

Classification of pork and beef meat images using extraction of color and texture feature by Grey Level Co-Occurrence Matrix method

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Abstract. In Indonesia, beef meat usually sells with expensive price. It because of long distribution from the cattle rancher to the end customer. This causing a high-cost on the production and distribution. This condition made some people trying to be tricky by mixing beef meat with another meat, such as pork. It occurs the financial loss for customers. Currently, the meat identification done manually using visual identification of human vision. This method has a lot of weaknesses to differ beef and pork meat due because it need expert to identify the difference. The improvement of science and technology in computer vision helps the customer to identify beef and pork meat automatically using its images. This research classification of beef meat and pork using back-propagation method for its classifier. The purpose of this study is identifying differences in beef and pork based on digital image. Color feature using first order statistic mean from its RGB color value and using Grey Level Co-Occurrence Matrix for texture analysis. Experiment result of classification of beef and pork meat using Back-propagation, RGB color histogram value, and Grey Level Co-Occurrence Matrix achieving 89,57% of accuracy result.

1. Introduction

Meat is a soft tissue of animal which covered by the skin and sticks on the bones. Meat is used as an ingredient for almost all daily meals. Meat is one of the favorite ingredients for everyone since it is consisting of many vitamins and minerals needed. [1] meat is also easy to cook and become variety delicious food. Almost every country in the world has a high demand for meat consumption, especially on beef, chicken, and pork.

In Indonesia, the price for red meat in the market is rather expensive. This is happened due to the length of meat supply chain from the farmer to the market [2]. This overly expensive makes some person do some tricky business which is mix beef with some other meat like pork or buffalo meat. Mixed beef will get financial loss from the customer side due to the meat they get. Indonesia also Moslem majority country which is forbidden to consumed pork meat, making pork meat rather cheaper price compared with beef meat. From the religious side, detecting pork and beef meat would be important if mixed meat possibly happens in their area, since Moslem religious is forbidden to consumed pork meat.



This research proposed an identification of beef and pork meat image from its color and texture. Identification using its image could be used as a promising alternative since this method is a non-destructive method, the meat detected will not destruct. The user will take the picture of the image, and the system can analyze the result immediately. The system will analyze its color, marbles or textures using Grey Level Co-Occurrence Matrix (GLCM). Some researchers, many use the GLCM method as a texture identification [3, 4, 5]. The color feature used in this research is an RGB color channel. Color and texture feature obtained will be classify using backpropagation neural network to determine label detected.

2. Research methodology

2.1. Data analysis

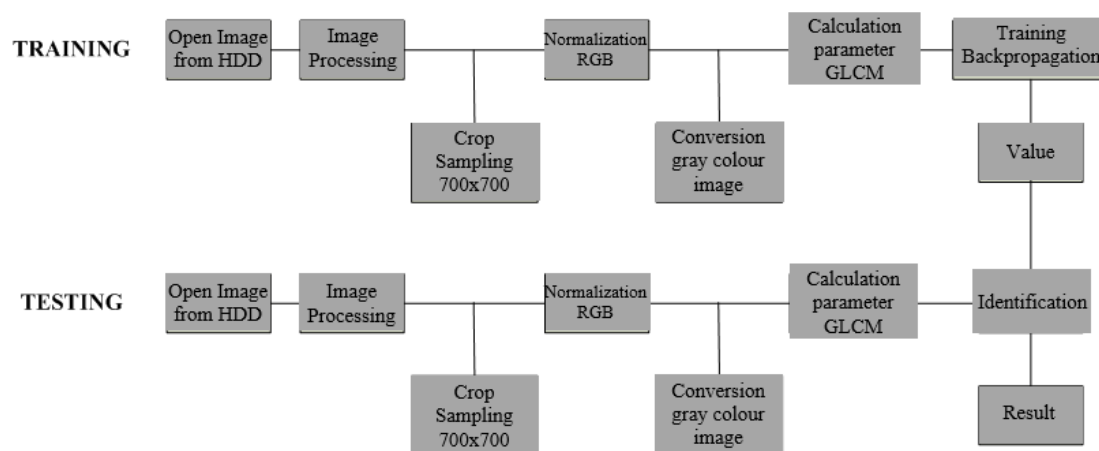


Figure 1. Block diagram of beef and pork meat identification.

