

Omega-3 Chicken Egg Detection System using a Mobile-based Image Processing Segmentation Method

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ABSTRACT

An Omega-3 chicken egg is a chicken egg produced through food engineering technology. It is produced by hen fed with high omega-3 fatty acids. So, it has fifteen times nutrient content of omega-3 higher than Leghorn's. Visually, its shell has the same shape and colour as Leghorn's. Each egg can be distinguished by breaking the egg's shell and testing the egg yolk's nutrient content in a laboratory. But, those methods were proven not effective and efficient. Observing this problem, the purpose of this research is to make an application to detect the type of omega-3 chicken egg by using a mobile-based computer vision. This application was built in OpenCV computer vision library to support Android Operating System. This experiment required some chicken egg images taken using an egg candling box. We used 60 omega-3 chicken and Leghorn eggs as samples. Then, using an Android smartphone, image acquisition of the egg was obtained. After that, we applied several steps using image processing methods such as Grab Cut, convert RGB image to eight bit grayscale, median filter, P-Tile segmentation, and morphology technique in this research. The next steps were feature extraction which was used to extract feature values via mean, variance, skewness, and kurtosis from each image. Finally, using digital image measurement, some chicken egg images were classified. The result showed that omega-3 chicken egg and Leghorn egg had different values. This system is able to provide accurate reading around of 91%.

Key words : chicken egg, P-Tile, computer vision, morphology, feature extraction, mobile

1. INTRODUCTION

Omega-3 chicken food is mixed with flax seeds which have high omega-3 fatty acids [1]. Therefore, the content of omega-3 in this egg is fifteen times higher than Leghorn's [2]. The resemblance of the physical appearance of omega-3 chicken egg with leghorn has made consumers difficult to differ both types. To differ omega-3 and Leghorn chicken's egg, its shell must be broken. Omega-3 chicken egg's yolk has a rather reddish orange color. On the other hand, Leghorn chicken egg's yolk's color is yellow. In addition, laboratory test can be conducted to find out the amount of omega-3 content in a chicken egg. Both manners have weaknesses, when the shell is broken, a chicken egg should be consumed immediately while the laboratory test requires a long process. In addition, not all laboratories had the equipment to test it.

Based on this background, the aim of this research is to produce an Android smartphone application which can be used to identify omega-3 chicken egg and leghorn using image processing method. Therefore, this application can differ both types of eggs. Some researches on the application of image processing for chicken egg detection have been conducted earlier [3,4,5]. One of them had the purpose to see the influence of giving high omega-3 fatty acids to the composition of the physical, chemical quality, and organoleptic of chicken egg. The chicken food was mixed with sardines oil. The result obtained was that the physical characteristics of the chicken egg were not affected by the given food. Omega-3 chicken egg had an egg yolk's score higher. The amount of omega-3 fatty acids and β carotene in an omega-3 chicken egg increased rather significantly [6,7]. Meanwhile, the other research created a mobile application for identifying the fertility of duck egg using image segmentation. A duck egg was put in a box with a lighting source. The steps used in this research were image processing methods. First, Image acquisition was done using a smartphone camera. After that, the image of the egg was converted to a grayscale because it must be saved into RGB image. So, it had to be converted to simplify the computation process. Next, the segmentation was done by determining the threshold value using Bernsen technique. The result of this research was the application had the ability to identify the fertility of a

duck egg quite accurately [8,9]. The next research was the detection of the chicken's embryo using K-means Automatic Thresholding. In this research, the detection of chicken embryo was done to see the fertility of the egg. The first step was converting original image to grayscale image. The next step was to determine a threshold value from the image. This research resulted in the conclusion that the K-means method was capable to perform segmentation of embryonic chicken form. So, it can determine whether the egg is fertile or infertile [10].

