Detection of the Beef Quality

Using Mobile-Based K-Mean Clustering Method

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Abstract— **Beef quality is determined by a number of parameters; some of which include size, texture, color feature, or meat smell. Recently, determining the meat quality is done by seeing the color and shape. However this method still has some weaknesses due to, for example, the subjectivity and inconsistency in human assessment. The aim of this research is to make an application to detect the meat quality. The application built was based on mobile using Java Programming Language on the Android integrated with Android SDK, Eclipse, and OpenCV. The method of image processing used pre-processing, k-mean clustering, and the analysis was conducted statistically with mean value and deviation standard. The quality detection meanwhile was performed using the texture and meat texture matching based upon the existing data. The application made could be used to seek the significant k-values and able to detect the level of quality by providing the level of accuracy at 80%.**

Keywords— *k-mean clustering, statistical analysis, Android SDK, OpenCV, Eclipse*

I. INTRODUCTION (*HEADING 1*)

Beef possesses many contents that are beneficial for human. One of the nutrient contents in beef that is highly beneficial for human body is protein. In addition, beef contains the high level of chemical element iron that can prevent the anemia as well as other beneficial contents such as selenium, zinc, vitamine B complex, and omega-3.[10]

Instead the existence of the high level of beneficial elements, it is still found many frauds in terms of the sale of beef. The high quantity of unqualified and inconsumable beef comes to be the highly devastating fraud done by the irresponsible parties.[11] Meanwhile, there is a need for society to have sufficient knowledge to be able to differentiate which beef is consumable.[4] Detecting the beef quality can be done using the facilities from the communication media such as smartphone. The use of smartphone brings a number of advantages such as flexibility, small size that makes it portable, affordability in comparison to the laptop. Another advantage is that it can be used as a tool to ease the human drudgery - in this case regarding making the application of digital image processing using the input of digital image of the beef to be detected for its quality. The mobile based beef detecting application was built using the operational system of Android Lollipop 5.0.2, operational system of Windows 7 and

Eclipse Juno and used the library OpenCV version 2.4.9. This application is supported with a number of pre-processing of image, segmentation of k-mean clustering by changing the values of k, and analyzed of feature extraction through the measurement values of means and the deviation standard for each meat images.

Meat can be assessed based on price and quality.[8] The quality of meat can be measured using four characteristics: marbling, meat color, fat color, and meat density. To determine the beef quality whether it is good or bad can be performed visually that is by comparing the real meat with the reference of the meat picture.[8,9] This research aims to develop an automatic system to determine the meat quality based upon the marbling using the technique of image processing. A number of researches have shown that the image processing can be applied to analyze the color and the texture of the meat that can be used as a reference in the identification process for the beef quality. [3,5,7]

II. THEORY

This research is focused on the development process of the image segmentation using the method of thresholding and image classification using the algorithm of K-Nearest Neighbor.[11]

The next research is the image identification to identify the type of beef using Wavelet Haar transformation[16]. The aim of the researchs are making an application of image identification system to identify the fresh beef using Wavelet Haar transformation. The process of image processing is performed by measuring the values of RGB in each meat image prior to perform the process of normalization to obtain the index value of R, G and B and conversion process from RGB model to HIS model to obtain the quantity of the values of hue, saturation and intensity. The value resulted from the process of image processing is used as the input parameter of the verification program.[16]

Specifically, the healthy beef is characterized with the bright red, shining, not pale, being elastic, not sticky and unique aroma. The specific nature of sensory of meat is able to determine the attractiveness for the consumers.[10] A number of specific qualities influencing the customers' acceptability

include color, pH, water holding capacity, cooking losses and tenderness.[10]

