

Estimation of Yellow Rust in Wheat Crop Using K-Means Segmentation



Agriculture

KEYWORDS :

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ABSTRACT

The presented work describes a software prototype system for yellow rust disease detection based on the infected images of various wheat plants. Images of the infected wheat plants are captured by closed circuit CCD cameras to cover approximately 3 sq. meter area that could acquire good quality images of wheat crop and processed for getting a gray colored image and then using image growing, image segmentation techniques to detect infected parts of the plants. Then the image is transferred to the analysis algorithm to report the quality. The methods evolved in this system are both image processing and soft computing techniques applied on a number of diseased wheat plant images. The wheat images are acquired by using a CCD camera of approx. 3 M-Pixel resolution in 24-bits color resolution. The images are then transferred to a PC and represented in MATLAB software. The RGB image is then segmented using K-means algorithm for segmentation of yellow rust in the wheat crop. The segmented yellow rust part is now analyzed for its percentage presence.

Introduction

Wheat crop in certain parts of Punjab, Haryana, J & K and parts of Uttarakhnad and bordering crop fields in Uttar Pradesh are affected by stripe rust or yellow rust of wheat caused by a fungal pathogen, *Puccinia striiformis* presently. The disease appears in the form of yellow stripes on wheat leaves. This disease appears if cold temperature with intermittent rains prevails during the months of February and March.

Wind is the main means of spread or dispersal of stripe rust. The spores are produced in huge numbers in pustules on the upper surface of leaves. Once the spores become airborne, the rust developing in any part of the wheat belt can spread rapidly to other areas; some spores can travel very far. In order to contain this disease from becoming an epidemic and move towards rest of the North Western Plain Zone and Northern Hill Zone of India, appropriate care has to be taken by the following measures.

1. Constant monitoring in all villages through farmer - participatory scouting and supervised by Assistant Director of Agriculture along with local KVK specialists and Sate Agricultural University professors. Vigil about its course of spread in each district is reported to the respective Director of Agriculture in each of the above state.
2. If the yellow rust is noticed in the wheat crop, it is advised to spray the crop with Propiconazole (Tilt) 25 EC @ 0.1 % (1 ml / litre).

The present monitoring and disease control measures have the following drawbacks:

1. It requires continuous monitoring by experts which might be prohibitively expensive. Further, in developing countries, farmers have to go long distances to contact experts, this makes consulting experts too expensive and time consuming, resulting in delay leading to high risk of disease spread. It also results in subjectivity and low throughput. Early information on crop health and disease detection can facilitate the control of diseases through proper management strategies.
2. Excessive use of pesticides for plant disease treatment increases costs and raises the danger of toxic residue levels on agricultural products. As pesticides are among the highest components in the production costs of field crops and have been identified as a major contributor to groundwater contamination, their use must be minimized. This can be achieved by more precise targeting of pesticides to those places in the field where they are needed.
3. Public risk disease: Since stripe rust can spread rapidly from one farm to another over long distances, actions by one person can have an effect on others, making stripe rust a 'social' or 'public risk' disease. Maximum benefits occur if centralized management strategies are adopted for stripe rust.

Thus there occurs a need for a simple and cost-effective optical device for remote disease detection, to assist in monitoring diseases in plants. In its most basic sense, remote sensing is the practice of gathering information about something without touching it. Photographic images of diseased plants can be called remote sensing. Machine vision is an area of research that is merging with remote sensing and finding use in agriculture. In machine vision, a computer analyzes an image and measures parameters within it. Ground-based uses of these fields allow greater precision and accuracy for disease assessment and quantification.

Related Works

The use of pesticides is required to be minimized, for plant disease treatment, since excessive use of chemicals leads to toxic residue on the crop and also to ground water and soil contamination. Therefore disease detection at an early stage and precise targeting of the pesticide in the areas where it is needed would be beneficial. A device based on canopy reflectance in several wavebands could be an answer to the problem. Self-Organizing Maps were used for visualization of data properties and presentation of interrelations between variables. Neural network based disease detection algorithms were developed. Through the use of these methods, classification performance increased from 95% to more than 99%. [1].

With the principal component analysis and the discriminant analysis, five characteristic parameters such as Sphericity, Roundness, Hu1, Hu2, equivalent radius were selected as the identification factors. Using these factors the recognizable rates of the samples among the three wheat diseases were 96.7%, 93.3%, and 86.7% respectively [2].

Sugarcane diseases appearing in the form of spots on leaves cause severe losses if not treated on time. These diseases are mostly Fungi based. The use of fungicides is required to be minimized, for plant disease treatment, since excessive use of chemicals leads to toxic residue on the crop and also to ground water and soil contamination. Segmentation of leaf area and lesion area is based upon simple threshold and Triangle thresholding methods. Finally diseases are categorized by calculating the quotient of lesion area and leaf area. The accuracy of the experiment is found to be 98.60 [3].

