CNN based on Overlapping Pooling Method and Multi-layered Learning with SVM & KNN for American Cotton Leaf Disease Recognition

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***Abstract*- The cotton agriculture industry faces the economic losses due to the pest infections and bacterial or viral contagions, the farmers lose nearly 10-20% of the total profit on an average annually in India. In this paper, a solution to the problem related to agriculture has been suggested, which involves the cotton leaf disease recognition by using the visual features. This paper implements the expert system for the recognition of crop diseases in the given set of images. The overlapping pooling has been utilized with the multi-layered perceptrons (MLP) with flexible layering mechanism to classify the plant leaves for detection of infected and healthy leaves. The graph based MLP network model has been employed to dynamically transform the feature orientation to discover the similar components in the given database. The k-nearest neighbor (kNN) and support vector machine (SVM) are utilized for the overlapping layer of classification to minimize the errors by double layered modeling. Various techniques like morphological segmentation, pattern matching, hue matching are combined in this model to accurately localize the disease region with more than 96% accuracy**.

Keywords: Multi-layered perceptrons, Support Vector Machine, Adaptive feature transformation.

I. INTRODUCTION

Cotton is known as "King of Fibers" and "White Gold" which enjoys the superior status among other cash crops and is main raw material for blooming textile industry. It supports the livelihood of around 60 million people. Also, it is an important agricultural commodity which provides the profitable amount to more than millions of farmers both in the developing and developed nations. Besides, this work gives great disclosure to the automatic recognition of diseases on the leaves. However, there are some problems with field crops such as to identify various disease and pests which influence the crops and also to analyze the nutrition deficiency in plants. Although, each problem has its own significance but among all above, the one which is the most important is the pests detection so that proper action can be taken to minimize the loss. Whenever certain condition arises then farmers gets aware and takes the right action to control the position. However, when the agriculturist don't have any right information then it may lead to the wastage of time and money because of opting incorrect control measures such as pesticides which are non-affecting. Additionally, it also leads to serious issue of crops. The diagnostic should be a good detective and have great observation skills. Therefore, it is very essential to keep an open approach until all the related facts regarding the problem will be collected. Also, it needs to consider the possibility of various causal factors. Besides, the control measures entirely depend upon causal agents and the right identification of diseases. So, disease diagnosis is most vital aspect of a plant pathologist's training. Further, if suitable identification of disease-causing agent and the disease is not taken then the control measures will lead to the wastage of money and time and further plant losses. Therefore, proper disease diagnosis is very important. Otherwise farmers can take help of agricultural technical experts who will give them good suggestions regarding how to increase productivity of crop and detection of diseases. However, farmer may also face some common issues such as the expert from whom a farmer want to take approach may not be able to provide related knowledge and information and also sometimes they are not able to take help because of the long distances or there might be a case when the agriculture expert is not available at that time of visit of farmer. Nowadays, many researchers are attracted towards the Image recognition in the sector of pattern recognition. So, similar type of flow is applied to the pattern recognition of plant leaves, which is used for diagnosing the cotton leaf diseases. Our program can detect exact difference of color present on the cotton leaves and further disease name will be stored in the database by comparing the color difference and image features related to the color. When crop start growing, some leaf spots of cotton appear practically in every cotton field. However, some have no significant effect on the growth of crops while others damage the young plants, regular growth of plants and fruit processing as well. This paper mostly deals with the effect of the leaf-spotting organisms on the leaves of the plant.

II. PREVIOUS STUDIES

A system for diagnosis as well as controlling of disease infection on cotton leaves together with soil quality monitoring with overall accuracy of 83.26% for disease detection was proposed [1].Curl virus disease of Cotton leaf, that is produced with a group of white fly-transmitted begomo trains and virus species was explained[2].Classification methods were defined with various parameters like accuracy, stress detection and disease severity of infected leaf of plant. Mainly they focused on the spectral images and defined biotic as well as abiotic stress in the plant in the form of accuracy [3].A system was proposed to automatically detect & classify plant leaf disease. The four step approach includes formation of color transformation structure of input RGB image, masking of green pixels, removal of those green pixels with particular threshold value by segmentation method followed by computation of texture statistics for useful segments and finally those extracted features are passed via classifier [4]. Experiment results showed 83–98 % nucleotide identifies in cotton leaves. The best model is the deep VGG16 model trained with transfer learning, which yields an overall accuracy of 90.4% on the hold-out test set. The proposed deep learning model may have great potential in disease control for modern agriculture [8].

