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Comparative Analysis of Geometrical Descriptors and Texture in Soybean Infection Categorizing Using Neural Network

Sourabh Shrivastava* and Dhara Singh Hooda

ABSTRACT: *With the advancements in Computer technologies, many application devices have been developed for specialty agriculture crop production around world wide. In this study we present an application of image processing in agriculture for detecting and categorization on the basis of Geometrical Descriptor Analysis (GDA), Texture and Probabilistic Neural Network (PNN). All these factor applies in soybean infected lesion and extract the feature vectors. With the help of PNN we have classify the disease in the soybean leaves. To test this hypothesis, three classiûcation models were assessed via cross checking, the first models is texture basis, second is pattern basis and third is pattern and texture basis. The results of this study recommended that: third model shape and texture might be applicable as discriminators. and its shows 94.62 average accuracy compare to other model.*

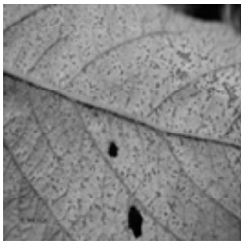
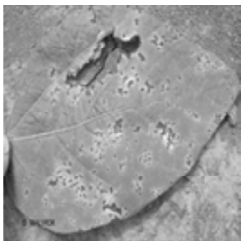
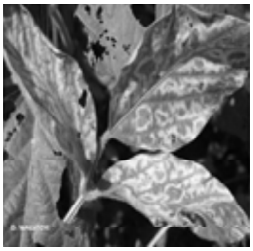
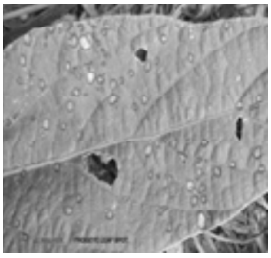
Keywords: *Bacterial Blight, Frog's eye, Brown spot, and Rust, Automatic Infection identification, Application of image processing, Geometrical Analysis*

INTRODUCTION

The recent techniques for sensor technologies growths allow devloped to closely admonisher and assure many terms of crop production. Geo-informatics and remote sensing or sensor networks can be useful to examine plant health, disease and insects, conditions of soil, and plant sciences. To set up a trustworthy and broad groundwork for precision agriculture, there is a anxious need for information with high spatial and high thematic resolution. The fungous and bacterial disease, along with plagues by insects result in plant infection and damage. The speed rate of disseminate of soybean disease calculates on current crop considerations and tendency to infection (Lucas *et al.*, 1992). When soya plants become septic, they can display the outer indications such as colored lesion that can happen on leaves of plant. These optical indications incessantly change their size, color and shape as the disease builds up. In current scenario mobile phone devices are increasing day by day and help to farmers for capturing images. The succeeder of machine learning for digital image pattern recognition also proposes applications in area of classification and recognition of soybean plant diseases. Once the image of an objective is caught up with by mobile phone digital image processing algorithms can be used to infusion several type of features from it. The utility of each boasts will depend on specific color and texture patterns to be affected in the image. They should be constant and invariant to circular motion, proportion and transformation (Lee *et al.*, 1999), if potential mistake are to be warded off. Recently assorted descriptions of color, texture shape, and size are mixed together for their applications in the agriculture and food industry. Commonly by increasing the features description used carrying into action of process and methods proposed can be improved. Moreover selective geometry information (size and shape) and both surface information (color and texture) of agriculture and food products in images play a major part in infection detection and class discrimination. There are versatile grounds for low yield in soybean cropped namely plant diseases, bugs'/insect assaults, climate conditions and most significantly the lack of necessitated cognition and knowingness among Indian farmers. The research work reported in this paper concentrate development of automatic Soya disease assortment on the basis of color, texture and shape using sensor and digital image processing

* Jaypee University of Engineering and Technology, Guna-473 226 (M.P.), India, *E-mail: sourabh.juet@gmail.com*

