International Journal of Research in Engineering, Science and Management
Volume-2, Issue-7, July-2019
www.ijresm.com | ISSN (Online): 2581-5792

Image Processing Techniques for Early Plant Disease Detection

R. Mhetre Priyanka[1], S. G. Shinde[2], P. S. Linge[3]
[1]*M.E. Student, Department of Electronics and Telecommunications Engineering, TPCTs College of Engineering, Osmanabad, India*
[2]*Professor, Department of Electronics and Telecommunications Engineering, TPCTs College of Engineering, Osmanabad, India*

***Abstract*: The economy of India is highly depends on agricultural production. Due to this reason early detection of plant diseases important in agriculture field. There will huge loss in productivity if proper care not taken. Detection of plant disease through some automatic technique is beneficial as it reduces a large work of monitoring in big farms of crops, and at very early stage itself it detects the symptoms of diseases i.e. when they appear on plant leaves. This paper presents a method for early plant diseases detection by leaf spot using leaf features inspection. Leaf image is captured and processed to determine the health status of each plant. Currently the chemicals are applied to the plants periodically without considering the requirement of each plant. This technique will ensure that the chemicals only applied when the plants are detected to be effected with the diseases. The uploaded pictures captured by the mobile phones are processed in the remote server and presented to an expert group for their opinion. Computer vision techniques are used for detection of affected spots from the image and their classification. A simple color difference based approach is followed for segmentation of the disease affected lesions. The system allows the expert to evaluate the analysis results and provide feedbacks to the famers. The goal of this research is to develop an image recognition system that can recognize crop diseases. Image processing starts with the digitized color image of disease leaf. A method of mathematics morphology is used to segment these images. Then texture, shape and color features of color image of disease spot on leaf were extracted, and a classification method of membership function was used to discriminate between the three types of diseases.**

***Keywords*: Digital Photographs, Matlab, Image Processing**

1. Introduction

Plant diseases cause major production and economic losses in agriculture and forestry. For example, soybean rust (a fungal disease in soybeans) has caused a significant economic loss and just by removing 20% of the infection, the farmers may benefit with an approximately 21 million-dollar profit. It is estimated that the crop losses due to plant pathogens in India result in about 50 billion dollars every year. Of this, about 65% (32.5 billion dollars) could be attributed to non-native plant pathogens. Some of the diseases caused by introduced pathogenic species are chestnut blight fungus, Dutch elm disease, and huanglongbing citrus disease.

The bacterial, fungal, and viral infections, along with infestations by insects result in plant diseases and damage. There are about 50,000 parasitic and non-parasitic plant diseases of plants. Upon infection, a plant develops symptoms that appear on different parts of the plants causing a significant agronomic impact. Many such microbial diseases with time spread over a larger area in groves and plantations through accidental introduction of vectors or through infected plant materials. Another route for the spread of pathogens is through ornamental plants that act as hosts. These plants are frequently sold through mass distribution before the infections are known. An early disease detection system can aid in decreasing such losses caused by plant diseases and can further prevent the spread of diseases.

After the onset of plant disease symptoms, the presence of disease in plants is verified using disease detection techniques. Presently, the plant disease detection techniques available are enzyme-linked immune sorbent assay (ELISA), based on proteins produced by the pathogen, and polymerase chain reaction (PCR), based on specific deoxyribose nucleic acid (DNA) sequences of the pathogen. In spite of availability of these techniques, there is a demand for a fast, sensitive, and selective method for the rapid detection of plant diseases. Disease detection techniques can be broadly classified into direct and indirect methods. An advanced plant disease detection technique can provide rapid, accurate, and reliable detection of plant diseases in early stages for economic, production, and agricultural benefits.

