WEED RECOGNITION SYSTEM FOR CROPS IN FARMS USING IMAGE PROCESSING TECHNIQUES AND SMART HERBICIDE SPRAYER ROBOT

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Abstract

Most of the farmers in india uses conventional methods for the sprayer of herbicide in farms for cultivation of crops the major problems includes here is the sprayer is spread throughout all the crops in farms in which the cultivated plants are also harmed by chemicals sprayed on it as the weed and plants looks same,the weed recognition method based on the image processing techniques and the automing the atic robot sprayer which will capture images and apply the morphological operations on images to identify the images to find the weeds from the plants. Dilation and Erosion methods are the methods used for weed recognition which helps to easily find the weeds and apply automatic sprayer on the weeds.The algorithm is based on erosion followed by dilation segmentation algorithm. This algorithm can detect weeds and also classify it. Currently the algorithm is tested on two types of images i.e. broad leaves images and narrow leaves images.

Index Terms: Weed detection, Image Processing, Erosion and Dilation, Smart herbicide Sprayer

I. INTRODUCTION

Agriculture is the part of economy in india, Many Indians are based on farming for their food and life, many farmers uses conventional ways for their farming such as pesticides or herbicides are sprayed through workers in the cultivated plants are also been harmed through chemicals because the weeds and crops looks same in the farms and it is difficult to find the weeds or identify them directly by a human and particularly spraying the herbicides on them. Good weed control management in winter crops is a vital part of successful and profitable crop production. Yield losses caused by weeds can vary enormously from being almost negligible to a complete loss.The method here use some of the image processing techniques to be used for weed recognition and automatically sprayer robot to directly spray the herbicides on crops in farms ,image processing techniques i.e morphological operations such as applying dilation and followed by erosion method on the images.

Herbicides play an important role in weed control but their use is criticized because it is used excessively and has potentially harmful effects.Weed control is one of the areas which demands automation. In conventional weed control systems, herbicides are sprayed uniformly all over the fields. Apart from the damaging consequences like negative impacts on plants, soil and underground aquifers, large amount of herbicides will be wasted, as only some parts of fields are covered with weeds. To prevent these consequences from happening a smart weed control system should be employed. These systems must be capable of locating weed parts of the field and as a result herbicide sprayers are told to spray right on desired spots. In fields, crops are supposed to grow in rows. Based on this assumption any kind of plants that grows within rows should be labeled as weed. But in row situations, crops are mixed with weeds.

A. Image Acquisition

One of the forms of image acquisition in image processing is known as real-time image acquisition. This usually involves retrieving images from a source that is automatically

capturing images. Real-time image acquisition creates a stream of files that can be automatically processed, queued for later work, or stitched into a single media format. One common technology that is used with real-time image processing is known as background image acquisition, which describes both software and hardware that can quickly preserve the images flooding into a system.

B. *Processing of Images*

Lidar(Light Detection and Ranging) is the sensor which is based on many measurements such as range,range rate and elevation values.Lidar sensor is an active sensor and it operates on the frequency regions.Lidars are relatively insensitive to light conditions.Lidars are less expensive compared to radars.

C. *Directed Spray of the Herbicide on the Weeds*

Several herbicide application methods are available to land managers for herbaceous weed control. Well group these methods roughly into broadcast and directed applications. Regardless of the method used, herbicides must be applied uniformly and at the correct rate. Incorrect pesticide application can result in wasted chemical, poor weed control, excessive carryover, and damage to desirable vegetation.

Identifying weeds within an image involves classifying the pixels. The purpose of segmenting the image into plant and background pixels is to detect the amount of plant material within a specific area. If the amount of plant material reaches a specifc threshold, that area is targeted for herbicidal spay application. A system that could make use of the spatial distribution information in real-time and apply only the necessary amounts of herbicide to the weed-infested area would be much more efficient and minimize environmental damage. Therefore, a high spatial resolution, real-time weed infestation detection system seems to be the solution for site-specific weed management.

II. REVIEW OF LITERATURE

Weed control is a critical issue and can significantly affect crop yield. Herbicides play an important role in weed control but their use is criticized because it is used excessively and has potentially harmful effects. Many studies indicate that use of herbicides is reduced by patch spraying. Manual scouting for patch spraying requires considerable resources and is not a feasible option. Many researchers have investigated Patch spraying using remote sensing and machine vision. Machine vision systems are suitable for plant scale whereas remote sensing can be employed on plot basis. Both of these systems essentially require image acquisition and image processing. Image size ranges in the order of megabytes, thus processing time depending on image resolution, crop and weed type, algorithm used and hardware configurations.

