Evaluation of Insect Damage on Beans using Image Processing Technology

Hasan M. Velioğlu[1]*, Özgür Sağlam[2]

[1]*Namık Kemal University Vocational School of Technical Science, Tekirdağ, Turkey*
[2]*Namık Kemal University Agricultural Faculty Plant Protection Department, Tekirdağ, Turkey*
**E-mail: mvelioglu@nku.edu.tr*

The 4th International Symposium on "Traditional Foods from Adriatic to Caucasus "
19-21 April 2018 Kyrenia – TURKISH REPUBLIC OF NORTHERN CYPRUS

Abstract

As a rapid, nondestructive and objective method, image processing technology has been widely used in determination of some quality characteristics of agricultural products. Online and rapid control of stored cereals and grains against insect damage is considered as an important step of quality assurance. In the present study, Bean Weevil (*Acanthoscelides obtectus* Say.) damage on beans were determined using image processing technology.

Key words: Image processing, beans, insect damage

1. Introduction

1.1. Image Processing Technology

A computer vision system is an attempt to replicate the human eye to brain assessment process, whereby the human eye is replaced by a digital camera and the human brain is replaced by a learning algorithm. The camera can record objective and consistent image data without substantial confounding noise. Then the learning algorithm links the image data to the appropriate quality class or level (Jackman et al., 2011).

In recent years, image processing technology has become a powerful tool in determining the quality characteristics of agricultural products. It can be used safely throughout the process for determining the quality characteristics of the product without touching or damaging it. Image processing is defined as analysing the image obtained from camera or scanner using proper software and correlate the numeric datas of image with the certain properties of material of interest. Image processing system generally consists of 5 components: Light source, image acquisition device (camera, scanner etc.), signal converter (usually exist in today's computers), hardware and software. The general methodology used in image processing is as follows; image acquisition, image preprocessing, segmentation, measurement and interpretation.

1.2. Insect Damage on Beans

*Acanthoscelidesobtectus*Say (Coleoptera, Bruchidae), bean weevil, is a cosmopolitan pest that damages its host plant, the kidney bean (*Phaseolus vulgaris* L.) in the field and during storage (Regnault-Roger & Hamraoui, 1994). Bean weevil, known as primary pest for beans, can only be detected after the damage occurred in the product. It grows inside the seed before the maturation and then leaves its host, the bean.

Detection of bean weevil or its damage on seed conducted by trained human controllers manually using microscope. While the insect lives just under the outer shell of the seed, it is not easy to distinguish without microscope. After the maturation it can be seen easily by naked eye but the time for recovery or protection is out and it causes serious cost and lost of the product. Figure 1a and 1b show the beans damaged by bean weevil.

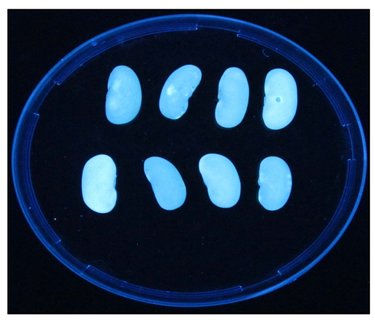

FIGURE 2. Acquired bean image

2. Materials and Method

The whole fine beans (*Phaseolus vulgaris* L.) were collected from local farm in Tekirdag, Turkey. Physical analyses for insect damage were done by well-trained human inspectors using binocular stereozoom microscope (SZ51, Olympus Inc., USA) and by naked eye. Image acquisition system consisted of closed box to prevent daylight, 365 nm UV lamps (4x15 W, PL15, Philips Electronics, Netherlands) and camera (NV14HD, Samsung Electronics, UK). The beans were placed in standard Petri dish and the images were acquired (Fig. 2). The RGB images were stored as JPEG file format with a size of 2272 × 1704 pixels. Image processing was done using Matlab® Image Processing Toolbox. An algorithm was written to indicate, separate and count the insect damaged beans in whole sample. The basic Matlab® functions: medfilt2 (2-D median filtering), bwlabel (label connected components), regionprops (measure properties of image regions) and bwboundaries (trace region boundaries) were used in the algorithm. The results containing pixel intensity values obtained by regionprops function were used to evaluate the insect damage according to a certain threshold value.

