Support Vector Machine for Classifying the Quality of the Egg based on the Color

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Abstract: Egg quality is an indicator to determine the freshness of an egg. One of a method to determine the egg quality is through an analysis of eggshell condition. Color intensity of the eggshell comprises of three classes, i.e. dark-brown, brown, and light-brown colors. This classification is based on the pigment concentration and the structure of eggshell. Dark brown egg stronger and thicker than the light brown one. The quality of an egg decreases faster for bright eggshell's color. This research classified the quality of broiler eggs based on the eggshell color using the support vector machine. This research used color red-green-blue (RGB) image of ninety eggs sample. Feature extraction was used to calculate the RGB of each egg. Normalization was used to get normalize RGB parameters (rgb) before classification through the use of support vector machine. Classification result showed the accuracy of 80 percent.

1 INTRODUCTION

Boiler egg is a favorite food that popular as the source of animal protein. Most of the people need this kind of food to fulfill the need for animal protein. An egg is cheap and easy to produce, yet it supplies the need for protein. A fresh egg is an egg without freezing treatment, preservation, as well as no embryo development, mixed yolk with albumen, intact, and clean (Badan Standarisasi Nasional, 2008). An egg consisted of three main component: eggshell, transparent fluid (albumen), and yellow fluid (yolk).

The egg can be contaminated with the microbiology easily, physical broken, vapor and other molecule intrusions; therefore, decreasing the quality of an egg (Jazil, 2013). If this situation continues, the egg's weight will be decreased and the egg white tends to more watery. The intrusions are also affected by temperature, relative humidity, and eggshell quality. Therefore, the eggshell quality should be examined to ensure the freshness of an egg. Before checking the quality of an egg, grading process is needed to avoid any doubts as well as its quality uncertainty and to get the homogenous egg.

The egg's quality is checked through analyzing the interior and exterior of an egg. External analysis checks the eggs condition, whereas the internal analysis checks the contents of the egg.

The Eggshell is the outer part of an egg which has some benefits, i.e. avoiding the physical and biological damage, gas circulation through porous at eggshell. The eggshell is the strongest part, smooth, lime coated, and bonds to the outer membrane. The eggshell quality depends on the form, smoothness, thickness, completeness, and cleanness (Badan Standarisasi Nasional, 2008) . Thin eggshell has thinner and more porous than the thick one, so decreases the quality faster. As an information, the thickness of eggshell is depended on the chicken strain, parent's age, stress, and disease. For an old hen, the eggshell will thinner because it can produce sufficient calcium for the eggshell (Sakroni et al,2015).

Eggshell texture and its thickness are decreased following the brightness of the eggshell color. There is a significant correlation between eggshell color and its thickness as well as the weight. But no clear correlation between its weight, albumen weight, egg yolk weight and color, Haugh unit, and the Calcium in the albumen and egg yolk. Therefore, some quality of an egg can be considered through seeing the eggshell color (Yang et al. 2009)

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Eggshell color was captured based on the color intensity and classified as dark brown, brown, and light brown. Storage time and different eggshell color affect its weight decreasing, Haugh unit value, and the deep of air cavity. The dark brown eggshell should be chosen since its quality decrease less than the light brown based on storage time (Jazil, 2013).

Some disciplines, e.g. optic, mechanical, electrical, acoustic, digital image processing, and machine vision, are used to classify and find the broken eggs. Image processing algorithms are used to detect egg cleanness and blood spot by analysing the maximum of its histogram as a criterion. This algorithm use HIS color space to detect the cleanness and the blood spot. The cleanness of eggshell is detected through area detection method. The accuracy of this research found the blood spot of 90.66% from broken eggs and 91.33% from original eggs with average accuracy of the algorithm was 91% (Dehrouyeh et al. 2010).