In one of the method of weed detection the author propose proposed image processing algorithm is used to take images of the plantation rows at regular intervals and upon identifying the weeds in the image, the herbicide is sprayed directly and only on the weeds. The algorithm predominantly uses an Erosion and Dilation approach to detect weeds. The colour image is converted to binary by extracting the green parts of the image. The amount of white pixels present in the region of interest is determined and regions with higher white pixel count than the predefined threshold are considered as weeds. The herbicide is stored in a container fitted with water pump motors attached to spray nozzles. Once the weeds are identified, a signal is sent from Raspberry Pi to the motor driver IC controlling the water pump motors to spray the chemicals over the weeds.[1]

The other method which is based on method to develop a new weed detection and classification method that can be applied for autonomous weed control robots. In order to achieve this goal plants must be classified into crops and weeds according to their properties which is done by a machine vision algorithm. Plants growing between rows are considered as weed, while inside a row, where crops are mixed with weeds, a classification method is required. Accordingly in the initial step, plants pixels were segmented from background with an adaptive method which is robust against variable light conditions as well as plant species. After that, crops and weeds were classified according to features extracted from wavelet analysis of the image. Finally, based on positions of weeds, herbicide sprayers are told to spray right on desired spots. The whole algorithm is implemented in LabVIEW software which is appropriate for real-time in field purposes..[4]

Method for Image Segmentation is a subset of an expansive field of Computer Vision which deals with the analysis of the spatial content of an image. It is used to detach regions from the rest of the image, in order to recognize them as objects. The key contributions of this paper are based on an algorithm and were exe- cuted step by step. Firstly Noisy Image was filtered with the help of various filters. Secondly Filtered Image was reconstructed with the help of Morphological Operations. Subsequently, Region Growing Technique was applied on reconstructed image and segmented image was implemented. Furthermore Segmented Image was divided into sub parts. Finally, Results are analyzed on three bases, firstly on the segmented noisy image and secondly on the filtered segmented image and finally on the sub parts of the noisy and filtered segmented image with four parameters such as PSNR (Peak Signal Noise to Ratio), MSE (Mean Square Error), Mean difference and Maximum difference.[5].

III. ALGORITHMS IN EXISTENCE

There are many algorithms/methods which are available for Weed Recognition in crops.

A. 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 value correlated variables using orthogonal transformation equal to the number of principal components. The transformation can be done in such a way that the first principal component largest possible variance. For the better classification, it has been one dimension of the image. Regardless, the advantages are low noise sensitivity, improved efficiency even in small dimensions, lack of redundancy.

B. Machine Vision Algorithm

An algorithm for the automatic recognition of ripe Fuji apples from the tree; they enhanced the difference between fruit from other objects within the image, based on the difference between luminance and red color (R-Y). Vision system to pick orange using a harvesting robot. The R/(R+G+B) feature was used for recognition of orange fruits on the tree. Apple fruit recognition algorithms based on color features to estimate the number of fruits and developed models for early prediction of apple yield, in a multi-disciplinary approach linking computer science with agricultural engineering and horticulture as part of precision agriculture. A new, computerized vision-based model to estimate the diameter and a number of apple fruit on a tree and hence its yield autonomously under natural weather conditions in fruit orchards.

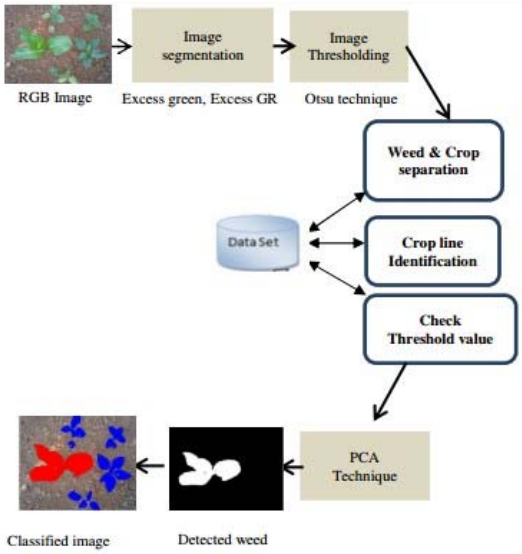


Fig. 1. Method of PCA

IV. PROPOSED APPROACH

The Proposed work is to focus on the detection of weeds in the farms.Identification of weeds in images.Location of the weed plant in the field based on the weed position.Depending on position of weed spray the herbicide on the position of weed.based on erosion followed by dilation segmentation algorithm. This algo rithm can detect weeds and also classify it. Currently the algorithm is tested on two types of weeds i.e. broad and narrow. The developed algorithm has been tested on these two types of weeds in the lab, which gives a very reliable performance.

A. Processing of Images

The colour image is converted to binary by extracting the green parts of the image. The amount of white pixels present in the region of interest is determined and regions with higher white pixel count than the predefined threshold are considered as weeds. The herbicide is stored in a container fitted with water pump motors attached to spray nozzles.