In traditional way, field monitoring for first spot detection and disease severity assessment are visually inspected by human naked eyes. And two scales are generally utilized for the disease estimation: a single leaf severity assessment [3] and a whole plant assessment [4]. However, disease assessment by human inspection is with limitations of labor-intensive, prohibitively expensive, subjective discrepancies and discontinuity. Especially, disease onset detection, which plays pivotal role in disease control and remedy, is easy to be missed due to the discontinuous inspections. Therefore, in the past decades, image processing and machine vision techniques have been extensively explored for plant disease study for their merits of invasive, rapid, continuous and precise measurement

capacities. Moreover, a number of inspiring algorithms have developed by image processing and computer vision techniques to detect, categorize, diagnose and quantize the plant disease in this multi-discipline field linking computer science with agriculture engineering [5]-[9].

The classification and recognition of crop diseases are of the major technical and economical importance in the agricultural Industry. To automate these activities, like texture, color and shape, disease recognition system is feasible. Images were acquired under laboratory condition using digital camera. Three major diseases commonly found are Rice blast (Magnaporthe grisea), Rice sheath blight (Rhizoctonia solani) and Brown spot (Cochiobolus miyabeanus) were selected for this research. The management of plants requires close monitoring especially for the management of disease that can affect production significantly and subsequently the postharvest life. The naked eye observation of experts is the main approach adopted in practice for detection of plant diseases. However, this requires continuous monitoring of experts which might be prohibitively expensive in large farms. Automatic detection of plant diseases is an essential research topic as it may prove benefits in monitoring large fields of crops and thus automatically detect the symptoms of diseases as soon as they appear on plant leaves. Therefore, looking for fast, automatic, less expensive and accurate method to detect disease by calculating leaf area through pixel number statistics. The leaf area monitoring is an important tool in studying physiological features related to the plant growth, photosynthetic & transpiration process. Also being helpful parameter in evaluating, damage caused by leaf diseases and pastes, to find out water and environmental stress, need of fertilization, for effective management and treatment.

This paper also presents an automated system integrated with machine vision techniques that will assist the farmers get the accurate information about their crops using their mobile phone. The uploaded pictures of paddy captured by the mobile phones will be processed in the central server and the analysis report will be presented to an expert group for their opinion, who will then be able to send proper recommendations through a simple notification using he system, according to the severity of the situation.

2. Literature survey

Ghaiwat et. al. presents survey on different classification techniques that can be used for plant leaf disease classification. For given test example, k-nearest-neighbor method is seems to be suitable as well as simplest of all algorithms for class prediction. If training data is not linearly separable then it is difficult to determine optimal parameters in SVM, which appears as one of its drawbacks [1].

Authors in paper [2] describe that there are mainly four steps in developed processing scheme, out of which, first one is, for the input RGB image, a color transformation structure is created, because this RGB is used for color generation and transformed or converted image of RGB, that is, HSI is used for color descriptor. In second step, by using threshold value, green pixels are masked and removed. In third, by musing pre-computed threshold level, removing of green pixels and masking is done for the useful segments that are extracted first in this step, while image is segmented. And in last or fourth main step the segmentation is done.

Mrunalini et al. [3] presents the technique to classify and identify the different disease through which plants are affected. In Indian Economy a Machine learning based recognition system will prove to be very useful as it saves efforts, money and time too. The approach given in this for feature set extraction is the color co-occurrence method. For automatic detection of diseases in leaves, neural networks are used. The approach proposed can significantly support an accurate detection of leaf, and seems to be important

approach, in case of steam, and root diseases, putting fewer efforts in computation.

According to paper [4] disease identification process include some steps out of which four main steps are as follows: first, for the input RGB image, a color transformation structure is taken, and then using a specific threshold value, the green pixels are masked and removed, which is further followed by segmentation process, and for getting useful segments the texture statistics are computed. At last, classifier is used for the features that are extracted to classify the disease. The robustness of the proposed algorithm is proved by using experimental results of about 500 plant leaves in a database.

Kulkarni et al. presents a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it gives better results with a recognition rate of up to 91%. An ANN based classifier classifies different plant diseases and uses the combination of textures, color and features to recognize those diseases [5].