Digital image processing has been widely used in some applications, especially in computer vision. Many image processing methods have been implemented on robotic, object classification, biometric system, medical visualization, image repair and restoration, industrial inspection, and human-computer interface (Ibrahim et al. 2012).

Many research on egg quality based on the exterior of an egg. Crack detection of an egg can be done with Susan edge detection and fuzzy thresholding. These researches concluded that the proposed algorithm outperformed Otsu and Power Law algorithms. By adding the Gaussian to the input image with variable between 0.002 and 0.001, the accuracy were 97% and 82%. This algorithm has minimum error (numbers of error pixels) less than grey level image compared to the other algorithms (Mansoory 2012)

The algorithm in HIS color space used extract useful features of captured images of eggs by machine vision to detect eggs defects. The algorithm can also detect the severity of dirt on eggshell (Dehrouyeh, 2010)

Classification through the use of support vector machine (SVM) has been widely used in egg's parasite. Feature extraction using image processing methods. Using a multi-class support vector machine (MCSVM) the study gives the accuracy by 97.70% (Avci and Varol, 2009). In addition, SVM was also used to classify kinds and salted egg's quality. This method is reported when classifying the salted egg, it achieved 81.25 % accuracy (Monro, 2013)

This study implemented the image processing of boiler eggs and classifying them based on eggshell's color. The classification result can be used to help in choosing the high-quality eggs.

2 METHODS

Figure 1 shows the research framework. Broiler eggs were used with three classes, i.e. dark brown eggshell, brown eggshell, and light-brown eggshell. A number of images used for dark-brown, brown, and light-brown were 30 eggs for each class.

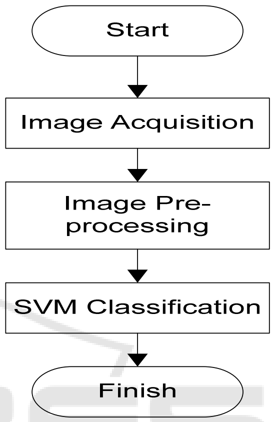

Figure 1: Research framework.

Image acquisition step of the egg used DSLR camera with 18 megapixel resolution. An egg was placed in a box mini-studio with three 18 watt LED light beams. Figure 2 shows the image acquisition process.

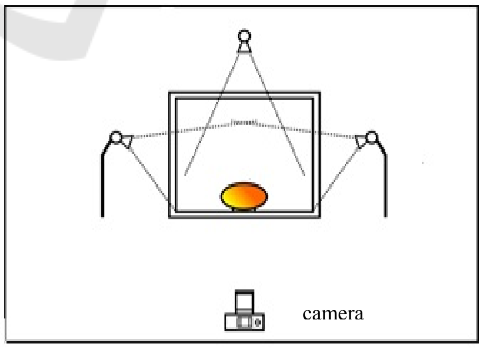

Figure 2: Image acquisition.

The study used 90 eggs; each eggshell's class of dark brown eggshell, brown eggshell, and light-brown eggs were 30 eggs. The images were saved as color images/Red-Green-Blue (RGB) images.

In pre-processing step, the image cropping and feature extraction were employed. Cropping was done to get small part of sample. The color feature was used in the study. Feature extraction was needed to gather some important information from an image. Color images have many RGB index value. Percent different of RGB index causes the different color representation, e.g. green, blue, etc. Higher color index of an image shows a more bright color and less color index shows the dark color. In this study the three index values were separated and used as a classification parameter. RGB index value of egg's image would be normalized to get zero to one range. The normalization of RGB index value was represented by r, g, and b variables as classification parameters.

Classification is a process to decide the class of an object. It uses the model with the ability to classify an object based on its attribute. One of the classification method is Support Vector Machine (SVM).

SVM can be simply explained by the searching of the best hyperplane (H) to separate two input classes of the input space. Figure 3 and 4 shows some patterns having two classes: +1 and -1. The class "+1" is shown in blue/circle, whereas the "-1" class is shown in red/rectangle. The classification problem is the problem to find hyperplane that separate two groups. Some hyperplanes can be found as discrimination boundaries.