Machine vision systems are suitable for plant scale whereas remote sensing can be employed

on plot basis. Both of these systems essentially require image acqui- sition and image processing. Image size ranges in the order of megabytes, thus processing time depending on image resolution, crop and weed type, algorithm used and hardware configurations

B. *Algorithmic Study*

Image Processing is key component of almost any weed detection and classification system and methods of using them are various. Individual plant classification has been successfully demonstrated with either spectral or color imaging . The spatial resolutions of spectral systems are typically not adequate for accurate individual plant or leaf detection. Then again, color imaging methods with higher spatial resolution do not oer the important additional information.

Plants must be classified into crops and weeds according to their properties which is done by a machine vision algorithm. Plants growing between rows are considered as weed, while inside a row, where crops are mixed with weeds, a classification method is required. Accordingly in the initial step, plants pixels were segmented from background with an adaptive method which is robust against variable light conditions as well as plant species. After that, crops and weeds were classified according to features extracted from wavelet analysis of the image. Finally, based on positions of weeds, herbicide sprayers are told to spray right on desired spots. Pre-processing involves the following steps:

- Capturing of Images

  The captured image is in RGB format. This is converted to gray-scale image and shows the gray-scale image.

Y =0.229*R +0.587*G +0.114 *B

- Conversion of RGB image to Grayscale image

- Conversion of Gray image to Binary image Grayscale image is converted into Binary image.The resulting binary image will have weeds in bright pixels and background in dark pixels.
- Applying Morphological operations

  Morphological Operation that is Erosion is applied on the binary image for eliminating irrelevant or hidden details (in term of size) from a binary image.To erode an image we move a structuring element (morphological lter/mask) of size 3x3 pixel by pixel upon the given image, so in this way we remove the unnecessary details from an image for fast processing.

$$A \ominus B = \{z \mid [(B)z \subseteq A$$

Fig. 2. Equation for Erosion

This equation indicates that the erosion of A by B is the set of all points z such that B, translated by z, is contained in A. Set B is commonly referred to as the structuring elements as well as in other morphological Operations. A = imerode (A, B)

Here A is the input image and B is structuring element.

$$A \oplus B = \{z \mid [(B)]z \cap A] \subset A\}$$

Fig. 3. Equation for Dilation

After eroding the image A, the dilation segmentation algorithm is applied, which has its own 3x3 structuring element, due to which it will dilate the required image.

A = imdilate (A, B)

V. SYSTEM ARCHITECTURE / SYSTEM OVERVIEW

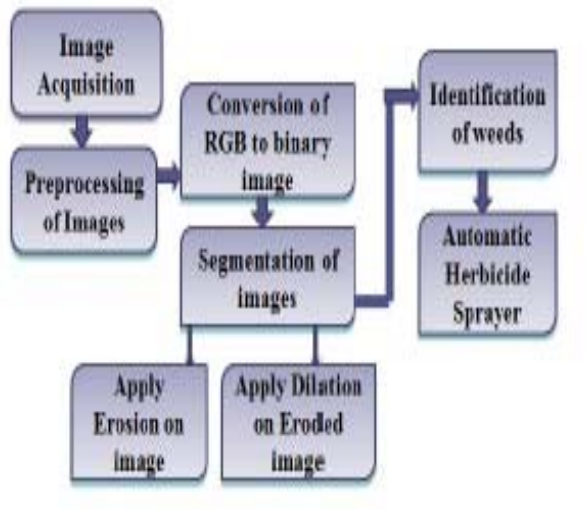


Fig. 4. Overall System of Weed Recognition

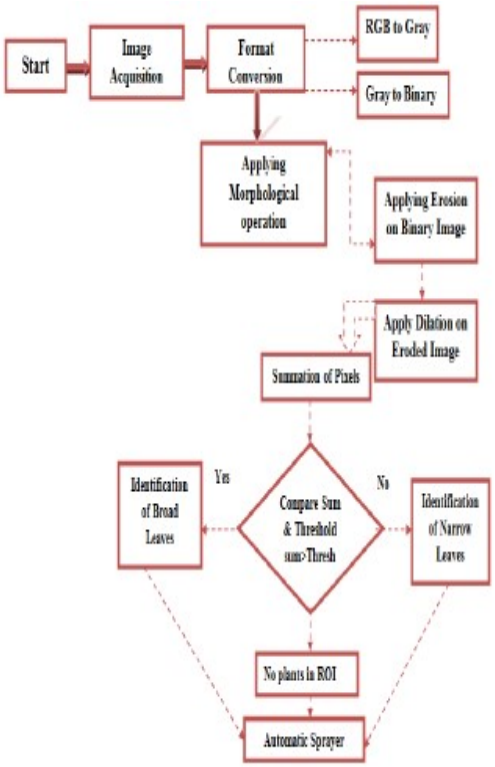


Fig. 5. Flowchart of Weed Recognition Approach

VI. ALGORITHM

The algorithm starts with image acquisition which is accomplished by the Cam- era.The next step is the processing of the image captured. The image is subjected to morphological modifications like thresholding, erosion and dilation to detect the presence of the plants in the Region of Interest (ROI), if present determining whether it is a weed or the plantation crop and final step is the directed spray of the herbicide on the weeds in the ROI