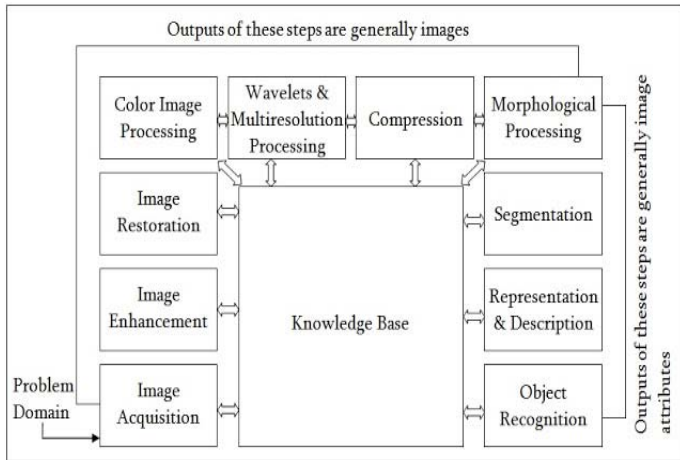In the field of computer vision, the steps of image processing are shown in Figure 1.[1]

Figure 1. Steps of image processing [1]

A digital image through digital image processing results in a new digital image including the image restoration and image enhancement. Meanwhile, the digital image analysis results in a decision or a data including pattern recognition.[2] In this research, the steps in processing the image included: size arrangement, histogram equalization and k-mean clustering segmentation.

K-Mean Clustering is an image segmentation technique based upon the color intensity. It is assumed that the object that will be separated tends to have different color intensities and each of objects has the almost equal color.[17] In k-mean clustering image division is conducted by dividing the image histogram in which its algorithm is as follows:[17]

1. Finding the maximum and minimum intensities used by image.
2. Dividing a number of Ns from minimum to maximum to determine the number of objects expected to be present in the image.
3. Having performed the division, the histogram will be divided into some parts called as cluster. Then, an investigation to the image in all points is performed in which each point will be grouped into the nearest cluster to make the final result of this process is the number of color on the image becoming N.
4. Seeking the result of means for all points in each cluster. Then, it is followed by replacing the color in all points into clusters with the means of each cluster.

The feature extraction is a method of taking the feature based upon the characteristics of image histogram.[14] The histogram shows the probability of the appearance of the value of greyish level of pixels in an image. From the values in the resulted histogram, a number of parameters of feature can be calculated including the means and the deviation standard.[2]

A.   The extraction of the feature of the first order is a method of taking the features based upon the characteristics of the image histogram. The histogram shows the probability of the appearance of value of greyish level of pixel in an image.[14]

B. *Statistical Feature Extraction*

The nth moment of the (normalized) gray level histogram is given by:[15]

$$\mu_n = \sum_{i=1}^{L} (k_i - m)^n \, p(k_i) \tag{1}$$

where:

k_i = gray value of the ith pixel

m = mean gray value of the pixel set

L = the number of distinct gray levels

$p(k_i)$ = normalized histogram (probability density function of the pixel set).

Note that the mean is given by:

$$m = \sum_{i=1}^{L} k_i \, p(k_i) \tag{2}$$

Thus: $\mu_0 = 1$; $\mu_1 = 0$; $\mu_2 = s^2$ = variance

Variance is a square of standard deviation.

where σ refers to the value of the deviation standard. N is the number of the total pixel; X_i the pixel value in the position of i and μ are the mean value of pixel.

1.   **Methods**

The research to detect the meat quality was performed on the android programming; thus making it to be in mobile basis. A number of supporting programs used in the research included IDE Eclipse, Java SDK, and OpenCV.

The hardware and software required in the process of making the application have the following specifications:

The application software:

- The operational system of Microsoft Windows 8 Professional 32-bit.
- Eclipse Juno, used to type the programming code for the application built.
- OpenCV 2.4.9 is one of libraries used for the image processing
- Operational System of Android OS, version 5.0.0 (Lollipop) used as the phase of implementation on the smartphone.

The hardware with the specifications:

- Laptop ASUS A450L with the Processor of Intel® Core™ i7-4500U CPU @1.8 GHz (4 CPUs),~2.4 GHz, RAM 12 GB, and Intel(R) HD Graphics Family. This device is used in the process of making the application.
- Smartphone Lenovo P70 was used at the phase of implementation and the testing of application.

