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Automatic Detection of Greenhouse Plants Pests by Image Analysis

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Abstract: One of the important challenges of agricultural sector is comprehensive management of pests and diseases. That needs precision and repeated observations of plant. Because of hydrometric condition and temperature of greenhouse, it is necessary the fast decision making to control the pests and diseases for purpose of avoiding of permanent and catching contamination. In this article, a method is presented based on automatic image analysis for confronting with Whitefly Pest. The images of contaminated leaves were captured. Then they were analyzed by the usage of MATLAB software. The algorithm was consisted of back ground removing and pests selection. The speed of processing was around 0.7 s per image. The detection rate was %90. The results of this research are useful in designing of automatic sprayers.
Key words: Image analysis, greenhouse, pest

INTRODUCTION

The agriculture sector is one of the most important fields that most profits will be gained by the usage of modern technology. In near future, we will observe the entrance of the first set of modern products such as pesticides into markets in order to intelligent control of pests, diseases, weeds and providing the precision inputs for targets, modern diagnostic systems for identifying the diseased plants, domestic animals and birds and so on.

A lot of research has been done on greenhouse systems and more generally on protected crops to control pests and diseases by biological methods instead of pesticides. Moreover, such systems that are partly isolated from outside environment and highly controlled are good test sites for creative methodologies in crop protection.

Greenhouses are considered as biophysical systems with inputs, outputs and control process loops. Most of these control loops are automatized (e.g., climate control). Ehret et al. (2001) reviewed automated monitoring for glasshouse crops. He discussed applications of digital imaging for monitoring glasshouse crops, but do not present any practical results. Caponetto et al. (2000) discussed the use of sensors to monitor the crop environment. Langton et al. (2004) discussed direct measurement of the crop response to environment while Koumpouros et al. (2004) discussed image processing for distance diagnosis in pest management.

Modern digital imaging technology is used widely for routine monitoring in industry, and particularly in food production (Brosnan and Sun, 2004) and software methods developed for industrial applications can be readily adapted for grading, on-line sorting and management of individual high value ornamental plants (Brons et al., 1993; Timmermans and Hulzebosch, 1996). Parsons et al. (2006) discussed assessment of ornamental horticulture crops in glasshouses. Feed-forward artificial neural networks are used to segment top and side view images of three contrasting species of bedding plants. The segmented images provide objective measurements of leaf and flower cover, color, uniformity and leaf canopy height. On each imaging occasion, each pack was scored for quality by an assessor panel and it is shown that image analysis can explain 88.5%, 81.7% and 70.4% of the panel quality scores for the three species respectively.

Early detection of symptoms (fungi) or of the initial presence of a bio-agressor is a key-point in the context of Integrated Pest Management (IPM) (Altner et al., 1977; Stern et al., 1959). Due to temperature and hygrometric conditions in greenhouses, rapid decisions are essential to control diseases and pests in order to avoid dissemination and permanent infestation (Van Lanteren and Woets, 1988; Lapchin and Shtienberg, 2002). Malais and Ravensberg (2003) obtained typical data for several pests about development time as a function of temperature and about female egg production. For example, a whitefly Trialeueoades Vaporariorum female on gerbera may lay about 130 eggs. The detection of biological objects as small as such insects (dimensions are about 2mm) is a real challenge, especially when considering greenhouses dimensions (10–100 m long).

However, no automatic methods are available to precisely and periodically evaluate the biotic status of plants. In fact, in production conditions, greenhouse staff periodically observes plants and search for pests. Traditionally, visual observations are made each week by human experts, often on colored sticky traps. It is difficult or even not possible to perform a continuous (typically daily) control and to examine every leaf in the greenhouse. The accuracy of these observations depends on the human eye resolution, even if magnification tools can be used. So we tended to use machine vision technique. Although there are different methods for quantifying the plant health such as radiometry, but the equipments are costly while the machine vision technique is user friendly and inexpensive. In this paper, we focus on early pest detection. First, this implies to regularly observe the plants. In an automatic system, this is done by digital imaging camera. Second, it is necessary to interpret image contents in order to identify objects corresponding to potential pests.

MATERIALS and METHOD

In this paper, we studied on Whitefly pests of ornamental crop.

