

## CROP DETECTION BY MACHINE VISION FOR WEED MANAGEMENT

Ashitosh K Shinde and Mrudang Y Shukla  
Dept. of Electronics and Telecommunication  
Symbiosis Institute of Technology, Pune, Maharashtra, India

### ABSTRACT

Weed management is one of the costliest input to the agriculture and it is one of the un-mechanised area. To bring mechanization in this area the most important step is the detection of weed in agricultural field. Weed can be detected by using machine vision techniques. Machine vision uses special image processing techniques. Weeds in agricultural field can be detected by its properties such as Size, Shape, Spectral Reflectance, Texture features. In this paper we are demonstrating weed detection by its Size features. After the image acquisition Excessive green algorithm is developed to remove soil and other unnecessary objects from the image. Image enhancement techniques are used to remove Noise from the images, By using Labelling algorithm each components in the Image were extracted, then size based features like Area, Perimeter, longest chord and longest perpendicular chord are calculated for each label and by selecting appropriate threshold value Weed and Crop segmentation is done . Result of all features is compared to get the best result.

**KEYWORDS:** Machine vision, Camera, Area, Perimeter, Longest chord, longest perpendicular chord.

### I. INTRODUCTION

Weeds have been existing on earth since men started cultivating. Every vegetation present in the agricultural field which is unwanted is called as weed. Weeds compete with crop for Sunlight, Space, Water and Nutrients in the soil. Weeds are the most underestimated crop pests in tropical agriculture although they cause maximum reduction/loss in the yields of crops than other pests and diseases. The total annual loss of agricultural produce from various pests in India, weeds roughly account for 37% [15]. They decrease quantity and quality crop yield and cause health hazards for humans and animals. Thus weed management is most important in every crop production system. Weeds are one of the major constraints in agricultural production. As per the available estimates, weeds cause up to one-third of the total losses in yield, besides impairing produce quality and various kinds of health and environmental hazards. Despite development and adoption of weed management technologies [14], the weed problems are virtually increasing. This is due to intercropping, mulching and crop rotations involving shift in weed flora, due to adoption of fixed cropping systems and management practices including herbicides development of herbicide resistance in weeds e.g. *Phalaris minor* in the 1990s growing menace of wild rice in many states and *Orobanche* in mustard growing areas invasion by alien weeds like *Parthenium*, *Lantana*, *Ageratum*, *Chromolaena*, *Mikania* and *Mimosa*[14]in many parts of the country impending climate change favoring more aggressive growth of weed species, and herbicide residue problems. This suggests that weeds problems are dynamic in nature, requiring continuous monitoring and refinement of management strategies for minimizing their effects on agricultural productivity and environmental health. A number of factors affects the quality and quantity of yield such as competitiveness of crop and weed present, density of crop and weed present, time of emergence of the weed relative to the crop, duration of weed present. The paper is organised as follows, In Section 1 literature survey, Field survey is discussed, Section 2 Image acquisition,

Excessive green algorithm, Image Enhancement, Size based feature extraction and Crop masking is given, Conclusion and future work is discussed in section 3

### 1.1: Related Work

In biological morphology based techniques shape and size recognition can be conducted. Most machine vision research on plant species identification has been done at leaf geometry level with some at whole plant level. Biological morphology can be defined as the shape and structure of an organism or any of its part. A wide range of machine vision shape features for leaf or plant detection is used such as area, length, width, perimeter etc. and generally achieve high recognition rates under ideal conditions.

Weed detection processes included were normalized excessive green conversion, statistical threshold value estimation, adaptive image segmentation, median filter, morphological feature calculation and Artificial Neural Network (ANN) by Hong Y. Jeon Lei F. Tian. With an accuracy of 72.6%[2]. For crop and weed detection the seven shape features extracted from the images, four were selected by discriminate analysis which was able to classify the two groups with 98.9% accuracy. This method is developed to detect only corn crop in the field. By S. Kiani, A. Jafari .[3][15][16].