Authors present disease detection in Malus domestica through an effective method like K-mean clustering, texture and color analysis [6]. To classify and recognize different agriculture, it uses the texture and color features those generally appear in normal and affected areas. In coming days, for the purpose of classification K-means clustering, Bayes classifier and principal component classifier can also be used.

According to [7] histogram matching is used to identify plant disease. In plants, disease appears on leaf therefore the histogram matching is done on the basis of edge detection technique and color feature. Layers separation technique is used for the training process which includes the training of these samples which separate the layers of RGB image into red, green, and blue layers and edge detection technique which detecting edges of the layered images. Spatial Gray level Dependence Matrices are used for developing the color co-occurrence texture analysis method.

Paper [8] presents the triangle threshold and simple threshold

methods. These methods are used to lesion region area and segment the leaf area respectively. In final step, categorization of disease is done by calculating the quotient of leaf area and lesion area. According to the research done, the given method is fast and accurate for calculating leaf disease severity and leaf area calculation is done by using threshold segmentation.

Authors describe an algorithm for disease spot segmentation in plant leaf using image processing techniques [9]. In this paper, process of disease spot detection is done by comparing the effect of HSI, CIELAB, and YCbCr color space. For Image soothing Median filter is used. In final step, by applying Otsu method on color component, calculation of threshold can be done to find the disease spot. There is some noise because of background which is shown in the experimental result, camera flash and vein. CIELAB color model is used to remove that noise.

The state of art review of different methods for leaf disease detection using image processing techniques is presented in paper [10]. The existing methods studies are for increasing throughput and reduction subjectiveness which becomes due to naked eye observation through which identification and detection of plant diseases is done.

3. Proposed system

A. Problem statement

An attack by disease-causing organisms generates a complex immune response in a plant, resulting in the production of disease-specific proteins involved in plant defense and in limiting the spread of infection. Louse also produce proteins and toxins to facilitate their infection, before disease symptoms appear such as the leaf color will change. These leaf colors play vital role in the development of plant disease detection.

Influence the next phase of the attack is usually seen through the leaves stems or fruit inspection. To manage the potential problems, early identification is required and correct diagnosis of disease should provide operators to prevent before damage to the whole of plant chili and the swift implementation of preventative methods should allow the farmer to get on top of most problems before serious damage if inflicted.

The traditional method of identifying plant pathogens is through visual examination. This is often possible after major damage has already been done to the crop then treatments will be of limited or no use. To save plants from irreparable damage by louse, farmers have to be able to identify an infection even before it becomes visible.

Advances in vision technology, software technology, and biotechnology have made the development of such this disease detection is possible. These researches are designed to detect plant diseases early, either by identifying the presence of the louse in the plant (by testing for the presence of louse movement) or the color and shape produced by either the louse or the plant during infection. These techniques require minimal processing time and are more accurate in identifying louse. Other than some equipment and training, other procedures such as plants on-site monitoring by automatically or by a person who has no special training can be implemented. This technique also reduces the chemicals applied to the plants periodically without knowing which area that affected is.

B. Proposed algorithm

Digital camera or similar devices are used to take images of leafs of different types, and then those are used to identify the affected area in leafs. Then different types of image processing techniques are applied on them, to process those images, to get different and useful features needed for the purpose of analyzing later.

Algorithm written below illustrated the step by step approach for the proposed image recognition and segmentation processes:

1. Image acquisition is the very first step that requires capturing an imge with the help of a digital camera.
2. Preprocessing of input image to improve the quality of image and to remove the undesired distortion from the image. Clipping of the leaf image is performed to get the interested image region and then image smoothing is done using the smoothing filter. To increase the contrast Image enhancement is also done.
3. Mostly green colored pixels, in this step, are masked. In this, we computed a threshold value that is used for these pixels. Then in the following way mostly green pixels are masked: if pixel intensity of the green component is less than the pre-computed threshold value, then zero value is assigned to the red, green and blue components of this pixel.
4. In the infected clusters, inside the boundaries, remove the masked cells.
5. Obtain the useful segments to classify the leaf diseases.

