IEEE Catalog Number : CFP1587H-ART
ISBN : 978-1-4673-7800-0

icici bme

Proceedings of

2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering

Science and Technology for Future Health

Institut Teknologi Bandung | November 2-3, 2015

Organized By:

Indonesian Sensor & Actuator System Society

Indonesian Biomedical Engineering Society icici bme

Proceedings of 2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)

Sponsored by:

Institut Teknologi Bandung
School of Electrical Engineering and Informatics
Faculty of Mathematics and Natural Sciences

Technically Co-Sponsored by:

IEEE

IEEE Indonesia – EMB Chapter
IEEE Indonesia – CAS Chapter

Supported by:

School of Life Sciences and Technology, ITB
Center for Instrumentation Technology and Automation (CITA)
Center for Health and Technology and Sport Science (CHTSS)
Indonesian Data Mining Society (IndoDM)
Research Center on Information and Communication Technology (RCICT)

Proceedings

2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)

November 2-3, 2015
Institut Teknologi Bandung
Bandung, Indonesia

Organized by:

Indonesian Sensor & Actuator System Society

Indonesian Biomedical Engineering Society

Masyarakat Elektronika Kesehatan dan Telemedika Indonesia

Indonesian e-Health and Telemedicine Society

Proceedings of

2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)

Copyright © 2015 by the Institute of Electrical and Electronics Engineers, Inc.
All right reserved

Copyright and reprint permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law, for private use of patrons, those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 1923

For other copying, reprint, or reproduction request should be addressed to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331

ISBN: 978-1-4673-7800-0
IEEE Catalog Number: CFP1587H-ART

Additional copies of this publication are available from:

The 4th ICICI-BME 2015 Secretariat
Labtek VIII Building 3rd floor
Institut Teknologi Bandung
Phone/Fax: +62 22 2534117
Email: icicibme2015@gmail.com
Website: http://icici-bme.itb.ac.id

Preface

Wilujeng Sumping,

Welcome to 2015 Fourth International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME), in Bandung, Indonesia.

On behalf of the organizing committee, we are delighted to welcome all of the participants to the ICICI-BME 2015. This biennial conference is organized under the auspices of the Institut Teknologi Bandung (ITB), Indonesian Sensor and Actuator System Society (ISASS), Indonesian Biomedical Engineering Society (IBES), and sponsored by the School of Electrical Engineering & Informatics, the Faculty of Mathematics & Natural Sciences, together with IEEE Indonesia EMB and CAS Chapters.

ICICI-BME is dedicated to the presentation and discussion of the latest developments and ideas in instrumentation, measurements, communications, information technology, and biomedical engineering, in both theory and application.

This conference also aims to strengthen the collaboration among international researchers, scientists, engineers, and industrial players in the fields of science and engineering. It is designed to be a meeting point for those who are involved, to globally exchange and share their views, ideas, and advances in science, technology, and industrial aspects.

Our gratitude to many people which helped making this conference a reality, to all of our invited speakers and guests, and for all of our committee members for their effort to ensure the success of this conference. Finally, we hope that all of participants will learn new things, make new contacts, get new ideas, and have fruitful discussion while having a pleasant experience during our conference in Bandung.