In the figure 1 above shows the training and testing process in the system. The explanations are described as follows:

2.1.1. Training process. Training Process is done to get the best weight value. This best weight value will be used in the testing process. The steps begin with image data acquisition. Data acquired from camera will be save in local storage. System will open the image file from the storage and shown in the application. Before the feature extracted from the image, image is resized and cropped to suits the system need. Raw image resolution from camera is too large to process, will affect the system computation cost. Cropping are done to ensure that the system will extract foreground image only. Cropping will take a center of the meat image as a region of interest of image. RGB color feature are then can be extracted from pre-processed image. The RGB value form image pixel intensities are then normalized into 0-1 value. After RGB normalized value obtained, next step would be extracting GLCM feature. RGB color is convert to Grayscale channel value, and calculate its neighbouring pixel value in 0, 45, 90, and 135 degrees. The value will then use to calculate 6 statistical feature mentioned above. The color and GLCM feature extracted are then used as a dataset of the system. Dataset will separate 80% for training process, and 20% for testing process. 80% dataset used to train backpropagation network to get best weight value.

2.1.2. Testing process. Testing process in the application will give the user best identification of beef, whether it is beef or pork meat. All the process from image pre-processing until classification calculation is done automatically. The weight value uses for this process are the best weight value obtained from training process.

3. System design

3.1. System analysis

System analysis is a descriptive analysis about the system components requirements, which is software and hardware requirements. This section also discusses about system block diagram design and development.

There are two steps identification in this application, which is training and testing process. Training process is done to get best weight value of Backpropagation network. Testing process used to classify beef and pork meat using best weight value obtained from Training process.

3.2. System design

System Design in this research is a system design process describe in block diagram, data flow diagram, data pre-processing diagram, backpropagation process diagram, and training and testing steps diagram. The design process in this research itself is divided into three phase: method calculation process, design process in flowchart format, and user interface design of the application.

3.2.1. Image input. This system will be used to identify between Beef and Pork meat. It will obtain features that can be used to distinguish both meat type. Input data used are beef image file. The images acquired using smartphone camera to ensure that this research do not need special device, and can be used with low resolution camera. Distance between camera and the object is around 20cm and using enough light illumination. Open Image process steps is shown on figure 2.

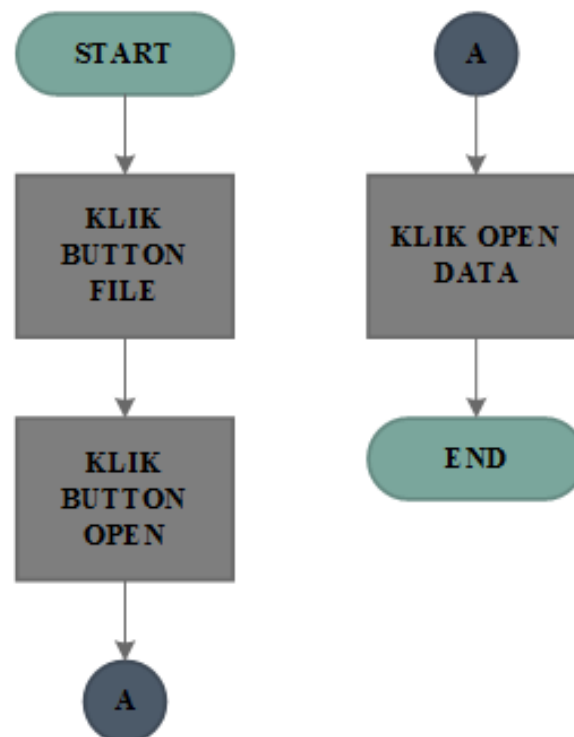


Figure 2. Open image process steps.

3.2.2. Feature extraction. Feature Extraction is the process of extraction texture and color data, and used as data classification. The feature determined have to guarantee to distinguish between two label of Beef and Pork Meat. Color feature use dis Red, Green, Blue channel value. Gray level co-occurrence matrix (GLCM) is the method used to extract texture feature of the meat.