For doing clustering appropriately, the search capability of GAs can be used, to set of unlabeled points in N-dimension into K clusters. On image data, we have applied the same idea in our proposed scheme. We have taken a color image of size m _ n and every pixel has Red, Green and Blue components. Every chromosome shows a solution, which is a sequence of K cluster centers. Population is initialized in various rounds randomly and from existing chromosome best chromosome survives in each round for the next round processing. In the first step of fitness computation the dataset of pixel is clustered according to nearest respective cluster centers.

Computing the features using color co-occurrence methodology

For feature extraction the method used is color co-occurrence method. It is the methodology in which both the texture and color of an image are considered, to come to the unique features, which shows that image. Over the traditional gray-scale representation, in the visible light spectrum, the use of color image features provides an additional feature for image characteristic. There are three major mathematical processes in the color co-occurrence method. First, conversion of the RGB

images of leaves is done into HIS color space representation. After completion of this process, to generate a color co-occurrence matrix, each pixel map is used, which results into three color co-occurrence matrices, one for each of H, S, I. Features called as texture features, which include Local homogeneity, contrast, cluster shade, Energy, and cluster prominence are computed.

4. Results

All the experiments are performed in MATLAB. For input data disease, samples of plant leaves like rose with bacterial disease, beans leaf with bacterial disease, lemon leaf with Sun burn disease, banana leaf with early scorch disease and fungal disease in beans leaf are considered. Fig. 1 shows the original images which are followed by output segmented images. Segmented image can be classified into different plant diseases. Fig. 2 shows the input and output image where input image is a banana leaf with early scorch disease and output image shows the classification of disease using feature extraction method. In the same manner classification of diseases of other input plant leafs are shown in Figs. 3–6.

The co-occurrence features are calculated after mapping the R, G, B components of the input image to the threshold images. The co-occurrence features for the leaves are extracted and compared with the corresponding feature value that are stored in the feature library. The classification is first done using the Minimum Distance Criterion with K-Mean Clustering and shows its efficiency with accuracy of 86.54%. The detection accuracy is improved to 93.63% by proposed algorithm. In the second phase classification is done using SVM classifier and shows its efficiency with accuracy of 95.71%. Now the detection accuracy is improved to 95.71% by SVM with proposed algorithm. The training and the testing sets for each type of leaf along with their detection accuracy is shown in Table 1.2 and Fig. 7. From the results it can be seen that the detection accuracy is enhanced by SVM with proposed algorithm compared to other approaches reported in [4, 5, and 7].

The numbers of leaf disease samples that were classified into five classes of leaf disease using proposed algorithm. Only two leafs with bacterial leaf spot disease are classified as frog eye leaf spot and one frog eye leaf spot is classify as bacterial leaf spot. The average accuracy of classification of proposed algorithm is 97.6 compared to 92.7 reported.

5. Conclusion

This paper presents the survey on different diseases classification techniques used for plant leaf disease detection and an algorithm for image segmentation technique that can be used for automatic detection as well as classification of plant leaf diseases later. Banana, beans, jackfruit, lemon, mango, potato, tomato, and sapota are some of those ten species on which proposed algorithm is tested. Therefore, related diseases for these plants were taken for identification. With very less computational efforts the optimum results were obtained, which also shows the efficiency of proposed algorithm in recognition and classification of the leaf diseases. Another advantage of using this method is that the plant diseases can be identified at early stage or the initial stage. To improve recognition rate in classification process Artificial Neural Network, Bayes classifier, Fuzzy Logic and hybrid algorithms can also be used The above section says how to prepare a subsection. Just copy and paste the subsection, whenever you need it. The numbers will be automatically changes when you add new subsection. Once you paste it, change the subsection heading as per your requirement.