Hatur Nuhun, Thank You

Mitra Djamal & Tati L. R. Mengko
Chairs of ICICI-BME 2015

ICICI-BME 2015 Committee

GENERAL CHAIR

M. Djamal	(ITB, Indonesia)
T. L. R. Mengko	(ITB, Indonesia)

ADVISORY BOARD

K. Suryadi	(ITB, Indonesia)	H.-D. Liess	(UniBw Muenchen, Germany)
E. T. Baskoro	(ITB, Indonesia)	M. Liess	(RheinMain, Germany)
J. Sembiring	(ITB, Indonesia)	I. Nakajima	(Tokai, Japan)
I. N. P. Aryantha	(ITB, Indonesia)	M. Nuh	(ITS, Indonesia)
C. Badri	(UI, Indonesia)	J. Rodrigues	(UBI, Portugal)
E. Y. Chuang	(NTU, Taiwan)	K. Shimada	(JAXA, Japan)
Y. Fujii	(Gunma, Japan)	S. Soegijoko	(ITB, Indonesia)
H. Grain	(La Trobe, Australia)	A. B. Suksmono	(ITB, Indonesia)
M. Horprathum	(MST, Thailand)	Suprijanto	(ITB, Indonesia)
J. Kaewkhao	(NPRU, Thailand)	E. Supriyanto	(UTM, Malaysia)
D. Kurniadi	(ITB, Indonesia)	G. J. Verkerke	(Groningen, Netherlands)

PROGRAM COMMITTEE

D. Abdurrachim	(TuE, Netherlands)	A. Prakosa	(JHU, United States)
K. Adi	(Undip, Indonesia)	I. K. E. Purnama	(ITS, Indonesia)
W. Adiprawita	(ITB, Indonesia)	M. H. Purnomo	(ITS, Indonesia)
M. K. Agusta	(ITB, Indonesia)	D. Riana	(STMIK NM, Indonesia)
Y. Ansar	(ITB, Indonesia)	M. I. Rusydi	(Unand, Indonesia)
I. Arif	(ITB, Indonesia)	T. A. Sardjono	(ITS, Indonesia)
F. Haryanto	(ITB, Indonesia)	N. Syakrani	(Polban, Indonesia)
E. M. Idris	(ITB, Indonesia)	Suprijadi	(ITB, Indonesia)
A. A. Iskandar	(UI, Indonesia)	W. Siswomihardjo	(UGM, Indonesia)
S. N. Khotimah	(ITB, Indonesia)	H. Zakaria	(ITB, Indonesia)
A. I. Mahyuddin	(ITB, Indonesia)	I. Zakia	(ITB, Indonesia)

ORGANIZING COMMITTEE

Astri Handayani
Agung Wahyu Setiawan
Donny Danudirdjo
Muhammad Shiddiq Sayyid Hashuro
Habibur Muhaimin
Misuari Sabirin
Donny Mirza
Rizki Putra Prastio
Agwin Fahmi Fahanani
Dian Rahmawati
Rebecca Chyntia
Adhelia Ekarani
Tiper Uniplaita
Koespriyandito
Rahma Dewi
Mochamad Irwan Nari
Ilman Himawan Kusumah
Amanatulhay Pribadi
Tuti Adi Tama Nasution
Johan Agathon
Raditya Artha
Aji Suryo

Table of Contents

KEYNOTE ADDRESS

PAPERS

2015 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)
Bandung, November 2-3, 2015

Beef Quality Identification using Color Analysis and K-Nearest Neighbor Classification

Kusworo Adi[1], Sri Pujiyanto[2], Oky Dwi Nurhayati[3] and Adi Pamungkas[1]
[1]Department of Physics, Diponegoro University, Semarang, Indonesia
(E-mail: kusworoadi@gmail.com)
[2]Department of Biology, Diponegoro University, Semarang, Indonesia
[3]Department of Computer System, Diponegoro University, Semarang, Indonesia

Abstract- Beef is one of the many produce prone to contamination by microorganism. Water and nutrition contents make an ideal medium for the growth and proliferation of microorganism. Contaminated beef will degrade and has less storage duration. Beef is valued by two factors; its price and its quality. The quality itself is measured using four characteristics; marbling, color of meat, color of fat, and meat density. Specifically, marbling is the dominant parameter that determines meat's quality. Determination of meat quality is conducted visually by comparing the actual meat and reference pictures of each meat class. This process is very subjective in nature. Therefore, this research aims to develop an automated system to determine meat by adopting the Indonesian National Standard requirement on the quality of carcass and beef (SNI 3932:2008) using the image processing technique. Image segmentation is carried out using the thresholding method and classification is conducted using the k-nearest neighbor algorithm. The features used to differentiate beef quality are marbling score, color of meat, and color of fat. Results indicate that the system developed is able to acquire images and identify beef quality as required in the Indonesian National Standard.