This research used 20 digital images data of beef taken using Smartphone Lenovo P70 and stored in the form of JPG format. The meat image further was processed using k-mean clustering method by changing the value k, followed by extracting the mean value and the deviation standards. The value would be used as the gold standard for the image testing.

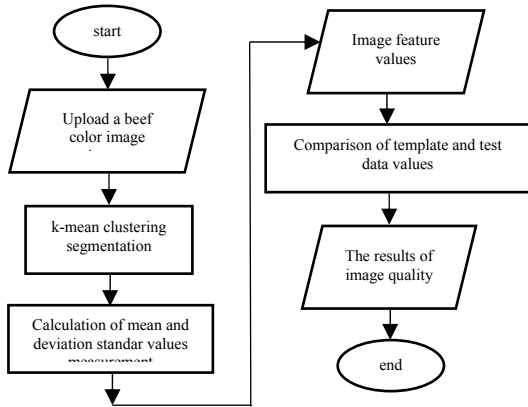The flowchart of the research steps showing in Figure 2 below.

Figure 2. The flowchart of the research steps

In the beginning of running the application, the user would be faced by the main menu button to start the image processing. Then, the image will be processed using the technique of k-mean clustering and the mean and the deviation standard are calculated. The data of the value was compared to the range value that has been defined; thus the system would decide whether the meat image has the good or poor quality.

The main menu page has 3 buttons: Start to Detect, Help and About. The button Start to Detect contains the menu of meat image processing. The result of the research further presents the page of detection menu consisting of 5 buttons: Camera, Galleries, K-mean, Analysis and Save with the interface display using layout scrollview.

2. Results
2.1 Taking the Meat Image

Taking the meat image was performed by pressing the button of Camera and Gallery. The button Camera was used to take the image of the meat directly using the camera feature from the smartphone. The button Gallery is used to take the meat image in the gallery of smartphone as shown in Figure 3.
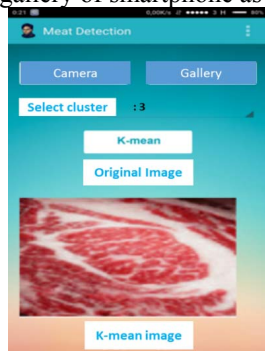

Figure 3. The Button Gallery

The meat image that has been downloaded was then processed using the technique of k-mean clustering. This process was done by changing the value of k= 2 making k = 6. The result of the changing of value k is presented in Figure 4.

Figure 4. The result of k-mean

Furthermore, the calculation of the extraction of the feature of mean values and deviation standard from the image of k-mean was done by pressing the button Analysis. The mean value and the deviation standard would be displayed together with the explanation of the good and poor quality of the meat. The result of the calculation of the feature extraction is shown in Figure 5.
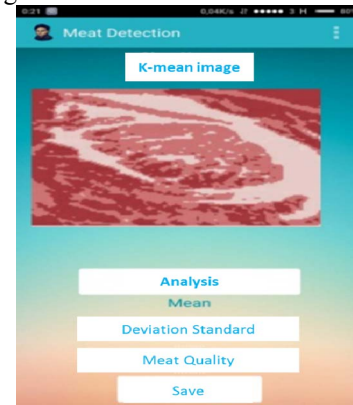

Figure 5. The feature extraction of meat image

The testing process to seek the value k that resembles to the original image was given to 10 meat images named grade4a.jpg, grade5a.jpg, grade6a.jpg, grade7a.jpg, grade9a.jpg, grade4b.jpg, grade5b.jpg, grade6b.jpg, grade7b.jpg, and grade9b.jpg. The image of grade6a.jpg and grade6b.jpg were in the size of 600x535 pixels; while others were in the size of 600x353 pixels. Each of images would be converted into the image of k-mean with the cluster 2 to 6. The sample of testing image of grade4a.jpg is shown in Figure 6.