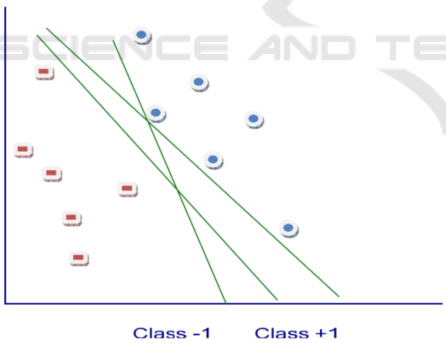

Figure 3: The lines are discrimination boundaries.

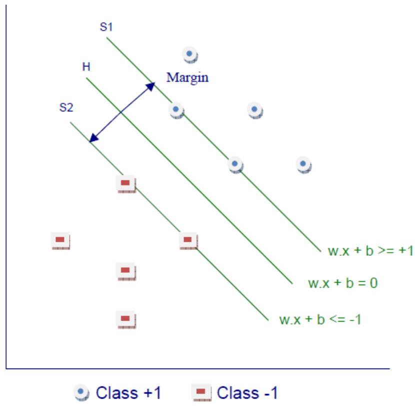

Figure 4 : Separator line between two classes.

After all the color of egg images have been extracted, the training and testing should be done. The SVM training was used to train the model in order to have an ability to match an image, whereas the testing step should be done to ensure that the model meets the minimum accuracy. SVM is a supervised classification method because it uses the target/label in training step. SVM is a nonlinear mapping to convert data training to a new higher dimension. This new dimension searches the hyperplane that separate data linearly. With this method every nonlinear map can be separate linearly in its corresponding higher dimension with the hyperplane. SVM finds the hyperplane through the use of support vector in the margin.

In this research, SVM was used to classify the eggs based on the color of eggshell. The multiclass SVM was used with tree method. This method compares the eggshell with the brown and light brown eggshell. The result was then compared with the dark-brown eggshell. Classification results were represented in a confusion matrixes that informs the actual and prediction of classification (Table 1).

Table 1: Confusion matrix.

		Predicted	
		Negative	Positive
Actual	Negative	TN	FN
	Positive	FP	TP

Where TN (True Negative) = correct prediction; FN (False Negative) = Incorrect prediction; FP (False Positive) = incorrect prediction; TP (True Positive) = correct prediction

The Confusion matrix is used to validate the model accuracy. Accuracy was calculated using equation (1).

$$\text{accuracy} = \frac{\text{the number of correct predictions}}{\text{the number of predictions}} \quad (1)$$

3 RESULT AND DISCUSSION

This research use three classes of eggshell color: dark-brown, brown, and light-brown (Figure 5,6, and 7).

Figure 5: Dark brown egg color.

Figure 6: Brown egg color.

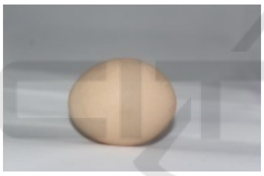

Figure 7: Light brown egg color.

To capture RGB feature, the images were cropped that only showed only the egg. Stages in feature extraction shown in Figure 8.

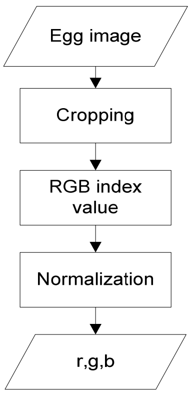

Figure 8: Feature extraction.

Figure 9 shows an example of image cropping.

Figure 9: Image cropping.