2. SEGMENTATION METHOD AND CHICKEN EGG ANALYSIS

2.1 P-Tile Thresholding Algorithm

Thresholding is a widely used tool in image segmentation where one is interested in identifying the different homogeneous components of the image [10]. Because of its simplicity, it is widely used especially in hardware where computational time is a major consideration. P-tile method is one of the earliest thresholding methods based on analysis of the image's gray level histogram. It assumes the objects in an image are darker (example have higher gray level) than the background, and occupy a fixed percentage of the picture area which is P%. The threshold is defined as the gray level that mostly corresponds to mapping at least P% of the gray level into the object. This method is simple and suitable for all sizes of objects. It can yield good antinoise capabilities, but obviously, it is not applicable if the object area is unknown or varied from picture to picture. Besides the statistic properties reflected in the histogram, the P-tile method also utilizes the object's percentage of the picture area, which assures its relatively satisfactory segmentation results. The threshold is defined as the gray level that mostly corresponds to mapping at least P% of the gray level into the object. Let n be the maximum gray level value, $H(i)$ be the histogram of image ($i = 0, n$), and P be the object area ratio [11,12].

2.2 Morphology Image Processing

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphological operations can also be applied to grayscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest [13]. In this research, we define the fundamental mathematical morphology operations dilation and erosion:

$$\text{Dilation} - D(A, B) = A \oplus B = \bigcup_{\beta \in B} (A + \beta) \quad (1)$$

$$\text{Erosion} - E(A, B) = A \ominus \tilde{B} = \bigcap_{\beta \in B} (A - \beta) \quad (2)$$

Where $\tilde{B} = \{-\beta/\beta \in B\}$. A binary image containing two object sets A and B . While either set A or B can be thought of as an "image", A is usually considered as the image and B is called a structuring element. The structuring element is to mathematical morphology what the convolution kernel is to linear filter theory. Dilation, in general, causes objects to dilate or grow in size; erosion causes objects to shrink. The amount and the way that they grow or shrink depend upon the choice of the structuring element. Dilating or eroding without specifying the structural element makes no more sense than trying to lowpass filter an image without specifying the filter [13].

2.3 Feature Extraction

Feature extraction is a process of taking the features of an object in the image to learn about the object. It is an initial step in performing classification and interpretation of an image. This process is related to the quantization of characteristics of image into a group of appropriate feature values. One of the methods used in the feature extraction is the statistical feature extraction of the first order and the feature extraction of the second order [1]. The feature extraction of the first order is a method of taking the feature based upon the characteristics of image histogram. The histogram shows the probability of the emergence of the value of gray scale in an image. From the obtained values of histogram, a number of parameters of the statistical feature of the first order can be calculated such as mean, variance, skewness, and kurtosis [1,5]. Further, we define mean (μ) value of gray image using the formula (3).

$$\text{mean}(\mu) = \sum_n f_n p(f_n) \quad (3)$$

where f_n refers to a value of gray intensity, and $p(f_n)$ describes its histogram value (probability of the emergence of intensity in an image). A variance (σ^2) is a value distribution of gray image intensity displayed a variety of elements in histogram from an image that can be found in the equation (4).

$$\sigma^2 = \sum_n (f_n - \mu)^2 p(f_n) \quad (4)$$

Skewness (α_3) illustrates the level of relative skewness of histogram curve from an image is defined as followed (5).

$$\alpha_3 = \frac{1}{\sigma^3} \sum_n (f_n - \mu)^3 p(f_n) \quad (5)$$

Kurtosis (α_4) shows the level of relative kurtosis of histogram curve from an image presents in formula (6).

$$\alpha_4 = \frac{1}{\sigma^4} \sum_n (f_n - \mu)^4 p(f_n) - 3 \quad (6)$$

This research was held to detect the type of chicken egg images. Chicken egg images will be taken using camera Android smart phone. Then, it will be processed with image processing method. Chicken eggs were laid in a candling box and would be taken using Android smart phone camera to be saved. Saved image would be processed using an image processing method. The distance between the chicken egg and the camera was 13 cm. Therefore, the egg candling box could be used for smartphone in any size. If the chicken eggs had been too close to the camera, it would have been difficult to find its focus. Algorithm design system describes how the system run to identify the chicken egg image. Fig. 1 depicts the flowchart of egg identification system.

