THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Detecting the Weeds in Crop Fields Using Image Segmentation

E. Keerthana
Student, Department of Computer Science and Engineering,
Rajalakshmi Engineering College, Chennai, Tamil Nadu, India

Abstract:
In image processing, even though there exist many advanced tools for classification and recognition of the images, some unrelenting challenges need to be faced when it transfers to different application requirements. In agricultural industry, discriminating weed coverings and crop rows under uncontrolled lighting on real-time remains a challenging task in image processing technique. The paper presents an image processing technique to get a knowledge and information within the crop field for the distribution of weeds, a prerequisite for site-specific treatments in agricultural sector, which is of boundless economic importance. An adjustable algorithm for segmentation of colour image using the Principal Component Analysis (PCA) and Otsu's thresholding method has been proposed for sorting and grading the weed in the crop field. It is carried out by constricting three-dimension vector of an image to one dimension using Principal Component Analysis method. We demonstrated here how image processing technique in MATLAB could be employed for weed classification in crop fields.

Keywords: *Image Segmentation, 3-D Otsu's method, Image acquisition, Principal Component Analysis*

1. Introduction

Agriculture plays an important role in the economy of any nation. Economy of agricultural industries directly depends on the products made through the agriculture. India is an agriculture based country, wherein seventy percent of the population depends on agriculture. A stable agricultural industry ensures a country of food security, source of income and source of employment. Enhancement of productivity needs proper type, quantity and timely application of soil, seed, weed detection, water and agrochemicals at specific sites. The paper intends to focus on the application of image processing in agricultural field particularly for weed detection. The traditional method was not too accurate and was time consuming. To overcome it, a set of features are investigated to get accurate results. Application of image processing can improve decision making for vegetation measurement, weed detection in crop fields, sorting, etc.
With image processing technique, an algorithm has been developed and evaluated for the detection of individual weeds. Images are first segmented and threshold values are to be considered for weed detection and classification. The Principal Component Analysis (PCA) have been done using certain adjustable algorithm and for sorting and grading weeds in field are done using Otsu's thresholding method. The overall process would have been implemented in MATLAB. The work will be focused on crop detection and identification in crop fields; this not only requires crop row detection but also requires discrimination among crops and weeds. We use PCA, in case of discrepancy between weed and crop to further classify the data.

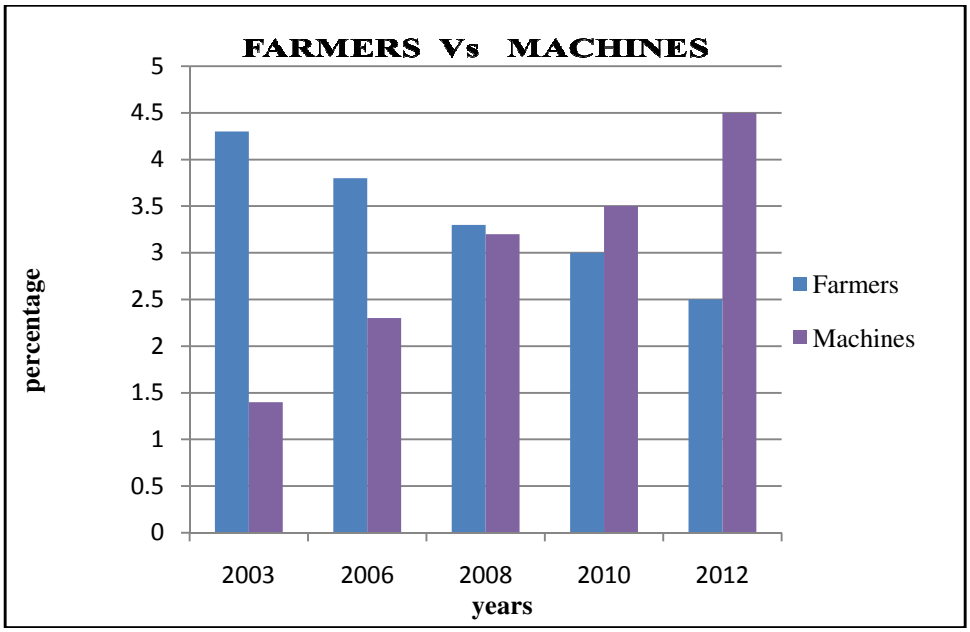

Figure 1: Farmers Vs Machines

Fig 1 shows the gradually an increase and decrease of the work carried out through farmers and machines in terms of years. Therefore higher labor or input costs and weeds reduce grain quality and price, so it is necessary to detect the weed in an earlier stage.