- Step1: Capturing of images.
- Step2: Conversion of RGB image to binary image.
- Step3: An image segmentation is conducted to divide the image into two classes i.e. plant and background.
- Step4: Applying Erosion on image using structuring element.
- Step5: Applying Dilation on the eroded image with structuring element.
- Step6: Summation of pixels by dividing images into parts.
- Step7: Compare sum and threshold and identify plant as narrow or broad leaves.

VII. MATHEMATICAL ANALYSIS

The Proposed framework is mathematically described as below be a system I = input images

O = output images

F = functions to be applied

I={I1,I2,I3}

F={F1,F2,F3,F4}

- Capturing of the Image

  Output1= F1{I1}
- To convert the RGB image into Grayscale image

  F2 =0.229*R +0.587*G+0.114 *B

  Output2 = F2{I2}
- To convert the Grayscale image into Binary image

  F3=im2bw
- To apply morphological operations
- Apply Erosion on Binary image A = imerode (A, B)
- Apply Dilation on Eroded Image

  D = imdilate (A, se)
- To calculate sum and threshold value

$$Sum = \sum_{i=0}^{M} \sum_{j=0}^{N}$$

Fig. 6. Equation for Summation

Sum = sum (sum (Eroded Image))

M= Number of Narrow Leaves

N=Number of Broad Leaves

VIII. APPLICATIONS

- Agriculture

  Automatic guidance may avoid over-application of chemicals and fertilizers, reducing environmental impact]. As weed populations have been found to be distributed heterogeneously in time and space within agricultural fields, weed control systems based on vision have been devel- oped to spray specifically the weed infested areas in real-time, reducing treatment costs as well as herbicide loading to the environment.

- Crop Scouting

  Crop scouting is the process of precisely assessing pest pressure (typically insects) and crop performance to evaluate economic risk

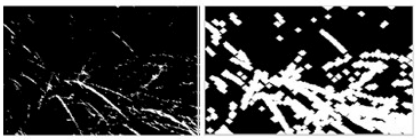
from pest infestations and disease, as well as to determine the potential eectiveness of pest and disease control interventions.

IX. RESULTS AND INTERPRETATION

The results shows the preprocessing of images of the narrow and broad in which input images of broad and narrow is been converted to binary image and then morphological opeartions is been applied to both images such as Erosion and Dilation is performed to easily recognize the weeds from images.

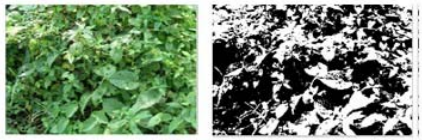
Input Image (Narrow Leaves) Binary Image

Fig. 7. Conversion of Input Image



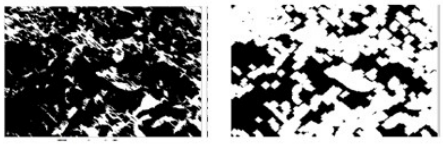
Eroded Image Dilated Image

Fig. 8. Eroded and Dilated Image



Input Image (Broad Leaves) Binary Image

Fig. 9. Conversion of Input Image



Eroded Image Dilated Image

Fig. 10. Eroded and Dilated Image

Following Results are based on one image of both narrow and broad leaves,in which the image white patches in image shows the weeds present in it .

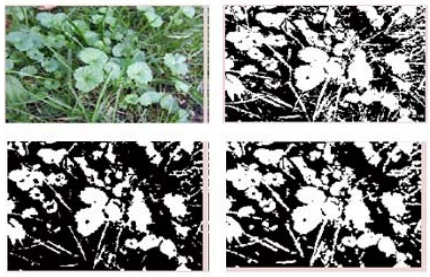


Fig. 11. Processing of Narrow and Broad Leaves

X. CONCLUSION

The work present system using image processing algorithm for weed recog- nition.images are processed by the proposed algorithm (Erosion followed by Dilation). The algorithms gave reliable results through images to detect the presence or absence of weed cover.an algorithm based on Erosion followed by Dilation and is design for weed recognition.

FUTURE SCOPE

The image analysis for weed detection can be further improved by dividing the image into more number of regions and have as many nozzles to spray the chemicals. It can be turned into a very robust closed loop system by incorporating a memory module. The image processing algorithm can be developed further so that the detection becomes more generic.

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