Weight Estimation of Wheat by Using Image Processing Techniques

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***Abstract*—Today, image processing applications in agriculture seems to spread rapidly. Image processing in agriculture are used in many areas such as classification of products, the detection of weeds, crop yields and weight estimation. In this study weight estimation of bread wheat and durum wheat in different amounts was performed by using image processing techniques. Image processing techniques were applied by using Matlab software. The counting of wheat kernels in image and weight estimation was carried out. Success rates were determined by comparing estimated weights of wheat kernels and their actual weight.**

***Index Terms*—image processing, wheat, weight estimation, durum, bread**

I. Introduction

Wheat is the most widely grown improved cultigen and it has an important role in nutrition, agricultural industry and commerce in the world. The wheat plant which has a very important position for rapidly increasing world population nourishment can be easily produced all over the world as it is depended on machined agriculture and high adaptation ability. In addition to being the raw material of wheat bread, wheat is used in the production of pastries and biscuits [1]. Physical properties of agricultural products such as length, thickness, width, surface area, bulk density, projection area is highly important in terms of engineering.

Image processing techniques are in used for measurement of physical properties of agricultural products in recent years. In general terms, image processing means that manipulation and analysis of pictorial information [2]. Image processing techniques are used in various fields such as industrial, security, geology, medicine, agriculture. Image processing and artificial neural networks in agriculture are used for purposes classification in fruit color analysis, monitoring of root growth, measurement of leaf area and determining weeds etc. [3]-[7].

Sadrnia *et al.* [8] classified and analyzed the fruit shapes in long type watermelon using image processing. The results of their study indicated that length to width ratio and fruit area (2D) to background area ratio can be used to determine misshapen fruit. Zayas *et al.* [9] used image processing to discriminate wheat and non-wheat and between weed seeds and stones in the non-wheat part of a grain sample. They reported that physical separation of stones prior to the image analysis program may be necessary for satisfactory discrimination. Also Zayas *et al.* [10] took advantage of the image processing techniques for classification and determination of shape properties 17 different wheat varieties. They developed methodology for wheat classes and variety identification by combination of image analysis techniques with wheat hardness physical measurements. Shouche *et al.* [11] quantified for shape variation in 15 Indian wheat varieties by digital image analysis using custom-built software. They placed fifty wheat grains on the scanner increase-down position avoiding grain to grain contact, thereby circumventing extensive programming needed to separate touching objects and also avoiding the associated loss of information in the images. They stored images in *.tif format for further analysis. Then they determined lengths, width, thickness, environment and shape coefficients of wheat grains via an image processing program. Bacci *et al.* [12] transferred images of wheat grain to a computer and analyzed via image processing technique. In this way, they determined the percentage of injured seeds through this technique. Symons *et al.* [13] used the image processing technique to discriminate nonvitreous wheat and vitreous wheat. Sabancı *et al.* [14] distinguished wild rye seeds mixed into wheat using artificial neural networks and image processing techniques. In addition, they classed wheat and rye seed in the image information received from a webcam.

In this study, weight estimation of bread wheat and durum wheat in different amounts was performed by using image processing techniques. By comparing obtained results with real weight was calculated the success percent of system. This study exemplifies image processing in agriculture.

II. Materials and Methods

In this study, image of bread wheat and durum wheat kernels was taken by using a Logitech C905 webcam.

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Technical specification of the Logitech C905 webcam is shown in Table I.

Images of bread wheat and durum wheat were taken from the same height by fastening the webcam.

TABLE I. TECHNICAL SPECIFICATIONS OF WEBCAM

Technical Specification of the Logitech C905 Webcam	
Interface:	Hi-Speed USB 2.0 certified
Maximum Definition:	High-Definition video (up to 1600 X 1200 Up to 8-megapixel photos (enhanced from native 2-MP sensor)
CCD Definition:	Native 2-MP HD sensor
Lens Type:	Carl Zeiss® optics with autofocus

Matlab software was used for algorithm of image processing. 100 pieces bread wheat kernels, 100 pieces durum wheat kernels were used for this process. A part of bread wheat and durum wheat kernels pictures are shown in Fig. 1. Black background was used at the stage of image processing for faster and correct results.