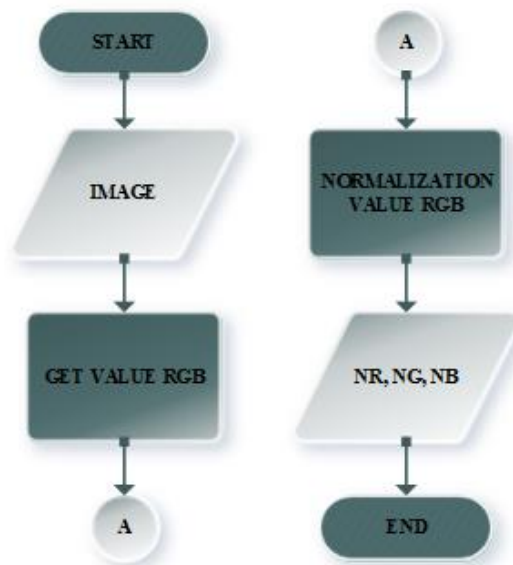


Figure 3. Color feature extraction process step.

Color space used for GLCM is averaging grayscale color channel. Figure 3 above shows color feature extraction process step. GLCM features obtained from *framework matrix* based on angle and space determined. This framework matrix then convert symmetrical matrix by summing framework matrix with transform framework matrix. The summation matrix result are then normalized to remove dependence between matrix. From the result, one can calculate some statistical method and used this method as a texture feature. The statistical feature used in this research are : energy, entropy, contrast, homogeneity, correlation, and inverse difference momentum. Texture extraction process is shown in the figure 4 below:

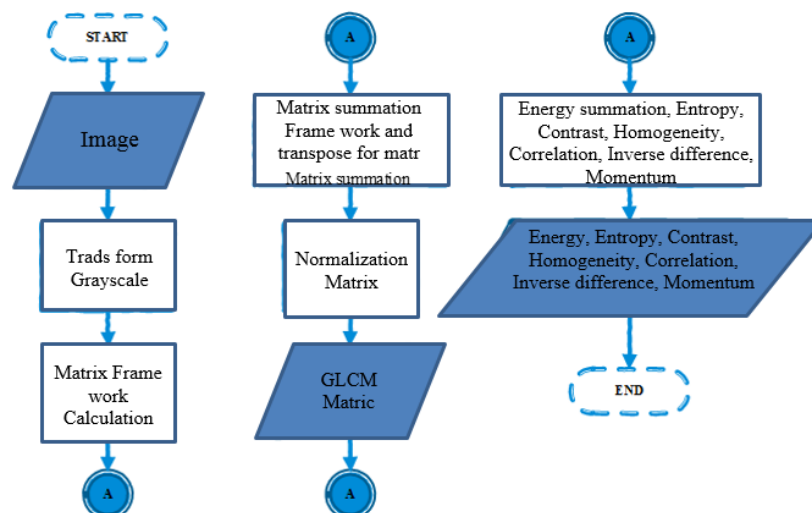


Figure 4. Texture extraction process step.

3.2.3. Classification. Meat classification is divided into 2 process, training and testing process. The classification is done using Backpropagation neural network algorithm. Figure 5 below shows training process step to obtain best weight value of the backpropagation neural network. Image is resized and crop to 700 x 700 image resolution before we can extract its features. RGB color value also need to be

normalized to get the range data between 0-1. Figure 6 below shows testing process step used to identify meat using best weighted value obtained from training process.

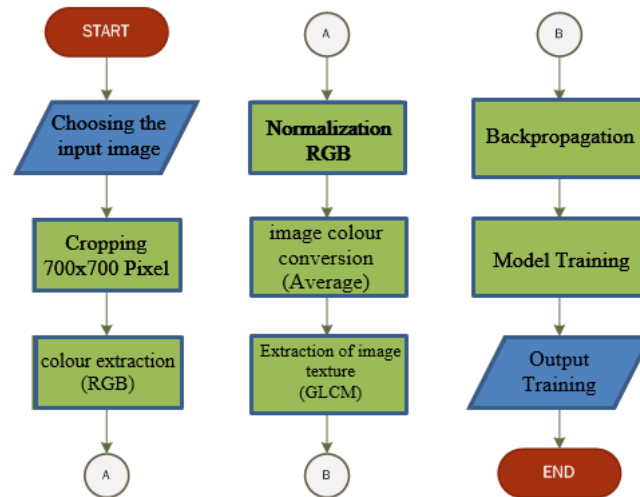


Figure 5. Training process step in backpropagation neural network.