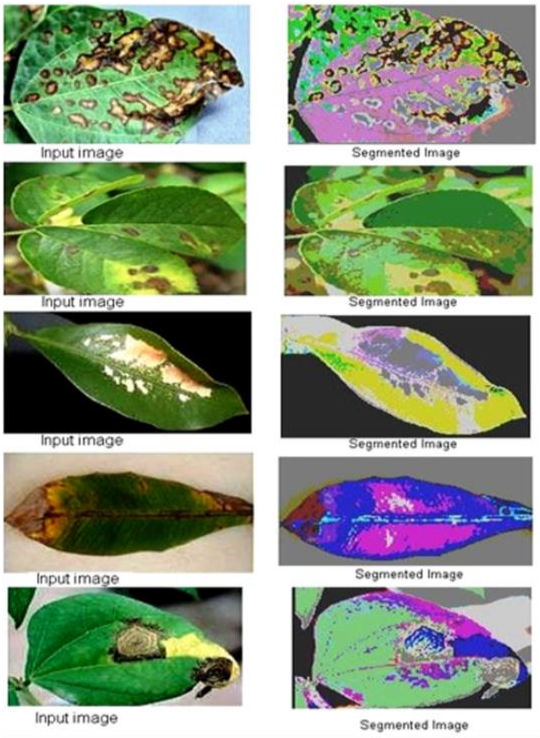

Fig. 1. Input and output images.

Fig. 2. Input and output image of banana leaf and output diseases is early scorch disease

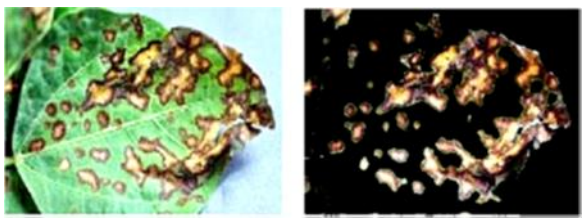

Fig. 3. Input and output image of beans leaf and output diseases is bacterial leaf spot

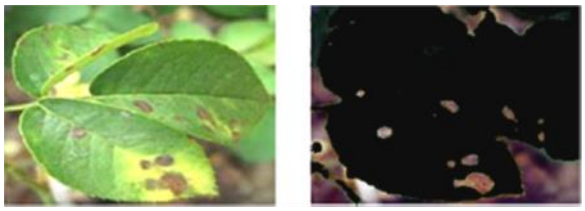

Fig. 4. Input and output image of rose leaf and output diseases is bacterial leaf spot

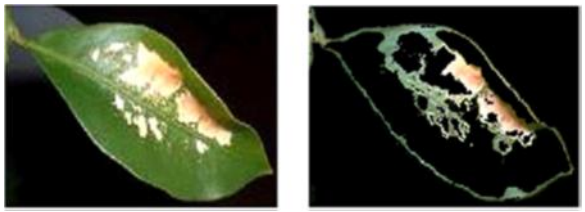

Fig. 5. Input and output image of lemon leaf and output diseases is sun burn disease

Fig. 6. Input and output image of beans leaf and output diseases is fungal disease