### 1.2: Field Survey

To get familiar with Indian agricultural field condition and to gather information about farmer's expectation from this project field survey is carried out in Loni kalbhor, Pune, Maharashtra, India. According to farmer Onion and Sugar Cane is the main crop taken by maximum farmer in that area. One of the costliest inputs to the agriculture is the De-Weeding which is 21.15%, 31.81% and 21.87% of total expenses for onion, Sugar Cane and corn respectively as shown in table 1. Currently the farmers are using expensive herbicides to kill the weed or the weeds can be removed manually which is labor dependent task.

**Table 1** De Weeding Expenses for 1 Acre

Crop	Onion	Sugar Cane	Corn
Time Period	4 Month	1 Year	2 Month
Total Yield	15,000KG	60,000KG	3000KG
Market Price	Rs 10/KG	Rs 2/KG	Rs 13/KG
Total Earning	Rs 150000	Rs 1,20000	Rs 39000
<b>Expenses</b>			
Labor Charges	Rs 10000	Rs 3000	Rs 3000
Fertilizers	Rs 3000	Rs 3000	Rs 3000
Transport	Rs 6000	NA	Rs 5000
Pesticides	Rs 1500	Rs 1500	Rs 1500
Total	Rs 20500	Rs 7500	Rs 12500
<b>De-Weeding</b>			
After 10 Days	NA	NA	Rs 2000
After 25 Days	Rs 2000	Rs 2000	Rs 1500
After 2 Month	Rs 2000	Rs 1500	NA
After 3 Month	Rs 1500	NA	NA
Total	Rs 5500	Rs 3500	Rs 3500

## II. MATERIALS AND METHODS

### 2.1 Image Acquisition

The digital images were captured under perspective projection and stored as 24-bit color images with resolutions of 5MP saved in RGB (red, green and blue) color space in the JPG format. The images were processed with MATLAB R2010 under Windows 7 and Intel Core i3-2370M CPU, 2.4 GHz, 2 GB RAM. The images were taken in month of March, April 2013. With different angles. The result of a project of this type relies heavily on the quality of the photo material that is used as input. Ideally we

want an image acquisition system that is robust in different lighting and weather conditions. But it is also important to keep the photo acquisition process uncomplicated since the system should be easy to use. All photographs used in this project were taken under natural lighting conditions. During all image acquisition the camera was pointing directly towards the ground.

### 2.2 Excessive Green

After the image acquisition it is necessary to remove unwanted information from the image. It is necessary to segment image pixels into vegetation and Non vegetation. For this excessive green color extraction algorithm is developed.

$$\text{Outimage}(x,y,z) = \text{inimage}(x,y,z) \text{ if } \left\{ \begin{array}{l} \text{inimage}(x,y,r) < \text{inimage}(x,y,g) \\ \text{and} \\ \text{inimage}(x,y,b) < \text{inimage}(x,y,g) \end{array} \right\}$$

$$\text{outimage}(x,y,z) = 0 \qquad \qquad \qquad \text{otherwise}$$

where  $\text{outimage}(x,y,z)$  is the output image after excessive green segmentation saved in jpg format,  $\text{inimage}(x,y,z)$  is the image acquired by an camera,  $x$  is the no of pixels in each row,  $y$  is the no of pixels in each column and  $z$  is the primary color plane for red the  $z$  is equal to 1, for green the  $z$  is 2 and for blue the  $z$  is 3. Input image is shown in figure 1 and output image is shown in figure 2[5-8]