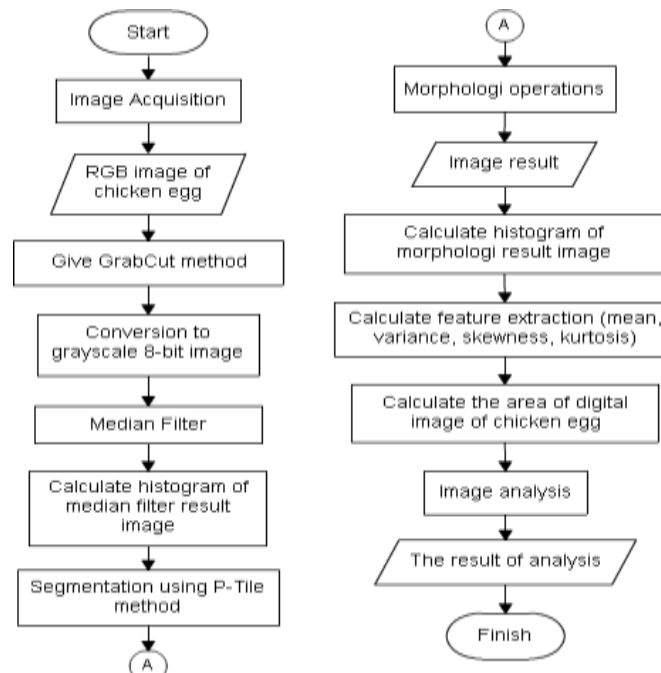


Figure. 1. Flowchart of egg identification system

The egg identification system steps in Fig.1 are as follows; image acquisition which can be done using an Android smartphone's camera or from pictures on the Gallery. After the acquisition is successful, it will be converted to RGB image. The image will be given the GrabCut algorithm to separate the object and background. RGB image is converted into grayscale 8-bit image. The grayscale image will be given a median filter with Kernel size 5x5. Calculating histogram value of median filter image result, this histogram will be useful for the segmentation process. In the segmentation process, P-Tile method is used. It will look for two threshold values, the lower and upper limit. The threshold values are obtained by inserting the percentage value. The percentage value can be found by using ImageJ. The two threshold values will separate egg yolk object and background. Egg yolk has pixel value 255 (white) and zero background (black). Image result of segmentation process will be given morphology operations. Calculating the histogram value of this

image that will be used for calculating the feature extraction values. Feature extraction values and the area of chicken egg used as a reference in determining the image is an omega-3 or leghorn chicken egg.

3. IMAGE ANALYSIS BASED ON MOBILE

3.1 Interface of The Application

Fig. 2 shows the interface of the application that contains information of the type of chicken egg.

