Automated Paraquat Sprayer By Using Raspberry-Pi

Sivaranjani M, Swathi V,
Vasanthi G , Revathi Y
8th Semester
Department of Electronics and Communication
T.J.S Engineering college
Chennai, India.

Venkat S
Asst.Professor
Department of Electronics and Communication
T.J.S Engineering college
Chennai, India.
venkatecetjs@gmail.com

***Abstract*— The conventional way of killing weeds in a crop plantation is to spray herbicides throughout the plantation. This results in contamination of the food crops and also the yield becomes less as some of the crop plants die along with the weeds. Thus there is a need for a smart weed control system. In this paper, an 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.

Keywords—Weed detection, Image Processing, Smart herbicide Sprayer, Raspberry-Pi.

I. Introduction

Agriculture is the backbone of Indian economy. It is a source of income for nearly 50% of the Indian population. It is mainly produce oriented and hence the profit or loss depends on the yield obtained. One of the major issues in agriculture is the control of weeds growing among the plantation crops. At present these kinds of plants are being removed manually, wherever possible, or weedicides are being sprayed uniformly all over the field to keep them under check. In conventional weed control systems, herbicides are sprayed uniformly all over the field. This technique is very inefficient as only about 20% of the spray reaches the plant and less than 1% of the chemical actually contributes to weed control, leading to wastage, contamination of the environment and health problems in people [1]. To avoid these consequences, a smart weed control system should be employed. These systems must be capable of locating weeds in the field and herbicide sprayers are directed to spray right on the desired spots. Also it focuses on reducing the costly labour and minimizes the use of pesticides that harms the normal growth of plants.

The machine vision [1] based approach uses shape, texture, colour and location based features individually or in combination of these to discriminate between weed and crop. An imaging sensor is a key component of almost any weed detection and classification system. Individual plant classification has been successfully demonstrated with either spectral or colour imaging. The spatial resolutions of spectral systems are typically not adequate for accurate individual plant or leaf detection.

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.

The first step in 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 specific 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. Methodology Adopted

The working of the system consists of three main steps [2]. Fig. 1 shows the process flow of the algorithm.

- The firsts step is image acquisition which is accomplished by the Raspberry-Pi Camera. The camera is mounted facing downwards on an extended arm from the chassis of the robot at a height of about 30 centimetres from the ground. Image acquisition is done in the presence of natural light.

- 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.
- The final step is the directed spray of the herbicide on the weeds in the ROI.

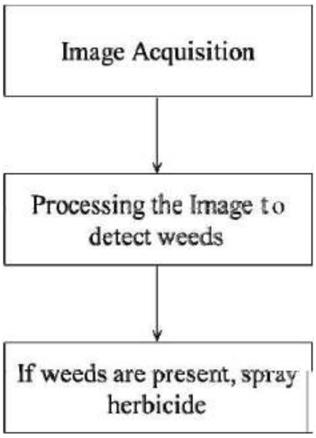

Fig. 1. Process flow chart

III. DETECTION OF WEEDS

A. *Erosion and Dilation Segmentation*

The process begins by capturing the image by the Raspberry-Pi Camera. Now only the green parts of the image need to be extracted. Each pixel of the colour image captured consists of three components – Red (R), Green (G), and Blue (B). A pixel can be considered as green if the value of G is greater than the other two components. Also the value of G must be above a threshold. Under normal conditions, the threshold can be set at 125 (midpoint for an 8–bit number). Those pixels whose green intensity is above the threshold are made white pixels and those below are made black. Thus the colour image is converted into binary image [3].

The next step is to erode the image by a suitable filter, which is usually a square matrix of 1's and 0's of odd order. Erosion is nothing but 2-Dimensional convolution between the binary image and the filter [4].

Now the eroded image is dilated. The filter or the structuring element is moved pixel by pixel over the binary image and when a part of the image overlaps with the filter, the value of the center pixel of the output image will be made 1, even if one of the pixel with value 1 in the filter overlaps with the pixel of value 1 in the image. Otherwise the value of the center pixel is made 0.

Here ragi plants (narrow leaves) are considered as plantation crops and other plants as weeds (usually broad leaves). After the above two processes most of the narrow leaf parts will be removed from the ROI [5], and hence the number of white pixels in that ROI will be less. If there are broad leaves in the ROI, it will result in a wide patch of white pixels in that ROI. Thus three cases can be identified here

- Case 1: No plants in the ROI. Here the ROI consists of only soil and thus the image after processing will consist of black pixels with a very few small, stray groups of white pixels.
- Case 2: Narrow leaves in the ROI. The number of white pixels in the ROI will be considerably more than Case 1 but less compared to that when there are broad leaved plants.
- Case 3: Broad leaves in the ROI. Here, the number of white pixels will be more than the previous two cases.

The herbicide will be sprayed only if the result of the decision is Case 3. The chemicals will not be sprayed if the outcome of the decision block is either of the first two cases.

IV. HARDWARE IMPLEMENTATION

The block diagram of the system is depicted in Fig. 3. The hardware includes a powerful ARM processor on a Raspberry-Pi controller. The above explained algorithm is implemented using C code on the Raspberry-Pi [6]. Raspberry-Pi Camera is used to take the pictures of the plants. The images thus taken are processed, and a decision is made based on the amount of activity (changes in pixels between white and black) in the processed image and the herbicide is sprayed to that part of the ROI. The spraying is accomplished by the use of water spray motors with a nozzle attached at one end. These components are mounted on a land robot that moves through the field, taking images at predefined intervals and processing each image taken, and thereby spraying the herbicide.