After cropping, RGB index value are calculated from egg images using Matlab as in Figure 9

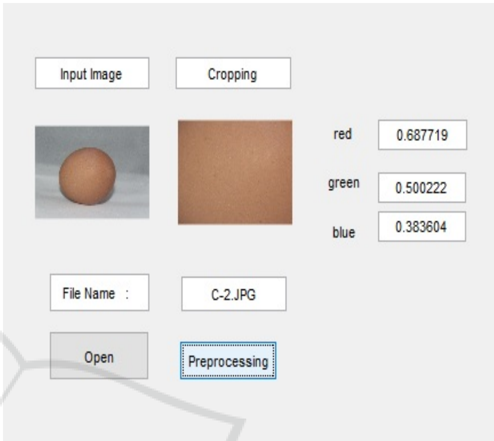

Figure 10: Preprocessing interface.

Table 2 shows the sample of RGB index value.

Table 2: RGB index value.

Image	Color index R	Color index G	Color index B
1	172.5	103.323	69.6447
2	170.058	100.607	70.1535
3	183.387	122.463	86.0195
4	176.04	123.086	96.9643
5	173.329	113.645	83.6685
6	181.252	136.334	104.862
7	182.933	131.47	95.2249
8	179.842	135.13	102.496
9	179.255	129.697	92.686
10	176.685	135.973	105.899
11	183.739	146.791	125.038
12	184.055	141.964	107.968
13	188.654	147.752	112.281
14	194.17	147.393	114.906
15	187.564	138.92	103.508

All RGB index value can be represented in a chart. Figure 11 shows the distribution of RGB index value for dark-brown eggshell, whereas Figure 12 and 13 show brown and light-brown eggshell respectively. Based on distribution of RGB index value chart, it shows clearly the different of dark-brown, brown, and light brown RGB. Light brown egg has minimum RGB range compared to brown and dark brown eggshell color. It means that this class has minimum different with the others.

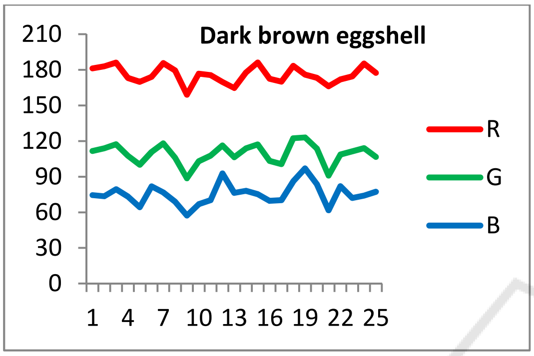

Figure 11: The distribution of the dark-brown eggshell RGB index.

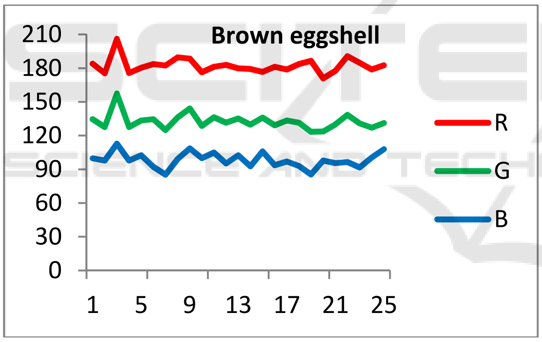

Figure 12: The distribution of brown eggshell RGB index.

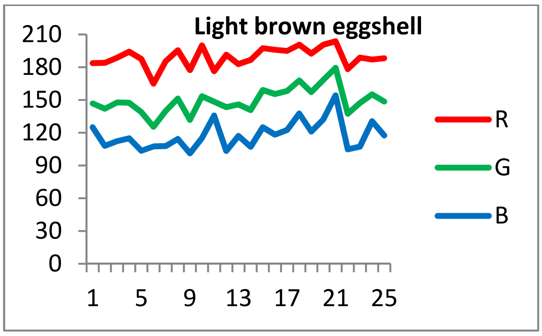

Figure 13: The distribution of light-brown eggshell RGB index.

RGB index value from previous process were normalized to get the value between 0 and 1 that were represented by r, g, and b variables. Normalization result from RGB index in Table 2 can be seen in Table 3.

