APPLICABILITY OF DIGITAL IMAGE PROCESSING FOR QUALITY CONTROL OF VEGETABLE MIXES

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Introduction

Nowadays, the consumer's comprehensive information supply is more and more important concerning their conscious decision on purchase. Answering to the demand, development of food quality control systems is in the focus of the food industry. The aim of the presented work was the estimation of ingredients ($^{m}/_{m}$ %) of vegetable mixes by digital image processing technique.

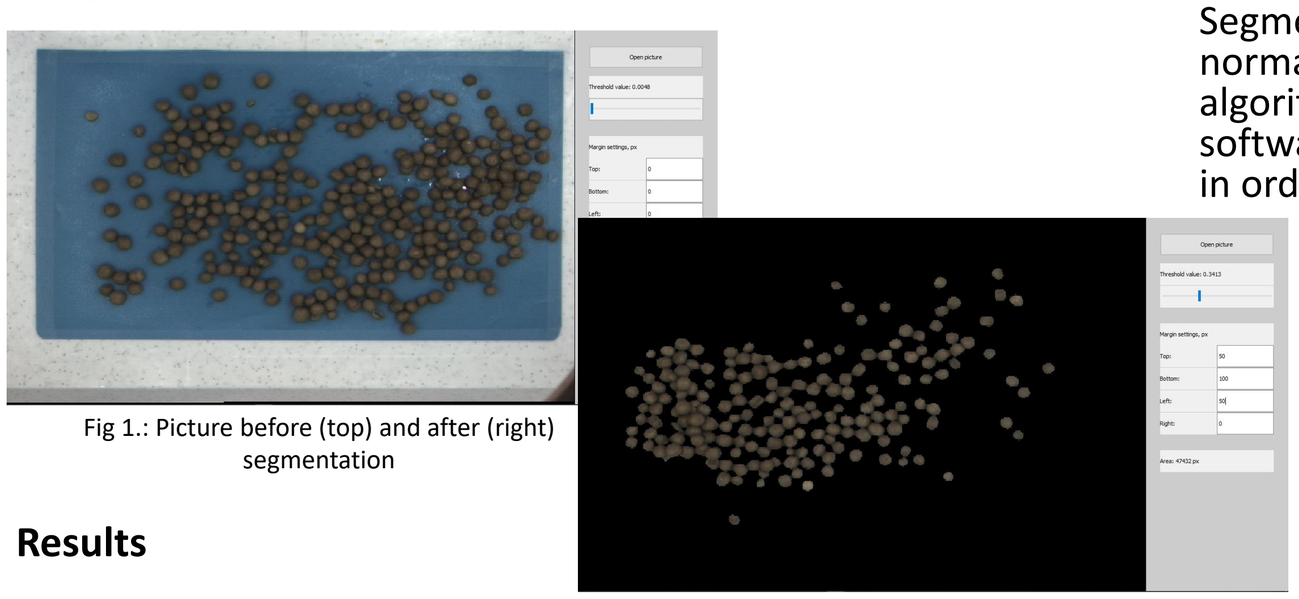


Fig 1.: Picture before (top) and after (right) segmentation

Materials and methods

Hitachi HV-C20 type 3CCD camera was used for image acquisition. During the experiment, different corn based vegetable mixes (green pea, chili, olive and red pepper, red kidney bean, green pea and red pepper) were used. For all samples, images were taken about the whole mix and the manually separated ingredients as well. Calibration of the computer vision system is essential, therefore corresponding mass (g) and visible area (cm^2) data were recorded. Segmentation was performed based on a threshold value of normalized color channels. Graphical user interface and algorithm were developed for image analysis using Scilab software. Curve fitting was performed on mass and visible area in order to find the best prediction model of lowest RMSE.

Results

The segmentation of the pictures (Fig. 1.) were performed by the same threshold value (0.3413). Exception to this was only the case of black olive, which needed to be evaluated by a lower threshold value (0.2981). This way gained pixel values were plotted as a function of the measured mass. Close linear relationship was found between the mass and the defined pixel of the different components (R^2=0,99–0,95). Rank correlation showed also a good and close relationship between those values. According to the RMSE results, the estimation of the samples' mass was characterized by only 0.3-3 g of error. This error is only 0.1-1 % compared to the average net weight (260-280 g). Based on the color parameters of the individually component types, the segmentation showed 98.5 % efficacy (Fig 3. Table 1) according to the Discriminant Analysis results.