Images of bread wheat and durum wheat kernels in certain rates were taken via webcam for weight estimation. Fig. 2 shows an image of the bread wheat kernels.

Image information of bread wheat kernels was converted to gray level image. Filtration was performed to pictures for reduce noise and interference. Bread wheat kernels images which were converted into gray levels are shown in Fig. 3.

Image information which was at gray level was converted to binary image by using Otsu's Method. Otsu algorithm provides the clustering of these pixels according to the distribution of pixel values in the image. Thresholding process is one of the important processes in image processing. Especially, this method is used for highlighting closed and discrete areas of the object in the image. It includes the arrangement of image which was divided into pixels until to the image in dual structure. Simply, threshold process is a process of discarding pixel values on the image according to specific values, and replacing other value/values [15]. Thus, determination of object lines and backgrounds of the object on the image were provided.

Threshold value was determined by using Otsu's method. If it was under this value, pixels were converted to "0"; if it was over this value, pixels were converted to "1". After gray level image information was converted to binary image information, small white pixels were filtered in the binary image. Filtered binary image information is shown in Fig. 4.

Bread wheat kernels which were located adjacently in the binary image information were separated by morphological operations. Counting of bread wheat kernels in the binary image information was performed successfully. Process steps thus far described were also repeated for durum wheat samples. Weight of durum wheat and bread wheat kernels for the numbers of 5, 10, 20, 50, 75 and 100 were measured with analytical balance (±0.0001g accuracy). To have a higher success rate, weight of wheat kernels were estimated by image processing technique according to previous measurements sets considering its numbers and weights and selecting the weight of the closest number set. Number of wheat and estimated weight values are shown in Matlab result screen (Fig. 5).

