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Removal of weeds using Image Processing: A Technical Review

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Abstract: The identification and classification of weeds are of major technical and economical importance in the agricultural industry. Weeds are extracted from images using image processing and described by shape, colour and size features. These features are used to classify different weeds and crop species. In this paper, we describe different classification techniques like SVM, NN, DA and methods like Otsu's, 2G-R-B which are used to differentiate weeds and crops. We analyze all the features of these methods and techniques. In this paper our main aim is to review the methods for detecting the weed in the crop by using image processing.

Keywords: Image Processing, Weeds, Support Vector Machine, Neural Network, Discriminant Analysis

Introduction

In India, there are 65-70% farmers. Agricultural land was last measured at 60.3% in 2012 [18]. In modern agriculture, the chemical spraying is used to remove weeds in fields. In order to minimize the chemical spraying volume, the practical solution is to spray herbicide only in the areas where weeds grow [5]. The most common use of computers is to replace human effort and involve traditional farming machinery and other equipment [16]. Weeds are the plants growing in a wrong place which compete with crop for water, light, nutrients and space, causing reduction in yield and effective use of machinery and can cause a disturbance in agriculture [17]. Weeds can also host pests and diseases that can spread to cultivated crops. Farmers spend a large amount of time and money managing weeds. For above reason, we are focusing on identification and removal of weeds using image processing, with the use of this technique of weed detection, a new machines can be designed to remove weeds. It would be helpful in removal of weeds from the crop with a very less human efforts and cost. To detect weeds from the original crop, there are three parameters to distinguish weed from the crop, namely they are: size, shape and colour.

Image processing is a method for converting an image into digital form and performing some operations on it to get an enhanced image or to extract some useful information from it. There are different image processing applications in agriculture like fruit grading, harvest control, seeding, fruit picking, remote sensing etc. The methods or techniques in image processing such as image segmentation, shape analysis and morphology, texture analysis, noise elimination and pattern recognition were applied for detecting weeds and crops [17].

Advantages of Image Processing [19]:

- Digital imaging is an ability of the operator to post-process the image that is to manipulate the pixel shades to correct image density and contrast.
- Digital image processing made digital image can be noise-free.

Disadvantages of Image Processing [19]:

- It is very costly depending on the system used, the number of detectors purchased.
- Time consuming.

In this paper Section 2 describes objective of our study. Section 3 explains various methods and classification techniques in detail. Finally section 4 draws the conclusion.

Literature Review

A leaf recognition system is proposed in [3] which use the leaf vein and shape that can be used for plant classification. This approach uses Fast Fourier Transfer (FFT) methods with distance between contour and centroid on the detected leaf image. This leaf recognition system showed an average recognition rate of 97.19%.

In [4], Color machine vision system is specialized for making colour measurements, such as location of objects based on colour, the extent of a colour object, and colour textures. The colour combinations were used as the input variables based on Discriminant Analysis (DA) and two artificial neural-networks (NN) classifiers. Pre-processing and post-processing algorithms were developed to shorten the processing time and to reduce noise. The result of test showed that the statistical DA classifier was more accurate than the NN classifiers.

A new method has been proposed which combines colour and texture characteristics because weed and crop leave overlaps with each other, so it becomes difficult to identify the weed. The SVM (Support Vector Machine) classifier is used to differentiate two classes. From the experiment result, new method is having high recognition rate and fast processing time.

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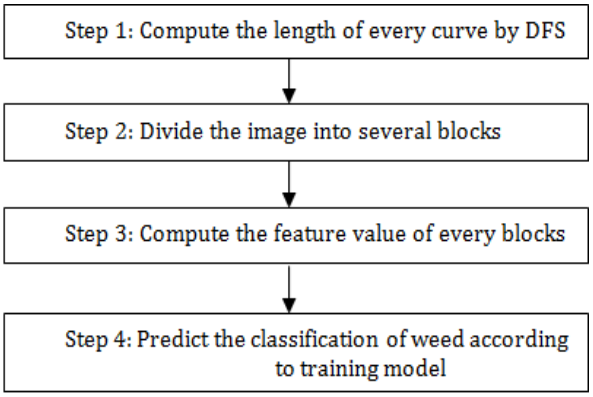

Figure-1. The Algorithm for weed location [5]

In figure 1, the researcher calculates the length of each curve respectively and stores the length of every curve. They divide the whole image into small size blocks; each block has an area of 60*60 pixels. They calculate the feature value of each block using formula. SVM is supervised learning model associated with learning algorithm that analyze data and recognize pattern. The objective of SVM is to solve the classification problem. The SVM classifier will generate a best decision which is determined by a small set of points within the training dataset [5].

