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Header Plug Detection in Combine Harvester Using Greenness Detection Algorithm

K. Lakshmi divya[1], D.Tejaswi[2], V.Naga Valli[3], D.S.Phanindra Varma[4]
[1]kalidindidivya2@gmail.com,[2]tejaswi.618@gmail.com, [3]valli.vegesna@gmail.com, [4]phanindra.dsp@gmail.com
[1,3]Department Of ECE, SRKR Engineering College , Bhimavaram ,A.P, India.
[2]Department Of ECE, SVECW(Autonomous),Bhimavaram,A.P,India.
[4]Department Of IT, SRKR Engineering College , Bhimavaram ,A.P, India.

Abstract: *Harvesting is the process of gathering mature crops from the fields. However, the field is always a combined outcome of weed plants as well as immature plants. These weed plants and immature plants are called header plugs. This paper is focused on detecting these header plugs in the crop using Greenness detection algorithm. The algorithm is a combination of RGB band extraction, Histogram and Masking operations used in image processing. This helps in crop estimation and early precaution to avoid major crop damage.*

Keywords: *Harvesting, Header plugs, Algorithm, Histogram, MATLAB.*

I. Introduction

Harvesting is the process of gathering mature crops from the fields. There are three methods used in grain harvesting: First-step is combining, second step is harvesting, in which a harvester cuts the grain and a pickup combine collects the windrows; and third-step is harvesting, in which the bulk grain is simultaneously chopped and threshed by stationary machines on the threshing floor. In the process of harvesting, the main aim is to cut the ripened plants. However, in the crop there are also weed plants as well as immature plants. These weed plants and immature plants are called header plugs**.**

They compete with crop plants and reduce the crop production increasing the cost of agriculture and hindering the progress of work. They also increase the irrigation requirement and reduce the value of product additionally they harbor insect pests, pathogen and parasites.

The available methods for detection of header plugs are as follows:

1.1 Weed Suppression Robot:

In this, the robot consists of two DC motors, an LRF, an azimuth sensor, an ultrasonic sensor, a tilt sensor, seven servomotors, two microcomputers, and a Bluetooth system. The robot recognizes the rice plants by means of its LRF, and can move autonomously in a paddy field in daytime and nighttime. In addition, the robot can be operated by remote control with a PC.

1.2 Weed detection by ground level hyper spectral data:

The main objective of this method is to detect annual grasses and broad leaf weeds with the aid of field spectroscopy tools. In this method, grass as well as broadleaf weeds with soil background are detected by analytical spectral devices and Field spec pro FR spectrometer.

The above techniques require more number of components, which makes the device complex and costly. These devices occupy large area and are difficult to maintain.

1.3 Weed Seeker and Weed IT optical spot spray technology:

These two systems currently available in Australia both use infrared reflectance units to sense the presence of green plants and can accurately deliver a set herbicide dose to those plants. Once a plant is detected, a solenoid is activated; turning on an individual nozzle and the weed is sprayed.

Combine harvester is an agricultural machine that reaps, threshes, and cleans a cereal crop in one operation. The available combine harvesters in the market are:

- PREET987-Self propelled machine
- Harvesking
- Crop Tiger 40 terra trac
- Balkar 654
- Kartar 3500 combine harvester

The above-mentioned combine harvesters are not designed to detect the header plugs. Therefore, in order to overcome the disadvantages in the present machinery we would like to develop a header plug detection system.

II. Colour Image Processing

The human visual system can distinguish hundreds of thousands of different colour shades and intensities, but only around 100 shades of grey. Therefore, in an image, a great deal of extra information may be contained in the colour, and this extra information can then be used to simplify image analysis, e.g. object identification and extraction based on color.

The RGB color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green and blue.

These three primary colors have specific primary wavelengths for the purpose of standardization does not mean these three RGB components acting alone can generate all spectrum colors. The word "primary" has been widely used to mean that the three standard primaries, when mixed in various intensity proportions, can produce all visible colors.