Table 3: Feature extraction.

Image	r	g	b
1	0.676471	0.405187	0.273116
2	0.666895	0.394537	0.275112
3	0.719165	0.480247	0.337331
4	0.690351	0.482689	0.380252
5	0.679723	0.445668	0.328112
6	0.710793	0.534644	0.411222
7	0.717386	0.515569	0.373431
8	0.705261	0.52992	0.401945
9	0.702962	0.508616	0.363475
10	0.692882	0.533229	0.415291
11	0.720543	0.57565	0.490344
12	0.721783	0.556721	0.423406
13	0.739818	0.57942	0.440319
14	0.76145	0.578013	0.45061
15	0.735546	0.544785	0.405916

The characteristic of egg images used for classification with r, g, and b parameters are shown in Figure 14, 15, and 16.

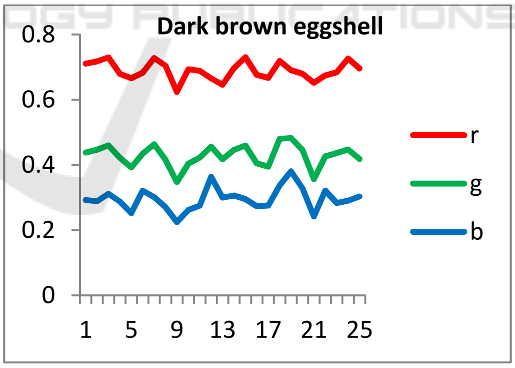

Figure 14: The distribution of dark-brown eggshell RGB index after normalization.

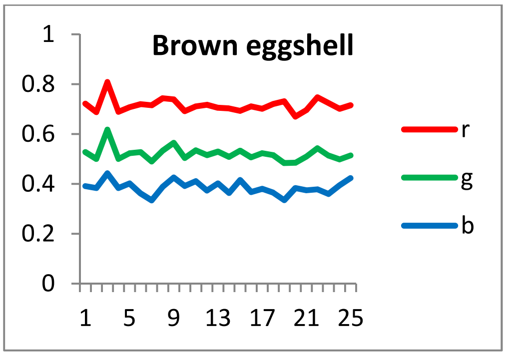

Figure 15: The distribution of brown eggshell RGB index after normalization.

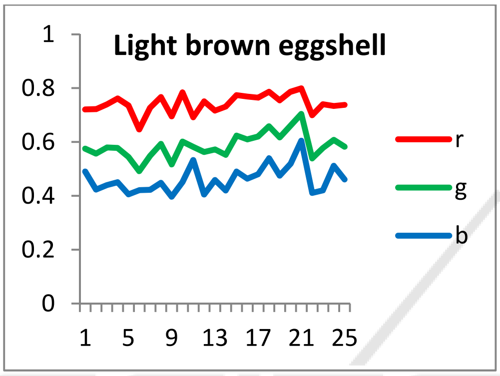

Figure 16: The distribution of light-brown eggshell RGB index after normalization.

Based on distribution chart of R, G, and B as well as the normalization result, the light-brown eggs had the smallest RGB index distribution compared to brown and dark-brown eggshells.

The next step was SVM classification that consisted of training and testing phase. Training phase used 25 eggs for each class. The total number of eggs for classification was 75 eggs. Five eggs were chosen as testing data for each class (15 eggs for all classes). The distribution of all train data and testing data can be shown in Figure 17 and 18.

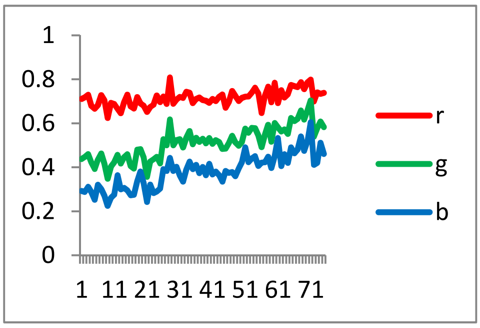

Figure 17 : The distribution of train data.