In [6], Morphological features based on leaf parameters have been discussed in leaf recognition technique. 11 shapes and 5 texture-based parameters have been used to identify the weed leaves. Linear discriminating analysis was more effective in classification of weed leaves. A classification accuracy based on textural features was not very good.

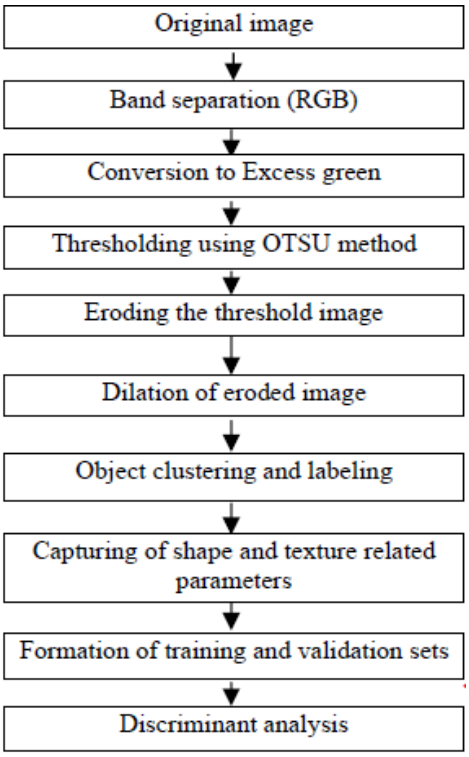

Figure-2. Steps in Image Processing for classification of weeds leaves [6]

In figure 2, the colour digital image is band separated and from these three band images, excess green image is converted into object region. Pre-processing is done before measurement of digital morphological parameters of shape and texture features. Thresholding of the image is done by histogram shape base OTSU method. This method is use to automatically perform clustering based image thresholding.

An intelligent system has been proposed in [7] which has the ability to identify tree species from photographs of their leaves and it provides accurate results in less time. Different properties like portion ratio, leaf dent, leaf vein, and invariant moment are used to identify plant. In this research paper, present work includes colour, vein, and texture and vein feature extraction for improving recognition accuracies. Block diagram of proposed method is shown in below figure 1. Pre-processing steps are performed on leaf image. Different features of the leaf are obtained and these features are given as input to the neural network. Training and testing of the neural network is carried out and the result is obtained.

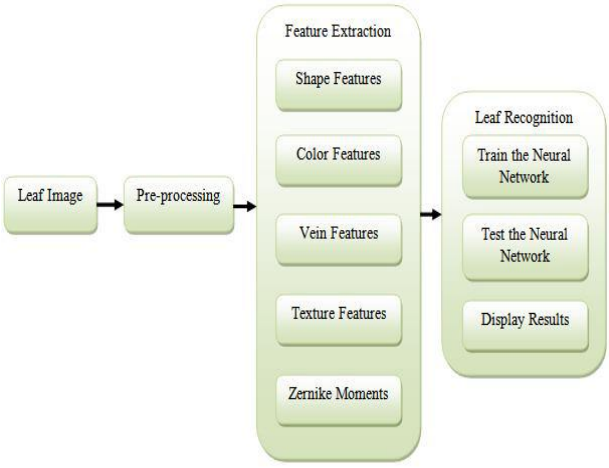

Figure-3. Block Diagram of leaf recognition system [7]

Development independent weeding machine requires a vision system which is able to recognize the correct position of crop. Several Shape features of weed and corn are extracted by morphological operation. Weed and corn can be differentiated using Discriminant Analysis and Neural Network. This method provides high accuracy due to significant difference between corn and weed [8].

A method of classifying wheat from plant is mainly focused. It has been shown in [9] that visual sign such as colour and texture alone do not provide enough information to obtain high classification accuracies especially for wheat and lolium (That is used as lawn and pasture grasses and as cover crops). This made us to choose NIR image along with colour camera.

In [10], the authors demonstrated measuring the similarity between shapes. Similarity between shapes is defined by following process.

- Solve the connection between two shapes.
- Use the connection for aligning.

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- Compute the distance between two shapes as a sum of matching errors between matching points.