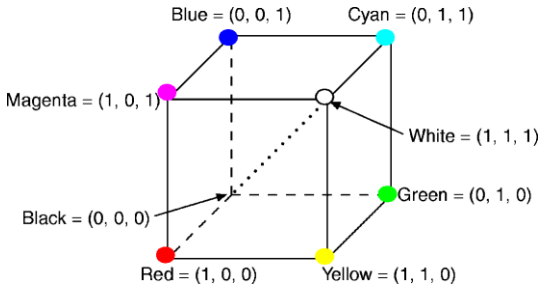

Figure 2.1: RGB color model

III. Greenness Detection Algorithm

Initially the image is acquired by using CCD camera and the greenness in the image is detected through various steps of the algorithm in MATLAB.

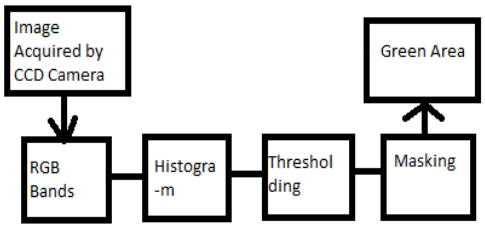

Figure 3.1: Greenness detection algorithm

CCD Camera:

CCD (charge-coupled device) is an integrated circuit etched onto a silicon surface forming light sensitive elements called pixel. A three-CCD camera is a camera whose imaging system uses three separate charge-coupled devices (CCDs), each one taking a separate measurement of the primary colors, red, green, or blue light.

RGB Bands:

Image processing classifies RGB bands to be the fundamental colour models for processing.An input image can be divided into these red,blue,green bands and processed further for finding the threshold values.

Histogram:

A histogram is a graphical representation of the distribution of data. It is an estimate of the probability distribution of a continuous variable. Histograms for each class were calculated for the color channels with Image Magic. Thresholds for the color channels were identified and set according to the histogram analysis. These thresholds were then used to automate image segmentation. The resulting binary images of each channel were combined by addition and subtraction operations, resulting in multi-level grey images. A further thresholding of these grey-level images led to binary images in which the objects of interest are represented in black (foreground) against a white background (black pixels).

MATLAB Software:

MATLAB (Matrix Laboratory) is a high –performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar math notations. Typical uses include Algorithm Development, Modeling, Simulation, visualization and prototyping

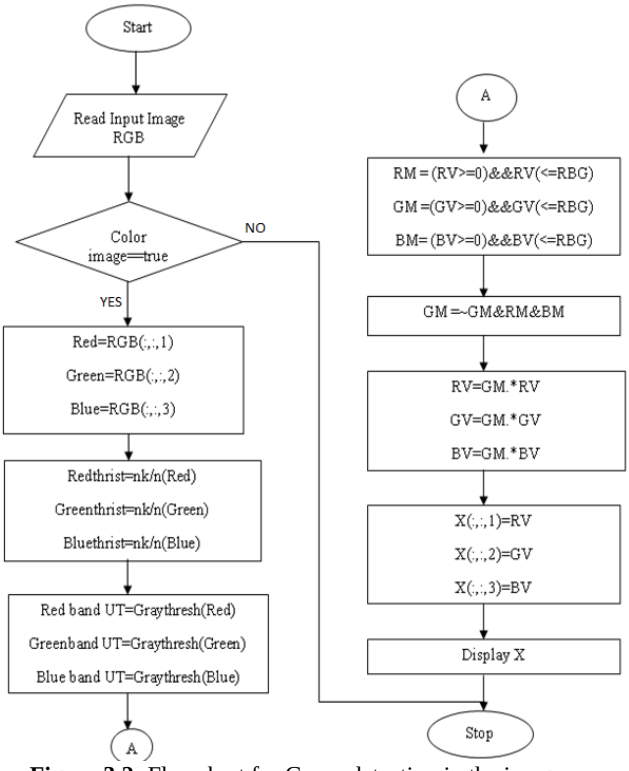

Figure 3.2: Flowchart for Green detection in the image.

