International Journal of Information, Control and Computer Sciences
ISSN: 2517-9942
Vol:1, No:10, 2007

A Real-Time Specific Weed Recognition System Using Statistical Methods

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***Abstract*—**The identification and classification of weeds are of major technical and economical importance in the agricultural industry. To automate these activities, like in shape, color and texture, weed control system is feasible. The goal of this paper is to build a real-time, machine vision weed control system that can detect weed locations. In order to accomplish this objective, a real-time robotic system is developed to identify and locate outdoor plants using machine vision technology and pattern recognition. The algorithm is developed to classify images into broad and narrow class for real-time selective herbicide application. The developed algorithm has been tested on weeds at various locations, which have shown that the algorithm to be very effectiveness in weed identification. Further the results show a very reliable performance on weeds under varying field conditions. The analysis of the results shows over 90 percent classification accuracy over 140 sample images (broad and narrow) with 70 samples from each category of weeds.

***Keywords*—**Weed detection, Image Processing, real-time recognition, Standard Deviation.

I. Introduction

WEEDS are "any plant growing in the wrong place at the wrong time and doing more harm than good" [1]. Weeds compete with the crop for water, light, nutrients and space, and therefore reduce crop yields and also affect the efficient use of machinery. A lot of methods are used for weed control.

Among them, mechanical cultivation is commonly practiced in many vegetable crops to remove weeds, aerate soil, and improve irrigation efficiency, but this technique cannot selectively remove weeds from the field. The most widely used method for weed control is to use agricultural chemicals (herbicides and fertilizer products). In fact, the success of agriculture is attributable to the effective used of chemicals.

Manuscript received August 13, 2007.

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Agricultural production experienced a revolution in mechanization over the past century. However, due to the working environment, plant characteristics, or costs, or there are still tasks that have remained largely untouched by the revolution. Hand laborers in 1990's still may have to perform tedious field operations that have not changed for centuries. Identification of individual weeds in the field and location their exact position is one of the most important tasks needed to further automate farming. Only with the technology to locate individual plants, can "smart" field machinery be developed to automatically and precisely perform treatments.

Simple methods of weed control avoid using chemicals. They are often used by farmers. However weed control can also be achieved by the use of herbicides. Selective herbicides kill certain targets while leaving the desired crop relatively unharmed. Some of these act by interfering with the growth of the weed and are often based on plant hormones.

The purpose of this paper is to investigate a machine vision system to distinguish individual weeds into broad and narrow weeds.

II. Objective

There are only two types of herbicides used: broad leave weed and narrow leave weed, our objective is to develop an algorithm which can

- Recognize the presence of weeds
- Differentiate the broad leaves weeds and narrow leaves weeds.

III. Materials

A. Hardware Design

The concept of the proposed automated sprayer system is shown in Fig.1, which includes camera, Central Processing Unit (CPU), and Decision Box which is used to control dc pumps. The images were taken at an angle of 45 degree with the ground. Using this method, the long narrow area in front of the sprayer could be captured with high resolution without increasing the image size.

The images are given to Central Processing Unit. The Decision Box is connected to the Central Processing Unit through a parallel port which ON or OFF the corresponding pumps, based on the type of image processed by the Central Processing Unit.

B. Software Development

The software is developed in Microsoft Visual C++ 6.0. A Graphical User Interface (GUI) is developed for Original image, processed image and to calculate the mean and standard deviation of those images. The image resolution was 240 pixel rows by 320 pixel columns.

IV. Method

Fig. 2 shows the Flow Chart of a Real-Time Specific Weed Recognition System which were developed to recognize the broad and narrow weed classification [2]. The algorithm was based on a Mean and standard deviation [5] of a green channel of an image to detect the target area in the fields.

A. Image Classification

In this paper we have classified image as narrow and broad. On the classification our system can identify weed on the bases of leafs. To identify the leaves as narrow and broad, we have used mean and standard deviation.

B. Image Acquisition

Our system get image as RGB color format with a resolution of 320 * 240. This mage can be a stored image or it can be a real image get from a attached camera or even in can be an image obtained from a video. If an image is not in the given resolution our system convert it into the standard format.

C. RGB to Grayscale

In next step we convert image in grayscle using equation 1:

$$f_{gray}(x,y) = 0.299 * f_r(x,y) + 0.587 * f_g(x,y) + 0.114 * f_b(x,y) \quad (1)$$

where $f_{gray}(x,y)$ is the pixel (x,y) in gtray level and $f_r(x,y)$ in the Red component of the RGB and $f_g(x,y)$ is the green component and $f_b(x,y)$ is the blue component of the pixel (x,y)

D. Mean Calculation

In the fourth step we calculated mean of the image using equation 2:

$$\mu = \frac{1}{MN} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} f(x_i, y_j) \quad (2)$$

where $f(x_i, y_i)$ is the intensity level of pixel x_i, y_j and M is the width of image and N is height of image. MN is total number of pixels in image. In our case we kept the image is standard so MN will be (320 * 240 = 76800). So our new equation is

$$\mu = \frac{1}{76800} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} f(x_i, y_j) \quad (3)$$