Fig 3.: Results of the Discriminant Analysis

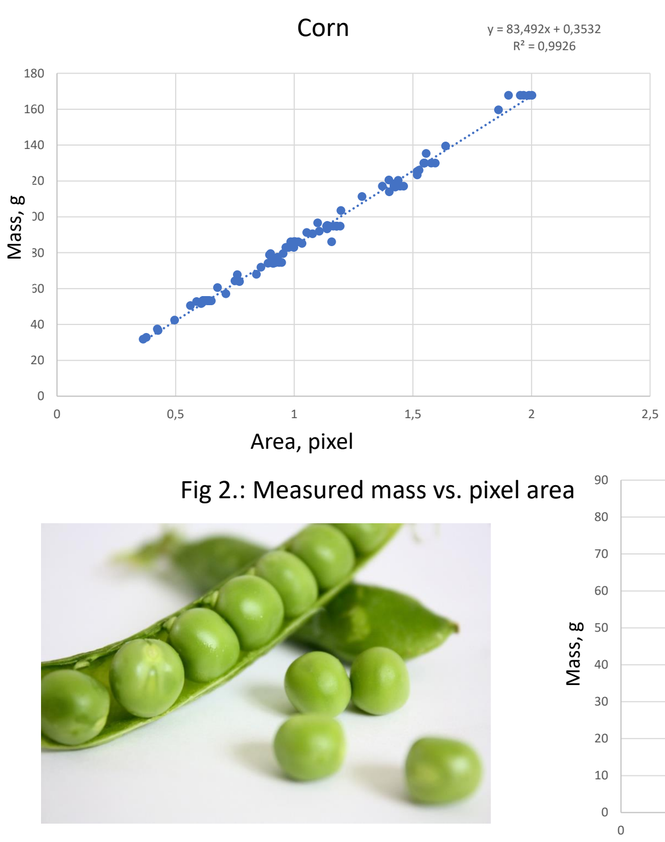
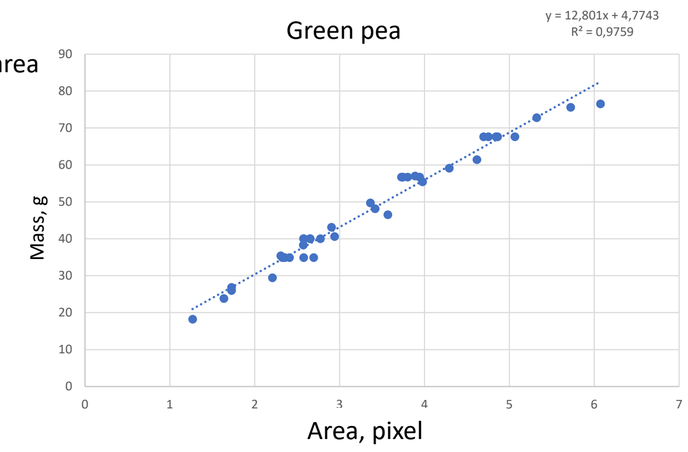


Fig 2.: Measured mass vs. pixel area



Classification Results[a,c]

			Predicted Group Membership						
			Bean	Green pea	Black olive	Corn	Paprika	Green olive	Total
Original	Count	Bean	20	0	0	0	1	0	21
		Green pea	0	38	0	0	1	1	40
		Black olive	0	0	20	0	0	0	20
		Corn	0	0	0	102	0	0	102
		Paprika	0	0	0	1	60	0	61
		Green olive	0	0	0	0	0	20	20
	%	Bean	95,2	0,0	0,0	0,0	4,8	0,0	100,0
		Green pea	0,0	95,0	0,0	0,0	2,5	2,5	100,0
		Black olive	0,0	0,0	100,0	0,0	0,0	0,0	100,0
		Corn	0,0	0,0	0,0	100,0	0,0	0,0	100,0
		Paprika	0,0	0,0	0,0	1,6	98,4	0,0	100,0
		Green olive	0,0	0,0	0,0	0,0	0,0	100,0	100,0
Cross-validated[b]	Count	Bean	20	0	0	0	1	0	21
		Green pea	0	38	0	0	1	1	40
		Black olive	0	0	20	0	0	0	20
		Corn	0	0	0	102	0	0	102
		Paprika	0	0	0	1	60	0	61
		Green olive	0	0	0	0	0	20	20
	%	Bean	95,2	0,0	0,0	0,0	4,8	0,0	100,0
		Green pea	0,0	95,0	0,0	0,0	2,5	2,5	100,0
		Black olive	0,0	0,0	100,0	0,0	0,0	0,0	100,0
		Corn	0,0	0,0	0,0	100,0	0,0	0,0	100,0
		Paprika	0,0	0,0	0,0	1,6	98,4	0,0	100,0
		Green olive	0,0	0,0	0,0	0,0	0,0	100,0	100,0

a. 98,5% of original grouped cases correctly classified.

b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 98,5% of cross-validated grouped cases correctly classified.

Fig 4.: Classification table of Discriminant Analysis

Conclusions:

The preliminary results of our experiment show a grate promise for further application. The computer vision system is able to evaluate properly the quality of the vegetable mixes. However, in order to develop an industrial application, proper further experiments are needed to be carried out.

Acknowledgement:

The project was supported by the European Union and co-financed by the European Social Fund (grant agreement no. EFOP-3.6.3-VEKOP-16-2017-00005).