Keyword: beef quality, marbling score, image processing, color analysis, k-nearest neighbor.

I. Introduction

Beef is one of the many produce prone to contamination by microorganism. Water and nutrition contents make an ideal medium for the growth and proliferation of microorganism [1, 2]. Contaminated beef will degrade and has less storage duration. Beef is valued by two factors; its price and its quality. The quality itself is measured using four characteristics; marbling, color of meat, color of fat, and meat density. Specifically, marbling is the dominant parameter that determines meat's quality [3, 4]. Determination of beef quality is conducted visually by comparing the actual meat and reference pictures of each meat class. This process is very subjective in nature. Therefore, this research aims to develop an automatic system to determine meat quality based on the marbling score using the image processing technique. Some research have shown that image processing can be applied to analyze the color and texture of meat that it can be used as a reference in the process of beef quality identification [3,4,5,6]. Furthermore, marbling grade evaluation has been conducted using the watershed algorithm and artificial nerve network [7]. This research focuses on the development of image segmentation process using the thresholding method and image classification using the k-nearest neighbor algorithm. Some research has already applied image processing with thresholding segmentation to extract features [8, 9, 10, 11]. This method is suitable for the process of meat quality identification based on color and texture. The algorithm developed proves to yield good results, that it can be implemented for the analysis of meat color and texture. Some methods applicable for this research include the thresholding segmentation method that can be used to identify marbling in meat.

II. Literature Review

Some research on the application of image processing for beef quality identification has been conducted earlier [4, 5, and 6]. One of those researches tried to determine the quality of meat using texture analysis with the gray level co-occurrence matrix (GLCM) method [3]. Beef quality is categorized into 12 grades based on the amount of fat it contains. Results show that this method is effective in determining the quality of meat. One research on the application of image texture to classify beef type yielded a correlation up to 0.8 [5]. Yet another research that designed the hardware and software for beef image segmentation using the vision thresholding method has been used as the initial process for meat quality testing [6]. Those researches indicate that image processing can be applied to identify beef quality.

The research conducted here tries to identify beef quality using the image processing technique referring to the Indonesian National Standard (SNI 3932:2008) on carcass and beef quality [12]. Beef quality requirements are classified into three; Class I, II, and III. Beef quality classes based on SNI is given in Table I.

TABLE I
BEEF QUALITY REQUIREMENT (SNI 3932:2008) [12]

No.	Type of test	Quality Requirement		
		I	II	III
1	Beef Color	Bright Red Score 1-5	Blackish Red Score 6-7	Dark Red Score 8-9
2	Fat Color	White Score 1-3	Yellowish White Score 4-6	Yellow Score 7-9
3	Marbling	Score 9-12	Score 5-8	Score 1-4
4	Texture	Soft	Medium	Coarse

Beef color observation is carried out by observing the color of the surface rib tendon with the help of a flashlight and then matching that with the standard color. The color score is based on the standard color score that is closest to the observed color. The beef standard color consists of nine color scores, ranging from light red to dark red, as depicted in Fig. 1.

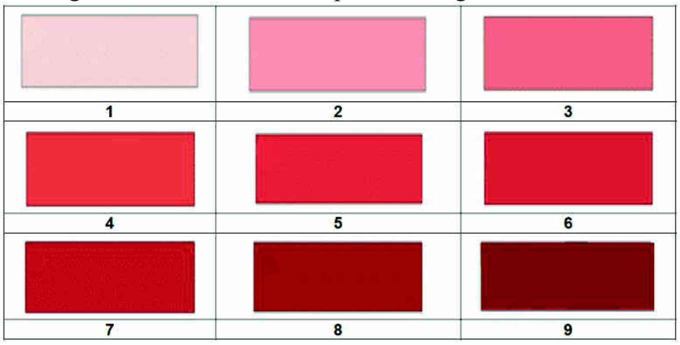


Fig. 1. Beef standard color [12].