Figure 6. The sample of testing image

Figure 8 shows the image as the result of the segmentation of k-mean for the image of grade4a.jpg with the number of k = 2, 3, 4, 5, and 6. Figure 7 shows the sample of segmented image grade4a.jpg, (a).Original Image, (b). cluster =2, (c). cluster = 3, (d). cluster = 4
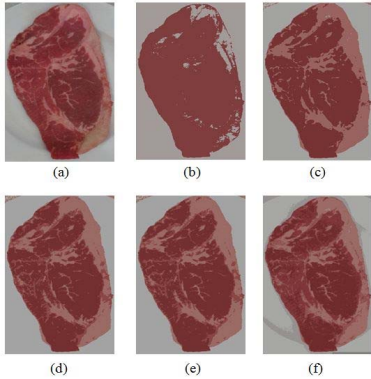

Figure 7. The sample of segmented image

From Figure 8, it can be seen that from the image of grade4a.jpg with k = 2, it obtained an image with two colors as the mean result of all values of RGB. Meanwhile, for k = 3, 4, 5, and 6, it was found the result of the segmentation result appropriate with the number of its group; thus from the number of this group it can be found that the number of the color group from the image that has been segmented. Table 1 presents the result of the image segmentation that has been tested and it shows that value of k that is significant in the process of image segmentation from each sample.

Table 1. The result of image segmentation

No	Name (.jpg)	Value of K tested					Sig.k
		2	3	4	5	6	
1.	Grade4a	-	-	v	-	-	4
2.	Grade5a	-	-	-	-	v	6
3.	Grade6a	-	-	-	v	-	5
4.	Grade7a	-	-	-	v	-	5
5.	Grade9a	-	-	-	v	-	5
6.	Grade4b	-	-	-	-	v	6
7.	Grade5b	-	-	-	v	-	5
8.	Grade6b	-	-	-	-	v	6
9.	Grade7b	-	-	-	v	-	5
10.	Grade9b	-	-	-	v	-	5

From Table 1, the remark (-) indicates that images tested were not alike and the mark men (v) shows that the tested images were alike; thus, it can be found that of 10 image data used in the testing, the value k was the most similar one compared to the original image that is when k = 5. This is because the categorization among pixels of meat image in k = 5 was evener making the color of the segmented image resembled to the color of the original meat image.

4.2 Testing on Fat Cluster

The testing on the fat cluster used the testing data that was similar with the test on the previous testing on the meat cluster. The test was conducted by looking at the fat cluster on the meat and compared to the original image to determine the significant value k. This is shown in Figure 8.

Figure 8. The image of the test on the grade 7b

Figure 9 presents the result of the segmentation of Image grade7b for the different value k.
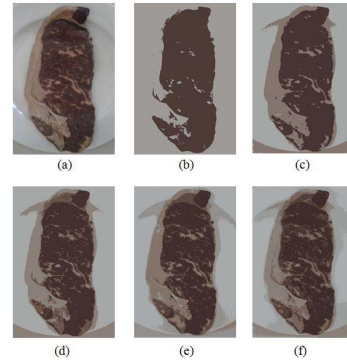

Figure 9. The segmented image grade7b.jpg, (a). Original Image, (b). 2 clusters, (c). 3 clusters, (d). 4 clusters, (e). 5 clusters, (f). 6 clusters

The result of the image segmentation that has been tested is shown in Table 2 with the significant value k.

Table 2. The result test on the meat cluster

No	Name (.jpg)	Value of K tested					Sig. k
		2	3	4	5	6	
1.	Grade4a	-	-	v	-	-	4
2.	Grade5a	-	-	v	-	-	4
3.	Grade6a	-	-	-	v	-	5
4.	Grade7a	-	-	-	v	-	5
5.	Grade9a	-	-	-	v	-	5
6.	Grade4b	-	-	-	-	v	6
7.	Grade5b	-	-	-	v	-	5
8.	Grade6b	-	-	v	-	-	4
9.	Grade7b	-	-	-	-	v	6
10.	Grade9b	-	-	-	v	-	5

Similar with Table 1, the remark (-) shows dissimilarity of the test image of test and remark (v) shows the similarity of the test image.