The proposed arrangement of approach was based on layered model and consisted of a two-level structure: the bottom layer was called the base-level module which consisted of three kinds of SVM-based classifiers trained by three feature sets and the second layer was called the meta-level module which consisted of SVM-based decision classifier trained by a meta-feature set which is generated through a new data combination method. This approach is more flexible and has higher success rate of recognition, when evaluated against other single classifiers and other strategy of classifier ensembles for wheat leaf diseases. [4]

Soya bean crop is affected by a disease called Soybean rust which is one of the most damaging foliar diseases of soybean, leading to substantial loss of yield. For efficient control of this disease it is critical that the disease be detected in the early developing stages for well-timed application of fungicide. Thus the need for a mechanism for timely detection of the disease cannot be over emphasized. Diseased Leaf images with different levels of rust severity were taken and investigated. Validation of the results of the two methods revealed that the manual threshold-setting method had the capacity of detecting soybean rust severity only under laboratory conditions, whereas the centroid-locating method had the ability of being applied in the field. [5]

The developed Neural Network classifier that is based on statistical classification displayed good results in all samples of various types of leaf diseases with a precision of around 93%. The neural network based classifier is very effective in recognizing leaf diseases, and the K-means clustering method provides efficient results in segmentation of RGB images. [6]

In developing countries, diseases in plants cause major production and economic losses in the agricultural industry. Monitoring of health and detection of diseases in crops is critical for sustainable agriculture. Crop disease needs to be detected at early stage for timely control. This paper describes the use of diseased tomato leaves to recognize the disease. In this paper color is used as a parameter to extract feature related information from images by calculating the 1st, 2nd & 3rd moment of color. Features extracted from the image are further used with classification algorithms and content based image retrieval systems.[7]

The following two steps are added subsequent to the segmentation phase. In the first step the mostly green colored pixels are identified. After that, these green pixels are masked based on specific threshold values, calculated using Otsu's method. In the second additional step the pixels with zero RGB values and the boundary pixels for the infected cluster are completely removed. Experimental results demonstrate that this technique is a robust solution for the detection of plant leaf diseases. The developed algorithm can effectively detect and classify the investigated diseases with an accuracy between 83% and 94%, and can expedite the solution proposed in [6] by 20%.[8]

This study describes the classification and recognition of paddy diseases based on image processing. It uses machine vision as a technique for detection and management of paddy diseases. It presents image processing techniques and a novel Gaussian Mean (GM) method for segmenting diseased paddy leaves. The proposed method comprises of an optimal threshold based segmentation method. Experimental results confirm that the suggested method automatically segments disease parts of paddy leaf efficiently and accurately. [9]

The purpose of this study is to identify and diagnose diseases related to cotton crop. Different diseases on cotton crop have different patterns which are relevant to various features extracted from the image e.g. the color of infected part is different for different pathogens. Also different diseases have different shapes of holes; generally the shape of the holes is elliptical, so calculating the major and minor axis is the main task. The features are extracted using self organizing feature maps and a back-propagation neural network is used to recognize the color of the image. This information is used for segmentation of cotton leaf pixels within the image. [10]

Wheat Crop Image Acquisition

The very first step in the presented work is to acquire the wheat crop images using the CCD cameras. Following Images are acquired using 5 MPixel Nikon camera from the field. It is proposed to install the closed circuit CCD cameras to cover approximately 3 sq. meter area that could acquire good quality images of wheat crop. Then transfer the image to the analysis algorithm and report the quality.



Fig. 1



Fig.2

Yellow Rust Segmentation using K-means

K-means clustering is a partitioning method. The k-means algorithm partitions data into k mutually exclusive clusters. Unlike hierarchical clustering, k-means clustering operates on actual observations (rather than the larger set of dissimilarity measures), and creates a single level of clusters. The distinctions mean that k-means clustering is often more suitable than hierarchical clustering for large amounts of data. K-means treats each observation in data as an object having a location in space. It finds a partition in which objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible.

Each cluster in the partition is defined by its member objects and by its centroid, or center. The centroid for each cluster is the point to which the sum of distances from all objects in that cluster is minimized. K-means computes cluster centroids differently for each distance measure, to minimize the sum with respect to the measure that is specified. K-means uses an iterative algorithm that minimizes the sum of distances from each object to its cluster centroid, over all clusters.

This algorithm moves objects between clusters until the sum cannot be decreased further. The result is a set of clusters that are as compact and well-separated as possible. You can control the details of the minimization using several optional input parameters to k-means, including ones for the initial values of the cluster centroids, and for the maximum number of iterations.

Following images shows the result after implementing the K-means algorithm on original wheat crop images.



Fig. 3 (Original Wheat Crop)



Fig. 4 (Segmented Yellow Rust)



Fig. 5 (Original Wheat Crop)



Fig. 6 (Segmented Yellow Rust)

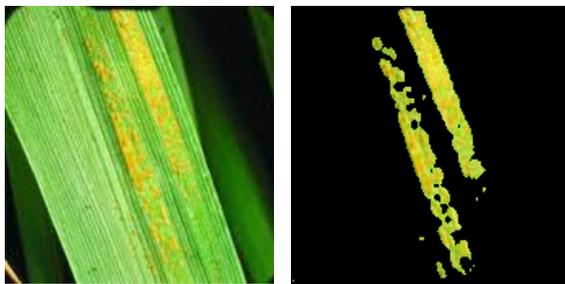


Fig. 7 (Original Wheat Crop) Fig. 8 (Segmented Yellow Rust)

Results

The segmented image i.e. the yellow rust image is now exposed to measurement algorithm, where the yellow rust area is computed with respect to entire acquired image area. This gives the degree of yellow rust penetration in the wheat crop under scan-

ner.

| Fig. No. | Total Wheat Crop Area under Scanner | Yellow Rust Area | % Yellow Rust |
|----------|-------------------------------------|------------------|---------------|
| 3, 4 | 200 x 256 sq. pixels | 10230 sq. pixels | 20% |
| 5, 6 | 200 x 256 sq. pixels | 12967 sq. pixels | 25% |
| 7, 8 | 200 x 200 sq. pixels | 9870 sq. pixels | 24% |

Conclusion

% Penetration of the yellow rust has been computed from the ratio of the yellow rust infected area and complete leaf area. This is an estimate of the yellow rust penetration into a single plant and a fair idea of yellow rust spread into the entire crop can be estimated by inspecting the entire crop segmented into zones and brought under the purview of the imaging sensors i.e. cameras.

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