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ORIGINAL ARTICLES

Mage Processing Application for Mangosteen Grading with non Destructive Method

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ABSTRACT

The amount of export quality mangosteen is only 30 - 40% of total production. This low percentage is caused by heterogeneity in fruit quality. There are some requirements in Indonesian Standard (SNI) and standard export of quality, which are normally assessed visually. Therefore image processing is recommended to be used in mangosteen grading. The objectives of this research are to determine maturity level and to make grade of mangosteen non-destructively using image processing. The Hardware used to process the image of mangosteen is the CCD camera and the computer which is equipped with video capture. Mangosteens were obtained from farmer fields in Wanayasa, Purwakarta Regency. West Java Province. The result showed that accuracy level of quality with image processing for the maturity level is 90% prediction. Moreover, accuracy level of calyx determination is 100%, and accuracy level of diameter from top view is 95.33% and 87.5% from side view.

Key words: Mangosteen, Image Processing, Maturity, Calyx, Diameter.

Introduction

Indicators of mangosteen quality are included maturity, size and calyx determination. Process sorting is manual. Maturity level sorting is useful for determining the location of market. Mangosteen with high-level of maturity are targeting for local market while mangosteen with low-level of maturity (index 3) are targeting for export market. Furthermore, middle-east country market prefer to small and medium size of mangosteen (quality I and II), while another country prefer to big size (super quality). Output quality of manual sortation depends on sorter condition so that the output of sortation is varied. The impact of manual sortation is inaccuracy for mangosteen prediction. Kader, (2002) stated quality index of mangosteen are fruit size, shape, size, and free of product defect, it is the same as nation quality standard requirement, and have visual evaluation.

Images of processing technique is one alternative technology that can be used for visual grading, This technology was developed to obtain the information for digital image by modifying part of the image which is needed to produce another image that is more informative (Arymurthy, A.M. and S. Setiawan. 1992), Haralick *et al.*, (1973) had processed the image for determining the texture. Another benefit of image processing technique in agriculture is: to measure the quality of salak fruit (Ahmad, U., 2001), to measure the length of cheese slices (Ni, H.X and S. Guansekaran, 2003), to examine the color of food surface (Yam, K.L. and S.E. Papadakis, 2004) and to grade the quality of apple (Leemans, V and M.F. Destain, 2004).

General objective of this research is to developing grading system of mangosteen and asses mangosteen quality with image processing. Specific objectives of this research are (1) to study indicator of mangosteen grade including color, size and calyx integrity; (2) to determine the level of mangosteen maturity based on skin color, (3) to apply image processing for mangosteen quality analysis with destructive.

Materials and Method

Materials:

The primary material of this research is mangosteen as with some quality level. These fruits come from wanayasa farmer at Purawakarta regency, west Java Indonesia.Research equipment consists of hardware and software. The hardware research are CCD color camera with OC 305 D model, 133Mhz processor computer with video capture Matrox meteor, 4 unit of 7 watt TL lamp, digital scale, caliper. There are two research software, first is the capture program and image processing program in C++ language with visual C microsoft complier

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Method:

This research process consists of three phases stages: image capturing, algorithm image processing, and quality determination.

Image Capturing Phase:

Mangosteen was captured by CCD camera. Background of this object are different, black background is determining the number of calyx and white background is determining the maturity. Background size was captured by camera lens in 15.5 x 11.5 cm, and distance of camera and background was 23.5 cm. Mangosteen image was recorded and saved in 256X192 pixels.

Algorithm Image Processing Phase:

These are research processes on algorithm image processing phase: (1) Program the digital image with real time including indicators of wide determination, RGB index, and 4 texture components, (2) using a method of area measurement with changing color image into binary image, then it was separate with threshold process, whereas white will be change into black. This object come from labeling process and area determined by number of white object pixel, (3) determining color intensity level that measured by Red Green Blue (RGB) score. RGB score is RGB average score of white object, (4) processing grade of mangosteen to determine margin score between two parameter. This score is grading parameter

Grading:

Manual grading was done by determine mangosteen diameter, while maturity was determined by comparing skin color with maturity index. Image digital grading was done by developing image digital processing program with numbering margin score between two parameters on every group of fruit quality. Whereas, validation process compare the result of digital image process with manual grading.

Results and Discussion

Mangosteen Maturity Determination:

The parameter of mangosteen maturity level is color. There are seven level of mangosteen maturity: index 0 is mangosteen with greenness yellow skin color, index 1 is mangosteen with yellowish green skin color, index 2 is mangosteen with reddish yellow with red spot skin color, index 3 is mangosteen with brownies red skin color, index 4 is mangosteen with purplish red skin color, index 5 is mangosteen with reddish purple skin color, index 6 is mangosteen with purple black skin color there are some RGB of each maturity level based on maturity index picture from agriculture ministry (see Table 1).

Table 1: RGB Score on Maturity Level.

Maturity level	R	G	B
Young	138	114	47
Mature	156	47	18
Over-mature	90	10	16

Table 1 show that the score of R and G can be used as the parameter of level maturity. This data used to sorting the level of maturity with computer program. Furthermore, mangosteen maturity level is tested through manual grading and image processing grading. Then, image processing grading compare to manual grading. Manual grading is comparing color skin of mangosteen with index of mangosteen from Indonesian ministry agriculture. Image processing grading is evaluation with image processing program with parameter of RGB. Comparison Result shows on Table 2.

Table 2: Comparison Results of Manual Grading and Image Processing Grading.