Fig 1. To be processed Image

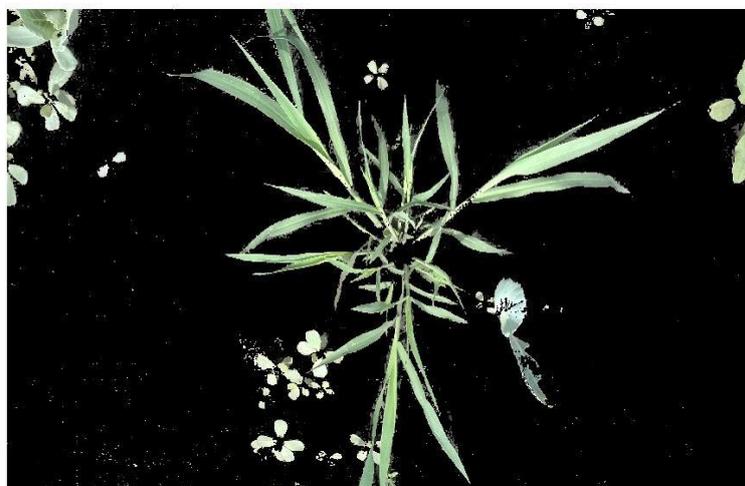


Fig 2. Excessive Green

## 2.3 Image Enhancement

The aim of image enhancement is to improve the interpretability or perception of information in images to provide better input for automated image processing techniques. In the proposed system spatial domain image enhancement techniques are used.

### 4.6.1 RGB to gray image conversion:

When converting an RGB image to grayscale, we have to take the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel. One such approach is to take the average of the contribution from each channel:  $(R+B+C)/3$ . However, since the perceived brightness is often dominated by the green component, a different, more "human-oriented", method is to take a weighted average, e.g.:  $0.3R + 0.59G + 0.11B$ .

#### 2.3.1 Median Filtering

Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

#### 2.3.2 Intensity Adjustment

Intensity adjustment is an image enhancement technique that maps an image's intensity values to a new range.

## 2.4 Labeling Algorithm

Connected component labeling works by scanning an image, pixel-by-pixel (from top to bottom and left to right) in order to identify connected pixel regions, *i.e.* regions of adjacent pixels which share the same set of intensity values  $V$ . Connected component labeling works on binary or gray level images and different measures of connectivity are possible. However, for the following we assume binary input images and  $\delta$ -connectivity. The connected components labeling operator scans the image by moving along a row until it comes to a point  $p$  (where  $p$  denotes the pixel to be labeled at any stage in the scanning process) for which  $V=\{1\}$ . When this is true, it examines the four neighbors of  $p$  which have already been encountered in the scan (*i.e.* the neighbors (i) to the left of  $p$ , (ii) above it, and (iii and iv) the two upper diagonal terms). Based on this information, the labeling of  $p$  occurs as follows:

- If all four neighbors are 0, assign a new label to  $p$ , else
- if only one neighbor has  $V=\{1\}$ , assign its label to  $p$ , else
- if more than one of the neighbors have  $V=\{1\}$ , assign one of the labels to  $p$  and make a note of the equivalences.

After completing the scan, the equivalent label pairs are sorted into equivalence classes and a unique label is assigned to each class. As a final step, a second scan is made through the image, during which each label is replaced by the label assigned to its equivalence classes. For display, the labels might be different gray levels or colors.

## 2.5 Size based feature Extraction

Size based features can be extracted by using Mathematical morphology. Morphology is an approach to image analysis which is based on the assumption that an image consists of structures which may be handled by set theory. This is unlike most of the rest of techniques. As it can be seen in Figure 3, there is a significant difference between the sizes of corn leaves and the leaves of the weeds.[4]



Fig. 3 Corn crop with Weed

### 2.5.1 Area

Area of any object in an image can be defined as number of pixels in that region. It possible to Differentiate Weed from Crop By analysing area features of each object in an image which are detected after performing the Labelling algorithm. From figure 4 it is clearly seen that the area mapped by corn crop is higher than that mapped by a weeds. By selecting appropriate area of an object weed and crop can be easily identified. In Figure 4. The crop of corn is identified.[4]



Fig.4 Area Based Crop detection

### 2.5.2: Perimeter

Perimeter of any object in an image can be defined as number of pixels in object boundary of that region. It possible to Differentiate Weed from Crop By analysing Perimeter features of each object in an image which is detected after performing the Labelling algorithm. From figure 5 it is clearly seen that the Perimeter of corn crop is higher than that mapped by a weeds. By selecting appropriate Perimeter of an object weed and crop can be easily identified. In Figure 5 the crop of corn is identified.[4]