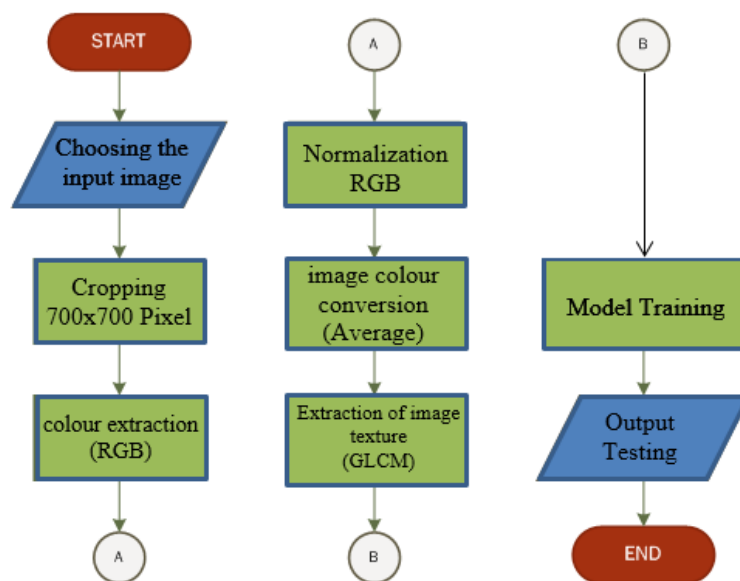


Figure 6. Testing process step in backpropagation neural network.

3.2.4. Backpropagation algorithm design. In the Backpropagation algorithm, there are three phase done and will obtain best weight value using the training data prepared. Here are the description of those three phase mentioned :

- Forward propagation phase. In forward propagation phase, input signals will propagate to the next layers which is called hidden layer using activation function determined. The output of hidden layers will then propagate to the next layer which is output layer using same activation function.
- Backward propagation phase. By calculating its loss function in the output, the algorithm can estimate existing error factor (δ_z). This error factor will then distributed to the previous layers. this δ_z value is also used to change neurons weights value which is directly related with the output.

- Weight modification phase. After all δ factor calculations, then all neuron weights value are modify together. Modification of neuron weight value are based on δ factor on previous layer.
- Backpropagation calculation design. The backpropagation algorithm used in this research will use binary sigmoid activation function.

4. Implementation

4.1. Main menu implementation

Main menu user interface is a main menu of the application shown first time when the application is executed. User can choose training process, testing process, or exit the application by choosing the button provided. Figure 7 below shows main menu user interface of the application developed. The application is developed using Microsoft Visual Basic .NET



Figure 7. User interface main menu.

4.2. Training process implementation

In the training process user interface, application will show Image input file, Cropped image, RGB pixel intensities value, average RGB pixel value, GLCM statistical value. User can start the training process from dataset stored before and save the training data to the storage. Figure 8 below shows the training process user interface.