1. Determination of the Parameter of Meat Image

The research conducted to determine the quality of the meat image required an analysis on the measurement based upon certain parameters. The parameters used in determining the meat quality in this research were based upon the Marbling Score and through the experiment to determine the range value of meat quality from the application. Marbling is a group of grains of fat located in the fiber tissue of meat.

The determination of the parameters in this research was the phase to determine the assessment of the beef quality. The determination of the beef quality could be done subjectively and objectively. The subjective assessment covered the assessment towards color, odor, tenderness and

taste. Meanwhile, the objective assessment could be done using the laboratory devices or with the standard of the comparison of the objective assessment towards pH, and the chemical composition of meat.[14] At this phase, the assessment on the quality was conducted subjectively from the color that was done based upon the sources from National Standardization Agency (BSN) about the quality of carcass and beef (SNI 3932:2008).[15] The determination of the parameter was measured from the color of meat, fat color and marbling. There are thress levels of the meat quality that can be shown in Table 3.

Table 3. The levels of meat quality

No	type of test	quality requirements		
		I	**II**	**III**
1	Meat color	bright red has score 1-5	dark red with the score of 6-7	Dark red with score 8-9
2	Fat color	White had score 1-3	Yellowish white with score 4-6	Yellow Score 7-9
3	Marbling	Score 9 – 12	Score 5 – 8	Score 1–4

The assessment on the meat color was conducted by seeing the color on the lateral eye muscle surface with the help of flashlight and by matching it with the color standard. The score value of the color was determined based upon the score of the most suitable score of the color standard for the meat color. The standard of meat color consisted of 9 scores started from pink to dark red as shown in Figure 10.
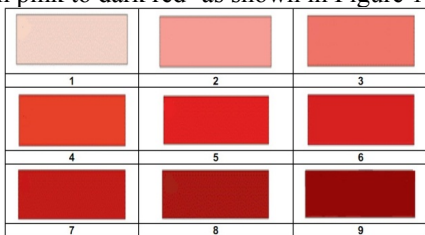
Figure 10. Standard of meat color

The assessment of the fat color was conducted by seeing the sub-cutis fat color (the deepest layer of skin) with the help of the flashlight and by matching it the color standard. The score value of the color was determined based on the score of the color standard that is the most suitable with the fat color. The standard of the fat color consisted of 9 scores started from the white to yellow as shown in Figure 11.

Figure 11. Standard of the fat color

Marbling assessment was conducted by seeing the intensity of the marbling on the lateral eye muscle surface with the help of light and by matching it with the marbling standard. The value of the marbling score was determined based upon the score of the marbling standard that was mostly suitable with the marbling intensity of the lateral eye muscle. The marbling standard consisted of 12 scores started from the practically no marbling to the more marbling as shown in Figure 12.
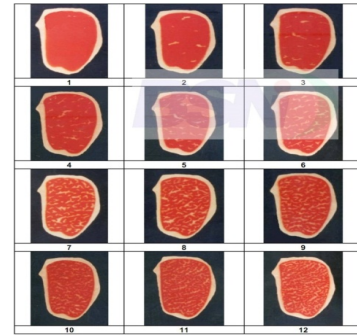
Figure 12. The marbling standard

4.3 The Determination of the Parameter of Meat Quality Based Upon Marbling

The determination of this phase is a phase to apply two parameters of meat quality that have been obtained from the determination of the parameters from the marbling scores. Such determination was performed to 20 data of image sample randomly. The sample of meat image was observed with the naked eye based on the marbling and the freshness of color. The result is shown in Table 4.