Weeds are extracted from images using image processing and described by shape features. Features are extracted to enable an optimal distinction of the weeds classes. For classification maximum 16 features are used. The selection can be done using data mining algorithms, which rate the discrimination of the features of prototypes. If no prototypes are available, clustering algorithms can be used to automatically generate clusters [11].

The authors demonstrate the system in [12] for detection and classification of different crops and weed species is presented. Near range images were taken with a bi-spectral camera (IR) mounted on a vehicle driving at a speed of about 8 km/h. The techniques used analyze the images including pre-processing steps to reduce noise and obtain comparable result.

- A segmentation of green plants and background is achieved by binarisation.
- The shapes of all plants were extracted and shape parameters, contour and skeleton features were calculated.
- The discriminant abilities were tested using data mining and classification algorithm using Discriminant Analysis.

Detailed Analysis of Methods

1. Methods

During our literature review we study the basic methods for the weed detection, all that methodologies are describe below:

1.1. 2G-R-B

2G-R-B method is used to convert the colour images into grey scale images in order to distinguish crop and soil better. In general, the green component G is far greater than red R and blue B component for the crops [5].

1.2. OTSU Method

OTSU method is used to automatically perform clustering-based image thresholding or transform the gray images into binary image. The Otsu's thresholding chooses the threshold to minimize the intra-class variance of the threshold black & white pixels [6]. The algorithm assumes that the image contains two classes of pixels following bi-modal histogram, that is foreground pixels and background pixels; then it calculates the optimum threshold separating two classes so that their combined spread that is intra-class variance is minimal.

2. Method Comparison

All the methods described for weed detection have some advantages and disadvantages, which are as below:

Table 1. Method Comparison of Image Processing

Method Name	Advantages	Disadvantages	Reference
2G-R-B	• Simple • Faster Processing Time	• Does not correctly extract the leaf image	[5]
OTSU	• Minimize intra-class variance	• Expensive to compute	[6]

3.Classification Techniques

3.1.1. Artificial Neural Network

Artificial neural networks (ANNs) are inspired by biological neural networks, particularly the central nervous systems of animals and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown. Neurons in an ANN are arranged into layers. The first layer interacts with the environment to receive input and so it is known as input layer. The last layer interacts with the output to present the processed data so it is known as the output layer. Layers between the input and the output layer that do not have any interaction with the environment are known as hidden layers [1].

3.1.2. Support Vector Machine

Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis (in other terms, it is a statistical process for estimating the relationships among variables) [2]. The main goal of SVM classifier is to build a decision surface that can differentiate two classes at a maximum distance. SVM classifier will generate a best decision surface, which is determined by a small set of points within the training dataset [5].

3.1.3. Discriminant Analysis

Discriminant analysis is regression based statistical technique used in determining which particular classification or an object belongs to on the basis of its characteristics [13]. In [14], the main goal of discriminant analysis is to estimate the relationship between a single categorical dependent variable and a set of quantitative independent variables. Discriminant analysis is able to handle either two groups or multiple groups.

Table 2. Comparison of Classification Techniques

ANN[15]	**SVM**[15]	**DA**[4]
• Hidden Layers map to lower dimensional spaces	• Kernel maps to a very-high dimensional space	
• Training is expensive	• Training is extremely efficient	• Training is efficient

• Classification extremely efficient • Requires number of hidden units and layers • Very good accuracy in typical domains	• Classification extremely efficient • Kernel & cost the two parameters to select • Very good accuracy in typical domains • Robust	• Classification accuracy more efficient • Good accuracy

Table 3. Advantages and Disadvantages of Classification Techniques

Classification Techniques	Advantages	Disadvantages
ANN	• Depending on the nature of the application • Robust • Analyze complex problem	• Training is expensive • Requires high processing time for large neural networks
SVM	• Effective in high dimensional spaces • High accuracy • Popular in text classification problems	• Limited speed and size, both in training and testing
DA	• Multiple dependent variables • Reduced error rates	• More difficult to interpret

ANN: Artificial Neural Network
SVM: Support Vector Machine
DA: Discriminant Analysis

Conclusion

From the literature review, we have studied different techniques to identify the difference between crop and weed. Each and every technique has several advantages, disadvantages and limitations for it. After study all the characteristics of classification techniques we have decided to go with Artificial Neural Network because ANN is robust and suited for complex as well as incomplete data. Thus, we can conclude that image processing is non-invasive and effective tool which can be applied in the domain of agriculture with great accuracy for analyzing agronomic parameters.

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