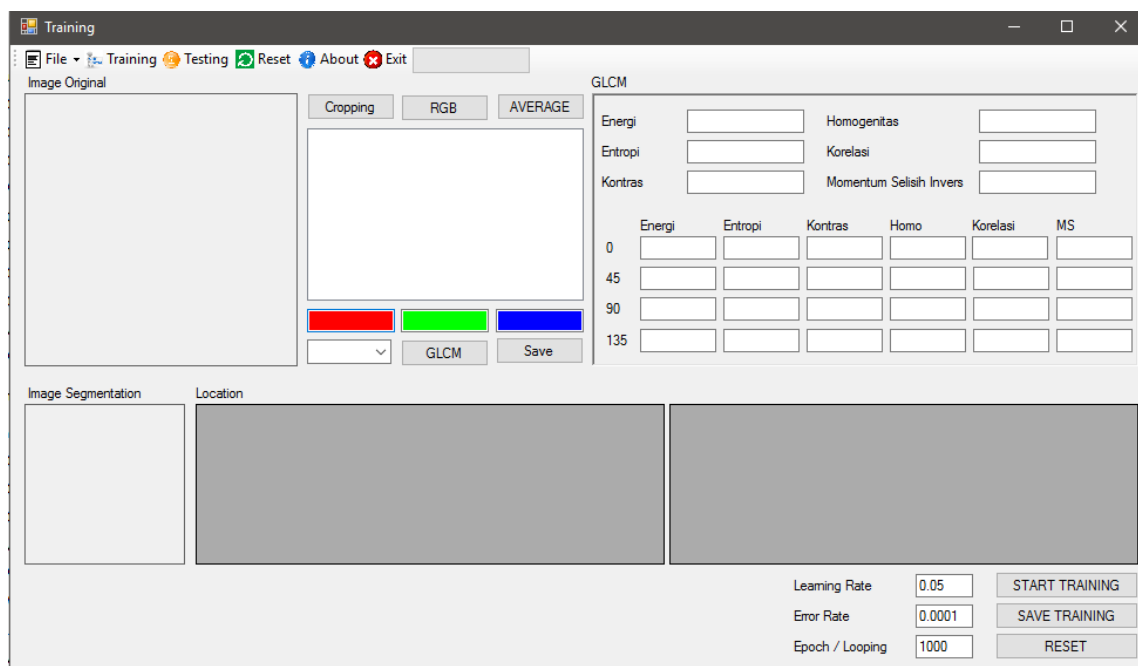


Figure 8. Training process user interface.

4.3. Testing process implementation

In the testing process user interface, application will show Image input file, Cropped image, RGB pixel intensities value, average RGB pixel value, GLCM statistical value, and best weight value obtained from training process. The best weight value shown are used for testing process. Figure 9 below shows the testing process user interface.

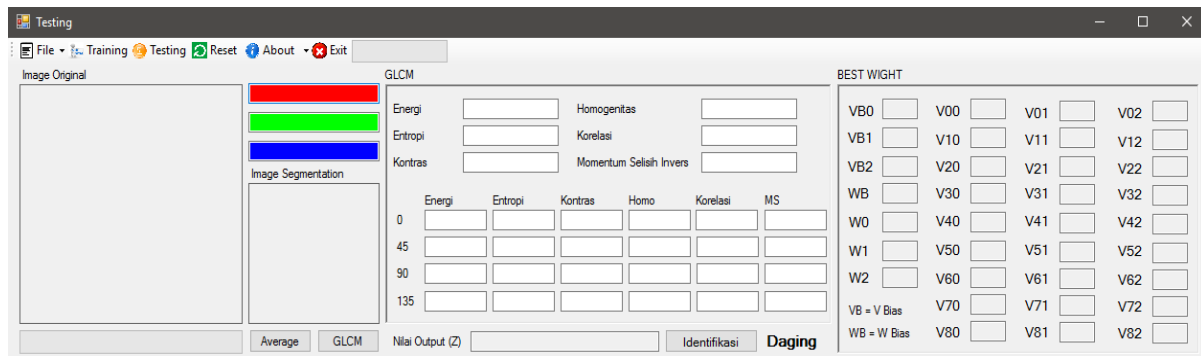


Figure 9. Testing process user interface.

5. Experiments and results

5.1. Application experiments

Accuration experiment is done in this experiment to test the efficiency of beef and pork identification using Backpropagation algorithm neural network. The experiments are using 12 image samples from some sources, with different meat composition and illumination. Those 12 image samples are from beef and pork meat. Table 1 below shows the identification results using 0.1 learning rate and 500 epoch, with 300 x 300 image pixel resolution and achieved 91.67% classification accuracy.

Table 1. Experiment with 0,1 learning rate and 500 epoch.

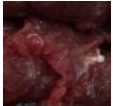
Meat img	Label	System Identifi cation	Results	Output
	Beef (Image taken from internet)	Beef	Correct	0.00498292503137839
	Beef (cross section)	Beef	Correct	0.0351720599331675
	Beef (with more fat)	Beef	Correct	0.0444386026958313
	Beef (low illumination)	Beef	Correct	0.253005721688253
	Beef (high illumination)	Beef	Correct	0.0530048747857912

Table 1.Cont.

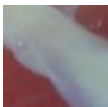
	Beef (leg part)	Beef	Correct	0.0276001078290195
	Pork (image taken from internet)	Pork	Correct	0.968485842220648
	Pork (cross section)	Pork	Correct	0.878029468944563
	Pork (with more fat)	Pork	Correct	0.991607085294398
	Pork (low illumination)	Pork	Correct	0.860865236637565
	Pork (high illumination)	Pork	Not correct	0.274025929885813
	Pork (leg part)	Pork	Not Correct	0.239005014679098

Table 2 below shows meat identification result using 0.1 learning rate, 5000 epoch from 300 x 300 image resolution and achieved 91.67% classification accuracy. The image used are the same with the image in table 1 above.

Table 2. Experiment with 0,1 learning rate and 5000 *Epoch*.