Fat color observation is conducted by observing the color of thin layers of fat with the help of a flashlight and matching them with the standard color. The color score is based on the standard color score that is closest to the observed color. The fat standard color consists of nine color scores from white to yellow as can be seen in Fig. 2.

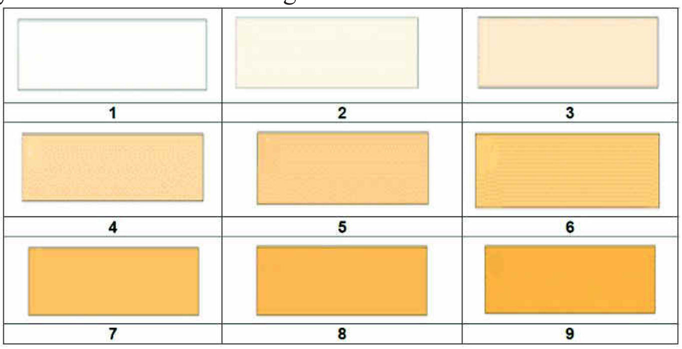


Fig. 2. Fat standard color [12].

Marbling observation is done by observing the intensity of marbling on the surface rib tendon with the help of a flashlight and matching it with the standard marbling. The marbling score is based on the nearest score to the surface rib tendon marbling intensity. Standard marbling consists of 12 scores, ranging from practically no marbling to numerous marbling, as described in Fig. 3.

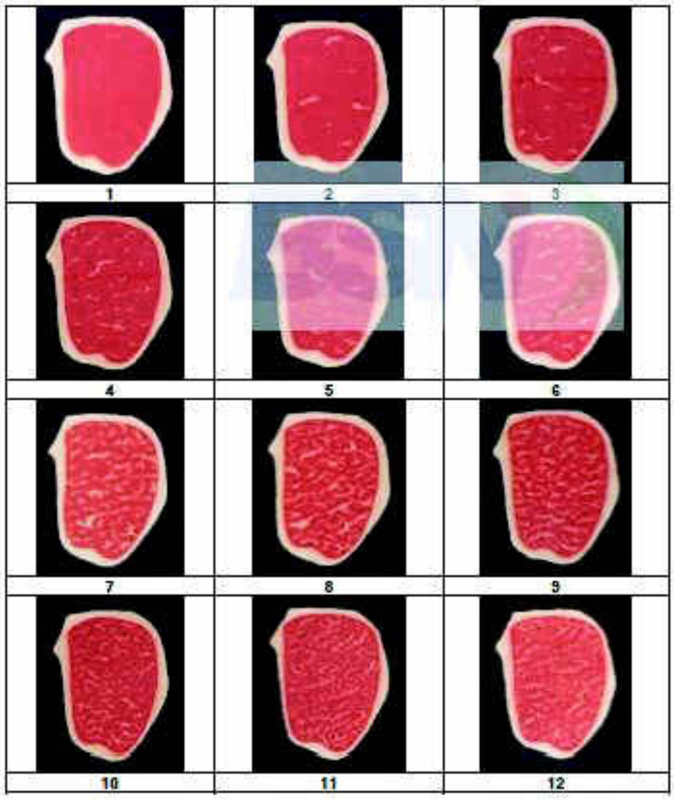


Fig. 3. Marbling standard color [12].

Observation of tendon texture is carried out by observing the softness/coarseness of surface rib tendon with the help of a flashlight and matching it with the standard meat texture. The texture score is based on the closest score to the standard texture. Meat texture standard consists of three scores; soft, medium, and coarse [12].

III. METHOD

The system design for beef quality identification in this research comprises beef image acquisition, image segmentation, features extraction, and beef quality classification. The diagram block for this system design is given in Fig. 4.

