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Cow Weight Estimation Using Local Adaptive Thresholding Method And Connected Component Labelling

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Abstract— **The development of technology, information and communication provides a new alternative to predict cow weight through Image Processing. This study utilizes Image Processing in visualizing the measurement of Chest Circumference and cow body length automatically. The cow weight estimation are very dependent on cow image segmentation result. Image segmentation method used in this study is local adaptive thresholding combined with the Connected Component Labeling (CCL) method. The implementation of the Chest Circumference and Body Length endpoints in the foreground is converted into centimeters (cm) to ensure cow weight estimation can be calculated using the Lambourne formula. In this study, the accuracy of RMSE was obtained from the cow weight data taken at 150, 170 and 190 cm distance. The accuracy is 20.35, 30.77 and 23.33 respectively. This research can be contribution to development of local cattle farms in Indonesia.**

Keywords—cow weight; calibration; edge detection; connected component labeling

I. INTRODUCTION

Data on cow weight is very important information for farmers and buyers. On the farmer's side, this information can avoid losses when a cow is sold. The weight is used to estimate price [1]. On the other hand, the buyer could determine the accuracy of cow weight to be purchased.

Nevertheless, there are farmers who roughly estimate cow weight, therefore the results are not accurate enough. Current technological, information, and communication developments have provided alternative solutions to determine cow weight. It could be conducted through Image Processing[2-4]. One image processing widely used in image reconstruction is the image segmentation method [5]. In the computer vision field, image segmentation plays a crucial role as a preliminary step for high-level image processing. [14].

Previous research conducted on image processing is carried out, designed and applied applications with the use of digital image processing techniques. It is capable to predict and classify cow weight using a combination method of K-Means Clustering with Active Contour Model. Feature extraction obtained is chest circumference and body length. It uses SVM Multiclass to classify. Based on this study, the best accuracy results obtained from the system is 0.5 ratio at 87.53% to determine cow weight with 8.26 seconds computation. The amount of data used was 100 training data and 17 test data [6].

Other research used K-Nearest Neighbor (K-NN) to estimate cow weight. The first step involved is preprocessing. It consists of resizing and contrast stretching operations. Research result exhibited the accuracy value of cow weight estimation at 28.19% with 21.44 seconds computing time [7].

A system with the use of digital image processing techniques that can facilitate cow weight estimation has designed and implemented using the Gabor Wavelet method and Support Vector Machine Multiclass classification [8]. The best accuracy value obtained was 77.78% at computing time of 20.25608 seconds. The amount of data used was 10 training data and 8 test data [8].

The application on estimating cow weight by utilizing cameras on Android-based smartphones has been analysis [9]. It applies the DAHAGA formula which has an accuracy of 97.9% and uses a template matching method that compares the original object with the image captured by the camera. The application executes the DAHAGA formula and displays the weights as the final result [9].

Several studies mentioned above used the determination of manual endpoint measuring parameters. Therefore it still involves the user to determine the point of chest circumference and length of a cow. This research advances theory on finding endpoints automatically.

Thus, this research provides a unique theoretical contribution to determinate endpoints automatically depends on the results of image segmentation. Image segmentation in this study uses local adaptive thresholding method which is combined with the CCL method to mark objects detected as cows.

The remainder of this paper is organized as follows: an analysis segmentation using local adaptive thresholding and connected labelling is presented in Section 2. In Section 3 implementation of segmentation and prediction of the cow weight. Finally, some conclusions are shed.

II. Research Method

A. Segmenting

Segmentation is the process of separating objects with backgrounds. By using the segmentation process, each object in the image can be taken individually. It is used as input for other processes [10]. In computer science, especially in computer vision and image processing, segmentation are the most developed methods. There are 3 stages in the own segmentation process, namely grayscale, image binarization and coloring. Grayscale is the stage to divide the intensity that will be used as white and the intensity that will be used as black to simplify the image that calculates RGB values. The second is the binarization process. The image binarization process is applied by giving black and white color to the image. White represents background or background and black represents objects or vice versa. The third is coloring, coloring is done to make the noise contained in the image white to ensure the results of the segmented object are well segmented. Therefore ensuring pixel calculation more accurate [10].