Table 1
Soybean Disease Description
Description of Soybean Disease

S. No.	*Soybean Disease Image (*)*	*Name of Disease*	*Features*	*Descriptions*	*Refrence*
1		Soybean Rust (SR)	Yield Loss Color Shape Size	The reported yield loss is up-to 80% Reddish Brown Polygonal Shape Area is 2-5	Miles *et al*. 2003
2		Bacterial Blight (BB)	Yield Loss Color Shape Size	The reported yield loss is 0-15% Yellow to light brown spot. Angular shape Irregular	Park and Lim, 1986
3		Sudden-Death-Syndromes (SDS)	Yield Loss Color Shape Size	The reported yield loss is 10-15% Dark brown with yellow circle Irregular Irregular	Roy *et al*. 1997 Westphal *et al*
4		Downy Mildew (DM)	Yield Loss Color Shape Size	The reported yield loss is 20-40% Yellowish Green Irregular Indefinite size	Sweets *et al*. 2008 Beckerman Bp-68-w
5		Brown Spot (BS)	Yield Loss Color Shape Size	The reported yield loss is 0-15% Brown Shape is like a seed Size is 1-5 mm	Loren, 2011
6		Frog Eye (FE)	Yield Loss Color Shape Size	The reported yield loss is 10-60% Reddish and purple Shape is circular Diameter is ¼ inch	Dorrance *et al*. 2010; Mian *et al*. 2008; Westphal *et al*. BP-131-W

techniques. Very few researcher work in this area. (Barbedo *et al.* 2013). Table no-1 shows the detail description of soybean disease.

MATERIALS AND METHODS

This field of study enforces a machine vision system for the recognition and assortment of the visual indications of soybean plant diseases, from the analytic thinking of disease. Diseased regions such as lesions, identification, shape analysis and texture analysis by image processing (shrivastava et. al 2013). With the help of segmented, pre-processed, and a set of image features was drew out from apiece region. GDA was then executed to distinguish which of these rendered most information about the image domain. Those characteristics that added little or no information were threw away. Table -4 describe the proposed expert system which is use in classification the soybean disease.

Image Set

The typeset of 500 images of soybean healthy and infected image used in this study was received from the field study with evaluation in Guna India. In total, each minimum 15 images pointed the damage caused by the 6 destructive disease name soybean rust, bacterial blight, sudden death syndrome, frog eye, downy mildew brown spot and healthy image set. These digital images were caught utilizing three-channel RGB mobile phone digital camera with changing field circumstances.

Image Pre-processing

In an image pre-processing we applied the channel extraction method. The original image is consist of RGB channel with the help of Matlab 2012 we extract the RGB channel and applies the segmentation on the basis of threshold method. After segmentation, we get the binary image and apply the filtering operation on the noise section. Multiple the red channel to binary image (inverted image) we get the background separated image (shrivastava et al. 2013).

Color Filtering Operation

Color filtering operation (shrivastava et al. 2013) had been applied to background separated image. Color filter works on the basis of pixel by pixel. Soybean image is consisting of three channels Red Green Blue and each channel consist own pixel value. All six type of disease indicated the red color or lesion is consisting by red to yellow color. In red channel the value of red is greater than blue and green in each pixel. So filter is calculated and analysis the value of each pixel and if find the value of red is greater than other two channel shows the infected region on the soybean leaves. In table no 2 shows the color filtering operation and detect the infected lesions.

Feature Extraction

In this research paper applied two types of feature vector a) GDA b) Texture Based all calculation parameter are shown in table no – 3(a) and 3(b). In feature extraction, we broadly look for invariance