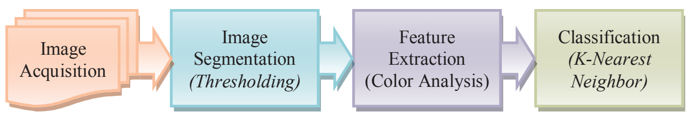


Fig. 4. Research block diagram.

Image acquisition is conducted vertically by varying the distance for image acquisition, camera resolution, and angle of acquisition. The distance variations employed are 20 cm and 30 cm. And the resolution is varied from 3.2 MP, 4 MP, and 5 MP. The varied angles are 0^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0, and 360^0. The image processing starts from image segmentation consisting of two stages. The first is separating the object (meat and fat) from the background. This process begins with thresholding the blue channel of the RGB (Red, Green, and Blue) image to obtain a binary image. Afterwards, the binary image is used as a mask for object cropping. Once the object is separated from the background, the second stage of segmentation i.e. meat and fat separation proceeds. This process itself starts by converting the RGB color image into grayscale. Then, the process of thresholding to separate meat and fat can ensue. The features used to determine beef quality are marbling score, beef color, and fat color. Marbling score is represented by the percentage of fatty area and the area of object (both meat and fat). The meat color and fat color are represented by the hue image on the HSV channel. In this research, marbling score, meat color, and fat color are extracted as features that determines beef quality. The process of beef quality classification is conducted using the k-nearest neighbor algorithm.

IV. Result And Discussion

Stages of image processing to identify beef quality comprise image acquisition, image segmentation, features extraction, and meat classification.

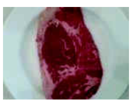
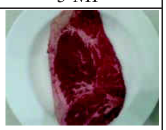
A. Image Acquisition

Results of beef image acquisition along with its marbling score is given in Fig. 5. It can be seen that there are five marbling scores that match the ones in the market. The marbling scores in this research are 4, 5, 6, 7, and 9.

Fig. 5. Samples of beef image acquisition

Image acquisition is conducted vertically by varying the distance, camera resolution, and angle of acquisition. The varied distances are 20 cm and 30 cm and the varied resolutions are 3.2 MP, 4 MP, and 5 MP. Samples of beef image resulting from distance and resolution variations are given in Table I.

TABLE I
Samples of Beef Image Resulting from Varied Distance and Resolution

		Resolution		
		3,2 MP	4 MP	5 MP
Distance	20 cm			
	30 cm			

In order to figure out the effect of angle in image acquisition, the following variations are made; 0^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0, and 360^0, as depicted in Fig. 6.

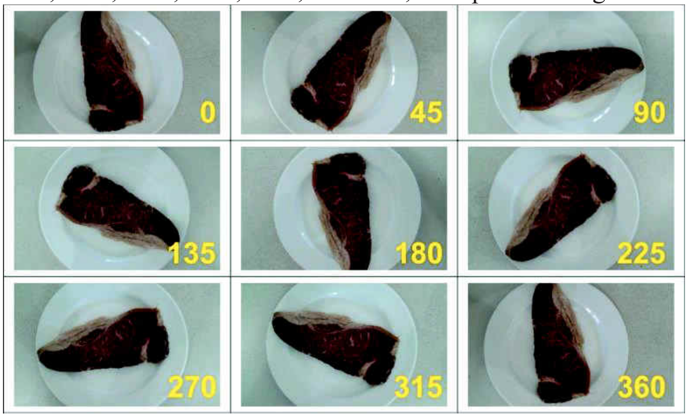
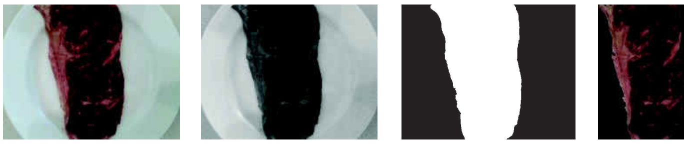


Fig. 6. Samples of meat image resulting from angle variation.