E . Standard Deviation Calculation

In the fifth step we calculated standard deviation of the image using equation 4:

$$\sigma = \sqrt{\left[\frac{1}{MN} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} (f(x_i, y_j) - \mu)^2 \right]} \quad (4)$$

where $f(x_i, y_i)$ is the intensity level of pixel x_i, y_j and M is the width of image and N is height of image. MN is total number of pixels in image. in our case we kept the image is standard so MN will be (320 * 240 = 76800) . So our new equation is

$$\sigma = \sqrt{\left[\frac{1}{76800} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} (f(x_i, y_j) - \mu)^2 \right]} \quad (5)$$

F. Classification of Images using Mean and Standard Deviation

The images are classified using the following procedure.

```
Start
  Sum (S) = μ + σ
  If S < 110 ()
     S = little weed
  Else if 110< S < 150
     S = Narrow Weed
  Else
     S = Broad Weed.
  Endif
End
```

110 and 150 are threshold values [3], [4], [5].

V. Results and Discussion

The results are shown in Fig. 3 which were classified using mean and standard deviation [6]. The 140 images of 70 for each class were taken. The algorithm classified 100% for little weed or no weed and 90% for narrow and braod weeds as shown in Table I and Table II.

VI. Conclusion

A real-time weed control system is developed and tested in the lab for selective spraying of weeds using vision recognition system. In this paper, feature extraction based system for weed classification and recognition is developed. The system shows an effective and reliable classification of images captured by a video camera. The system composes of four main stages: image capturing, image pre-processing, feature extractions and classification. Histogram is used in this paper to classify the weeds.

VII. Future Work

In this paper weed image, which has one dominant weed species can be classified reasonably accurate. But the case of more than one weed classes cannot be accurately classified. Further research is needed to classify mixed weeds. One way is to break the image into smaller region. With smaller region, there will be less possibility to find more than one weed classes in this small region.

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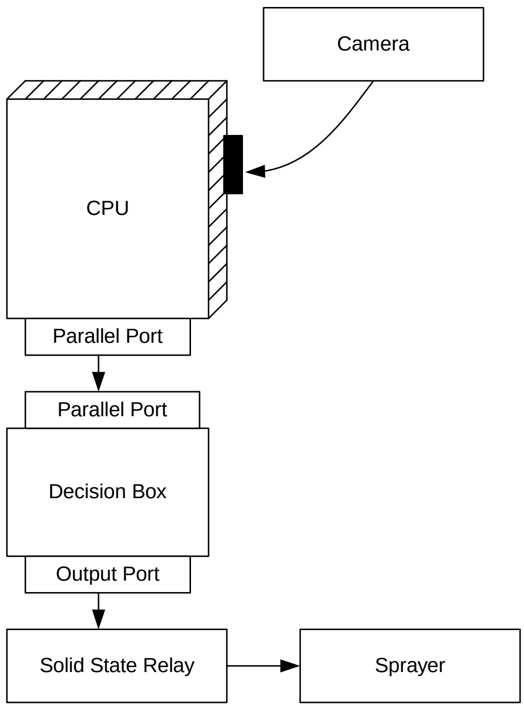