1.1. Need for Image Processing on Agricultural Sector

An efficient tool for analysis of application on different areas is image processing. The tool can be used for the measure of parametric values related to agronomy with accuracy and economy. Image processing application in the field of agriculture can be widely grouped into two categories: Imaging techniques which have been taken as the first category and the second one was on applications. The Precision Agriculture (PA) uses data from GPS, GIS, and Remotely Sensed Images for monitoring, analyzing and controlling the stress, weed level, diseases and other issues. In rural areas it is difficult to access these types of data. The cost of these tools are not affordable to those farmers for farm management. In India 91% are the farmers, out of which most of them are marginal farmers. In farm management, the critical and trending issues were faced by the farmers through the excess weeds in crop fields. Now image processing techniques are used to identify the weeds among the crops fields and thereby the images are taken as an input data for weed detection.

2. Basic Methods

2.1. 3-D Otsu's Method

3-D Otsu's method is one of the Image processing technique, used to convert gray level images into binary images. It can be processed by calculating the threshold in which it splits into two pixels. It is used to perform automatically clustering-based image thresholding. The algorithm takes the image into two classes namely Foreground and Background classes. Henceforth 3-D Otsu's method have been proposed for double thresholding.

2.2. Principal Component Analysis (PCA)

In signal processing, to reduce the dimension and decorrelation of the data, a statistical technique can be used such as Principal Component Analysis (PCA). The set of observations of possibly correlated variables were converted into set of values of linearly correlated variables using orthogonal transformation called principal components. The number of original variables are greater than or equal to the number of principal components. The transformation can be done in such a way that the first principal component has the largest possible variance. For the better classification, it has been proposed that PCA is used to map 3-D Eigen vector values into a one dimension of the image. Regardless, the advantages are low noise sensitivity, improved efficiency even in small dimensions, lack of redundancy.

3. Proposed Methodology

Initially RGB image was captured using digital cameras and then segmentation process has to be carried out. On the basis of vegetation Index, it is applied with two Thresholding namely, the first image thresholding where it identifies the green parts on the image i.e., weed or crop. Next the second thresholding to separate both crops and weeds. With the buildup of template previously, crop lines are identified by combining that information with the crop parts identified after second thresholding. Lastly total least-square linear regression is applied through the equation to differentiate each weed and crop, where crop lines are extracted. If the level

of the weed exceeds the threshold value, CA method will be considered on each and every row of the crop field in the sequential order to segregate weed from the crop.

3.1. Image Acquisition and Segmentation

The next step is initiated after the image has been captured in RGB model, a greenness has been identified by considering predominant spectral component which is vegetation. The vegetation Index differentiates it whether it is a vegetation or not vegetation and also extract excess green (ExG). Green plants are identified by calculating excess green minus excess red index. The color space transformations from RGB to one-dimensional view involves two main steps:

i) Color space Normalization

ii) Index computation

3.1.1. Color Space Normalization

The original RGB image has been normalized using the range [0,1] and thereby we obtain the normalized spectral r, g, b components.

r=R/R+G+B, g=G/R+G+B, b=B/R+G+B (i)

where R, G and B are the normalized co-ordinates which ranges from 0 to 1 and thus follows as:

R=R/*Rmax,* G=G/*Gmax,* B=B/*Bmax* (ii)

Where, Rmax-Gmax-Bmax-255 for the 24 bit images,

3.1.2. Indices Computation

The indices are computed based on the following equations:

Excess green: ExG= 2g-r-b (iii)

Excess red : ExR=1.4r-g (iv)

Excess blue: ExB=1.4b-g (v)

Excess green - Excess red:ExGR=Exg-ExR(vi)

3.2. Image thresholding

The simplest way to perform image segmentation is through thresholding. From a gray scale image, thresholding can be used to create binary images. Herewith the input images are converted into gray scale images and to binarize the maximum variance of the threshold value, Otsu method are to be chosen. Normalization has been done by NExG in case of identifying the weed leaves, which has dark spots, shadows and patches. Thereby the plant pixels are reflected on the spots which helps to overcome the problem of identification using R≈G≈B which is in white color for R-G-B values. The living plant material (weed or crop) appears as white spots and the rest (straw, stone, soil surface and other debris) are in black. At the first thresholding, it just identifies whether it is green plant(s) or crop or weed. During the second Thresholding, it helps to identify both the crop and weeds. Lastly double thresholding has been a proposed approach.

3.3. Crop Row Identification

The next step is to detect the crop row using straight line equation and on each crop row by linear regression method. The parameters of the straight lines were calculated from the pixels which has considerably to be as crop rows.