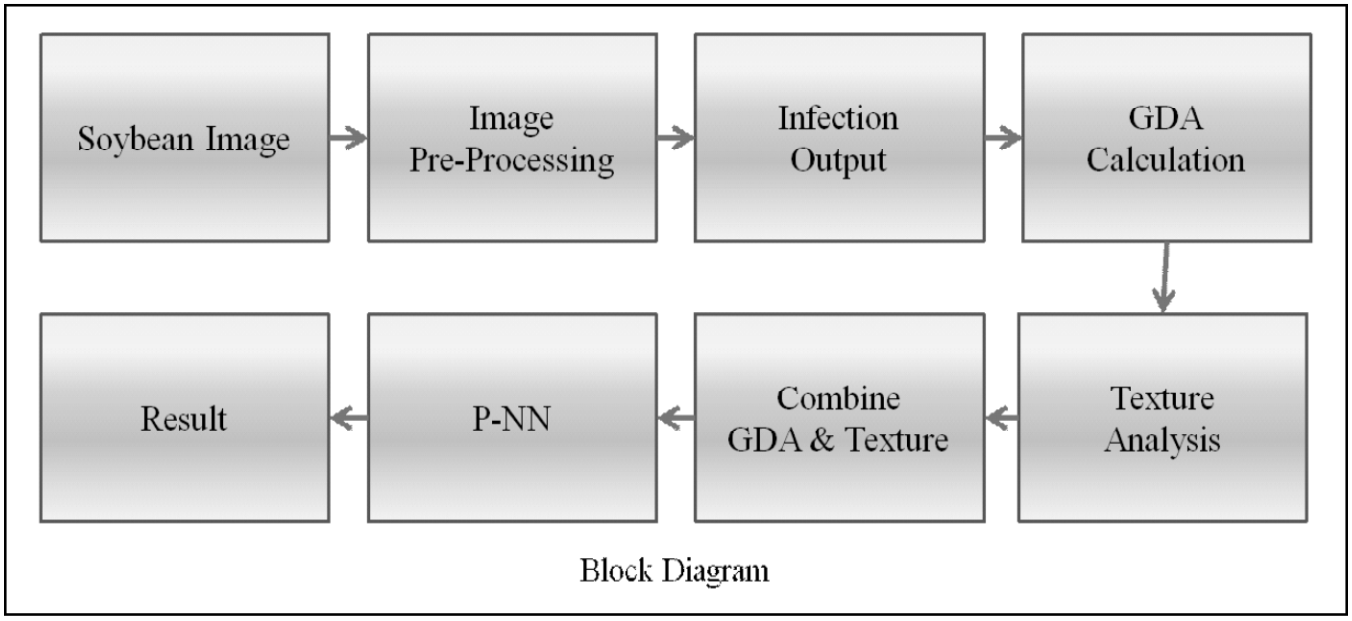


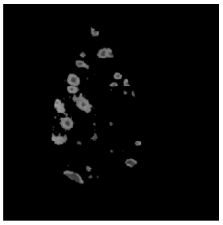
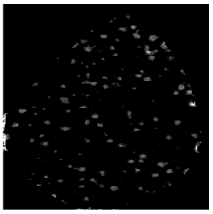
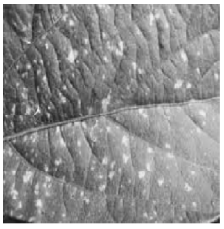
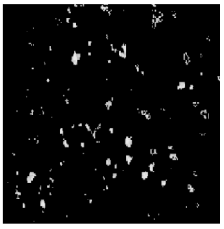
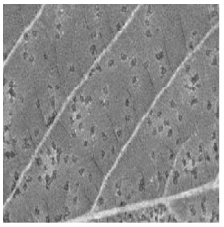
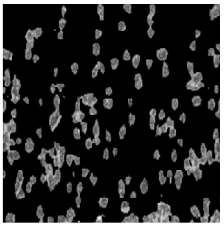
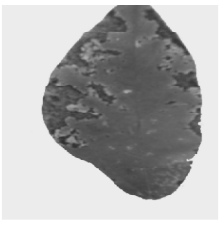
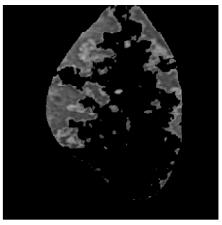
Figure 1: Block Diagram of Proposed Method

attributes so that the extraction procedure does not change according to chosen (or specified specifies. That is, process should determine GDA faithfully and robustly whatever the value of any parametric quantity that can control the appearance of a shape. The aim of texture feature description is to deduct measurements that can be used to classify the feature a particular texture. As such, the rear in conflict needs on the measurements, as there were for shape description. The invariance needs for feature discriptior extraction, namely n variance to rotation scale and position, can apply equally to texture extraction.

Geometrical descriptor analysis

High-level feature characteristic and extraction pertains finding shapes in digital images. This feature vector extraction process can be view as related to the way in which we recognize the world: many books for babies explain essential statistical shapes such as triangles, circles and squares. In this paper we uses six feature descriptor area, perimeter, compactness, roundness, minimal boundary box, equivdiameter. Oh the behalf of these six parameter we easily extract the feature of infected lesion which find in above section. In figure – 2 shows the binary image of binary image of the infected region and calculation of centroid and roundness of the infected lesion. Binary image of infected region to help to find out the area and no of regions occur in the infected soybean leaves. All these GDA feature vector describes in x6 to x12 in the block diagram. These feature vector help to classify the disease. In figure 2 bacterial blight show the big lesion area, frog eye shows the no. of infected region is very high, downy mildew shows the very few infected regions, soybean rust shows the pin point area and brown spot shows the mixture of huge area and minimum area of lesion. All these parameter to help to classify the disease.

