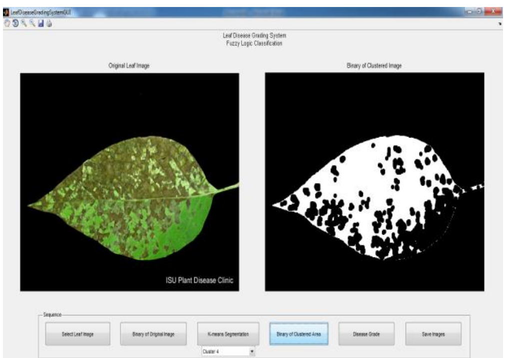

Fig 4: Binary image of the segmented cluster

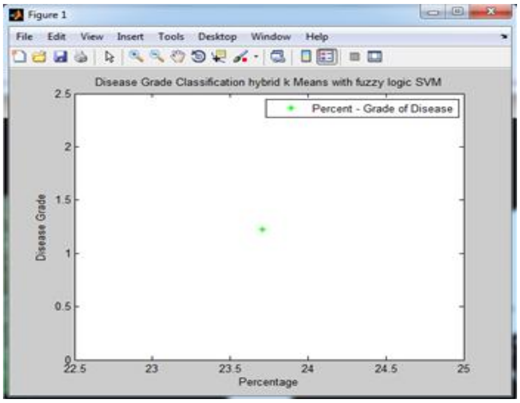

Fig 5: Disease grade classification

Conclusion

The suggested system is based on a new hybrid algorithm that combines KMCs, fuzzy logics, and SVMs. The contaminated picture is used as the input, and the image is then transformed to a binary image. The clusters are segmented using KMCs. Analysis is made with the dataset of 500 images. Classification is taken place with the fuzzy logic SVM so that the disease grade is calculated therefore with that the severity of the infected disease is analysed. The proposed algorithm has an improved accuracy in detection of disease. Furthermore in future the same is implemented with a big dataset.

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