3.4. Principal Component Analysis

The main objective of PCA is to classify weed from the crop. When the threshold value exceeds, PCA transforms the data into new co-ordinates with the greatest variance. PCA takes the data matrix containing the correlated values of*n* objects by *p* variables. It then summarizes it using uncorrelated axes (principal components or principal axes) that are linear combinations of the original *p* variables. The variations among the objects are displayed by a few earlier calculated *k* component values. In a multidimensional space, objects are represented as a cloud of *n* points with an axis for each of the original *p* variables. The mean of the variables is then calculated for the centroid of the points. The average squared standard deviation of n values around the mean of that variable gives the variance of each variable is

$$V_i = \frac{1}{n-1}\sum_{m=1}^{n}\left(X_{im} - \overline{X}_i\right)^2$$

The linearly correlated variables are used in calculating covariance, which is represented by,

$$C_{ij} = \frac{1}{n-1}\sum_{m=1}^{n}\left(X_{im} - \overline{X}_i\right)\left(X_{jm} - \overline{X}_j\right)$$

Where,

C_{ij} = Co-variance of the variables i and j

m = Sum of all n objects

X_{im} = Value of variable i_{in} object m

X_{jm} = Value of variable j_{in} object m
X_i = Mean of variable i
X_j = Mean of variable j

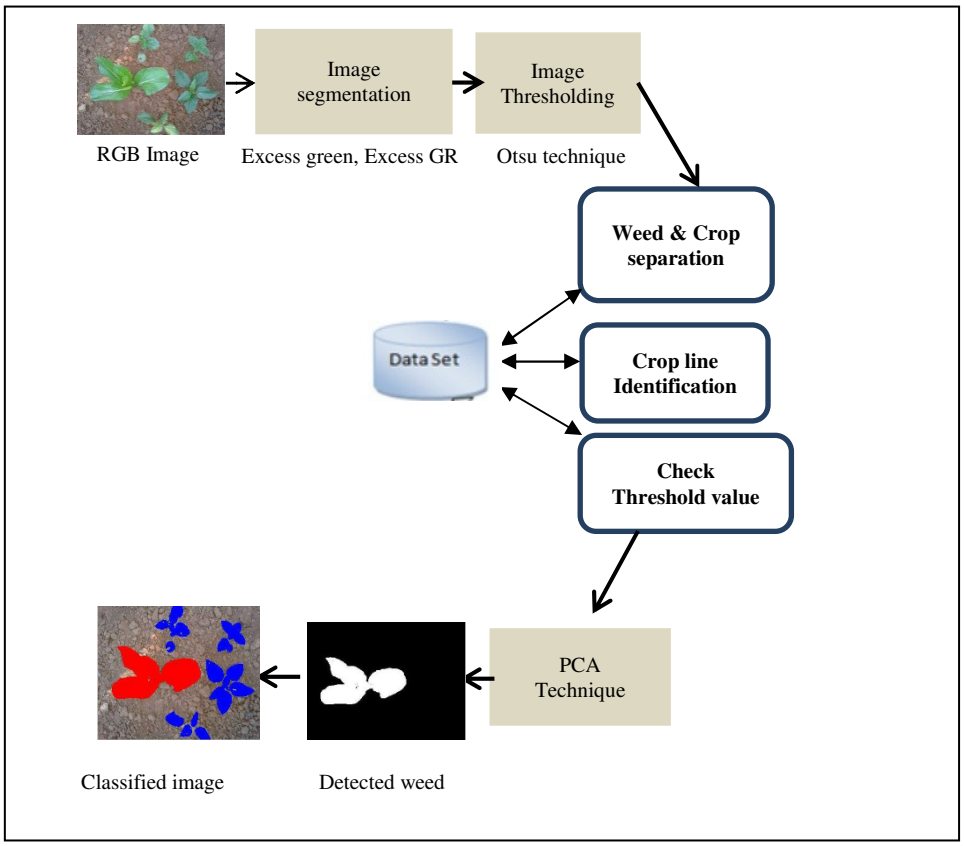

Figure 2: Systematic analysis of weed detection

4. Results and Analysis

The weed can be identified by using the first and the second thresholding. During the first thresholding, the greens are identified and at second thresholding, only crop plants are identified where the weed pressure is extremely high. Thus the double Otsu method is suitable for the weed and the crop from fields, based on linear line adjustment. Extraction of greenness are then adopted and secondly, if the level of greenness is more than the set threshold PCA, it is suitable to classify the weed from the crop. The images are widely taken on different crop fields with pure quality for further processing. Finally, over the images, the weed and the crops are successfully detected and classified.

