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Comparison some physical properties of six varieties of wheat seeds using image processing

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Abstract

Automated computer methods which utilize high-speed image capturing and data processing are the most advanced methods, providing a high degree of accuracy in seed quality testing and sorting. In order to present a quick and accurate method for measuring physical properties, the image processing technique was used to characterize the physical properties of six bread wheat genotypes (*Azar2, Gaskozhen, MD, Pishgam, Sainoz and Sardari*). From each variety, 100 seeds were selected randomly and high quality images of them were acquired. Feature extraction of images, including dimensions, projected area and color of them was down. The results showed that the sardari and sainoz varieties had the maximum and minimum values of seed length. Also for the width and projected area of seeds, maximum and minimum values belong to pishgam and sainoz varieties, respectively.The sardari and MD varieties respectively presented the high and low mean values of R, G and the maximum and minimum values for B belong to sainoz and MD varieties, respectively. These results can be useful in recognition and classification of wheat varieties.

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Introduction

Wheat is one of the most important foods all over the worldbecause of its agronomical adaptability and ability of itsflour to be made into various food materials (Pazoki and Pazoki, 2011). It is a major source of energy, protein, and dietary fiber in human nutrition. Wheat provides approximately one-fifth of the total calorific input of the World's population so that the annual production of wheat has greatly increased in the last years (Khoshroo *et al*., 2014).

Information on physical properties of agricultural products is needed in design and adjustment of agricultural machines. The geometric properties such as size and shape are the most important physical properties considered during the separation and cleaning of agricultural grains, Also color properties of seeds are very important in classification of them (Ghamari *et al*., 2008).

Measurement of crop seeds characters such as color, texture other physical features are simple, but is slow and somewhat subjective and give results which may be difficult to quantify for both business and technological purposes. Therefore, looking for repeatable, quick and automated methods to identify and classify the crops seeds is fundamental in agricultural machinary and seed production (Najafabadi and Farahani, 2012; Varma *et al*.,2013). Because of varietal variability in wheat seeds, knowing the physical properties of different varieties of them is necessary. The morphological characters of grains are heritable in nature and play an important role in variety identification (Pazoki and Pazoki, 2011).

In view of this, several studies have been conducted on the physical properties such as size and shape of different agricultural crops, such as; hemp seed (Sacilik *et al.,* 2003) , lentil seeds (Amin *et al.,* 2004), rice seed (Jouki and Khazaei, 2012), safflower seeds (Baümler *et al.,* 2006), popcorn kernels (Karababa, 2006) , linseed (Selvi *et al.,* 2006) , coriander seeds (Coskunerand Krarbaba, 2007), faba bean (Altuntas and Yiliz, 2007), wheat, barley, chickpea and lentil seeds (Gürsoy and Güzel, 2010), chickpea seeds (Ghamari *et al.,* 2008).

According to the small size of wheat seeds, dimension measurement isdifficult and time consuming; therefore, developing a rapid, easy, accurate andnondestructive method seems to be necessary. In recent years, computer visionsystem has been increasingly used in the agricultural and food industry(Razavi *et al.,* 2010). The uses of machine vision technology for quality inspection, classification, sorting, and grading agricultural products become more interest (Yimyam *et al.,* 2005).

A digital image is a representation of a two-dimensional image as a digital value called pixels. Digital image processing is the technology of applying a number of computer algorithms to process digital image. The outcomes of this process can be either images or a set of representative characteristics of the original images. The features from the digital images are used to generate patterns. These patterns are input to the machine algorithms based on which the objects are classified into their respective classes (Punn and Bhalla, 2013).

Some studies have been done on feature extraction of wheat using image processing. In a study toclassification the rain wheat graincultivars, the color, morphological and textural features of them using image processing were extracted (Pazoki and Pazoki, 2011). Another study extracted different color and morphological features of four varieties of wheat (Arefi *et al.,* 2011).

The objective of this work was to study some physical properties of six varieties of wheat seeds using an image processing system to develop appropriate technologies in design and adjustment of machines used during harvesting, separating, cleaning, handling and storing them. The results also can be used for identification and classification of those

varieties.

Material and methods

Sample Preparation

Six wheat varieties called azar2, gaskozhen, MD, pishgam, sainoz and sardari which are grown in Iran, were prepared from the Kurdistan Center for Agricultural and Natural Resources Research. The samples were cleaned manually to remove stones, straw, and damaged seeds. Initial moisture content (MC) of samples was determined by using the oven method at 105°C for 24 h (Esref and Hulya, 2008). Initial MC of azar2, gaskozhen, MD, pishgam, sainoz and sardariwere 8.05, 7.52, 7.15, 7.12, 6.98 and 7.63% (w.b.), respectively. For extracting the physical properties, from each variety, 100 seeds were selected randomly.

