A Novel Machine Vision System for Identification of Yellow Rust in Wheat Plants

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Abstract

The crop of wheat is very often infected by a disease that leaves spots of brown, gray or off-white colors on the wheat plants. Scientifically, this disease is known as Yellow Rust. It's a kind of fungus that often kills young seedlings. The fungus spreads by air. Therefore, it is important to monitor the leaf at regular intervals so as to keep track on quality of growing wheat crop. In the presented paper, a novel machine vision system has been proposed that visual inspects the leaves of the plants and based on spots on leaves, it determines the nature of disease and its depth into the crop. The size of the fungus, color depth and location and locus of the fungus on leaves give an accurate determination of crop quality. In the presented work, the image of the crop leaves are taken by a good quality color camera and processed for getting a gray colored and segmented image depending upon the nature and size of the fungus. A criterion is set for acceptable and rejects crop quality based on the fungus level.

Keywords: Yellow Rust, Leaf Morphology, Perimeter, Segmentation, Leaf Area.

1. INTRODUCTION

Wheat crop in certain parts of Indian states of Punjab, Haryana, J & K and parts of Uttarakhand 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 February and March. The affected leaves dry up, the grain shrivel and the yield is very low. e.g.in Rabi 2010-11, this disease led to huge losses in these states, the outburst of yellow rust in Districts of Kathua, Samba and Jammu on variety PBW 343 in the season (2008-09) was serious.

Wind is the main means of spread or dispersal for 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 the presented paper, the visual inspection of yellow rust identification work is divided into following steps:

1. Image Acquisition
2. Thresholding
3. Segmentation
4. Feature Extraction
5. Result Comparison

2. IMAGE ACQUISITION

In the proposed thesis work, the crop plants 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 PC and represented in MATLAB software. Here, it is to be noted that the proposed system is not to identify or visually inspect the each and every plant, but rather to identify at least one infected leaf

from the mass that may lead to infect the entire crop. Therefore, the objective is to identify the culprit one.

The key idea in the presented work is to develop a novel technique for detection of any disease/infection from the leaves in wheat plants that suffers at a higher rate than any other crop. After capturing the image, the leaves images are brought under image processing techniques to identify the growth and type of infections. Fig. 1 shows the image taken by CCD camera from the field in 24-bits color format.

FIGURE 1

3. THRESHOLDING

The acquired color image is now converted to gray scale color scheme. Local and global thresholding approaches may be utilized to produce a binary image from the gray scale image. In the present work, a median filter of 3x3 kernel is applied and then a thresholding algorithm based on Otsu method is applied (global thresholding) [6]. Fig. 2 is the image after converting the same into gray shade format. Median filter is applied to remove the salt and pepper noise which is normally present in the crop field images. Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel. However, with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than the mean. The median is much less sensitive than the mean to extreme values (called outliers). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image. The results after applying the median filter are shown in Fig. 3. When Otsu algorithm is applied over the filtered image, a binary image as shown in Fig. 4 is obtained.

FIGURE 2

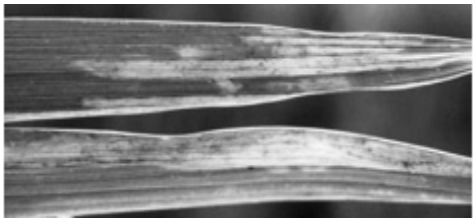

FIGURE 3

FIGURE 4

4. SEGMENTATION

The threshold image is now segmented based on bwlabel algorithm in MATLAB. Fig. 4 is taken as input image for segmentation. Below are the figures after segmentation using 8-connectivity of pixels and bwlabel function in MATLAB software.

Small leaf portions based on connected pixels basis can be left out as they do not contribute much in visual inspection of wheat plants. Another segmentation based on color is also employed in the presented work. Color based segmentation suggest the discoloring of the leaf due to any infection present in the crop.

FIGURE 5

FIGURE 6

5. LEAF CONTOUR EXTRACTION

`In order to calculate the leaf area, the contour of the leaf is to be determined. The contour of the leaf is extracted using the sobel operator in matlab. Fig. 7 shows the result after applying the sobel operator on input image.

FIGURE 7

The Sobel method finds edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient of intensities is maximum.

6. LEAF PERIMETER AND AREA COMPUTATION

Leaf parameters are computed using the matlab command regionpros. It calculates the leaf perimeter and area. The leaf perimeter is the no. of pixels on the leaf contour. The leaf area is computed by counting the number of pixels confined within the contour as extracted in leaf contour extraction section of this paper. Later on, the infected leaf area is computed from the segmented image.