B. Local Adaptive Thresholding

Thresholding produce a binary image. It has two gray level values: black and white. The following is a grayscale image thresholding process to produce a binary image:

$$G(x,y)=\begin{cases}1, if\ f(x,y)\geq T\\ 0, if\ f(x,y)<T\end{cases} \quad (1)$$

Description:

g(x,y): grayscale binary image f(x,y)

T: threshold value

T value has a very important role in thresholding process. The quality of the binary image depends on the T value used.

The method used in this study is the local adaptive thresholding method. In this method, local threshold values can be calculated in one of three ways:

$$T=\frac{\sum_{(x,y)}\sum_{\in W} f(x,y)}{N_W}-C, or \quad (2)$$

$$T=median\{f(x,y),(x,y)\in W\} \quad (3)$$

$$T=\frac{\max\{f(x,y),(x,y)\in W\}+\min\{f(x,y),(x,y)\in W\}}{2} \quad (4)$$

Information:

W : the processed block

Nw : the number of pixels in each W block

C denotes a constant that can be determined independently if C = 0 means the threshold is equal to the average value of each pixel in the block.

Using three methods above, it successively calculate the T value by calculating the mean, median, and average maximum and minimum values of pixels in the window [11].

C. Connected Component Labeling

Connected Component Labeling is a method used to classify regions or objects in a digital image. The CCL algorithm applies pixel connectivity theory on the image. All pixels in a region are connected or are also referred to as correlated when adhering to pixel adjacency and proximity. Pixel proximity rules utilize the proximity between one pixel and the other pixel. Therefore, every pixel correlated possess closeness to each other because it has a neighboring relationship. The image that can be processed using the CCL algorithm is in the form of binary images or monochrome images. For neighboring pixel itself, it must have a length or distance of 1 unit or directly between the pixel or the other without any intermediary [12].

There are 2 rules in the CCL method, namely 4-connectivity and 8-connectivity, which is described below:

a) 4-*Connectivity*

1) Searching for each pixel in an image, starting from the row to the matrix column to finding different pixel points (p)
2) After finding different pixels, it will check pixel p neighboring unit/pixel to the left and above it.
3) If the neighboring pixel value is p=0, then it is marked (table) new.
4) If the two neighboring pixel value p = 1 then one of the pixels is marked as p, then make a note that the two different pixels are equivalent.

At the end of the process, all pixels possessing value of 1 (in binary imagery) have been labeled. Nevertheless, there may still be many equivalent values. Therefore the equivalent values are sorted simultaneously in equivalent classes and given a different sign in each equivalent class.

b) 8-*Connectivity*

The steps in 8-connectivity possess the same principle as 4-connectivity. A slight difference is apparent when searching for each line 4-connectivity. After the pixel value (p) was found, then it is connected with the upper and left pixel. However, on 8-connectivity it will connect each pixel by checking the top, left, diagonal upper left and diagonally upper right. Following are the steps of 8-connectivity*:*

1) If all four neighboring pixels value are 0 then p is given a new marking.
2) If only one of the neighboring pixels is 1 then it is marked by the neighboring pixel as p
3) If two or more neighboring pixels value is equivalent to 1 then mark one of them as p. All the neighboring pixel possessing value 1 are considered equivalent.

The last process of 4-connectivity or 8-connectivity is to check or scan the image then replace each sign with the mark of the equivalent class.

D. *Lambourne*

Lambourne is a formula used in calculating the weight of an animal, such as a cow and goat, based on chest circumference and body length [13].

$$BB = \frac{LD^2 \times PB}{10840} \quad (5)$$

Information:

BB = Weight (kg)

LD = Body Length (cm)

BB = Chest Circumference (cm)

E. *System Design*

The system design in this study includes several stages, namely data input, segmentation, determination of endpoints, conversion of pixels to cm, and calculation of the cow weight estimation.