Meat Image	Label	System Identification	Results	Output
Image 1	Beef	Beef	Correct	1.1851E-07
Image 2	Beef	Beef	Correct	1.1167E-05
Image 3	Beef	Beef	Correct	8.0293E-06
Image 4	Beef	Beef	Correct	0.01969044
Image 5	Beef	Beef	Correct	3.4802E-05
Image 6	Beef	Beef	Correct	0.00024717
Image 7	Pork	Pork	Correct	0.99999905
Image 8	Pork	Pork	Correct	0.99995373
Image 9	Pork	Pork	Correct	0.99999992
Image 10	Pork	Pork	Correct	0.99991450
Image 11	Pork	Beef	Not Correct	0.00918475
Image 12	Pork	Pork	Correct	0.98160769

5.2. Discussion

From the experiment results in table 1 and table 2, we can conclude that the classification accuracy using backpropagation neural network will be higher if the network trained with more epoch. However, stable weight value will achieved once the epoch reach 5000.

The accuracy percentage for each epoch can be calculated using the formula below:

$$\frac{\text{Correct classified data}}{\text{All data test}} \times 100\%$$

Here is the results for some epoch tested :

$$500 \text{ epoch network} = \frac{11}{12} \times 100\% = 83,3\%$$

$$1000 \text{ epoch network} = \frac{10}{12} \times 100\% = 91,67\%$$

$$3000 \text{ epoch network} = \frac{11}{12} \times 100\% = 91,67\%$$

$$5000 \text{ epoch network} = \frac{11}{12} \times 100\% = 91,67\%$$

Classification accuracy based on percentage results for each class:

$$\frac{\text{Sum of percentage accuracy for all label}}{\text{Amount of label}}$$

$$500 \text{ epoch network} = \frac{100+83,3}{2} = 91,65\%$$

$$1000 \text{ epoch network} = \frac{100+66,67}{2} = 83,33\%$$

$$3000 \text{ epoch network} = \frac{100+83,3}{2} = 91,65\%$$

$$5000 \text{ epoch network} = \frac{100+83,3}{2} = 91,65\%$$

Total Classification accuracy for beef and pork meat identification is 89,57%.

6. Conclusion and suggestion

6.1. Conclusion

According to the experiment results, we can conclude that :

- Implementation of Beef and Pork meat classification using its RGB and GLCM feature, developed in MS Visual Basic .NET is suitable with the design specified.
- Application can be used to improve the classification accuracy, by using another learning rate, and adding more hidden layer in the network.
- Backpropagation neural network can be used for beef and pork meat identification, with RGB and GLCM as its features. Classification accuracy for the system is 89.57%.
- Image acquired from 10-20 distance. This system can be used to identify any part of meat, with different illumination as well.
- Percentage of success rate in each label is 79.14% for pork meat, and 100% for beef meat.

6.2. Suggestion

From the experiment results, author would like to give some suggestion for future research:

- Adding more image data in training process for more classification accuracy percentage.
- Could be developed in the realtime environment to be more useful and user friendly.
- Could be developed as a mobile application to be more efficient and a low price device.
- Could be used for another object identification such as lamb, chicken, buffalo meat, etc.

References

- [1] Muhammad Yudha 2015 *Manfaat Daging Sapi Berdasarkan Kandungan Gizi Lengkap* [online] Available: <http://www.cantikitu.com/2015/09/manfaat--Beef-dan-kandungan-gizinya.html>
- [2] Fiki Ariyanti 2016 *Ternyata Ini yang Bikin Harga Daging Sapi Mahal* [online] Available:

- <http://bisnis.liputan6.com/read/2571327/ternyata-ini-yang-bikin-harga--Beef-mahal>
- [3] Asmara, R Andrie, F Rahutomo, Q Hasanah and C Rahmad 2017 Chicken meat freshness identification using the histogram color feature In *Sustainable Information Engineering and Technology (SIET), 2017 International Conference on* pp. 57-61
 - [4] Rahmad, Cahya, I F Rahmah, R A Asmara and S Adhisuwignjo *Indonesian Traffic Sign Detection and Recognition Using Color and Texture Feature Extraction and SVM Classifier*
 - [5] Asmara, Rosa A, Y Hamidi and Dwi Puspitasari 2017 Tropical hardwood species identification based on first order statistical moment of cross section images color and texture extraction using gray level co-occurrence matrix In *Information and Communication Technology and System (ICTS) 2017 11th International Conference on* pp. 7-12 IEEE