Feature extraction

In order to determine physical properties of wheat seeds, it used image processing technique which consists of an image capturing box, a digital camera, and an image analysis software. The image capturing boxwas supplied high quality images of seeds in constant suitable situation without any optical noises. A digital camera (sony DSC-W370, 14.1 Mpixel) was used to capture top-view images of the seed which was located 15 cm above it to capture standard image from samples with as good resolution as possible (Kilic *et al.,* 2007).

The seedswere placed on a white calibration plan to calibrate size and color. The normal illumination condition withwhite fluorescent lamps was used. Fig. 1 shows an obtained image.There were a total of 600 images (100 images of any variety). The software (Matlab version R2012B) offered the possibility of extracting the values of some physical properties such as dimensions and color of seeds.

After acquiring all wheat images, some pre-processingfunctions such as rotation and noise elimination on the images to enhancement of them were down. Every image was opened in the Matlab using image read command. This command writes a m*n*3 matrix for any image, where m, n and 3, indicate the number of rows, number of columns, and color intensity (256 different levels) of different pixels, respectively.

In this research, it defines wheat's physical properties as follows:

Length and Width: Length is the wheat's major axis orof wheat. The Width is minor axisor maximum distance from a boundary pixel to another boundary perpendicular to the major axis.

Projected area:projected area is the area of the 2D projection image of the top view wheat.

Color:It keeps the color model in RGB (Red, Green, Blue) as it is original color space when acquiring images, and it is easily to transform toother color metrics when needed.

In order to obtain length and width of seeds, comparative method (comparing with the calibration plan) was used. Because the calibration plan was white (R, G and B equal to 255), the number of pixels which the R, G and B amounts of them were less than 255 was calculated along the major and minor axis. The ratio of these amounts to the number of row and column in the matrix indicate the length and width of seeds.In the same manner the projected area of seeds was determined by counting number of pixels inside the boundary and comparing with the known calibration size.

For extracting color features, the amount of R, G and B inten different regions on the seed's images were measured separately, and mean of these amounts were reported for any seeds.In the RGB model, color change depends evenly on three independent parameters (R, G, and B).

Also it has converted RGB color mode of original captured images to hue-saturation-intensity (HSI) color mode.The HSI color model decouples the

intensity component from the color information, and ithas been considered intimately related to the way in which humans perceive colors. In the HSI model, color change is reflected mainly in the continuous change of one parameter (hue) (Gonzalez and Woods, 1992).

In a study on determining wheat vitreousness using image processing and a neural network, The HSI color model was used simply based on an assumption that an artificial neural networks wouldprefer the HSI model over the RGB model because artificial neural networkswere designed based on an analogy to the human neuralsystem(Wang *et al.*,2003).

The IHS color values are obtained from the RGB values by the following conversion equations (Suo *et al.,* 2010):

$$I = {(R+G+B)}/{3} \quad (1)$$

$$S = 1 - \left(\frac{3}{(R+G+B)}\right) * a \quad (2)$$

$$H \cos^{-1} \frac{(0.5 * (R-G) + (R-B))}{\left((R-G)^2 + (R-B) * (G-B)\right)^{0.5}} \quad (3)$$

Where:a=min(R,G,B)

Resultsand discussion

Dimensions and projected area

The average, minimum, maximum, standard deviation and coefficient of variation values for the length, width, andprojected area of sixwheat varieties are shown in Tables 1. The values of length varied from 4.82 to 8.07 mm. As this table shows sardari had the highest mean seeds length 6.87 mm,and sainoz had the least mean seeds length 5.52 mm.In a study (voicu *et al.,* 2013) on physical properties on three different varieties of wheat, maximum and minimum values of mean length were 5.09 and 7.22 mm, respectively.

The values of width and projected area of seeds varied from 2.40 to 4.50mm and 10.92 to 15.43 mm², respectively. Maximum values of width and projected area of seeds belong to pishgam with mean values of 3.97mm and 18.96mm², and sainoz varieties had the minimum values of width and projected area of seedswith mean values of 3.32mm and 14.88mm², respectively. Gürsoy and Güzel (2010) observed similar trend in the dimension and projected area of wheat. He recorded highest and lowest values of means 6.40 to 7.39 mm for length, 2.56 to 3.08 mm for width and 13.85 to 18.10 mm² for projected area.

The importance of dimensions is in determining the aperture size of machines, particularly in separation of materials (Guevara-Hernandez and Gomez-Gil, 2011). These dimensions may be useful in estimating the size of machine components. The major axis have been found to be useful by indicating the natural rest position of the material and hence in the application of compressive forces to induce mechanical rupture.

Table 1. The statistical parameters for dimensions and projected area of wheat varieties.

