A computer vision application to detect unwanted weed in early stage crops

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Abstract: This article shows an application for computer vision to detect unwanted weed in crops from one region with more agricultural impact in Colombia. We took images in different crops, wanting estimate population degree from arvenses species. An Image processing was developed to obtain regions of interest were finally processed through neural networks.

Key- words: machine vision, weed identification, classical classifier, neuronal networks, unwanted weed, weed in crops.

1 Introduction

Currently it is necessary that the processes are carried out in all fields of development worldwide are friendly to the environment. The use of agrochemicals indiscriminately generates erosion and high levels of environmental pollution. Precision agriculture contributes to the improvement of agricultural processes and maximize production. For this reason the detection of unwanted weeds in crops automatically opens possibilities to improve the process of pesticide application in a controlled manner.

Colombia's economy is based on agricultural processes, which until now develop mostly manually, which leads to increases in production costs and low accuracy when performing processes with high environmental impact as the application agrochemicals to control weeds.

In particular, the process of eradication of unwanted weeds in crops is done manually which generates an appropriate time to propose alternatives to improve this process making Colombia a country with an opportunity to be competitive in world markets.

2 Problem Formulation

Crops need to acquire the necessary nutrients from the soil for their growth and production is expected; however the presence of unwanted weeds in crops can decrease productivity because they compete for nutrients. In particularly, unwanted herbs growing in crops must be Treated to Maintain a balance, Because If They do not reach Measures control About 40% Could lose of world agricultural production [1].

There are several ways to maintain control of unwanted weeds in crops. Preemergence herbicide application [2] after making sowing or early growth stage generates good results in weed control but long-term degenerates causing soil erosion.

Thus, computer vision provides a possibility to detect unwanted herbs in order to establish a mechanism for positioning them to make an application of herbicide more controlled way in order to reduce the environmental impact caused by the agrochemicals.

3 Problem Solution

Classical techniques preprocessing, processing, segmentation and classification were used for discrimination between unwanted grass and leaves of crops analyzed. Below we will explain the process that took place for the selection of crops and detection of weeds.

3.1 Crop selection

An area of Colombia which had high impact on gross domestic product given the agricultural work was selected. The area of greatest contribution to gross domestic product of agriculture in the Andean region is Cundinamarca [3]. The government of Colombia has a priority chains that are important for the country for economic competition worldwide, among those are some vegetables and tubers like potatoes.

The route started in the area finding various crops in different stages of production. Particularly the study began with crops early as the time of production; these were broad bean, potatoes, beets, strawberry and spinach, among others.

Fig. 1 Broad bean crop growth phase in the presence of weed species

In figure 1 is shown one crop visited who It had presence of arvense specie in lesser.

3.2. Image Acquisition

305 Were photographs taken in the area of Cundinamarca - Boyaca in Colombia, Ensuring That Were like lighting levels. The time slot Intended for making images was early morning. This was done because it was expected to define processing parameters having similar conditions.

Fig.2 Growing broad bean with presence of weed

It was intended that the images taken had presence of weed species very close to the crop so that it could conduct an initial recognition of the herbs that were in competition, and thus determine some factors which could become discriminating among species in the screening or classification stage.

The photographs were taken with a Nikon camera with a resolution of 24.1Mpx with focal length of 18 -55, in order to have more details that could be useful when we realize the analysis of features.

3.3 Segmentation

A sequence of morphological treatments [4] was prepared in order to ready the image to extract the regions of interest which will later be identified and classified. The software used for this was OpenCV in Python using WEKA.

The images were analyzed in RGB and HSV so which of the six channels giving more information to perform the segmentation process. After analyzing, saturation and green channel offered greater definition of regions.

In figure 3 is shown one example of green channel image, that shows clearly a difference between the soil and vegetal component.

Fig. 3 Beet crop with weed. Image in gray scale from channel G.

At the time of automatic thresholding, mathematically intensity variation present in the reflection of light on the soil particles that are present resulting in a saturated image regions is meaningless detect, see Figure 4.

Fig. 4 Image channel G segmentated

High levels of noise present in the segmented image can generate more confusion when performing the extraction of plant of the crop. So we proceeded to analyze the image in the channel color saturation (see Figure 5), in which the plant part given the colorimetric purity that is present in the image is highlighted.

Subsequently the same procedure as with the previous image in the G channel, automatic segmentation is performed in order to extract only the regions that are of interest to detect the presence of plant component, resulting in a much cleaner extraction (see figure 6).

Fig. 5 Beet crop with weed. Image in gray scale from channel S.

After this morphological treatments were performed to filter the noise left in the image, since it was necessary to eliminate the remaining pixels to start with the recognition process between plant species.

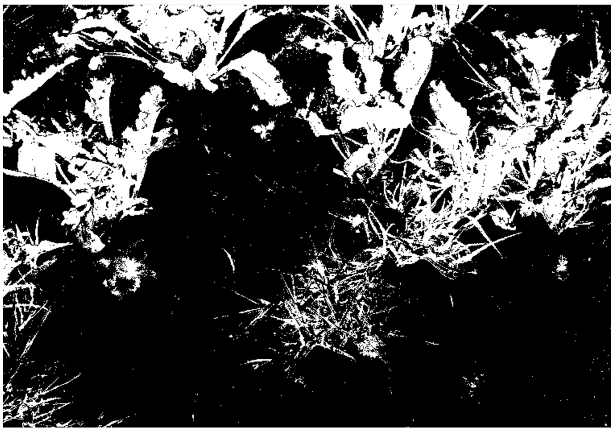

Fig. 6 Image channel S segmentated

his process of segmentation and image filtering masks allowed estimation of plant elements in order to remove regions with plant component on the RGB image, so that could analyze only the features that were present in the segmented areas. Obviously the characteristics associated with the form of plants can not be a discriminatory as between species although weeds have an elongated pattern, overlapping leaves create a segmented with higher rates of confusion. Moreover, in the color analysis, it was shown that there were variations in color intensity on plants in relation to unwanted weeds.

