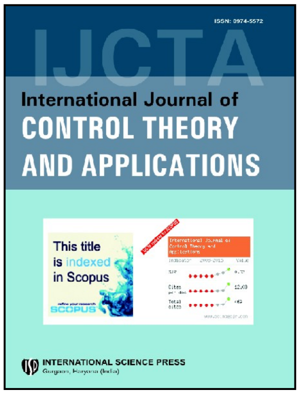

International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 21 • 2017

Leaf Disease Detection Using Combined Feature of Texture, Colour and Wavelet Transform

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Abstract: Technological advancement in the field of agriculture has made farmers to yield more productive crops. This has led the farmers to increase their productivity based on the approach to the problems they face with the use of technology. In this juncture we try to develop a novel solution to the diseases that occur in leaves which when diagonised at the early stage can improve the productivity, thus by increasing the revenue that is generated out of the yield. In this paper we provide a case study by using image processing techniques that provide a novel approach to identify the early detection mechanism using the images that are acquired over a camera. The acquired leaf images are processed using various color models and features are extracted using double density dual tree complex wavelet transform. These features are further compared with that of the leafs which are not having any disease using thresholding technique. It is observed that the proposed technique is fast enough as the image is color transformed and the features that are extracted are well formed such that any leaf can be easily classified as a diseased leaf or not. Results show that with only one feature, that is, features which are extracted using double density dual tree complex wavelet transform has an average accuracy of 99%, but tend to decrease within a large database. Hence, it is proposed to combine different texture and colour features which are combined to form the final feature vector. Results show that the accuracy of the proposed technique is 99.9% and is consistent within a database of 100 classes.

Keywords: Leaf Disease, Color Model, Double Density Dual Tree Complex Wavelet Tranform, Color Correlogram, Fractal Based Texture Features, Thresholding.

1. INTRODUCTION

With development of technology is every area there is a rapid increase in productivity in every sector. Agriculture is one area where the productivity has to be increased based on the increasing demand. Preventive measures need to be taken in this area such that the growth of the crop is not harnessed by any of the factors which include environmental changes. These changes in the environment cause the weather to change and further lead to bacteria and fungal infection development in the crop. Such a development will cause the productivity to decrease. Hence, there is a need of hour to prevent such state in the crop by early diagnosis.

Various techniques exist in the literature for early diagnosis and prevention of the diseases that occur in various crops. In the earlier days, farmers used to monitor the crops on daily basis and take appropriate preventive measures such that the crops can be prevented from the diseases at the same time maintaining an optimal yield. But with the increase in demand based on the market, farmers in the current scenario tend to have crops that have higher productivity. Such a mass production requires much man power for monitoring of the plants or crops.

For this purpose, famers try to improve the productivity by selecting the crops in such a way the crops are having high resistance over the diseases. But due to the climatic changes which cannot be controlled and are stochastic by nature, the cultivator has to move to a new step by changing the monitoring system such that the system can guide them about the preventive measures. Hence, in this paper we proposed a novel system that uses color models for extraction of the color components in the leaf structure. Majority of the plant diseases mainly effect the leafs of the plants. Hence, we have concentrated on the analysis of the color models on the leafs. The leaf color will be changing when the disease starts. But to the naked eye it may appear as if it is normal. Therefore, the system is assisted with color models output for proper enhancement of the diseased leaf.

In the literature, various feature extraction techniques exist that provide better accuracy in different degrees of freedom. The accuracy of such system depends on the number of features that are extracted from the leafs. As the number of features increase the computational complexity also increases which further increases the time in computation. Hence, there is a need for selecting the appropriate features from the extracted features. For this purpose, dimensionality reduction is proposed. But such a dimensionality reduction does not cater to the improvement in accuracy. Hence, in this work we propose to extract much high level features by the use of double density dual tree complex wavelet transform. These features are high level features that help in classification.

This paper is organized five sections. Section II provides a detailed description of the past work in this direction. Section III discusses the problem. Section IV clearly explains the proposed solution and Section V details the methodology used in the proposed work. Section VI provides the results obtained based on the methodology. Section VII outlines the conclusion.