3. Results and Discussion

According to the analyses of human inspectors the healthy and damaged beans could be determined under microscope. The nit, larvae or mature insect could be detected with microscope or the insect damage could be seen by naked eye. After the image acquisition, it was seen that the damaged beans showed brighter image than the healthy ones under UV light. The use of certain threshold value provided correct determination of damaged beans in the whole sample. Figure 3 shows the difference of irradiance among the healthy and insect damaged beans in which the healthy ones are brighter than the others. Matlab® algorithm could separate the damaged beans and could give the number of them in the sample with high accuracy (95 %). According to good agreement between the results of image processing and human inspection proved that the system can be used by producers, inspectors and quality controllers. Additionally, this rapid system is convenient for non-skilled person to do the analyses.

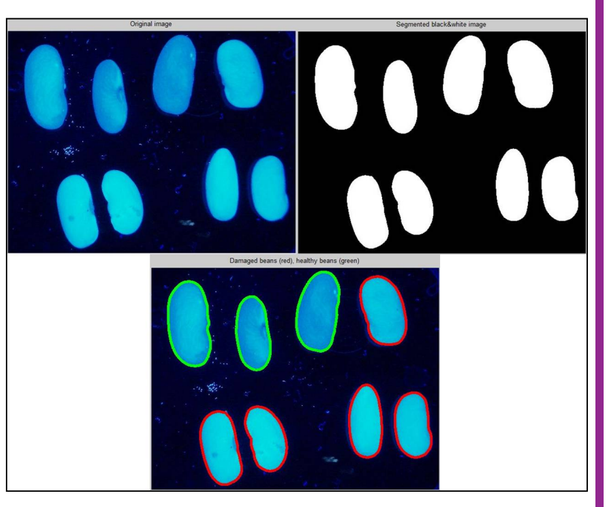

FIGURE 3. Healty and insect damaged beans under UV light

4. Conclusion

The use of computer vision and image processing to measure and evaluate the visual attributes of foods, including color, is gaining acceptance in the industry. The main advantages of computer vision are speed, accuracy, flexibility, repeatability, and quantitative measurement (Alçiçek & Balaban, 2012).

Some quality assessments in agricultural production are still conducted by trained human controllers manually and the analysis and results are considered as costly, inconvenient, boring and doubtful according to the human factor. Needs on objective, consistent and rational measurement results has increased the demand for computerized image processing techniques. In recent years, image processing techniques has been widely used in determination of shape, color, texture and size of agricultural products. Manual measurement techniques has been replaced by image processing according to the advantages such as accurate and consistent results of this novel technique. These systems are flexible in application and they can be used in process lines instead of human inspection.

The present study showed that the images of beans under UV light can be used in seperation of healty and damaged ones automatically with using suitable algorithm. However there is still need to use different imaging techniques such as multispectral or hyperspectral imaging to reach more accurate results.

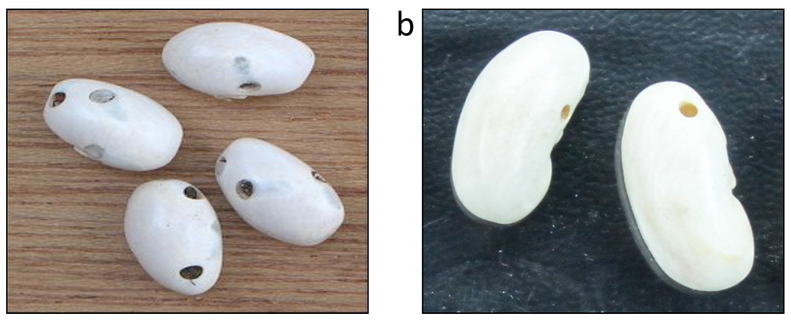

FIGURE 1.a. Bean weevil damage on beans (Anon., 2012), 1.b. (present study)

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