Table 2
Infected Lesion by Color Filtering

Soybean Disease	*Original Image*	*Infected Image*
Bacterial Blight		
Frog Eye		
Downy Mildew		
Soybean Rust		
Brown Spot		

Texture Analysis

The purpose of color based feature descriptors has been demonstrated to be quite remarkable in many visual inspection chores. In some other chores, texture analysis are necessitated because of disproportionately achromatic or color turns up. In many practical application, texture and color must be joint to accomplish good implementation [Mansor *et al.* 2013 & Arivazhagan *et al.* 2010]. Texture feature vectors and color features, analysis have been generically is use in compartmentalization with reserve feature selections, classifier design can be greatly implied. Hence, we implement texture features from the gray level co-occurrence matrix (GLCM, Haralick *et al.* 1973, He *et al.* 1987) to classify soybean diseases. Feature vector for texture classification is shown in table 3(a). This method measures and calculate the occurrence of gray levels between a specific position in the image and a neighboring pixel. Measurements that are possible to estimate via the co-occurrence matrix are: mean, contrast, entropy, uniformity, third moment and

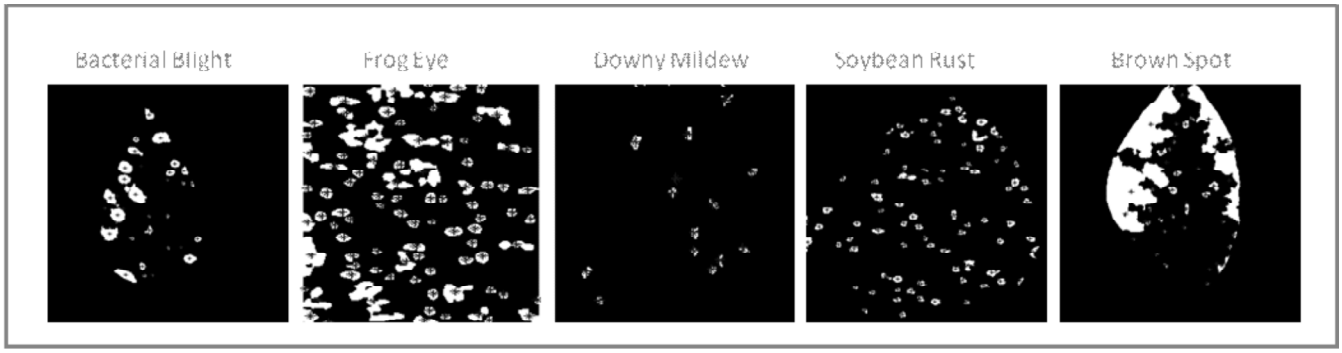


Figure 2: GDA

Table 3
(3a) Texture and (3b)Shape Feature Vector

Texture(3a)		*Shape(3b)*	
Features	*Expression*	*Feature*	*Symbol/formula*
Mean	$m = \sum_{i-0}^{L-1} z_i p z_i$	Area	**A**
Contrast	$\sigma = \sum_{i=1}^{k} \sum_{j=1}^{k} (i-j)^2 p_{ij}$	Perimeter	**1**
Smoothness	$R = 1^{-1}/(1+\sigma^2)$	Compactness	**C = l^2/4**
Third Moment	$\mu_3 = \sum_{i=0}^{L-1} (z_i - m^3) p(z_i)$	Roundness	**1/c**
Uniformity	$U = \sum_{l=0}^{L-1} p^2(z_i)$	Minimal Bounding Box	$A_m = l_b.S_b$
Entropy	$e = \sum_{i=0}^{L-1} p(z_i) \log_2 p(z_i)$	Equivdiameter	sqrt(4*Area/pi).

smoothness.texture descriptor describe in x1,x2,x3,x4,x5 in block diagram. These five texture descriptor help to classify the disease.