2. LITERATURE SURVEY

Various techniques have come out in horticulture sector in the recent past and are good source of income. Pomegranate is a tree that grows well in arid and semi-arid regions. The environmental conditions in these areas harness the yield of the crop and further destroying the crop if not taken remedial steps at the earliest. Various diseases are observed in these crops viz., bacterial blight, fruit spot, fruit rot and leaf spot. The system is trained and tested using these diseases by extracting different features like GLCM from the crop and are further classified using artificial neural network[1].

Diseases in plant cause a drastic decrease in the productivity of the crop. Supervision of the large field corps is an increasing demand in the current era. Hashal *et al.* [2] proposed a novel technique for detection of diseases in the crops based on the analysis of the leafs. Segmented leafs are filtered out using a high pass filter for detection of the diseased part and are further processed using fractal based texture feature. These texture feature are further classified using multiclass SVM and observed an accuracy of 96.6%. Barbedo[3] has provided a survey of the recent systems that are deployed in agriculture that are used for solving the problems in agriculture. These expert systems concentrate on diagnosing the plant diseases as well. This survey has also provided a detailed report on how the problem is handled in the past, the developments in such systems and the problems with these systems such that they can be used by other researchers as a future scope and can be explored in the near future.

The major point that effects the crop is the environmental condition. Weather is the one which cannot be regulated by any cultivator. Anand *et al.* [4] proposed a novel approach for identification and classification of plant diseases in brinjal leafs. They have concentrated in extraction of various diseases that occur in brinjal leafs viz., bacterial wilt, cercospora leaf spot etc. For this purpose k-mean clustering is used for segmenting the image and these are further classified using neural networks. Sachin *et al.* [5] provided the techniques that are used in image processing for assistance of the farmers in diagnosing and classification of diseases in crops. The basic steps that are involved in image processing for disease detection are image acquisition, pre-processing, segmentation, clustering, feature extraction and classification. Different approaches that can be used in each of these steps are also clearly discussed. Based on the diseases that are spreading over a wide range there is a need for development of resistant varieties and also to develop protective techniques that can prevent the expansion of the diseases. Laser analysis is one such technique that can aid in diagnostics of the defective plants that have got infected by viral and mushroom diseases. It is observed that this approach has outperformed with the existing techniques [6]. With the help of remote sensing the crops are been monitored for diseases and controlled irrigation. But such a technique tends to be slow and also contains many problems that delay the preventive mechanism. In this juncture Sai Kirthi *et al.* [7] has developed a eAGROBOT, a prototype robot which is a ground based agricultural robot that enhances the preventive mechanism by exploiting the problems that exists in complex satellite based systems. Fungal diseases reduce the productivity of the crop. Such diseases can be identified and can be prevented by taking preventive measures at the earliest. Unhealthy regions of the crop are segmented first using thresholding technique and further different features are extracted from these regions. These features tend to be high dimensional features based on the techniques that are used for feature extraction. Hence, dimensionality reduction is applied. Further, the reduced feature space is classified using neural network and observed to have an accuracy of 98.3% [8]. Vijai *et al.* [9] has surveyed different disease classification techniques that cater plant leaf disease detection and segmentation of the diseased crops. Based on the discussion.

3. PROBLEM DEFINITION

Plant diseases can be identified by the analysis of the leaf structure. For this purpose, the diseased part of the leaf need to be segmented. Segmentation of the diseased part of the leaf takes time and the accuracy of the segmentation depends on the algorithm that is developed and also on the disease. In the current scenario, with the environmental change, adaptive segmentation need to the implemented. In order to reduce this process of segmentation there is a need to develop novel approaches that can reduce this time complexity.