Manual Index (Maturity Level Parameter)	Program Index (Maturity Level Parameter)			
	Young	Mature	Over-mature	Number
Young	47 (78,33%)	11 (18,33%)	2 (3,33%)	60
Mature	8 (13,33%)	41 (68,33%)	11 (18,33%)	60
Over-mature	1 (1,67%)	5 (8,33%)	54 (90,00 %)	60

Table 2 about the image processing grading based on color skin showed that good result for the index over-mature 90%, The failed prediction of maturity index is the highest, because manual grading has difficulty on differentiating red index with visual method. Ahmad (2001) stated color hasn't real physic characteristic. Color is psycho-physiological response on different intensity.

Mangosteen Grading With Non-Destructive Method:

Calyx Integirty Grading:

Calyx integrity determination is assement of mangosteen quality based on its calyx integrity. Before process of calyx integrity determination, mangosteen was sorted to find differentiation factor. This factor is parameter of calyx integrity condition. In this research, calyx integrity condition is evaluating mangosteen quality according to its area. Width area is determined by threshold process on calyx.

Table 3 is the statistic result included mean, deviation standard, maximum and minimum score. This data are database for developing calyx integrity sortation program. This program used to determine the number of mangosteen calyx.

Table 3: Statistic Result of Calyx Grade Parameter.

Statistic	Calyx Grade Parameter (Number of Calyx)			
	Complete (4)	3	2	1
Mean (pixel)	7705,47	6338,35	4810,90	3620,53
Std. Deviation (pixel)	745,57	383,83	427,10	176,00
Max (pixel)	9756	6960	5461	3877
Min (pixel)	6889	5711	4358	3183
Low level (pixel)	7000	5700	4000	3000
Up Level (pixel)	-	7000	5700	4000

Table 3 shows that there are differentiation of area width between complete calyx (4), 3 calyx 2, calyx, and 1 calyx. Data of calyx grade parameter on Table 3 become input to developing grading program, hereinafter it apply to image processing and mangosteen grading.

The comparison result of manual grading and image processing grading is described on Table 4.

Table 4: the comparison result of manual grading and image processing grading.

The actual number of Calyx	The number of calyx on program				Total
	Complete (4)	3	2	1	
Complete (4)	15 (100 %)	-	-	-	15 (100%)
3	2 (13,33%)	13 (86,67%)	-	-	15 (100%)
2	-	2 (13,33%)	11 (73,33%)	2 (13,33%)	15 (100%)
1	-	1 (6,67%)	1 (6,67%)	13 (86,67%)	15 (100%)

There are no different between numbers of mangosteen calyx on manual grading with image processing grading. It can be find on prediction succeed has 100%. Factors influencing result differentiation is defect factor of mangosteen (on calyx and skin), so the time for defect skin threshold has an impact to area width.

Diameter Grading:

Diameter grading is assessment of mangosteen quality based on its diameter. There are two processes of diameter determination. The first process is taking mangosteen image from above and second process is taking mangosteen image from side. From this second process, its area will be wide because added by calyx area, while image from above there is no additional area (Figure 1).

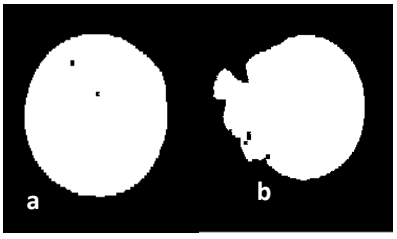

Fig. 1: Mangosteen *Threshold*; (a) above image; (b) side image.

Grading with Image Processing from Above:

The initial step grading with image-processing is determining the differentiation factor. Determination of differentiation factor was done by searching the number of pixels at each grade. Grade are determined manually by measuring mangosteen diameter the classified by mangosteen standard for Indonesia. The Diameter Grade Parameter with Image Processing from Above and SNI Classification is described on Table 5.

Table 5: The Diameter Grade Parameter with Image Processing from Above and SNI Classification.

	Diameter Grade Parameter		
	Super	I	II
Diameter (Indonesian standard SNI)	>65 mm	55-65 mm	<55 mm
Area Grade (Pixel Average from Above)	13500	8500-13500	<8500

Data of diameter grade parameter on Table 5 become input to developing image processing program and processing mangosteen grade base on its size. These values entered to processing program as a tool for mangosteen grading. Further, program will be validated by using a different sample of mangosteen with the previous process. Furthermore, mangosteen diameter will measure manually, and its results will be compared. The comparison result has 95.33% prediction succeed. While the prediction failed was 4.73%, its found that mangosteen was measured manually put on Grade I, but grading with image processing put on Grade II.

Grading with Image Processing from Side:

Grading with image processing from side is modifying differentiation width of area. Average differentiation between image processing from above and from side is 945 pixels. The Diameter Grade Parameter with Image Processing from side and SNI Classification showed on Table 6.

Table 6: The Diameter Grade Parameter with Image Processing from Side and SNI Classification.

	Diameter Grade Parameter		
	Super	I	II
Diameter (Indonesian standard SNI)	>65 mm	55-65 mm	<55 mm
Area Grade (Pixel Average from Side)	14500	9500-14500	<9500

The comparison result has 91.67% prediction succeed. While the prediction failed was 4.17%, it found that mangosteen was measured manually put on Grade I, but grading with image processing put on Grade II.

Conclussion:

1. Image processing program can predict mangosteen maturity level based on the skin color, it was 90% prediction succeed.
2. Calyx integrity grading is the assessment of mangosteen quality based on its calyx integrity. The level of prediction succeed of image processing program for calyx integrity is 100% for complete integrity calyx (4) complete
3. Diameter grading is assessment of mangosteen quality based on its diameter. There are two processes of diameter determination, its image processing from above and from side. Image processing from above has 95.33 % succeed prediction and image processing from side has 91.67% succeed prediction.

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