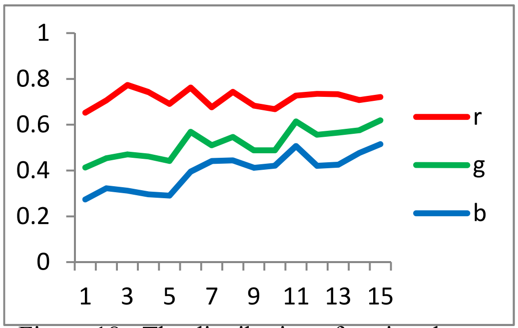

Figure 18 : The distribution of testing data.

In classification phase, multiclass SVM was used. By tree method, the brown and light brown are compared. The winner would be compared with dark brown egg that give the result whether an egg is classified in dark brown, brown or light brown class. To solve the classification problem, the separator line should be prepared: i) between brown and light brown, ii) between light brown and dark brown, and iii) between brown and dark brown; these equations are: svmStruct1,svmStruct2 and svmStruct3.

The procedures for training the SVM can be summarized as follow.

First, the SVM classifier was generated through the "svmtrain" function in Matlab. At the first stage, the separation (svmStruct1 variable) was between brown and light brown eggshell.

```
svmStruct1=svmtrain(train_data,target1,
'Showplot',true)
```

Second, the separation classifier, svmStruct1, then compared with the dark-brown eggshell class. The "svmStruct2" separation classifier with the same function to svmStruct1:

```
svmStruct2=svmtrain(train_data,target2,
'Showplot',true)
```

Third, classification was comparing the brown eggshell with the dark-brown eggshell (svmStruct3 variable):

```
svmStruct3=svmtrain(train_data,target3,
'Showplot',true)
```

The SVM equation that has been made is as follows:

```
svmStruct1 =
SupportVectors: [13x3 double]
Alpha: [13x1 double]
Bias: -1.2220
KernelFunction: @linear_kernel
KernelFunctionArgs: {}
GroupNames: [75x1 double]
```

```
SupportVectorIndices: [13x1 double]
ScaleData: [1x1 struct]
FigureHandles: []

vmStruct2 =
SupportVectors: [13x3 double]
Alpha: [13x1 double]
Bias: -1.2220
KernelFunction: @linear_kernel
KernelFunctionArgs: {}
GroupNames: [75x1 double]
SupportVectorIndices: [13x1 double]
ScaleData: [1x1 struct]
FigureHandles: []

svmStruct3 =
SupportVectors: [25x3 double]
Alpha: [25x1 double]
Bias: 1.0676
KernelFunction: @linear_kernel
KernelFunctionArgs: {}
GroupNames: [75x1 double]
SupportVectorIndices: [25x1 double]
 ScaleData: [1x1 struct]
FigureHandles: []
```

Table 3 shows the confusion matrix of the testing result.

Table 3: Confusion matrix.

		Prediction		
		First class	Second class	Third class
Actual	First class	5	0	0
	Second class	0	2	3
	Third class	0	0	5

From Table 3, it is observed that accuracy obtained is 80%. From the confusion matrix, the dark brown and light brown eggs can be identified correctly. For the brown eggs, as much as 60% are identified as light brown eggs. This can be caused by almost the same intensity of brown color. The difference between brown and light brown is not much different

4 CONCLUSIONS

In this paper, the egg images are captured to identify the class of chicken based on the color of their eggshell. The color feature extraction using the average value of RGB. SVM classifier is used to identify the classification with the accuracy is 80%. The lighter brown eggshell the faster deterioration quality. Consumers are encouraged to choose dark brown consumption eggs that have the lowest level of degradation quality during storage. Future research on the classification performance of several classifiers will be conducted to find the best classifiers.

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