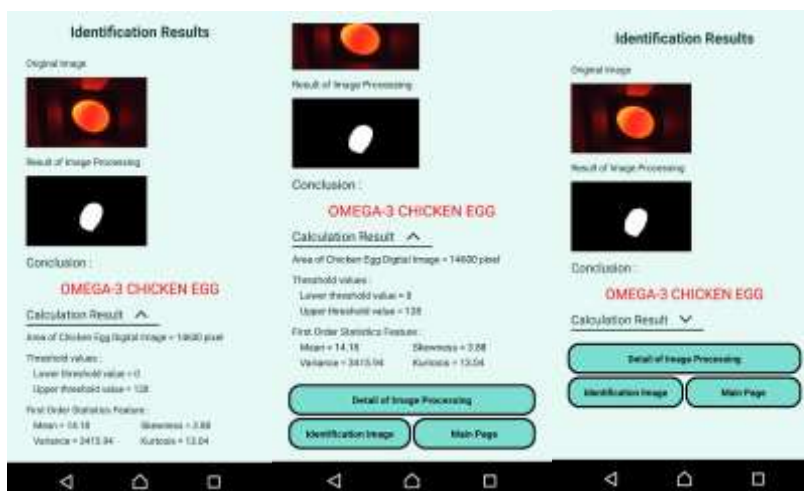


Figure 2. Interface of the application

The major process is segmentation method using P-Tile method. In this research, the process of segmentation used two threshold values. The lower threshold value was obtained by inserting a percentage value of 89%. While, the upper threshold value was obtained by percentage value of 94,5%. To obtain the threshold value, it required histogram of the chicken egg's digital image. This digital image had been processed previously using GrabCut, converted to grayscale image, and median filter. The next step was calculating the histogram value of the chicken egg's digital image that had been processed earlier. This digital image would be resized by width x height of 490 x 276 pixel. Therefore, the total number of pixel in this image was 135240. To find the lower threshold value, it required the knowledge of the number of pixels with percentage value of 89%. The number of pixel for percentage value of 89% was 120363,6. Meanwhile, to find the upper threshold value, it required knowledge of the number of pixel with percentage value of 94,5%. The number of pixel for percentage value 89% is 120363,6. The same as lower threshold calculation, the total area of an upper threshold is 127801,79.

3.2 The Result of Erosion and Dilation

The result of segmentation still produce image that is not yet perfect. There is some background pixel still visible. To solve this problem, morphology operations is used. Morphology operation used first is an erosion followed by dilation. Erosion operation used to eliminate background pixels that still appear. Then was followed by dilation operation aims to add pixels on the object that lost after segmentation. In this research, erosion and dilation operations using the structuring element (SE) with size 3x3. Erosion operation was performed three times. Dilation operation was performed four times. Fig. 3(a) depicts the segmentation result in chicken egg before morphology process whilst (b) after erosion and dilation operations of segmented image.

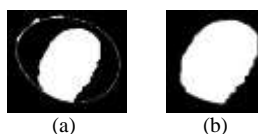


Fig. 3(a) First Image; (b) after erosion and dilation operations

3.3 Calculating Area of Chicken Egg Digital Image

Chicken eggs used in this research were omega-3 and Leghorn chicken egg. In physical appearance, both of the eggs are similar. One way to differ omega-3 and Leghorn egg is to crack the shell of the eggs. When broken down, it can be seen that the egg's yolk of omega-3 chicken egg has more orange color than Leghorn egg. From the diameter of the egg yolk, both eggs are not too much different in size. Therefore, the diameter of egg's yolk is not referable to differ both eggs. Another way to differentiate omega-3 and Leghorn chicken egg is laboratory tests which is aimed to see the content of nutrients in each omega-3 and Leghorn chicken egg. Because of limitations of the research, nutrient content was cited through the study of the literature. Table I displays the range value of omega-3 and leghorn chicken egg using eq.3-6.