This study used to input data in the form of images of cow obtained from one slaughterhouse (RPH) by taking photos directly using a cell phone, with an angle of 90º. Data taken was 117 images with three different distances: 150cm, 170cm and 190cm. Image taken on each distance was 39.

Segmentation stage was conducted using two methods, the local adaptive thresholding method. The segmentation result were processed using the second method (CCL) to classify the region.

The region of the cow object formed from the segmentation process is used to determine the end point of the chest circumference (LD) and body length (PB) automatically [9].

After determining the endpoint, the pixel was converted into cm because as the endpoint results are still in the form of pixels. The conversion results will be used to calculate cow weight. Calibration is a method used to convert pixels to cm is calibrated. Calibration values are obtained from the average ratio of the original size (cm) to the size of the image (pixel). After the calibration value is obtained, the conversion of pixels to cm is done by means of the chest circumference multiplied by the calibration results as well as the length of the body.

The final stage is to calculate cow weight using the Lambourne formula based on the value that has been converted to cm. Flowchart of the methods is shown in the Fig.1 below

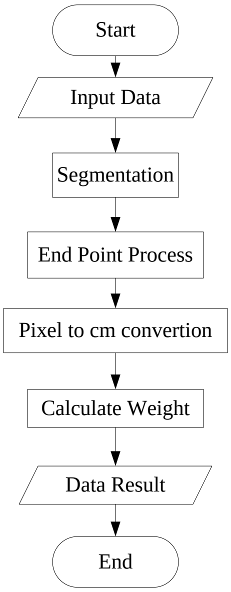

Fig. 1. Flowchart of Cow Weight Estimation System

III. FINDING AND RESULT

A. *Segmentation Experiment*

The Adaptive function is used for segmentation using the local adaptive thresholding method. It determined the threshold value (T) using the mean. If it is greater than T, the pixel value is 1. Otherwise, the value is 0. The centroid is used to determine the midpoint of the cow object. X and Y points were constructed in order to check the centroid. Y coordinates were assessed to find the background. After it was determined, the coordinate point stops and forms chest circumference and body length

B. *Estimation result*

The assessment was carried out in accordance with the system design, which had been made before using a cow object captured from 3 different distances. This assessment was conducted to determine the cow weight estimation from the3 distances.

Fig. 2. Cow Image

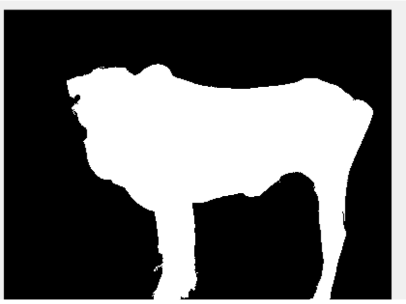

Fig. 3. Segmentation dan CCL Image Result

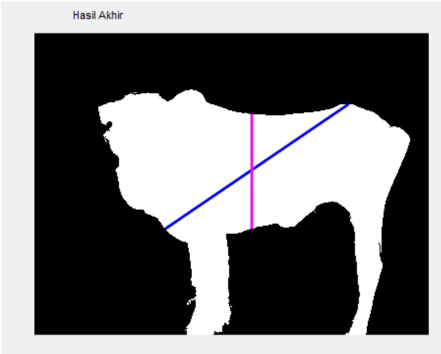

Fig. 4. Determination of the Chest Circumference (LD) and Cow Body Length (PB) endpoints.