Table 4
Algorithm Process

For Each Soybean Infected Image **Do**
Image Pre-processing
Set Threshold Value
Lesion Identification
For Each Color Filtered Image **Do**
Feature Extraction
Texture Analysis
GDA Analysis
End for
For Feature Vector **Do**
Developed model-1
Developed model-2
Developed model-3
End for
All Models
Applies PNN classifier
Plot the graph
Plot the tables
End for

RESULT AND DISSCUSSION

PNN Classifier (Donald F. Specht 1990) is applied for sorting of disease by on the interest of shape and texture analysis. In PNN sorting method, no sorting model is built in advance. PNN relates back to the training data in the sorting of each new sample. Therefore, one can say that the whole training set is the classifier. In this paper section 2.3.1 and 2.3.2 extract the feature on the basis of texture and shape analysis. For analysis and validate the result we focus on three model. First model represent the texture based classifier. In this model we use x1, x2, x3, x4, x5, x6 feature vector. Second model based on shape based classifier. In this model use x7, x8, x9, x10, x11, x12. Third model based on shape and texture based classifier. In this model combine the model 1 and model 2. In PNN classifier three types of data required first is training data which is used as a database of all type of soybean disease feature vector. Second is

sample data, it requires the infected image of soybean disease which wants to test from training data set. Third is class, class defines the types of infection, example in this paper we used five type of disease so here class is five. In this paper we use a huge number of soybean database. We use 30,20,31,26,12 data samples for soybean rust, downy mildew, frog eye, sudden death syndrome, brown spot respectively. All these classification is based on PNN classifier. The average classification accuracy result of model 1 is 82.7 and model 2 is 68% and combined model 3 result 94.62 shows the better classification result. All classification result is shown in table 4 and table - 5. All samples and training data is used in different variation and result in shown in table 4.

Table 4
Disease Classification Result

Category	*Number of observations classified into categories*														
	Model – 1(%)					*Model – 2(%)*					*Model – 3(%)*				
	SR	DM	FE	SDS	BS	SR	DM	FE	SDS	BS	SR	DM	FE	SDS	BS
SR 30	1	0	0	0	20	1	1	2	1	29	1	0	0	0	
DM	5	25	0	0	0	3	15	0	3	0	1	22	1	0	0
FE 0	1	15	2	0	2	1	25	1	0	0	1	30	0	0	
SDS	0	0	6	21	2	10	3	4	20	4	1	0	0	25	0
BS 0	0	0	4	10	0	2	2	5	8	0	0	2	0	10	
Classification Accuracy	85.7	92.5	71.7	77.3	83.3	57.1	68.1	78	64	66.6	90.63	91.6	90.9	100	100

Table 5
Average Classification Result

Model	*Description*	*Average Classification*
Model -1	Texture Based	82.1
Model-2	GDA Based	66.76
Model-3	Texture and GDA Based	94.62

For validated the result, figure 6 shows the graphical classification representation. Shape based feature vector is used in this representation. Figure 6 shows the graphical representation of region and pixel. All type of soybean infected diseased are used for comparative study of lesion area. Region defines the spot occurs in the infected soybean leaves and how many pixels in the single spot defines the pixel. When we analysis the object area in figure 6 we see the area of frog eye (green stem) is almost same in all lesion compare to other disease and quality of lesion occur is more than other disease. As per literature survey the lesion size is almost same, so in this paper proof this sentence because the all lesion in size is same which is denote by green color in figure 6. As per literature survey the brown spot is very big in area so we proves this sentence in figure 6 blue stem represents the brown spot. As per literature survey soybean rust lesion size is almost same but its occurs on 2-5mm varies so in figure 6 it is represents by red stem. As per literature the downy mildew spot occur very less in the soybean leaves so figure 6 shows the yellow stem. As per literature survey sudden death syndrome lesion area always varies show in figure - 6 cyan show represents the sudden death syndrome.

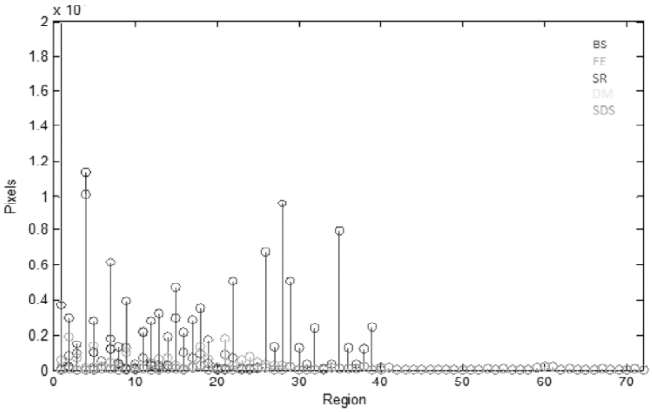


Figure 6: Comparative Analysis of Lesion Area of Disease

CONCLUSION AND FUTURE SCOPE

All six disease are well classify as per result. Model-3 shows the best performance compare to other two model. In future we have try to build a expert system with cure for the solving the problem of the farmer.

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