Fig. 1 Flowchart of Sprayer System

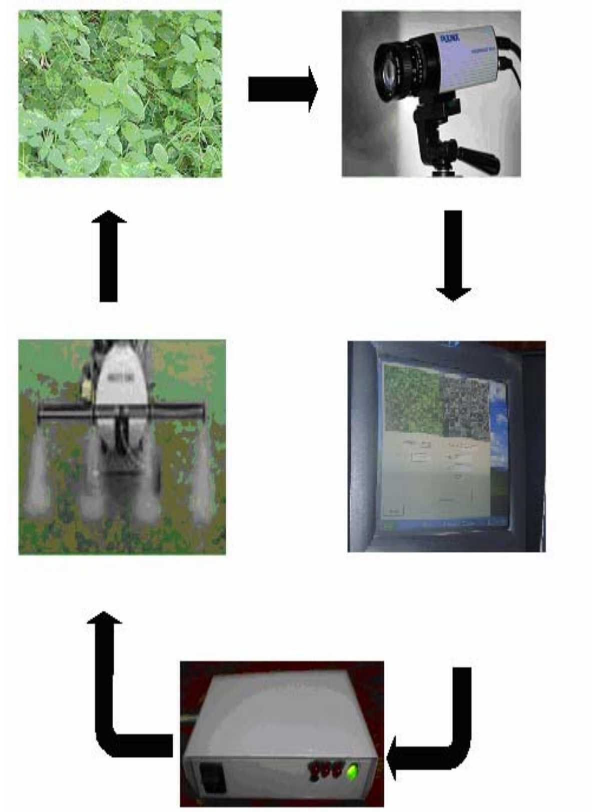


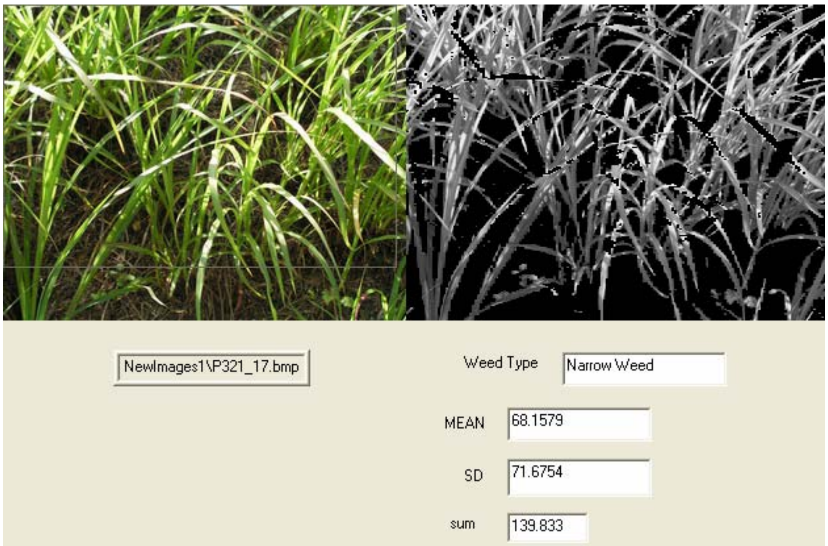
Fig. 2 The concept of a Real-Time Specific Weeds Sprayer System

TABLE I
OVERALL RESULTS OF DIFFERENT TYPES OF WEEDS

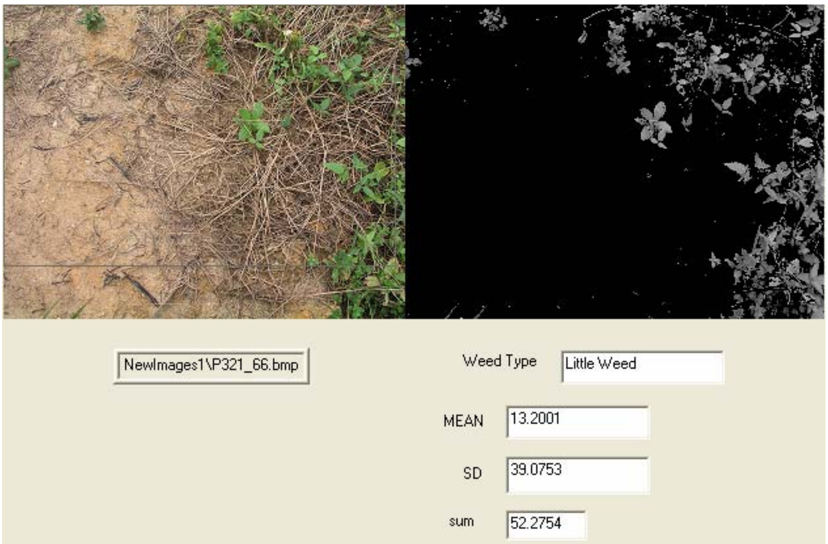
Weeds Type	Results %
Broad Weeds	90%
Narrow Weeds	90%
Little Weeds	100%

TABLEII
MEAN AND STANDARD DEVIATION OF NARROW, LITTLE, AND BROAD WEEDS

Narrow Weed		Little Weed		Broad Weed	
Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
66.9363	70.9712	35.3245	69.1112	112.964	58.4875
61.6848	71.4163	43.4536	60.2391	103.116	71.1278
52.2804	61.8306	13.2001	39.0753	77.7018	77.8261
68.573	78.365	03.0254	18.4361	103.116	71.1278
58.2573	66.1702	36.1077	60.2708	103.116	71.1278
58.2683	66.1902	43.7209	64.5397	99.0496	67.912
51.1177	59.3375	07.7288	34.2927	110.462	56.3064
68.3887	70.8596			103.116	71.1278
68.1579	71.6754			100.277	68.4302
48.925	69.9396			110.462	56.3064
74.1731	69.4476			112.964	58.4875
55.7446	65.2409			110.462	56.3062
69.0549	73.4647			103.116	71.1278
42.9651	71.0352			100.385	70.817
63.7859	73.5026			103.116	71.1278
67.7947	65.3041			103.112	71.1270
64.5344	66.9098			110.462	56.3064
54.8995	71.0849			118.293	64.9563
51.8789	70.5988			101.633	58.4929
64.8435	77.9068			110.462	56.3064
66.449	74.1513			89.9144	66.8987
63.4495	74.2876			120.644	64.3578
70.0569	73.5148			110.462	56.3064
65.3786	74.8256			135.63	56.9742
64.6936	77.1831			51.8686	70.8791
43.9876	68.2442			87.8101	76.3658
44.0304	68.9515				



(b) Narrow weed



(c) Little weed

Fig. 3 Classified Images