5. Conclusion

One of the effective machine vision system for an agricultural domain has been proven as an image processing. Imaging techniques are applied on different images like X-Ray, infrared, hyper spectral that helps in identifying an indicator for finding the greenness termed vegetation indices, leaf area index or measuring canopies, irrigated land mapping etc.,to achieve the greater accuracy. Certain image processing algorithms are used to classify the weeds which affects the yield. The accuracy on classification helps the farmers to apply herbicides in the correct form and thus save the environment and the cost. The same technique that were used in the weed classification can also be applied in the fruit grading systems to achieve better accuracy. The above mentioned techniques that are used for the image processing helps to attain accuracy for the study of an agronomic parameters in the agricultural applications. Based upon certain algorithms and image acquisition limitations the accuracy of the classification changes from 85%-96%.

In this proposed approach, for the purpose of image processing and analysis, PCA and Otsu's approaches are attempted. The primary intention is to offer automated process of weed detection, which cuts the role of labor and ultimately increases the productivity.

6. References

i. S. Lavania and P. S. Matey, "Novel Method for Weed Classification in Maize Field Using Otsu and PCA Implementation," 2015 IEEE Int. Conf. Comput. Intell. Commun. Technol., pp. 534–537, 2015.
ii. I. Ahmed, I. Ahmed, A. Adnan, M. Islam, and S. Gul, "Edge based Real-Time Weed Recognition System for Selective Herbicides ,"International Multi Conference of Engineers & Computer Scientists;2008, p680, no. November 2015
iii. A. Vibhute and S. K. Bodhe, "Applications of Image Processing in Agriculture: A Survey," Int. J. Comput. Appl., vol. 52, no. 2, pp. 34–40, 2012.

iv. G. P. Sys, R. Sensor, E. Centre, C. Technologies, I. Conferences, C. Technologies, S. Ifip, I. Conference, W. Quality, O. Monitoring, I. F. Culture, N. Measurement, N. M. Fruit, C. Coupled, D. Near, M. Greenhouse, A. Humidity, A. Neu, P. C. Analysis, T. Sisim, and I. Pro, "Wavelet transform to discriminate between crop and weed in perspective agronomic images," Comput. Electron. Agric., vol. 11, no. 2–3, pp. 2009–2010, 2010.

v. A. Xavier P. Burgos-Artizzua, Angela Ribeiroa and C. F. Tellaecheb, Gonzalo Pajaresc, "Improving weed pressure assessment using digital images from an experience-based reasoning approach," Comput. Electron. Agric., vol. 65, pp. 176–185, 2009.

vi. A. J. Ishak, A. Hussain, and M. M. Mustafa, "Weed image classification using Gabor wavelet and gradient field distribution," Computers and Electronics in Agriculture, vol. 66, no. 1. pp. 53–61, 2009.

vii. M. H. Siddiqi, I. Ahmad, and S. B. Sulaiman, "Weed Recognition Based on Erosion and Dilation Segmentation Algorithm," 2009 International Conference on Education Technology and Computer. pp. 224–228, 2009.

viii. M. You and C. Cai, "Weed Seeds Classification Based on PCA, 2DPCA, Column-directional 2DPCA and (2D)2PCA," 2009 Int. Asia Symp. Intell. Interact. Affect. Comput., pp. 187–190, 2009.

ix. H.-P. Kriegel, M. Schubert, and A. Zimek, "Angle-based outlier detection in high-dimensional data," Proceeding 14th ACM SIGKDD Int. Conf. Knowl. Discov. Data Min. (KDD '08), pp. 444–452, 2008.

x. A. T. Nieuwenhuizen, L. Tang, J. W. Hofstee, J. Müller, and E. J. van Henten, "Colour based detection of volunteer potatoes as weeds in sugar beet fields using machine vision," Precis. Agric., vol. 8, no. 6, pp. 267–278, 2007.

xi. I. Ahmed, M. Islam, S. Inayat, A. Shah, A. Adnan, and A. H. Design, "A Real-Time Specific Weed Recognition System Using Statistical Methods," Precis. Agric., vol. 1, no. 10, pp. 244–248, 2007.

xii. K. H. Ghazali, M. M. Mustafa, and A. Hussain, "Color Image Processing of Weed Classification : A comparison of two Feature Extraction Technique," Proc. Int. Conf. Electr. Eng. Informatics, pp. 607610, 2007.

xiii. C. Yang, S. O. Prasher, J. Landry, H. S. Ramaswamy, and A. Ditommaso, "Application of artificial neural networks in image recognition and classification of crop and weeds," Can. Agric. Eng., vol. 42, no. September, pp. 147–152, 2000.