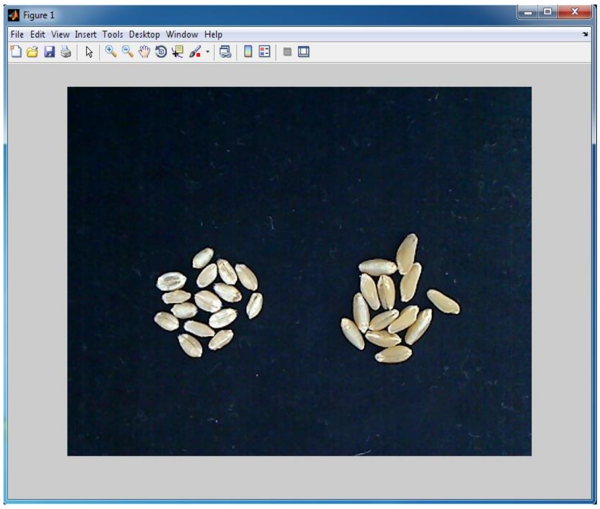

Figure 1. Image of bread wheat and durum wheat kernels

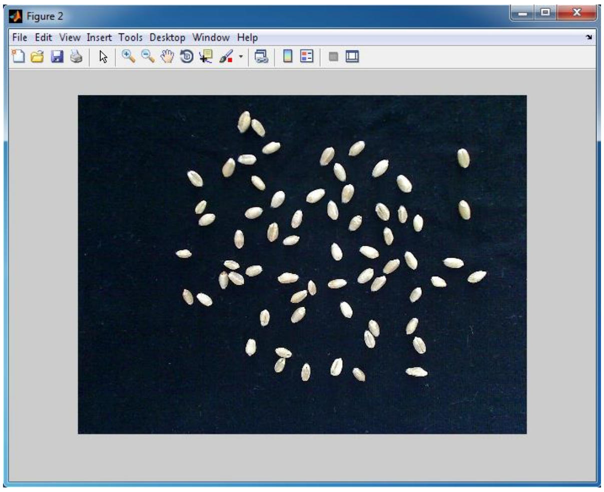

Figure 2. Original image of bread wheat kernels

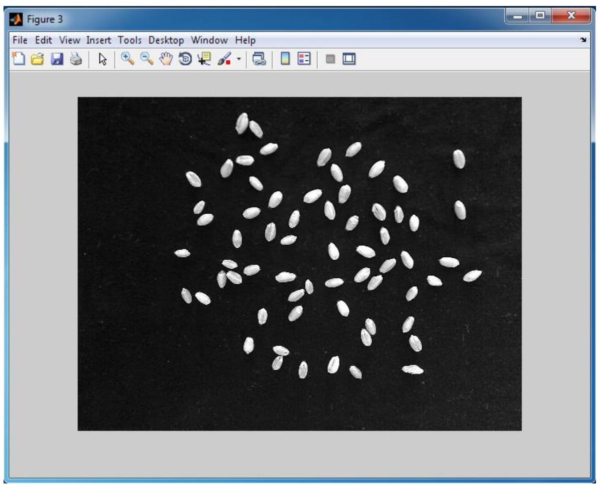

Figure 3. Gray level images of bread wheat kernels

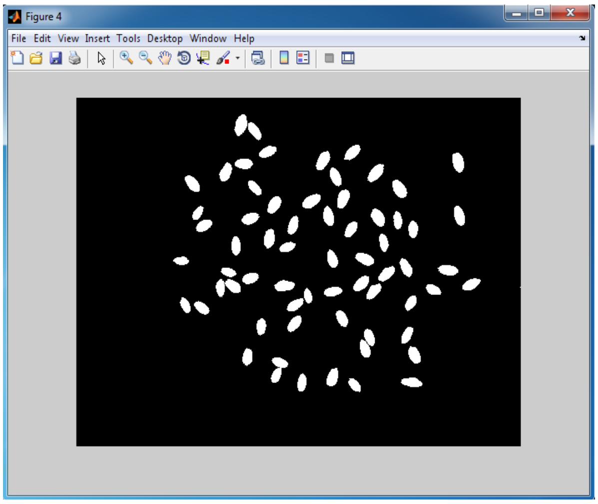

Figure 4. Binary image information of bread wheat kernels

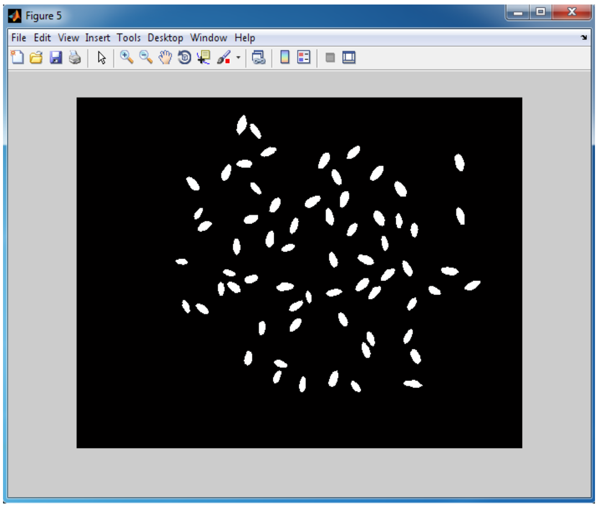

Figure 5. After morphological operations image information of bread wheat kernels

TABLE II. DETERMINED AND MEASURED WEIGHT AND SUCCESS RATE

Wheat species	Number wheat (piece)	Weight of determined by using image process algorithms (g)	Weight of measured with analytical balance (g)	Success rate (%)
Durum wheat	24	1.0950	1.0987	99.66
	55	2.4552	2.5042	98.04
	73	3.2505	3.3237	97.79
	94	4.1804	4.2799	97.67
Bread wheat	28	0.9692	0.9758	99.32
	57	2.0667	2.1254	97.23
	78	2.8108	2.8985	96.97
	99	3.5566	3.6801	96.64

III. RESULTS AND DISCUSSION

Images of the durum wheat and bread wheat kernels at different proportion which were taken with webcam processed by using image processing algorithms and counting wheat were performed. Approximate weights of the wheat were calculated according to the previously measured data. Thereafter, those wheat kernels were measured with analytical balance and performance of system was evaluated. Weights of determined by using Image process algorithms and measured with analytical balance are shown in Table II.

Flow diagram of the process of the system is shown in Fig. 6.