Therefore the original images with the previously segmented image are masked, allowing only have the desired information (see Figure 7).

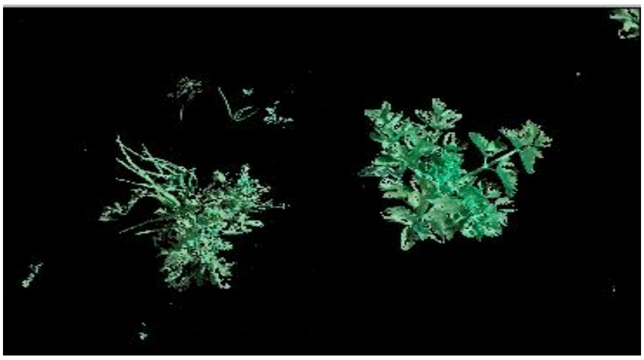

Fig.7 Segmentation mask with the image in RGB color scale

3.4 Recognition among plant species

To recognize among species a random dispersal of seeds was made, that will be the sample to extract relevant information from the RGB channels in order to find the differentiating ranges between species as it had previously found that feature from the visual identification.

400 samples as the dataset, of which 65% of these were determined as test data were taken. Supervised systems were used [5] for sorting between species.

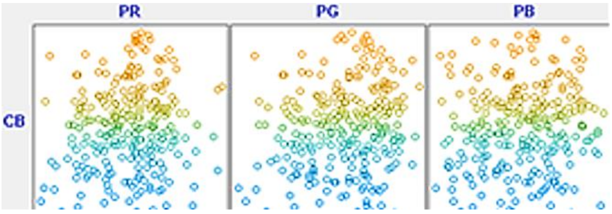

Fig 8. C Combination of crop features and weed species. Analysis carried out with WEKA's help.

CB represents the blue channel data of the crop and unwanted weeds are represented by PR, PG and PB, which are data each RGB channels, respectively (see Figure 8). While full separation between data and weeds growing no-show, the difference is noticeable that these have. After analyzing all possible combinations between data crop and the weed species, defined as those who had greater dispersion were relations with the information crop from the blue channel, because with the other samples was greater overlapping points and crossings, making more difficult the differentiation between samples.

3.3.1 Artificial neural networks

To make the identification of plant species unidirectional artificial neural network [6] trained with sigmoid activation function type and training was performed by the scaled conjugate gradient algorithm [7].

Culture data were analyzed in relation to the characteristics of color spaces weed in order to estimate the separation between data although these were very close.

Each of the data sets allowed us to estimate which channel on the scale RGB offered more information that could be discriminatory between plant species, considering that having done the analysis of the positioning of the points in space, the values of crop in the blue channel offered greater separation from weeds and so was the one that was taken as a starting point.

A neural network was performed in order to analyze the results of the classification in each of the three channels of color space. Each of the trained neural networks had varying the number of neurons in the hidden layer in order to define training with the highest classification result, the range of nodes analyzed was from 1 to 10[8].

70% of the test sample was selected as training data and the other 30% is divided equally between test data and validation.

When analyzing crop data regarding the weeds in the blue channel, the maximum efficiency obtained was 55.4% with a neural network that was 10 neurons in the hidden layer, however the result with one neuron was around 50.5 % effective.

Subsequently, crop data were analyzed in relation to information from the red channel of the weed, which had a greater result than previous tests neural network. Most effectively achieved was 63.8% was obtained with six neurons in the hidden layer. The lowest result of network effectiveness was obtained with a neuron giving a 60.2%.

Finally training the next network was made in which crop data were analyzed in relation to the green channel of the weeds. In this network, the more effectively it reached was 83.5% with 4 neurons in the hidden layer and the lowest value was 80.1% with a neuron in the hidden layer.

These results were satisfactory given the complexity of identifying between species as data color spaces.

Table 1 shows the matrix of total confusion where the result of the classification is demonstrated between plant species using a feedforward neural network with three-layer, four neurons in the hidden layer and sigmoid activation function is shown.

1	77 38.5%	10 5.0%	88.5% 11.5%
2	23 11.5%	69 45.0%	79.6% 20.4%
	77.0% 23.0%	90.0% 10.0%	83.5% 16.5%
	1	2	

Table 1 Results of classification using an artificial neural networks with four neurons in hidden layer

With this number of neurons overfitting is not caused and it can resolve the problem of classification with results that we consider acceptable given the complexity of overlapping data.

4 Conclusions

Detection of weeds in crops can be improved in the process of applying herbicides, in the particular case of this application, image processing was a critical aspect since obtaining the mask and the identification of regions of interest, taking note that you do not have the same levels of light intensity, it was a major challenge.

It is important that the images taken are crops that are in early stage in order to generate a possibility of detecting possible for weed control.

The feedforward neural network had an acceptable behavior, compared to the analysis of neurons in the hidden layer that allowed for significant percentage of success for classification among plant species.

4.1 Future Works

This analysis is the initial stage of a proposal that allows the controlled application of herbicides. This requires refining image processing algorithms that allow fieldwork even though high lightness levels available, which in turn provide shadow in crops. Additionally, there is the interest to work alternative methodologies for detection of unwanted herbs in crops to supplement the detection performed by the computer vision system.

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