At first, the images of infected leaves were captured by a digital imaging camera (Sony NO.DSC-P100). Then they were pre processed to remove unexpected noises. For this purpose, the first order differentials of matrices of images were calculated (Equation 1). Next step was removing of background. After that, the extraction of quantitative information from images, such as counts of objects, edges, boundaries and other details were performed by calculating of second order differentials (equation 2).

$$m = \sum_{i=0}^{L-1} riP(ri) \qquad (1)$$

Where r_i donates the gray level of input image, P is the histogram of input image, L is the number of gray levels and m is the average of gray levels of input image.

$$\frac{\partial 2f}{\partial x2} = f(x+1,y) + f(x-1,y) - 2f(x,y)$$
$$\frac{\partial 2f}{\partial y2} = f(x,y+1) + f(x,y-1) - 2f(x,y) \qquad (2)$$
$$\nabla 2f = \frac{\partial 2f}{\partial x2} + \frac{\partial 2f}{\partial y2}$$

$$\nabla 2f = [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1)] - 4f(x,y)$$

Where, f(x) donates input image (Gonzalez and Woods, 2005).

The graph of the main image processing operators has shown in Figure 1. Image processing flow for whitefly extraction has shown in Figure 2.

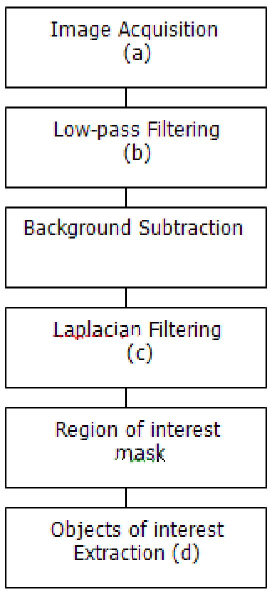

Figure 1. Diagram of the main image processing operators

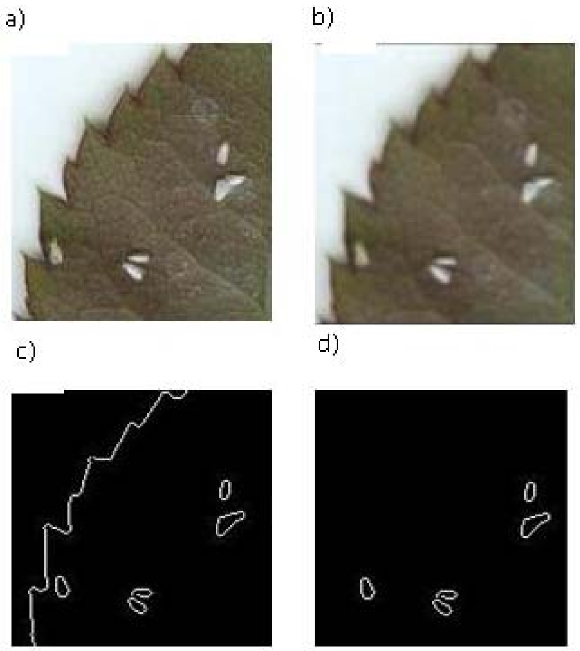

Figure 2. Image processing flow for whitefly extraction. a) original image, b) low-pass filtering, c) laplacian filtering, d) whitefly extraction.

RESULTS and DISCUSSION

The system was tested on a set sample of 50 images. At that time, the greenhouse was infested with Whiteflies. The purpose of the system was to identify the mature Whitefly and count them.

To assess the quality of our system, the results were compared with expert results. They manually counted the Whiteflies on 50 images. The counting results for the sample set were averagely between 0 and 6 whiteflies per leaf. The speed of processing was around 0.7 s per image. The detection rate was %90. Figure 3 presents the detailed results for the sample set.

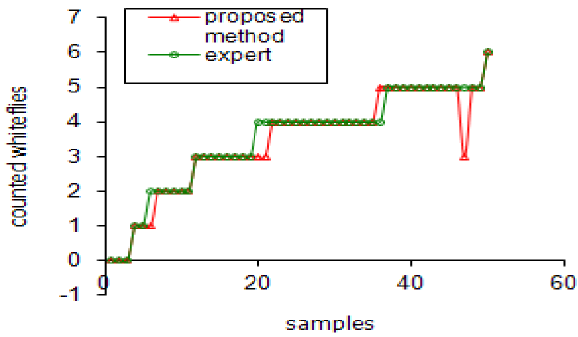

Figure 3. Diagram of whiteflies counting results

Globally, the detection rate was satisfactory. One of the biggest sources of error in detection was that two overlapping whiteflies were segmented into one region. So the system counts one whitefly instead of two or more.

In this study, the images were processed offline. The results of this study will be useful for real time pesticide applicators, but it is advisable that the algorithm is optimized so that speed of processing should be faster. Also this proposed system could detect the mature whiteflies, so it is suggestible the system which could detect the pests in early stages of their growth.

CONCLUSION

As previously mentioned, modern techniques are widely used in agriculture, but most of them are costly. Whereas we aim at proposing a generic and inexpensive method. The goal of our work is to automate operation in greenhouses. According to obtained results, the proposed approach is satisfactory.

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