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A Real Time Efficient Management of Onions Weeds Based on a Multilayer Perceptron Neural Networks Technique

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ABSTRACT: Weeds compete with the crops for light, water and nutrients within the soil, hindering the yield and the quality of agricultural products. Weeds chemical management is the best solution; however, the widespread use of herbicides is harmful to the environment. Moreover, over time, some weed species develop immunity to these products. In this paper, an advanced technique based on artificial neural network vision is presented in order to make benefits of high herbicide saving and to improve production while using a low cost system. The proposed concept makes benefits of low cost with good efficiency. In fact, the m ultilayer perceptron neural networks technique is performed in order to detect weeds roots in the onions cultivation which results on a localized spraying of infected areas allowing thereby the reduction of the herbicides amount. The proposed concept has been validated by experimentation whose results prove a good saving amount due to efficient real-time weeds recognition.

***Keywords*:** weeds recognition; multilayer perceptron; neural networks, chromaticity index; onions cultivation; localized herbicide spraying

INTRODUCTION

Marketing of all agricultural products depends on their quality. Nowadays, the vegetables and fruits skin is one of the most significant parameters which determine the quality. In fact, the presence of skin damages is synonyme of low external quality. This can be caused either by organic or mechanic process.

(El-Faki, 2000) used color machine vision for the detection of weeds in wheat and soybean fields. They used a color index for both the preprocessing and statistical discriminant analysis for weed detection. (Astrand. 2002,2003) used the green chromaticity index on RGB images to detect beets. (Aitkenhead, 2003) used a simple method to discriminate plants from weeds using plant size as a parameter. Several methods were proposed to descriminate soil, plants and weeds in (Søgaard, 2005), (Burks, 2000) and (Piron, 2011). (Bossu, 2007) makes use of Hough transform in order to distinguish weeds in the inter-parcels soil, whereas, (Hadoux, 2012) takes benefits of an hyperspectral imager to detect weeds in wheat cultivation.

Weeds control, in growth stage, is the most important challenge in onions cultivation. Their slow development results in infections caused by successive invasions, while their longilineal leaves cast no shadow on emergin g weeds. Both mechanical and chemical weeding are used in all cultivations, nevertheless, if the latter is sown, only the second

weeding is considered. with such shallow-rooted, some mechanical practices, like agricultural machinery, may damage growing onion bulbs. Thus, manuel weeding is more suitable, however, it results in financial and time losses.
In this paper, a low cost system based on artificial neural network vision is proposed to overcome cited problems and to insure a high herbicides saving while improving the production yield and quality. Through a proposed real time image processing in the onions cultivation, adventitious roots are well descrimated resulting on a localized spraying of infected areas. The spraying is performed with high precision considering a usual speed of the machine in an agricultural parcels.

MATERIALS AND METHODS

Artificial recognition is a process of separating the objects of interest from the background. Color thresholding is the process of separating the objects in an image based on the color values such as RGB and HSV. A major advantage of color thresholding is that threshold can be fixed based on more than one parameter. This reduces noise in the output image and results in a higher classification rate (CCR). Color thresholding can be implemented using different color spaces such as RGB, HSV, HIS and La*b*. The acquired image is subdivided into three parts, the plants, the weeds and the soil. In order to well identify these components, a two steps process is proposed and illustrated hereafter.

The first researchers to test vegetation indices that were derived using color chromatic coordinates and modified hue for distinguishing green plant material in images from bare soil, corn residue, and wheat straw residue (Meyer, 1998).

In order to distinguish birds (Nadimpalli, 2006) proposes a neural networks technique. RGB represents the red, green and the blue color components of the pixels in an image. Each color ranges from 0-255. Color pictures taken by a camera frequently use RGB color space. Hence we included this color model for the study. A threshold values are fixed based on all the three-color components. A simple output is a bit map image which consists of only two gray levels (black and white), in which white generally represents the foreground pixels or the pixels of interest and black represents the background pixels. Recognition becomes simple if the birds are distinct from the surroundings in terms of color, texture etc. Perhaps the cheapest and easiest way could be the use of a digital camera to take pictures of the birds and software to recognize the birds in the captured image. Sometimes intensity information is not sufficient with natural images under varying light conditions.