TABLE I. THE RANGE VALUE OF OMEGA-3 AND LEGHORN CHICKEN EGG

Area of Digital Image	Range Value	
	Omega-3 Chicken Egg	Leghorn Chicken Egg
10228 – 10891 pixel	<i>Mean</i> > 4,8; <i>Variance</i> > 1202,03 <i>Skewness</i> < 7,08; <i>Kurtosis</i> < 48,1	<i>Mean</i> ≤ 4,8; <i>Variance</i> ≤ 1202,03 <i>Skewness</i> ≥ 7,08; <i>Kurtosis</i> ≥ 48,1
10892 – 11555 pixel	<i>Mean</i> > 6,42; <i>Variance</i> > 1595,03 <i>Skewness</i> < 6,06; <i>Kurtosis</i> < 34,77	<i>Mean</i> ≤ 6,42; <i>Variance</i> ≤ 1595,03 <i>Skewness</i> ≥ 6,06; <i>Kurtosis</i> ≥ 34,77
11556 – 12219 pixel	<i>Mean</i> > 7,46; <i>Variance</i> > 1847,81 <i>Skewness</i> < 5,59; <i>Kurtosis</i> < 29,19	<i>Mean</i> ≤ 7,46; <i>Variance</i> ≤ 1847,81 <i>Skewness</i> ≥ 5,59; <i>Kurtosis</i> ≥ 29,19
12220 – 12883 pixel	<i>Mean</i> > 9,48; <i>Variance</i> > 2326,75 <i>Skewness</i> < 4,89; <i>Kurtosis</i> < 21,95	<i>Mean</i> ≤ 9,48; <i>Variance</i> ≤ 2326,75 <i>Skewness</i> ≥ 4,89; <i>Kurtosis</i> ≥ 21,95
12884 – 13547 pixel	<i>Mean</i> ≥ 11,1; <i>Variance</i> ≥ 2708,2 <i>Skewness</i> ≤ 4,47; <i>Kurtosis</i> ≤ 18,01	<i>Mean</i> < 11,1; <i>Variance</i> < 2708,2 <i>Skewness</i> > 4,47; <i>Kurtosis</i> > 18,01
13548 – 14211 pixel	<i>Mean</i> > 12,46; <i>Variance</i> > 3021,1 <i>Skewness</i> < 4,19; <i>Kurtosis</i> < 15,52	<i>Mean</i> ≤ 12,46; <i>Variance</i> ≤ 3021,1 <i>Skewness</i> ≥ 4,19; <i>Kurtosis</i> ≥ 15,52
14212 – 14875 pixel	<i>Mean</i> > 14,1; <i>Variance</i> > 3396,27 <i>Skewness</i> < 3,89; <i>Kurtosis</i> < 13,15	<i>Mean</i> ≤ 14,1; <i>Variance</i> ≤ 3396,27 <i>Skewness</i> ≥ 3,89; <i>Kurtosis</i> ≥ 13,15

The process of differentiating omega-3 and Leghorn chicken egg was done through digital image of each chicken egg. Chicken egg's digital image was given some image processing, which were GrabCut, conversion to grayscale image, median filter, P-Tile segmentation, and morphology operations. The image result of those processes calculated the feature extraction values. The area of chicken egg and feature extraction classified the value. The classification of these values was used as a reference to identify omega-3 and Leghorn chicken egg. In this research, 60 eggs were used as initial data to know the feature extraction value and the area of omega-3 and Leghorn chicken egg digital image. From these data, it can be summed up that range value was used to classify the omega-3 and Leghorn chicken egg. The range value was determined by observing the area of digital image and feature extraction values. In any range of the area, minimum and maximum values were taken from the feature extraction values of the data samples. After that, deciding the value could generate the correct classification. The accuracy of this application can be calculated; Accuracy = (the correct data/the amount of data) x 100% = (55/60) x 100 % = 91,6 %.

4. CONCLUSION

The conclusion that can be drawn from the result of this research are as follows:

An application of Egg Detection was able to identify the image of omega-3 and Leghorn chicken egg through image processing using an Android smart phone. Image processing methods used in this research were GrabCut, converting RGB image to grayscale 8-bit, median filter, P-Tile segmentation, erosion and dilation operation, measuring digital image and feature extraction parameters. In this application, there were two percentages which were used to find the threshold value using P-Tile segmentation method. Percentage lower limit value was 89% and upper limit value was 94,5%. Chicken egg's images were classified by measuring the egg's yolk's digital images and the feature of extraction parameters such as mean, variance, skewness, and kurtosis. The accuracy of the classification of omega-3 and leghorn chicken egg for 60 data samples is 91,67%. Future work will be focused on the development of a variety of operating systems, such as iOS, Windows Phone, and Blackberry.

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