III. EXPERIMENTAL DESIGN

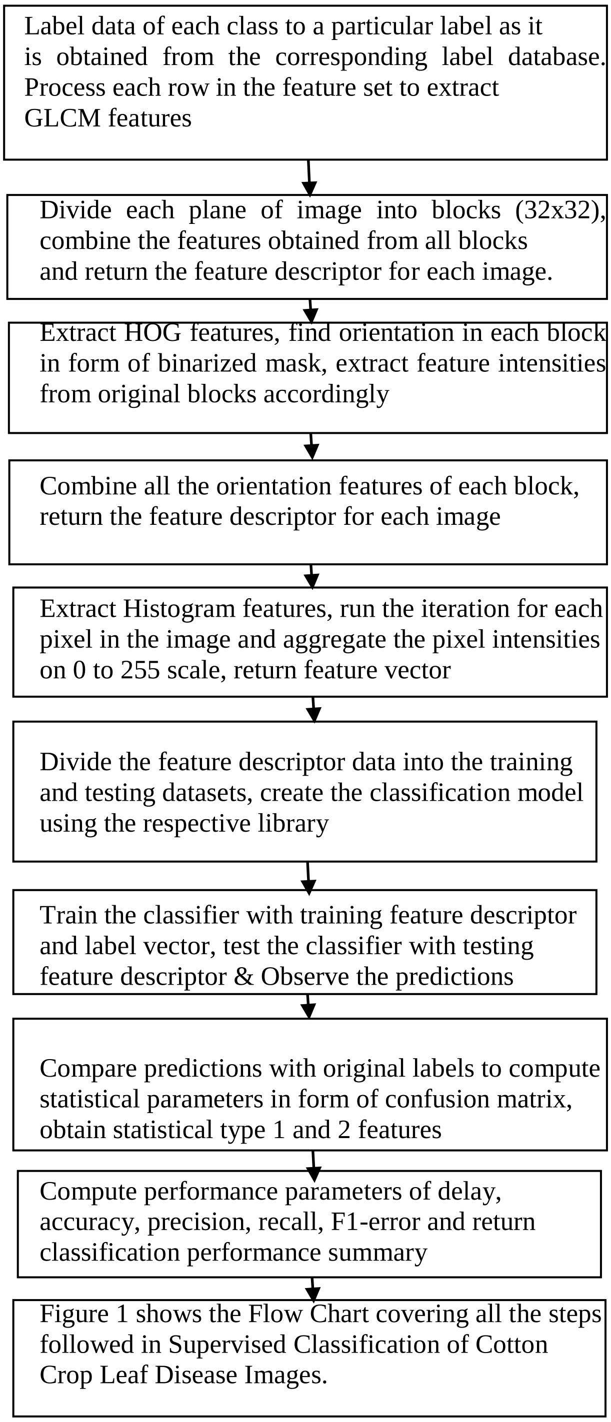


Fig. 1. Flow Chart of Supervised Classification of Cotton Crop Leaf Disease Images

The crop disease classification in this paper is accomplished by using the multi-faceted image features with the multiple classification algorithms. The variety of the classification algorithms are analyzed along-side the different feature descriptors in order to recognize the best combination of classification algorithm and feature descriptor. Support Vector Machine (SVM), Neural Network with Multi-layer Perceptrons and K-nearest Neighbor (KNN) techniques are utilized in the proposed model. The whole phenomenon of classification can be represented with the following flow chart:

IV. RESULTS & DISCUSSION

The algorithm is applied on the cotton leaves at different stages of development in MATLAB. Image Processing toolbox of MATLAB provides help in segmentation and pre-processing of leaf image and the algorithm detects the color and shape variations in the leaf. There are several types of diseases that affect cotton plant which includes Alternaria, Anthracnose, Bacterial Blight, Cercospora Leaf Spot, etc.