Figure 1. An onion young sprouts

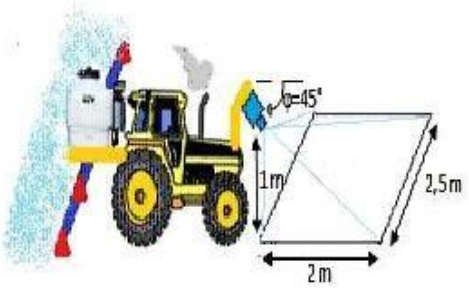

Figure 2. Experimentat setup synoptic

Artificial neural networks are now one of the best methods for object recognition. Their decision-making capability is very good and has been proved useful in many research applications. Even the neural network requires input images which have been pre processed using methods such as thresholding by RGB, HSV etc. Pre processing makes the recognition easy as it removes all the unwanted pixels. Therefore it reduces the time the algorithm spends on working on these pixels.

By associating neural networks to the famous multilayer perceptron technique, well known for its simplicity and flexibility, the system becomes more efficient. The learning was performed manually by indicating the true color for some pixels. Thereby, there is no need of human intervention and the plant species classification is well performed. Artificial recognition of weeds allows, thus, a localized spraying with reduced herbicides amount

RESULTS AND DISCUSSION

A. Discriminating process between soil and vegetation:

Color vegetation indices utilize only the red, green and blue spectral bands. The advantage of using color indices is that they accentuate a particular color such as plant greenness, which should be intuitive by human comparison [8]. Considering the green chromaticity index given by the following equation:

$$OEG = 128 + (G - B) + (G - R)$$

Where R, G and B are the actual pixel values obtained from color images, based on each RGB channel. The equation provides an interesting image which consists of vegetation on a black background. By applying an adaptive thresholding, which varies according to light conditions, the recognition process becomes very fast and highly efficient.

Indeed, for each pixel of the RGB image, the calculated OEG index is compared to the threshold. If OEG is greater than the threshold, then, the pixel keeps these values R, G and B. Otherwise; they are set to 0 which is the black color. The resulting image contains vegetation on a black background.

B. Discriminating process between weeds and onion:

Since onion, having 4 to 5 leaves per plant, has a blue trend color, a blue chromaticity index process is elaborated in order to distinguish weeds from onion. Since each pixel of the image is constituted from red, green

and blue channel (fig.3), so the first layer is subdivided into three neurons with sigmoid activation. The hidden layer is a processing stage containing two neurons with the same activation function as the former layer. The output layer is a single neuron with the Heaviside activation function. The Multilayer Perceptron Neural Networks training was performed manually by indicating the true color for some pixels and comparing the output result to the target sample.

The multilayer perceptron inputs are driven by the red, green and blue component of each pixel. The output is categorized into two classes, either weed or onion. For better recognition, authors propose to process with bloc of 8*8 pixels. This reduces errors and allows robustness toward brightness changes.

The average execution time on a computer with specs like a 1.8 GHz Core Duo processor and a 2 Gbyte RAM is about 50 ms. A real-time processing to 10 frames per second was implemented. Thereby, the system operates at a rate around 5 km per hour which is close to the usual working speeds in agricultural parcels (Fig. 3). The machinery speed can be higher in case of use of a faster processor.

In order to validate the proposed system, an experimental setup was realized. Two types of parcels were considered. The first is safe and the second is infected. Experimental results are depicted in fig.4, which is subdivided into two columns. Results of discriminating soil / vegetation are shown in Fig.4c, whereas, those of discriminating onion / weed are illustrated in Fig.4d. Fig.4a (fig.4b) shows the input image of an onion crop within a safe (infected) field. Fig.4e and fig.4f depict the results of the discrimination process. Soil is represented in black, while onions are in green whereas weeds are in red color. Around 95% of weeds were distinguished. Experimental results prove that the proposed system is a powerful tool for weed recognition in growing onions.

Since color of the very young onion sprouts is slightly similar to weeds colors, then they are not distinguished with the proposed concept. By the same for weeds whose color tends towards that of onions.