Fig.5 Perimeter Based Crop detection

### 2.5.3: Longest Chord

A line connecting two pixels on the object boundary is called a chord. For many shapes, the length and orientation of the longest possible chord give us an indication of size and orientation of the object. If the chord runs between the boundary pixels  $(x_1, y_1)$  and  $(x_2, y_2)$ , then its length  $lc$  and orientation are given by equation 2. It is possible to Differentiate Weed from Crop By analysing Longest Chord features of each object in an image which is detected after performing the Labelling algorithm. From figure 6 it is clearly seen that the significant difference between Longest Chord of corn crop and weeds. By selecting appropriate Longest Chord Length of an object weed and crop can be easily identified. In Figure 6 the crop of corn is identified.

$$lc = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (2)$$



Fig.6 Longest Chord Based Crop detection

### 2.5.4: Longest perpendicular chord

Longest perpendicular chord of any object in an image can be defined as the maximum length of all chords that are perpendicular to the longest chord can give us additional shape information. It is possible to Differentiate Weed from Crop By analyzing longest perpendicular chord features of each object in an image which is detected after performing the Labelling algorithm. From figure 7 it is clearly seen that the Longest perpendicular chord of corn crop is higher than that mapped by a weeds. By selecting appropriate Longest perpendicular chord Length of an object weed and crop can be easily identified. In Figure 7 the crop of corn is identified.[4]



Fig. 7 Minor Axis

## 2.6 Crop Masking

After Successful detection of weed by different techniques it is necessary to find the weed in an image for that crop detected is masked with black color by finding the origin, length, width of each bounding box the result is shown in figure 8.



Fig. 8 Crop Masking

## 2.7 Weed Detection

After the crop masking weed is detected by applying excessive green algorithm the weed is detected. The bounding box algorithm is performed on the image to map the weeds. Once the weed is mapped by bounding box. Algorithm to find the co-ordinate of the each bounding box is developed and performed and the co-ordinate of each detected weed is printed on the Image as shown in figure 9.



Fig. 8. Weed Detection

### III. CONCLUSION & FUTURE WORK

Image processing algorithm for detection of weed in the indian agricultural field for the management of weed is successfully developed and tested. For each stages of De weeding the thresholding parameter for each feature is calculated for Sugar cane and corn crop. Detected Weed co-ordinates can be used for calculation of actuation parameters. Through the serial communication calculated Coordinates can be given to the robot controller. The developed algorithm is simple and faster than the algorithms which uses artificial intelligence techniques as the number of calculation in this algorithm is much lesser than that of AI Algorithms as there is no requirement training algorithms and Huge Database. Accuracy of the algorithm can be increase by using the more features and localized image processing techniques. In the future Accuracy of the algorithm can be increased by using spectral reflectance features based weed detection and texture features based weed detection, It is possible to develop Robotic machine which will Run through Agricultural field and By using the weed Co-ordinates it can Spray herbicides on particular weed plant precisely or by using mechanical tool it Can Up-Root the Weeds.

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## **AUTHOR’S BIOGRAPHY**

**Ashitosh Shinde** pursuing the M.tech degree in Electronics & Telecommunication Engineering from Symbiosis International University, Pune. He has Bachelor of engineering degree from University of Pune, India. He has Diploma degree from Cusrow Wadia Institute of Technology. His research interests include Technology in agriculture, Image processing, Robotics, Embedded systems.



**Mrudang Shukla** is assistant professor at Symbiosis Institute of Technology in Electronics and Telecommunication department. His research interest is in image processing and defining vision and path for automated vehicle in agricultural field. He has M.Tech in Electronics and Communication System DDU(Dharmsinh Desai University, Nadiad, Gujarat and BE in Electronics and Telecommunication D N Patel COE Shahada, North Maharashtra University NMU, Jalgaon)