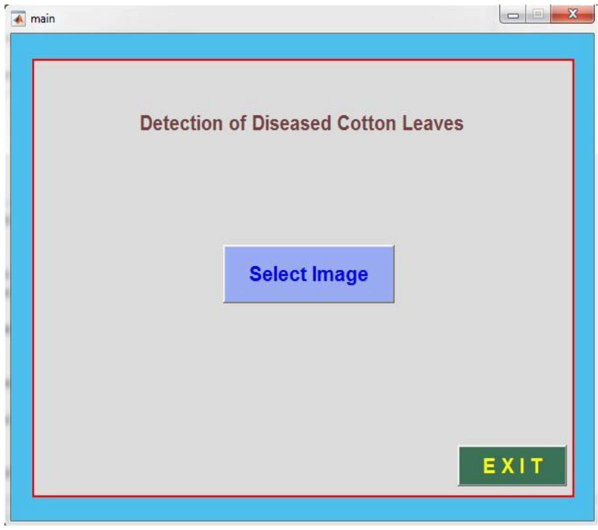


Fig. 2. Main window of Graphical User Interface

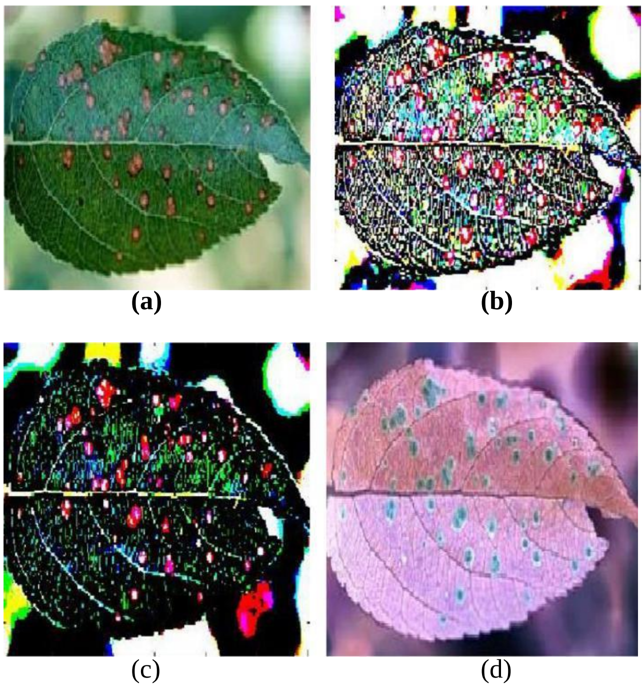
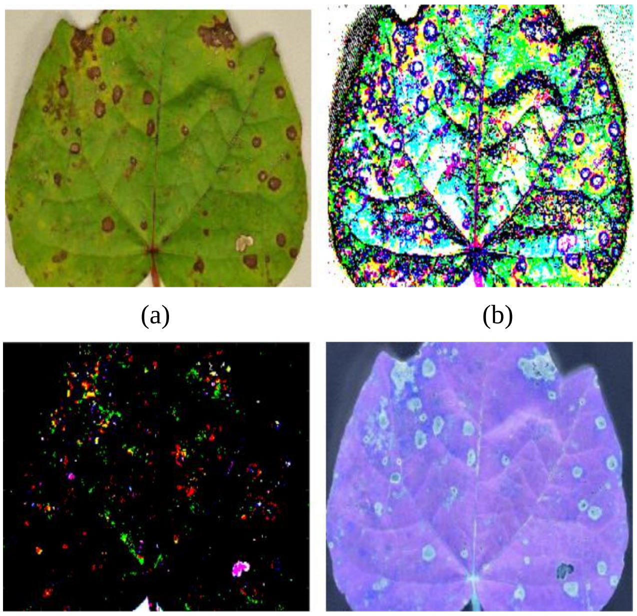


Fig. 3. Images of cotton leaf at initial stage of development a) Original Image (diminished background) b) Segmented Image c) Segmentation of color variation d) Disease detected

Figure 3 shown below displays the images of cotton leaf at initial stage of development in which Fig 3a shows Original Image (diminished background), Fig 3b shows Segmented Image, Fig 3c shows Segmentation of color variation and Fig 3d shows Disease detected image.