The proposed concept has the ability to detect weeds in real-time in the cultivation of onions either in parcels or in the inter-parcels soil while running at usual speed between the rows of crops even on different type of soils.

A classification based on morphological criteria and / or texture is possible if the overlap between onions leaves and those of weeds is acceptable, however, it requires more computation time which hinders the real-time operation at the usual speed.

The multilayer perceptron neural networks technique makes benefits of a localized spraying of infected areas allowing thereby the reduction of the herbicides amount.

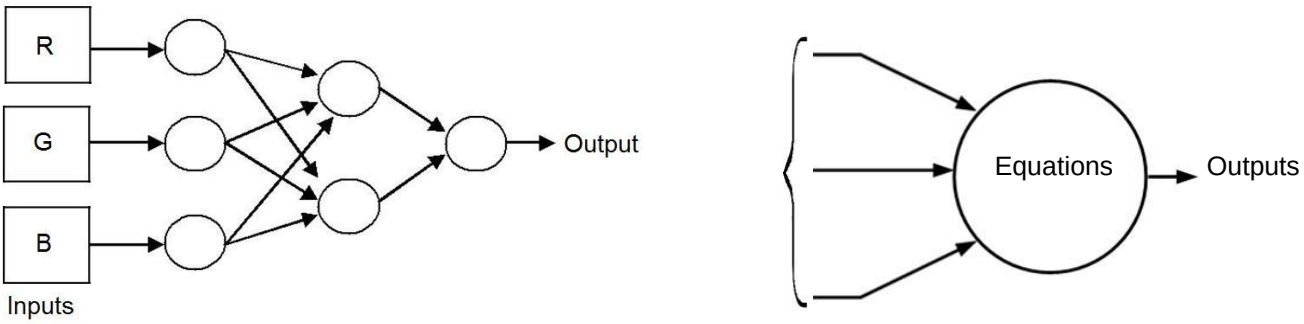

Figure 3. Multilayer perceptron neural networks technique

Figure 4a. Safe onion parcel

Figure 4b. Infected onion parcel

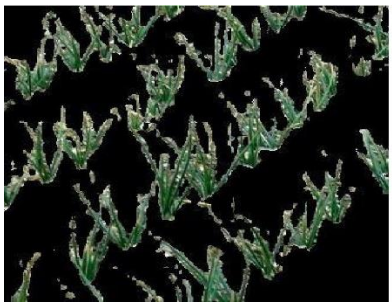

Figure 4c. Results of the discriminating soil / vegetation

Figure 4d. Results of the discriminating onion / weed

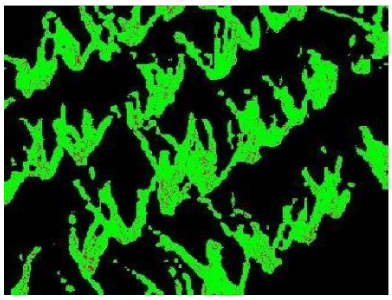

Figure 4e. The output image of the onion parcel (no weeds)

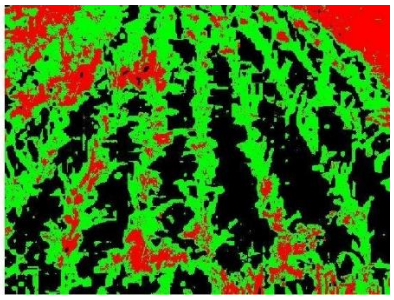

Figure 4f. The output image of infected onion parcel (weeds are the red pixels)

Figure 4. Experimental results of the proposed system

CONCLUSION

A multilayer perceptron neural networks technique was presented in this paper. It allows the management, in real time conditions, of onion weeds with high efficiency which results on an herbicides saving. Furthermore, the proposed concept has the ability to detect weeds in real-time in the onions cultivation either in parcels or in the inter-parcels soil while running at usual speed between the rows of crops even on different type of soils. The proposed concept has been validated by experimentation whose results prove a good saving amount reaching 75% with efficient real-time identification of weeds around 95%.

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