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Automatic feature extraction and detection of plant leaf disease using GLCM features and convolutional neural networks

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Abstract

Agricultural productivity plays a key role in determining the economy of a country. Detection of plant leaf disease is a vital task as it greatly affects the agricultural productivity. If proper detection is not done, it may lead to serious damage in the quality and quantity of the agricultural yield. In this research we propose a novel scheme for the detection of plant leaf diseases using deep convolutional neural networks (DCNN). In the proposed framework, initially, the plant leaf images are preprocessed using filtering and enhancement techniques. In our work, image filtering is done using 2D Adaptive Anisotropic Diffusion Filter (2D AADF) for noise removal. Using these de-noised images, enhancement is done using Adaptive Mean Adjustment (AMA) technique. This step helps to

intensify the region of interest in the image. Using the enhanced image, segmentation is performed by means of clustering and thresholding. Clustering is done using the Improved Fast Fuzzy C Means Clustering (IFFCMC) Algorithm and image thresholding is performed using the Adaptive Otsu (AO) thresholding algorithm. From the segmented images, features are extracted using grey level co-occurrence matrix (GLCM). Dimensionality reduction of features is performed using principle component analysis (PCA). Finally, classification is done using a novel DCNN architecture. The proposed architecture has four convolutional layers, two fully connected layers and one SoftMax layer. Experimental results show that the proposed framework is effective and achieves best classification results other classifiers.

Introduction

Plant leaf disease is a major threat that affects the global agricultural production. It has been reported that around 10% of food production is affected globally because of plant diseases [1]. Manual identification of leaves with the disease is a time consuming and laborious process. If these leaves are not identified at the earlier stage, it may lead to the wide spread of the disease in the field that may cause severe damage to the agricultural productivity. Computer vision and machine learning techniques are widely being used for the automatic detection of such plant diseases [2], [3], [4], [5], [6], [7], [8], [9]. Among machine learning algorithms, convolution neural networks are popularly being used recently for leaf disease classification systems due to its high accuracy [10], [11], [12]. Hence, in our research we propose a novel scheme for automatic detection of plant leaf diseases using convolutional neural networks.

The overall contributions of this paper are twofold:

A novel deep convolutional neural network architecture for the detection of plant leaf diseases.

Quantitative evaluation of classification algorithm using metrics like recall, specificity, F-score and precision.

The rest of the paper is organized as follows. Section 2 includes a detailed literature survey of the previous works in the literature. Section 3 describes the proposed methodology. The results and discussion are performed in Section 4. Conclusion of the paper is presented in Section 5.

Section snippets

Literature survey

A technique for the detection of plant leaf diseases using soft computing was proposed in [13]. In this paper, images are preprocessed using smoothing filter. Genetic algorithm was used for the segmentation of leaf images. Three co-occurrence matrices were generated from each of the RGB components and from the matrix, features like energy, contrast, homogeneity, etc., were generated. Finally, classification was performed using support vector machine (SVM) classifier. Hybrid intelligent system

Proposed methodology

The proposed methodology comprises of steps like image preprocessing (filtering and enhancement), segmentation, feature extraction and classification. This is depicted in Fig. 1. The noisy leaf image is initially acquired. This image is pre-processed using filtering and enhancement. Image filtering is done to remove noise and enhancement is done to increase the contrast and details of the image. From the enhanced image, the region of interest (ROI) is segmented using image segmentation. Then,

Parameter settings

The proposed system was simulated using MATLAB software running on windows intel i3 core processor with 6 GB RAM. The value of n used in our framework was chosen to be 5. Also, the value of threshold τ was selected to be 99%.

Conclusion

In this research we proposed a novel technique for the detection of plant leaf diseases using deep convolutional neural networks (DCNN). Here, images were preprocessed using 2D Adaptive Anisotropic Diffusion Filter (2D AADF) and Adaptive Mean Adjustment (AMA). The pre-processed images were segmented using Improved Fast Fuzzy C Means Clustering (IFFCMC) and Adaptive Otsu (AO) thresholding. From the segmented images, GLCM features were extracted. The dimension of the extracted features was

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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