(a) (b)

(c) (d)

Fig. 4. Images of cotton leaf at later stage of development: a) Original Image (diminished background) b) Segmented Image c) Segmentation of color variation d) Disease detected

Figure 4 shown below displays images of cotton leaf at later stage of development in which Fig 4a shows the Original Image (diminished background), Fig 4bshows Segmented Image, Fig 4c shows Segmentation of color variation and Fig 4d shows Disease detected image.

Algorithm is being implemented on 40 infected images and the results are found to be accurate enough to detect whether the plant is infected with any of the above said disease. A comparative analysis of area covered by the disease is used to find the severity of the infection.

This is shown in the graph below where the threshold value of infected area decides the severity.

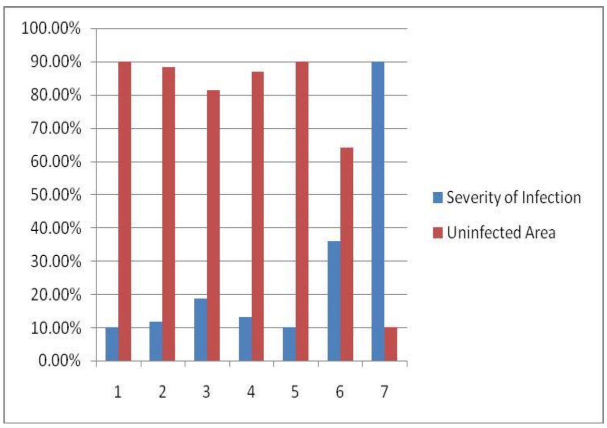


Fig. 5. Comparison analysis of area covered under infection that depicts Severity of infection

Figure 5 represents graph showing comparative analysis of area covered under infection by seven different types of diseases found on cotton leaf along with the severity level of each disease. For first disease numbered 1, area covered under leaf is 91% out of which 9 % area of leaf has been found infected. The severity level of infection of first type of disease on cotton leaf has been found to be 9.89% while 90.11% area of leaf is healthy. The results for second disease numbered 2 depict that out of 95% of area covered under leaf, 11 % area of leaf has been found infected. The severity of level of infection of disease has been found to be 11.58% while 88.42% area of leaf is healthy.

The analysis for third disease numbered 3 shows that out of total 64% area covered under leaf, 12 % area of leaf has been found infected. The severity level of infection of disease has been found to be 18.75% while 81.25% area of leaf is healthy. The results for fourth disease numbered 4 depict that area covered under leaf is 100% out of which 13 % area of leaf has been found infected. The severity of level of infection of disease on cotton leaf has been found to be 13% while 87% area of leaf is healthy. The results obtained for fifth disease numbered 5 prove that area covered under leaf is 50% out of which 5 % area of leaf has been found infected. The severity of level of infection of disease on cotton leaf has been found to be 10% while 90% area of leaf is healthy. The results obtained for sixth disease numbered 6 depict that area covered under leaf is 100% out of which 36 % area of leaf has been found infected. The severity of level of infection of disease has been found to be 36% while 64% area of leaf is healthy. The alarming results have been obtained for seventh type of disease. For seventh disease numbered 7, area covered under leaf is 50% out of which 45 % area of leaf has been found infected. The severity of level of infection of disease on cotton leaf has been found to be 90% while 10% area of leaf is healthy.

V. CONCLUSION & FUTURE SCOPE

In this paper, the feature descriptors of gray level co-occurence matrix (GLCM), histogram of oriented gradients (HoG) and histogram (HIST) are utilized to detect the leaf diseases in the proposed model to classify the visual diseases.

The agriculture-based leaf images are used for the various set of diseases, which must be evaluated in order to get the disease region and classify the type of the disease in the selected region. This disease occurrence analysis and classification model is determined to help the farmers across the globe, as this system utilizes the visual information to identify the existence of disease in the given image. This expert system can help the farmers with lower or almost no knowledge of plant pathology to detect, understand and analyze the emerging disease symptoms. Such information can be used for early precautions and disease preventions, which can result in high yield. Hence this work carries vast importance to the agriculture industry and poses the ability to minimize the loss caused by the various crop diseases overall to the national and international productions. For the real-time systems, the SVM and KNN are the best options, when accuracy is imperative factor. In the future, both SVM and KNN must be improved for the time parameter, which is significantly higher and can increase the overall classification delay in the real-time systems. The deep learning classification may be efficient with the exponential growth in data volumes.

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