7. FEATURE EXTRACTION

In the presented paper work, following observations are supposed to be monitored:

I. Leaf Morphology
II. Leaf Area, perimeter
III. Completeness of the leaf
IV. De-coloring of leaf due to fungus or decease

Leaf Morphology of the leaf suggests and compares the leaf under test with the standard or reference image of the leaf. Leaf morphology comparison between standard and leaf under test is approximate and not exact. However, the normalization of leaf under test with respect to size is must before comparison. Leaf Area and perimeter suggest the size of the leaf after normalization of the leaf size with respect to standard one. Completeness of the leaf with respect to its morphology suggests that if any part of the leaf is bitten by an animal, then, that part of the field may be infected by the animal's larva transferred on the leaf. That larva may penetrate into the crop and may infect the same and the nearby plants as well.

8. HISTOGRAM ANALYSIS

A RGB image is converted to gray scale image using the following formula:

Gray Color Code = (0.299*R + 0.587*G + 0.114*B)

Where R -> Red, G-> Green and B-> Blue Color Value

Histogram of the input image is one of the complementing tool in identifying and confirming the presence of yellow rust in wheat plants. Any sharp rise of the yellowish color peak in the histogram indicates the presence of yellow rust in wheat crop/plant. The peak in histogram in yellow region can be fair estimate of the yellow rust infection into the plants.

9. RESULTS

Table1 shows the area and perimeter of the segmented leaves using the regionprops function in MATLAB software. The yellow rust infected part in image is yellowish. We can find the percentage infected area of leaf due to yellow rust from the above table. And that will give the penetration of the disease into the plant. It is an important indicator to distinguish infection by morphological features. That is easy to get the differences by comparing the morphological

characteristics among different wheat diseases, such as area, diameter and other features. Further the identification or degree of penetration may be verified by histogram analysis. The amount of green tissue is an indication of health and the growth stage and condition of the plant. The use of digital images to quantify the greenish color shows that it is possible to obtain information about the amount of red, green, and blue light emitted for each pixel The RGB values can be converted to hue, saturation and brightness (HSB) to simplify the interpretation of digital color-data.

10. CONCLUSION

Agricultural applications are an ideal target for the implementation of machine vision technologies. The ability to use image sensors remotely, requiring no contact with the subject or intervention by an operator provides a measure of robustness usually difficult to achieve in this area. RGB histogram analysis of a wheat plant image can be very strong tool in identifying the degree of penetration of the yellow rust into the crop. Ratio area calculation provides the measure of the disease and a quantitative analysis can be drawn for the yellow rust spread on the whole crop area. Using image processing techniques in monitoring the wheat crop, a fair idea of any kind of disease can be guessed in time if the image acquiring devices are installed to cover a wide area of the crop,

Sr. No.	Figures	Area (sq. Pixels)	Perimeter (Pixels Unit)
1		4471	392
2		4485	317
3		2997	339
4		2701	278

TABLE 1

11. REFERENCES

[1] S.S. Abu-Naser, K. A. Kashkash and M. Fayyad [2008] "Developing an Expert System for Plant Disease Diagnosis, Journal of Artificial Intelligence"

[2] Mohammad Ei –Helly, Ahmed Rafea, Salwa Ei – Gamal And Reda Abd Ei Whab[2004] "Integrating Diagnostic Expert System With Image Processing Via Loosely Coupled Technique", Central Laboratory for Agricultural Expert System(CLAES).

[3] Zhi-Chun Huang, Patrick P. K. Chan, Wing. W. Y. Ng, Daniel S. Yeung, "Content based image retrieval using COLOR moment and gabor texture feature", *Proceedings of 9th international conference on machine learning and cybernetics,Qingdao, pp-719-724,11-14 July 2010*

[4] R. Brunelli and O. Mich, "Histograms Analysis for Image Retrieval*," Pattern Recognition, Vol.34, No.8, pp1625-1637,2001*

[5] P. S. Suhasini, Dr. K. Sriramkrishna, Dr. I. V. Muralikrishna "CBIR using Color histogram processing", *Journal of theoretical and applied information technology,pp-116-122,2009*

[6] J. Huang, S. R. Kumar, M. Mitra, W. J. Zhu, and R. Zabih, "Image indexing using Color correlograms" *,IEEE Int. Conf. Computer Vision and Pattern Recognition, San Juan, Puerto Rico, Jun. 1997, pp.762– 768.*

[7] Jau-Ling Shih & Ling-Hwei Chen, "Color image retrieval based on primitives of Color moments".

[8] Dimitrios Moshoua, Cédric Bravo , Jonathan West , Stijn Wahlen , Alastair McCartney , Herman Ramona "Automatic detection of 'yellow rust' in wheat using reflectance measurements and neural networks"

[9] Extraction and analysis of digital images feature of three kinds of wheat diseases Jinghui Li, Lingwang Gao , Zuorui Shen IPMist Lab, College of Agriculture and Biotechnology, China Agricultural University, Beijing100193, China.