The next step is feature extraction. Feature extraction process must be efficient such that the features that are extracted from the leafs are well suited for a classifier that classifies the diseased leafs from the non-diseased leafs. Further, these features must not be low level features such that the accuracy of the system tend to decrease. Hence, there is a need to extract high level features. As all the leafs will be of same color and texture, most of the features that are extracted will be having similar values. Hence, this problem becomes a non-linear classification in terms of the classifier perspective. Hence, high dimensional features need to be extracted such that this non-linear nature can be converted to a linear classification by the use of a novel classifier.

4. PROPOSED SOLUTION

In order to reduce the time complexity in segmentation it is proposed to use color models and extract the output of the color model. Figure 1 shows the image of a brinjal leaf which is a diseased leaf. Such images are collected and stored in a database for further analysis.

Further, features are extracted from the color model output using double density dual tree complex wavelet transform. These features are compared against the healthy leaf features that are extracted using the same procedure for classification. Classification is performed using thresholding operation wherein the value of the diseased leaf will be more negative and low when compared to the healthy one.

5. METHODOLOGY

Figure 1 shows the diseased leaf and it is processed to extract the color model output. It can be observed from figure 1 that most of the leaf structure interms color has changed to yellow and brown due to the disease. Hence,

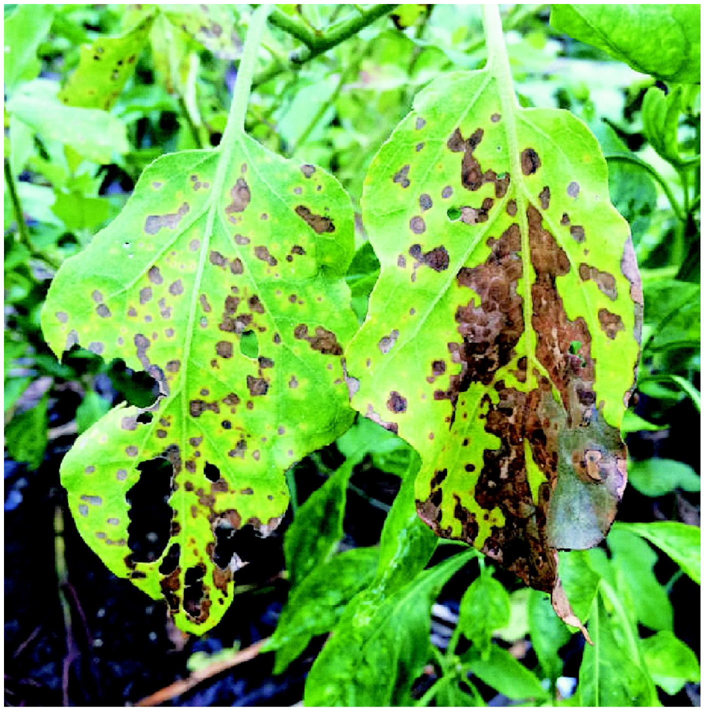

Figure 1: Brinjal Leaf Sample (Courtesy : plantvillage.org)

the more prominent colors are extracted and are retained for further processing, discarding all other colors. Further, features are extracted using double density dual tree complex wavelet transform[10].

The 2-D double density dual tree complex wavelet transform is more expansive which is 4 times when compared to the existing DWT. In other words, it results in as many wavelets in the same dominating directions. This transform is observed to have improved directional selectivity which outperforms the existing DWT[10]. Further, thresholding operation is performed against the mean of these feature values over the healthy leaf features which easily classifies the given leaf as a diseased leaf or not. Figure 2 shows the block diagram of the proposed system.

Generally, texture features are computed based on the statistical parameters that are computed from the feature values that are extracted from the image. These features tend to have certain limitations and inadequacies which further tend to reduce the performance accuracy of the system. Hence, in this paper we propose to use fractal[11-12] based features that better represent the texture in the image when compared to the traditional techniques such as GLCM[13]. Fractal dimension represents the roughness of a surface[12].

Color features tend to represent the images in various color bands. It may be noted that most of the leafs will be of green color. Hence, one may question that there is not necessity of color analysis here. But when some disease occurs in some part of the leaf the color content of the leaf changes. Hence, there is a necessity to include color as a feature. In this work we propose to use color correlogram[14] which is extracted as feature to the final feature vector. Color correlogram include the spatial correlation of colors and are used to describe how this spatial correlation is distributed globally[14].