B. Image Segmentation

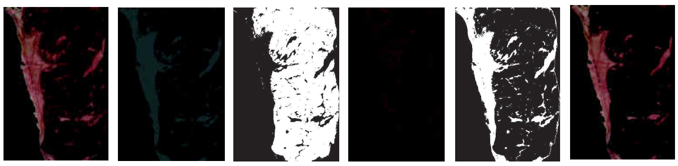
Image processing begins with image segmentation that consists of two stages. The first step is separating the object (meat) from its background. It begins with thresholding the blue channel of the RGB (Red, Green, and Blue) image to obtain a binary image. Afterwards, the binary image is used as a mask for object cropping, as described in Fig. 7.



(a) (b) (c) (d)

Fig. 7. The first stage of image segmentation; (a) RGB image; (b) Blue channel; (c) Binary image; (d) Segmentation result

Once the object is separated from the background, the second stage of segmentation i.e. meat and fat separation proceeds. This process itself starts by converting the RGB color image into grayscale. Then, the process of thresholding to separate meat and fat can ensue, as outlined in Fig. 8.



(a) (b) (c) (d) (e) (f)

Fig. 8. The second stage of image segmentation;
(a) RGB image; (b) Grayscale image; (c) Meat binary image;
(d) Meat segmentation result; (e) Fat binary image; (f) Fat segmentation result

C. Features Extraction

The features used to determine beef quality are marbling score, color of meat, and color of fat. Marbling score is represented by the percentage of fatty area and the area of object (both meat and fat). The meat color and fat color are represented by the hue image on the HSV channel. Samples of features extraction result are given in Table II.

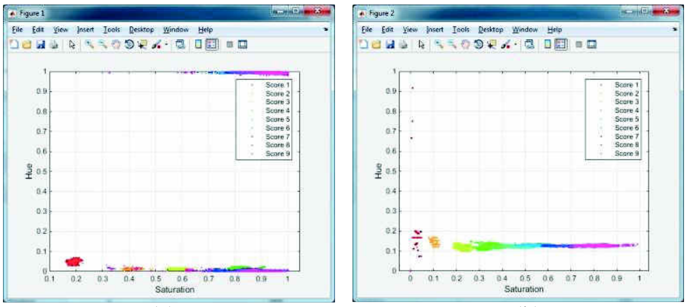
TABLE II
SAMPLES OF FEATURES EXTRACTION RESULT OF BEEF IMAGE

No.	Images	Features				
		Color of meat		Color of fat		Percentage of marbling
		Saturation	Hue	Saturation	Hue	
1		0.6064	0.7266	0.4523	0.4305	0.6305
2		0.4849	0.0876	0.3008	0.0835	0.2795
3		0.4196	0.0586	0.3016	0.0521	0.8388
4		0.5105	0.3512	0.3834	0.0752	0.2967
5		0.4341	0.1025	0.2662	0.0760	0.5269

Those three extracted features are then used in the process of meat classification.

D. Beef Quality Classification

The classification process uses the k-nearest neighbor algorithm. K-nearest neighbor is an algorithm that classifies objects based on similarities of data to the others. Geometrically, the nearer a trial data to a test data, the more likeness they have. The value of k in this algorithm states the number of nearest neighbors involved in the determining the class prediction label on test data. From the chosen k neighbors, a class voting from those k-neighbors proceeds. Then the class with the most neighbors is the class label predicted for that test data. Fig. 9 depicts a graphical representation of k-nearest neighbor distribution for beef quality test by determining the meat and fat color as stated in the Indonesian National Standard.

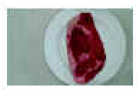


(a) (b)

Fig. 9. K-nearest neighbor distribution graph;
(a) Color of meat; (b) Color of fat.

Beef quality determination is made by matching the percentage of fat on beef images with that of the Indonesian National Standard. A sample of beef quality classification based on the Indonesian National Standard requirement is given in Table III.