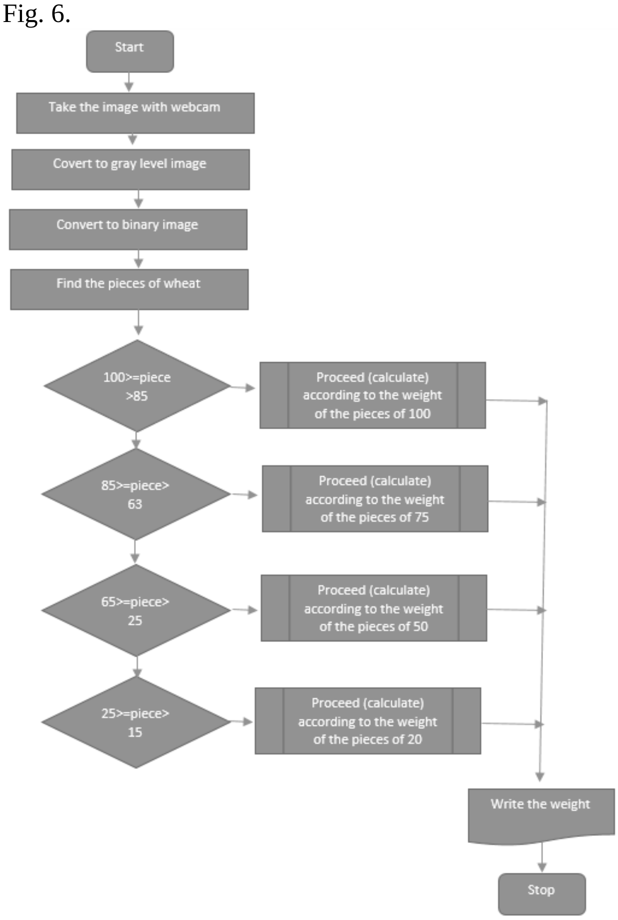

Figure 6. Flow diagram of the process of the system

Success rate graph for durum wheat is shown in Fig. 7 and success rate graph for bread wheat is shown in Fig. 8.

According to the graph, success rate reduces when the number of grains in both bread wheat and durum wheat increases.

While the number of grains in durum wheat 24, success rate is 99.66%. Success rate decreases to 97.67% when the grain number rises to 94. For bread wheat while grain number is 28, success rate is 99.32%. When the grain number rises to 99, success rate decreases to 96.64%.

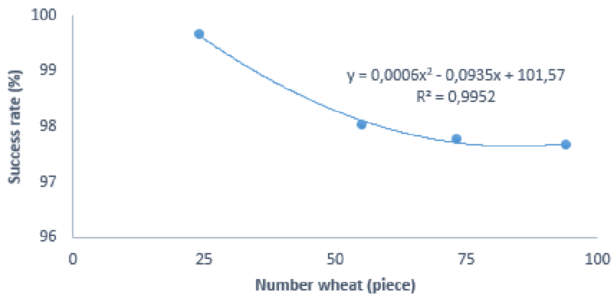

Figure 7. Success rate graph for durum wheat

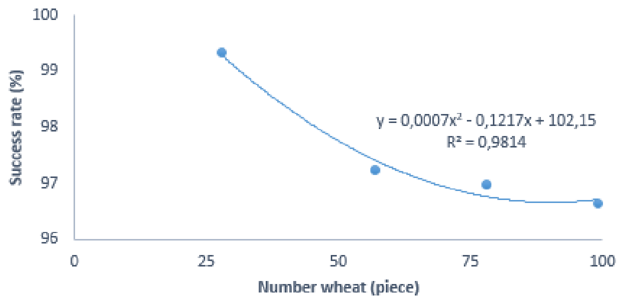

Figure 8. Success rate graph for bread wheat

IV. Conclusion

In this study, weight estimation of bread wheat and durum wheat in different amounts was performed by using image processing techniques. By comparing obtained results with real weight was calculated the success percent of system.

According to the values obtained from the measurements of durum and bread wheat to certain ratio 4, system success rate of durum wheat was average 98.29%, system success rate of bread wheat was determined as 97.54%.

Real-time weight estimation of durum and bread wheat by developing the system with moving band and camera system. Also, packaging process of wheat in a certain number can be performed. This study is an example of using image processing in agricultural field.

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