The next step is classification. In this work we have proposed to use a simple distance based classifier which is proposed here to reduce the computational overhead by each classifier. It is also proposed to compare different classifiers viz., SVM[15], PCA[15] which are computationally efficient but are not used to reduce the overhead in this work.

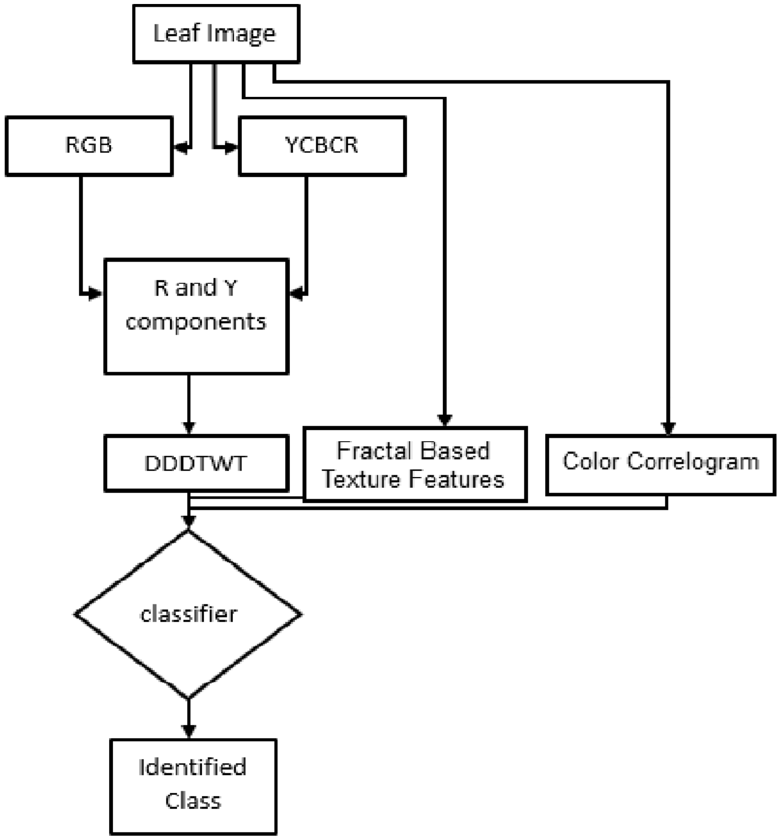

Figure 2: Block Diagram of the proposed system

6. RESULTS

Figure 3 shows the database used in this work. The database contains 100 of healthy leafs and unhealthy leaf which are the diseased leafs.

Figure 3: Database of the leafs

Figure 4 shows the output of the color transformation with the input image in figure 4(a). Figure 4 (b) shows the red component image. Figure 4(c) shows the yellow component image.

Figure 4 (a): Sample input image

Figure 4(b): Extarcted red component

Figure 4(c): Extracted yellow component

These individual components are extracted as the diseased leaf is having only red and yellow as the majority diseased structure. Hence, only these two components are preserved and the remaining are discarded. Combining these two components final image is formed which is passed for feature extraction and classification against the healthy leaf. Figure 5 shows the combined component image.

Figure 5: Combined color component image

A test case is provided against healthy image and a non healthy leaf image which provides the output as the diseased or healthy leaf based on the input. Figure 6 and 7 shows the result of such input.