Table 4. The result of the naked-eye observation towards 2 samples of the meat sample
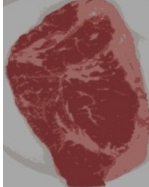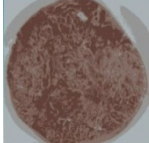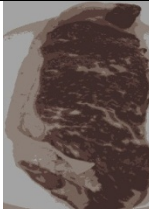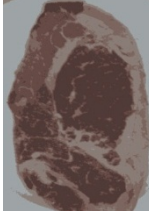
Image	Meat Score	Fat Score	Quality
	3	2	I
	6	4	II
	9	4	III

From 20 meat images, it was found 3 images with good quality of meat; those are data 1,2, and 5. Meanwhile, other 17 data had the poor quality of meat.

4.4 Statistic Result of Image

The next process was to convert 20 testing data of meat image to the image of the segmentation of k-mean clustering and converted to the most significant cluster that is 5. From the cluster image, it would obtain the mean values and the deviation standard. Afterwards, the result of the processed image quality would be compared to the original image that has been found for its quality whether it was proper or improper. Table 5 presents the data of the result of the image processing.

Table 5. The segmentation result of k-mean mean using the Meat Detection application

Original Image	Image with k=5	Image Analysis	
		Mean	deviation standard
		97.29	47.87
		104.76	42.19
		86.98	45.18
		99.25	42.39

Based on the table of the detection result 5 above, it can be concluded that the method of the image processing with the segmentation of k-mean clustering using the similar meat data and cluster 5 resulted in the different numbers of statistic value of mean and deviation standard. From the result obtained, it also influenced the reading accuracy to determine the meat with good or poor quality. To determine the reading accuracy, it needs a formula as shown in the equation (4).

Accuracy = 100% - (deviating data)/number of data

To obtain the range value, then the data sample of the meat image is divided in accordance with the level of quality obtained. In each quality, the maximum and minimum value from the statistic measurement was taken. From the result, the statistic range value of each meat quality was obtained as shown in Table 6.

Table 6 Range of Mean and Deviation Standard in each of meat quality

Meat Quality	Range	
	Mean	Deviation Standard
I	96.5 – 99.5	47 – 48
II	99.5 – 105	39 – 42.5
III	mean < 96 and 105 > mean	St dev < 38, 47 > St dev < 42.5 and St dev > 48

From the research result, it is found four statistic values of devastating poor meat quality and categorized in the good range of meat quality (Data 11, 12, 19, and 20). The method to determine the accuracy can be done using the equation below.

$$accuracy = 100\% - \frac{4}{20} * 100\% = 100\% - 20\% = 80\%$$

From the table of system accuracy, it is found the level of accuracy for the identification of the meat quality based upon the measurement of the feature extraction using k-mean clustering method that is reaching 80%. There is a need for further research to be able to find the fix reference to determine the good and poor meat quality.

5. Conclusion

Based on the result of the research and discussion, a number of points can be concluded follows.
1. The application made in this final assignment could process the meat image coming from the previous research that has ever been downloaded trough the gallery of smartphone, and the image processed through the segmentation phase used the k-mean clustering method.
2. In the data used in the research, the value k that was mostly resembling the original image was when k = 5.
3. Based on the research result on the sample of testing data used for the determination of the parameter of image, range value of mean on the meat image with good quality in the range of 96.5 to 99.5 and the value of the deviation standard between 47 and 48. The range value of the mean in the image of the meat with medium quality was in the range of 99.5 to 105 and the deviation standard in the range of 39 to 42.5. Meanwhile, the range value of mean in the image of meat with poor quality was under 96.5 and above 105 and the value of the deviation standard under 38 between 42.5 and 47 and above 4.
4. The result of the detection on the meat quality from this application showed the percentage of the good level of achievement. Overall, the level of achievement of the application of the digital image processing using the k-mean clustering method was at 80%.

Future Work

The application of the digital image processing of meat detection with the opency and eclipse–based k-mean clustering segmentation method still has a number of things to be

developed for example the parameter of extraction that needs to be added with Skewness, Kurtosis, Entropy or the extraction of the statistic feature of the 2nd Order.

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