Firstly, the image is read through a CCD camera and if it is a colored image then we acquire the Red, Green and Blue bands. The histogram of each color band is obtained to set upper threshold value for each band. The masked areas of Red, Green and Blue are obtained by the conditions given in the flowchart. However, our main aim is to detect the green regions only. Therefore, for obtaining Green masked area we find the regions where all the color bands are true. Then we multiply the RGB values with Green masked region and finally we obtain the Green values and Green detected area is displayed. Therefore, the green colored area is detected if there is any Green content in the image.

IV. Results

RGB bands are obtained for the Original Image as shown in the fig.4.1 followed by Histograms, green masked area and green detected areas as shown in the fig.4.2 - 4.7.

Figure 4.1: Original image

Figure 4.2: Blue band

Figure 4.3: Green band

Figure 4.4: Red band

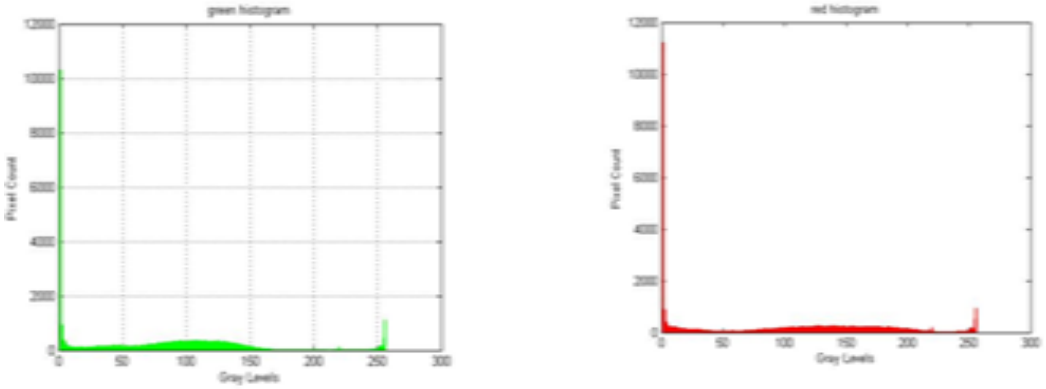

Figure 4.5: Green and Red Histograms

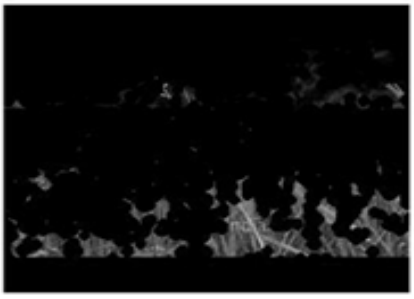

Figure 4.6: Green masked Area

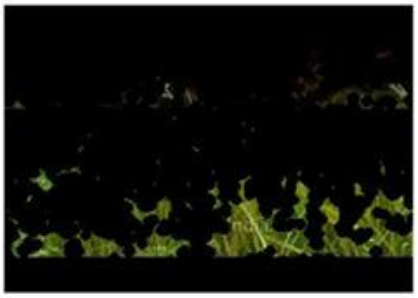

Figure 4.7: Green detected region

Thus, the region with the healthy crop(Green region) is detected and weeds in the field are estimated.

V. Conclusions

Thus, the algorithm is successful in detecting the green region in the image which helps in estimating the amount of weeds in the crop. This estimation helps the farmer to take necessary preventive measures in the early stages of the harvest.

Moreover this method of detecting the weeds in the field can be done with less cost and less hardware utility, making it available for common farmer.

VI. Future Work

Here, the detection of weeds in the crop is done by capturing images of the field and processing them individually. This can be further improved to video processing technique, where the video image of the field is captured and processed.

The detection technique can further be implemented to perform even the removal of weeds efficiently without the use of manual stress and costly
Machinery.

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