Property	Parameter	Variety					
		azar 2	Gaskozhen	MD	pishgam	sainoz	sardari
	MEAN	6.31	6.00	5.89	6.08	5.52	6.87
	MIN	5.04	4.83	5.19	5.31	4.82	5.52
length	MAX	7.54	7.10	6.79	7.01	6.24	8.07
(mm)	STD	0.48	0.36	0.36	0.35	0.27	0.43
	CV	7.61	5.96	6.12	5.69	4.81	6.30
	MEAN	3.51	3.83	3.46	3.97	3.32	3.37
	MIN	2.40	2.77	2.63	3.31	2.88	2.82
width	MAX	4.50	4.44	4.43	4.42	4.00	3.90
(mm)	STD	0.35	0.32	0.31	0.25	0.26	0.21
	CV	9.94	8.25	8.83	6.23	7.62	6.30
	MEAN	17.42	18.06	15.99	18.96	14.88	18.24
	MIN	10.92	11.87	11.18	15.34	11.54	15.43
area	MAX	22.89	23.59	20.79	22.85	19.37	23.53
(mm²)	STD	2.35	2.02	1.72	1.58	1.55	1.67
	CV	13.51	11.18	10.77	8.33	10.42	9.13

Surface color

The average, minimum, maximum, standard deviation and coefficient of variation values of R, G and B are shown in table 2. The ranges of values were 145.32-243.52 for R, 102.3-209.89for G and 73.89-173.51for B. As this table shows the sardari and MD varieties respectively presented the high and low mean values of R and G. The R and G values for sardari were 232.67 and 197.46 and forMD were 204.23 and 148.58, respectively. Also the maximum and minimum values for B belong to sainoz (144.27) and MD (97.08) varieties, respectively.

Table 2. The statistical parameters for R, G and B of wheat varieties.

Property	Parameter	Variety					
		azar2	gaskozhen	MD	pishgam	sainoz	sardari
	MEAN	228.06	219.53	204.23	224.73	216.56	232.67
	MIN	195.66	145.32	178.41	197.91	207.04	224.48
R	MAX	242.81	235.06	227.58	243.52	228.21	240.38
	STD	6.72	10.74	6.45	10.04	4.87	3.43
	CV	2.95	4.89	3.16	4.47	2.25	1.47
	MEAN	172.15	161.63	148.58	172.26	170.33	197.46
	MIN	130.4	102.3	133.38	138.1	154.32	185.17
G	MAX	189.06	180.51	168.68	205.97	195.88	209.89
	STD	8.42	9.01	7.12	17.79	5.84	5.37
	CV	4.89	5.57	4.79	10.33	3.43	2.72
	MEAN	111.52	103.02	97.08	124.12	144.27	129.1
	MIN	79.82	79.32	73.89	87.56	130.52	110.15
B	MAX	151.66	119.54	124.36	171.96	173.51	146.21
	STD	11.04	6.54	9.96	25.88	7.58	7.01
	CV	9.9	6.35	10.26	20.85	5.25	5.43

Table 3 shows the values of average, minimum, maximum, standard deviation and coefficient of variation for H, S and I.As this table shows sardari had the maximum of mean values for H and S (0.71 and 0.39), and sainoz had the minimum values of them (0.37 and 0.19).Also maximum values of I (186.41) was belong to sardari, and MD varieties presented the low mean values of I (149.96).

Table 3. The statistical parameters for H, S and I of wheat varieties.

property	parameter	Variety					
		azar 2	gaskozhen	MD	pishgam	sainoz	sardari
	MEAN	0.55	0.53	0.5	0.5	0.37	0.71
	MIN	0.31	0.35	0.43	0.36	0.22	0.65
H	MAX	0.61	0.58	0.59	0.64	0.45	0.74
	STD	0.04	0.03	0.03	0.05	0.04	0.02
	CV	7.07	5.5	6.04	11.03	12.07	2.2
	MEAN	0.35	0.36	0.35	0.29	0.19	0.39
	MIN	0.21	0.27	0.25	0.15	0.13	0.26
S	MAX	0.49	0.42	0.47	0.43	0.23	0.37
	STD	0.04	0.03	0.04	0.09	0.02	0.02
	CV	12.24	7.96	11.83	29.34	11.74	6.85
	MEAN	170.57	161.39	149.96	173.7	177.05	186.41
	MIN	142.21	108.98	134.31	144.39	166.63	174.27
I	MAX	191.89	177.73	171.2	207.15	199.2	197.96
	STD	7.54	7.89	7.11	16.55	5.24	4.98
	CV	4.42	4.89	4.74	9.53	2.96	2.67

Knowledge about the colorof wheat seeds is very important in the development the systems for recognitionvarieties according to morphologicalproperties of them, such as the works have been done on recognition and classification of wheat grain cultivars (Pazoki and Pazoki, 2011; Wang *et al.,* 2003).

Fig. 1. An acquired image of wheat seed.

Conclusion

Some physicalproperties of six varieties of wheat seeds including length, width, projected area, R, G, B, H, S and I were obtained using image processing technique. The results showed that geometric properties vary from variety to variety. These data can be used for design and adjustment of agricultural machines in the agricultural process of these varieties of wheat. Also, there was significant difference between color properties of varieties which can be useful in recognition and classification of them.

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