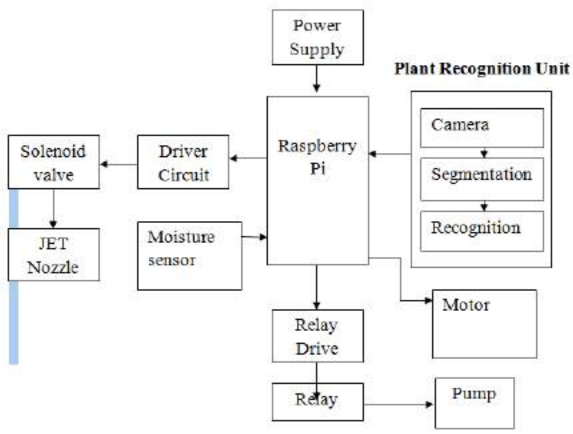

Fig. 3. Block diagram of the Smart Herbicide Sprayer Robot

The Schematics of the Smart Herbicide Sprayer Robot shown in Fig. 5 depicts the complete system design. The motors attached to the wheels and the water pump motors are interfaced to the Raspberry-Pi controller through the motor driver IC L293D.

The controller is powered by 5V power supply. The camera is connected through Camera Serial Interface (CSI) connector. The driver circuits of the wheel motors are controlled by the GPIO pin 25 and the driver circuits controlling the water pump motors are connected to GPIO pins 23 and 24. A switch

- The wheels of the robot are connected to geared 60 rpm motors powered by a 6V battery [7 - 9].

The rover contains two s mall water pump motors, placed in containers filled with herbicide, connected to nozzles for spraying.

A motor driver IC, L293D, is used for interfacing them with Raspberry-Pi.

1) Dimensions

- Width : 18 cm
- Length : 22 cm
- Wheel width : 2 cm
- Wheelbase : 14 cm

is provided to enable the driv er circuits through a 5V supply pin on the controller. A 6V power supply is provided to the driver circuit for actuating the motors.

V. Results And Discussions

Fig. 4 shows the stages of image processing from colour image to the final output image (simulation).

A. The results obtained from hardware implementation.

Fig. 4 shows a part of the plantation. The left side of the image contains a different plant which is identified as a weed and the herbicide is sprayed on left side.

Fig. 4. Acquired and processed image - 1

In Fig. 5, weeds are present only in a portion of the image. However, the herbicide is still sprayed on the left side.

Fig. 5. Acquired and processed image - 2

VI. Conclusion And Future Scope

An algorithm to detect weeds among plantations was successfully developed and a prototype of the Automatic Weed detection and Smart Herbicide Sprayer Robot was designed and implemented successfully. The robot comprised of hardware that can support and effectively spray herbicides on the detected weeds in real-time. A test track was designed with a row of ragi (*E. coracana*) plants and randomly placed broad -leaved weeds. The weeds were successfully identified and sprayed upon by the robot and this process takes approximately 3 seconds. All the weed plants were detected properly, with a few ragi (*E. coracana*) plants being detected as weeds in cases where they grew in large clusters.

A. Future Scope

The system designed has a lot of scope for improvement and many more features can be added to this robot.

- The major shortcoming of the robot is its dependency on good and stable lighting conditions. So, it can be equipped with a light intensity sensor to automatically adjust variables such as the threshold for extracting green pixels, shutter speed and white balance.
- 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.

References

[1] Kamarul Hawari Ghazali, Mohd. Marzuki Mustafa, Aini Hussain "Machine Vision System for Automatic Weeding Strategy using Image Processing Technique," American-Eurasian J. of *Agriculture & Environmental Science,* vol. 3, no. 3, pp. 451-458, 2008.

[2] Amir H. Kargar B, Ali M. Shirzadifar, "Automatic Weed Detection System and Smart Herbicide Sprayer Robot for corn fields," *IEEE Int. Conf. on Robotics and Mechatronics*, Tehran, pp. 468 – 473, Feb. 2013.

[3] Muhammad H. Siddiqi, Irshad Ahmad, Suziah Bt Sulaiman "Weed Recognition Based on Erosion and Dilation Segmentation Algorithm," *Int. Conf. on Education Technology and Computer,* Singapore, Apr. 2009, pp. 224-228.

[4] Rafael C. Gonzalez, Richard E. Woods, "Morphological Image Processing," in *Digital Image Processing*, 3nd edition, New Jersey, Prentice-Hall Inc., 2006, pp. 649-657.

[5] Asnor Juraiza Ishak, Siti Salasiah Mokri, Mohd. Marzuki Mustafa, and Aini Hussain, "Weed Detection utilizing Quadratic Polynomial and ROI Techniques", *in Proc. of 5th Student Conf. on Research and Development,* Malaysia, Dec. 2007, pp. 1-5.

[6] Raspberry-Pi Foundation, "Raspberry-Pi Documentation," [Online]. Available: https://www.raspberrypi.org/documentation/. Last Updated: 1st May 2015.

[7] Ajit G Deshmukh, V.A. Kulkarni, "Advanced Robotic Weeding System," *Trans. on Electrical and Electronics Engineering*, vol. 1, no. 3, 2013, pp. 232 – 236.

[8] Chengliang Liu, Mingjun Wang, and Jun Zhou, "Co-Ordinating control for an agricultural vehicle with individual wheel speeds and steering angles," *IEEE Control Systems Magazine,* vol. 28, no. 5, Oct. 2008, pp. 21-24.

[9] H. Pota, R. Eaton, J. Katupitiya, S.D. Pathirana, "Agricultural robotics: A streamlined approach to realization of autonomous farming," *2nd Int. Conf. on Industrial and Information System,* IEEE, Aug. 2007, pp.85-90.