References

[1] W.W. Shane, P.S. Teng, "Impact of Cercospora leaf spot on root weight, sugar yield, and purity of Beta vulgaris," Plant Dis., vol. 76, pp. 812- 820, 1992.
[2] J. Vereijssen, H.H.M. Schneider, A.J. Termorshuizen, M.J. Jeger, "Comparison of two disease assessment methods for assessing Cercospora leaf spot in sugar beet," Crop Protection, vol. 22, pp. 201-209, 2003.
[3] R.K. Jones, C. E. Windels, "A management model for Cercospora leaf spot of sugar beets," Minnesota Extension Service, University of Minnesota, 1991.
[4] Y. Takeda, Crop management in Hokkaido-the manual cultivation of rice, field crops, fruits, and flowers, chapter 5, pp. 90, November 2011.
[5] G. Polder, G. W. A. M. van der Heijden, H. Jalink, J. F. H. Snel, "Correcting and matching time sequence images of plant leaves using Penalized Likelihood Warping and Robust Point Matching," Computers and Electronics in Agriculture, vol. 55, pp. 1-15, 2007.
[6] A. Camargo, J. S. Smith, "Image pattern classification for the identification of disease causing agents in plants," Computers and Electronics in Agriculture, vol. 66, pp. 121-125, 2009.
[7] Y. Tian, C. J. Zhao, S. L. Lu, X. Y. Guo, "SVM-based Multiple Classifier System for recognition of wheat leaf diseases," In Proceeding of 2010 Conference on Dependable Computing, pp. 189-193, November 2010.
[8] T. Rumpf, A. K. Mahlein, U. Steiner, E. C. Oerke, H. W. Dehne, L. Pumer, "Early detection and classification of plant disease with support vector machines based on hyperspectralrefelcetance," Computers and Electronics in Agriculture, vol. 74, pp. 91-99, 2010.
[9] R. Pydipati, T. F. Burks, W. S. Lee, "Identification of citrus disease using color texture feature and discriminant analysis," Computers and Electronics in Agriculture, vol. 52, pp. 49-59, 2006.
[10] R. Zhou, S. Kaneko, F. Tanaja, M. Kayamori, M. Shimizu: "Robust detection of Cercospora Leaf Spot in sugar beet using orientation code matching," The 11th International Conference on Quality Control by Artificial Vision, pp.99-106. 2013.
[11] F. Ullah, S. Kaneko, S. Igarashi, "Orientation Code Matching for robust object search," IEICE Trans. On Inf. & Sys, E48- D, No. 8, pp. 999- 1006, 2001.
[12] J. L. Tang, D.J. He, Z.L. Zhu, "Research on segmentation methods of plants and soil background," In Proceeding of Chinese Society of Agricultural Engineering, 2011.
[13] S. Knerr, L. Personnaz, G. Dreyfus, "Single-layer learning revisited: a stepwise procedure for building and training a neural network," In Neurocomputing, Springer Berlin Heidelberg, pp. 41-50, 1990.
[14] J. X. Du, X. F. Wang, and G. J. Zhang, "Leaf shape based plant species recognition," Applied Mathematics and Computation, vol. 185, 2007
[15] H. Fu and Z. Chi, "Combined thresholding and neural network approach for vein pattern extraction from leaf images," IEEE Proceedings-Vision, Image and Signal Processing, vol. 153, no. 6, December 2006
[16] J. Du, D. Huang, X. Wang, and X. Gu, "Shape recognition based on radial basis probabilistic neural network and application to plant species identification" in Proceedings of 2005 International Symposium of Neural Networks, ser. LNCS 3497. Springer, 2005
[17] R. C. Gonzalez, R. E. Woods, and S. L. Eddins, Digital Image Processing Using MATLAB. Prentice Hall, 2004
[18] IngeborgTastl and Gunther Raidl, "Transforming an analytically defined color space to match psychophysically gained color distances," the SPIE's 10th Int. Symposium on Electronic Imaging: Science and Technology (San Jose, CA), vol. 3300, 1998, pp. 98–106
[19] A. L. Yuille, D. Snow, and M. Nitzberg, Signfinder: Using color to detect, localize and identify informational signs, Int. Conf. on Computer Vision ICCV98, 1998, pp. 629–633.
[20] B. Funt and G. Finlayson, Color constant color indexing, IEEE Trans. On Pattern Analysis and Image Processing 17 (1995), 522–529.
[21] Erik Reinhard, Michael Ashikhmin, Bruce Gooch, and Peter Shirley, Color transfer between images, IEEE Computer Graphics and Applications September/ October 2001.
[22] Maria Petrou and Panagiota Bosdogianni (2003). Image Processing: The Fundamentals. 3rd Edition, John Wiley & Sons, LTD, England.