TABLE III
SAMPLES OF BEEF QUALITY CLASSIFICATION

No.	Images	Score			Beef quality
		Color of meat	Color of fat	Marbling score	
1		9	6	8	II
2		9	4	4	III
3		2	4	11	I
4		9	4	4	III
5		9	4	7	II

It can be seen in Table III beef quality is classified based on features of color of meat, color of fat, and marbling score as required in the Indonesian National Standard. This shows that requirements for quality beef can be integrated into image processing system.

V. CONCLUSION

Results of this research show that the system developed here is capable of exceptionally acquire images and identify beef quality. This image processing system is designed by adopting the requirements of the Indonesian National Standard on carcass and beef quality (SNI 3932:2008).

ACKNOWLEDGMENT

This research was funding from Indonesian Directorate General of Higher Education Program in 2015.

REFERENCES

[1] Li, J., Tan, J., Martz, F.A., and Heymann, H., “Image texture features as indicators of beef tenderness”, Meat Science 53, 1999, pp. 17-22.
[2] De Huidobro, F. R., Miguel, E., Blazquez, B., and Onega, E., “A comparison between two methods (Warner–Bratzler and texture profile analysis) for testing either raw meat or cooked meat”, Meat Science 69, 2005, pp. 527–536.
[3] Shiranita, K., Miyajima, T., and Takiyama, R., “Determination of meat quality by texture analysis”, Pattern Recognition Letters 19, 1998, pp. 1319-1324.
[4] Shiranita, K., Hayashi, K., Otsubo, A., Miyajima, T., and Takiyama, R., “Grading meat quality by image processing”, Pattern Recognition 33, 2000, pp. 97-104.
[5] Basset, O., Buquet, B., Abouelkaram, S., Delachartre, P., and Culioli, J., “Application of texture image analysis for the classification of bovine meat”, Food Chemistry 69, 2000, pp. 437-445.
[6] Chen, K. and Qin, Ch., “Segmentation of beef marbling based on vision threshold”, Computers and Electronics in Agriculture 62, 2008, pp. 223–230.

[7] Meng, X., Sun, Y., Ni, Y., and Ren, Y., "Evaluation of Beef Marbling Grade Based on Advanced Watershed Algorithm and Neural Network", Advance Journal of Food Science and Technology 6 (2), 2014, pp. 206-211.

[8] Adi. K, Gernowo. R., Sugiharto. A., Firdausi. K. S., Pamungkas, A., and Putranto. A. B., Tuberculosis (TB) Identification in The Ziehl-Neelsen Sputum Sample in NTSC Channel and Support Vector Machine (SVM) Classification, International Journal of Innovative Research in Science, Engineering and Technology, 2013, Vol. 2, Issue 9.

[9] Adi, K., Gernowo, R., Sugiharto, A., Pamungkas, A., Putranto, A.B., and Mirnasari, N., "Autothresholding Segmentation For Tuberculosis Bacteria Identification In The Ziehl-Neelsen Sputum Sample", Proceedings The 7th International Conference on Information & Communication Technology and Systems (ICTS) 2013, ITS, May 15-16, 2013, Bali.

[10] Adi, K., Pujiyanto, S., Gernowo, R., Pamungkas, A., and Putranto, A. B., "Identification of Plasmodium Falciparum Phase in Red Blood Cells using Artificial Neural Networks", International Journal of Applied Engineering Research ISSN 0973-4562 Vol. 9, Number 23, 2014, pp. 13917-13924.

[11] Pamungkas, A., Adi, K., and Gernowo R., "Identification of Plasmodium Falciparum Development Phase in Malaria Infected Red Blood Cells using Adaptive Color Segmentation and Decision Tree based Classification", International Journal of Applied Engineering Research ISSN 0973-4562 Vol. 10, Number 2, 2015, pp. 4043-4055.

[12] Indonesian National Standard, "Carcass and Beef Quality". SNI 3932:2008.