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Smart Automated Agriculture System for Weed Detection

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***Abstract* - Weed management is one of the costliest input to the agriculture and it is one of the un-mechanized 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 Labeling 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.**

***Index Terms*: Machine vision, 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.

II. LITERATURE SURVEY

There are basically 4 technique used to detect the crop and weed in the agriculture field.

A. Biological Morphology Based Technique

In biological morphological shape and size features are extracted. Shape features like, major axis, areas, minor axis, aspect ratio, width are used for detection of plant. Hidden features are also found with the help of biological morphological technique. Hong Y. Jeon Lei F. Tian [3] used the excessive green colure algorithm for segmentation of soil and vegetation, after that median filtering for removing the noise, morphological features and calculation of statistical threshold value. Using this, they got 72.6% of precision. Seven shape features for detection of crop and weed is used by S. Kiani, A. Jafari[4] but this is limited to only for corn crop and they got the accuracy 98.9%.

B. Plant Reflectance Based Technique

Spectral reflectance technique is used for plant species identification. Spectrometer is necessary to record spectral reflectance parameter but cost is higher than the common former can offered. Various types of spectral reflectance parameter is used like for vegetation indices, to measure crop properties in the visible spectrum typically ratios of broadband reflectance values are used. The features like, variance of the near infrared spectrum, skewness, average gives the high level of success in color segmentation [6]. Piron et al got 72% of accuracy in their proposed system for detection of weed in carrot rows.

C. Visual Texture Based technique

In this technique texture features of the image such as, energy, entropy, contrast, homogeneity, inertia are used for detection of plant. By using the support vector algorithm and extracting the texture features energy, entropy, inertia, homogeneity, contrast and relegated got the 93% of precision[7]. Kiani S, verified that different ANN gives different accuracies with five texture features energy, contrast, homogeneity, inertia, entropy as a input to the ANN[4]. Gabor wavelet combined with PCA algorithm got 90.5% of precision. In this paper wavelet transform Db4 is used for extracting the texture features of crop and weed images.

III. PROPOSED METHOD

A. 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. 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.

B. Excessive Green

In excessive green color algorithm soil is removed from the images and only green color information is remain which is required. Excessive green color algorithm is,

Outimg(x,y,z)=Inputimg(x,y,z)
If{inputimg(x,y,r)<inputimg(x,y,g)and inputimg(x,y,b)<inputimg(x,y,g)}; Outputimg(x,y,z)=0
Otherwise x,y,z are the number of pixels in row, number of pixels in column, primary color respectively.

Z=1 for primary color red, z=2 for primary color green and z=3 for primary color blue.

Image after the excessive green color algorithm is shown in figure 2.

Figure 1: Input image

Figure 2: Excessive Green Image

C. 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 gray scale, 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.

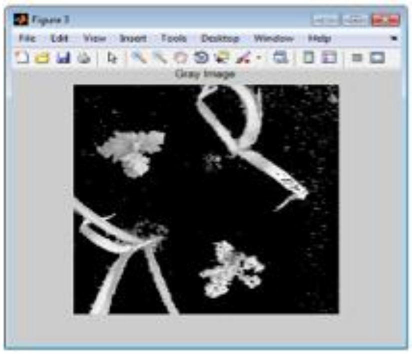

Figure 3: Gray Image

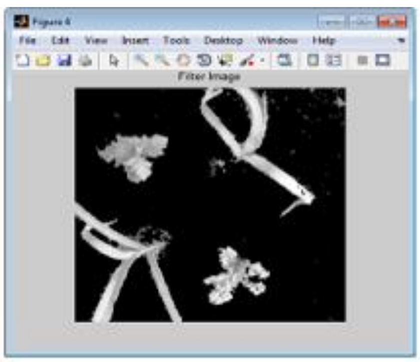

Figure 4: Filter Image

D. Labeling Algorithm

In connected component labeling image is scan pixel by pixel that is from top to the bottom and left to right for identify connected pixel regions. Regions of adjacent pixel share the same set of intensity values. In our system we used binary input image and 8 connectivity.

E. Feature Extraction

Input image is divided into the number of small images and for each segment its texture feature are extracted using _db4‘. Area of each segment is calculated. Five texture features extracted are energy, entropy, contrast, homogeneity, inertia. Formulas are shown below,

Energy $=\sum ij(C(i,j))^2$..............................(1)
Entropy $=\sum i,j(C(i,j)*\log(C(i,j))$...............(2)
Inertia$=\sum I,j\ (i-j)^2\log(C(i,j))$....................(3)
Contrast$=\sum I,j((i-\ j^2)*C(i,j))$....................(4)
Local homogeneity$=\sum i,j(1/(1+(ij)^2))*C(i,j)$….(5)

F. 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 crop leaves and the leaves of the weeds.[4]

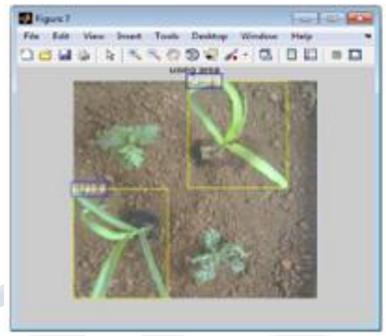

Figure 5: Using Area

Figure 6: Using Perimeter

Detected crop and weed are shown by bounding box in size based features.
Area: It defines number of pixel in the region.
Perimeter: It defines number of pixels in the boundary of region.
Major Axis: It defines number of pixels in the longest line which moving through center of region and connected to the boundary of that region.
Minor Axis: It defines number of pixels in the shortest line moving through centre of region and connected to the boundary of that region. Sugar cane is used as a crop. 30 samples (Images) are used for training and 20 samples are tested and for 18 sample gives proper result. Detected size based features area, perimeter, major axis and minor axis are shown in figures 5,6,7,8. Comparing the all method crop and weed is detected shown in figure 9 and figure 10.

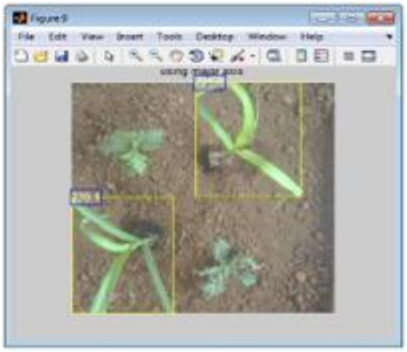

Figure 7: Using Major Axis

Figure 8: Using Minor Axis

Figure 9: Final Crop Detection

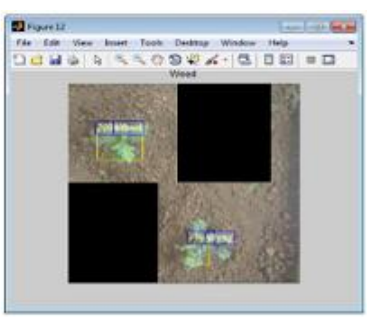

Figure 10: Final Weed Detection And Crop Masking

IV. CONCLUSIONS AND 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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