Figure 6(a): Input test case

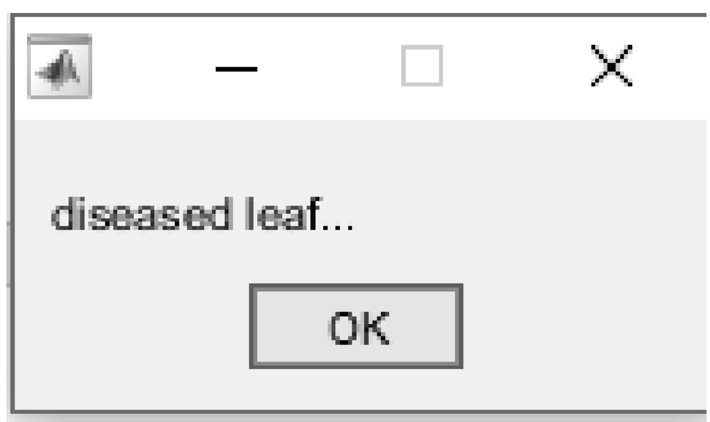

Figure 6(b): Output of the proposed system

Figure 7(a): Input test case

Figure 7(b): Output of the proposed system

Further, different features extracted using Fractal dimension and color correlogram are concatenated to improve the performance of the system. These features are stored in the database for testing.

In this work we have compared the proposed technique with different classifiers. Figure 8 shows the comparison of classification using different classifiers.

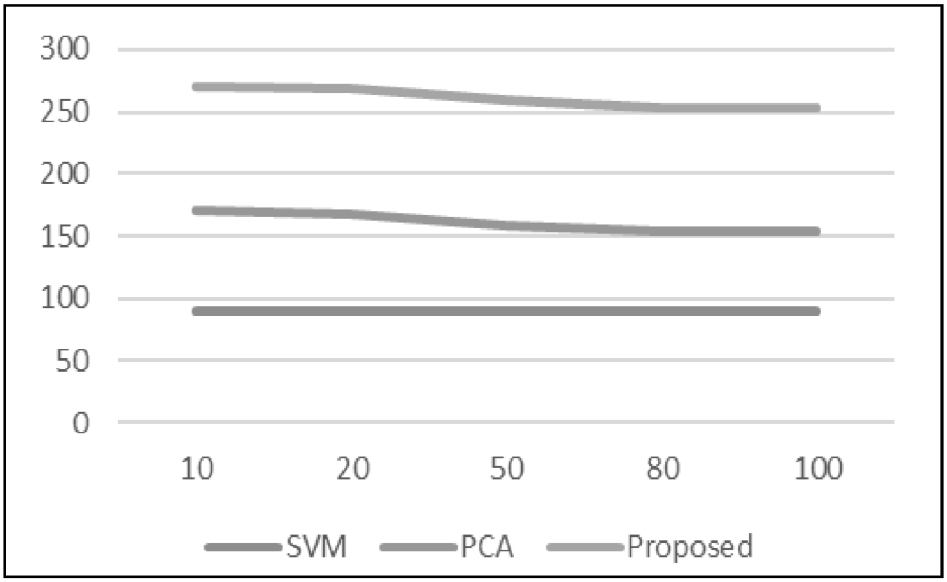

Figure 8: Comparison of recognition accuracy for different classifiers

Figure 8 shows the comparison of recognition accuracy for various classifiers. It can be observed from figure 8 that the proposed technique outperforms traditional classifiers. It is observed that the accuracy in recognition is consistent with increase in the number of classes and observed to be 99.9%.

7. CONCLUSION

Prevention of the disease in the crop increases the productivity. Hence, a novel system is developed which informs the cultivator by extracting the image of the leaf directly and processing it based on the system that is designed which extracts color planes of the input leaf image. Features are extracted from the leaf image using double density dual tree complex wavelet transform which provides better selectivity in various orientations. Results shows that the classification using a simple thresholding technique provides an accuracy of 99% which outperforms the existing techniques. Further, it is also observed that the system is primarily tested with only 15 classes and the accuracy tend to decrease with increase in number of classes. Hence to maintain the same accuracy and to retain consistent performance of the system, more number of features are extracted. Fractal based texture features along with color correlogram features are added to the existing wavelet features which form the final feature vector. With this the accuracy of the proposed system tend to be consistent and is observed to be having 99% recognition accuracy. The proposed technique is also observed to be fast enough as it reduces the time complexity in segmentation.

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