TABLE I. COW WEIGHT ESTIMATION

Data no.	**Table Column Head**			
	Manual Measurement	***Scenario 1***	***Scenario 2***	***Scenario 3***
1	400	221	203	224
2	203	275	187	206
3	235	5	0	113
4	203	218	0	0
5	173	259	206	227
6	354	220	0	0
7	270	291	309	341
8	226	232	210	210
9	202	205	8	0
10	280	240	181	215
11	291	417	0	268
12	234	427	372	315
13	159	275	195	214
14	195	162	207	214
15	262	166	220	242
16	413	246	0	123
17	197	293	242	234
18	354	211	232	258
19	438	304	368	311
20	226	368	229	227
21	159	273	218	239
22	252	266	0	5
23	145	172	0	0
24	390	275	0	7
25	179	149	157	141
26	210	205	200	216
27	173	317	223	224
28	377	260	235	238
29	320	279	0	209
30	252	303	0	258
31	342	422	307	332
32	253	160	0	132
33	440	277	26	285
34	443	260	230	243
35	193	223	0	0
36	210	246	0	123
37	195	211	232	258
38	173	368	229	227
39	179	576	0	0

Based on Table 1, the results of the cow weight estimation assessment result through measurement of Chest Circumference (PB) and Body Length (PB) resulted in varying estimated values. Scenario 1 was cow image taken at a distance of 150 cm. Whereas scenario 2 was taken at 170 cm and scenario 3 at 190 cm.

The evaluation process of cow weight estimation system is done by measuring the accuracy of the model forecast results using the Root Mean Square Error (RMSE). RMSE is the average value of the sum of squared errors, it can also state the size of the error generated by a forecast model.

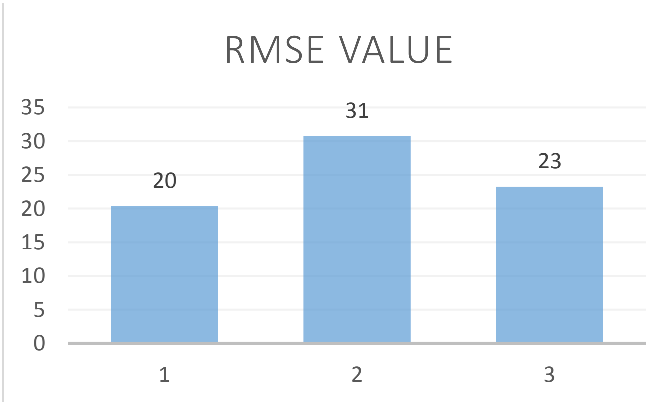

Fig. 5. Cow weight estimation system accuracy graph

Fig. 5 exhibits that scenario 1 has the smallest RMSE value. Low RMSE values indicate that the variation of the values generated by a forecast model is close to the variation of the observation value. Whereas scenario 2 has the highest RMSE value.

IV. Conclusion and Further Research

Assessment evaluation phase in scenarios 1, 2 and 3 exhibited that distance does not significantly affect the estimation results. The main factor in cow weight estimation is the captured image possess complex background. Therefore the segmentation process is bad. The cow object produced by segmentation is very influential in determining the endpoint of the Cow Circumference and Body Length as the main parameters of the cow weight estimation.

The results of research on the development of cow weight estimation software can contribute directly for local farmers to selling of cows easily.

Furthermore, some of the techniques reviewed in this paper can be used as a previous step for another technique. For example, an optimization thresholding method could be the input for an image segmentation. Therefore, it would be our further research.

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Reference

[1] Nahari, R. V., Jauhari, A., Hidayat, R. & Alfita, R., "Image Segmentation of Cows using Thresholding and K-means Method". International Journal of Advanced Engineering, Management and Science, pp. 913-918, 2017.

[2] J. Ch, T. A. Makalew, A. H. S. Salendu, and E. K. M. Endoh, "Analysis of the Advantages of Cow Cattle Selection in Suluun Tareran District, South Minahasa Regency," J. Zootek, vol. 3, no. 2, pp. 18–26, 2014.

[3] W. Fuadi, "Designing the Height Identification System and Taekwondo Kick Using the Chess Board Method," J. Electr. Technol., vol. 1, no. 1, pp. 66–70, 2016.

[4] P. S. Ni, "Balinese script image segmentation on palm oil using cielab method and projection profile," TESIS, pp. 1–103, 2015.

[5] Nahari, R. V., & Alfita, R. "Classification Sensing Image of Remote Using Landsat 8 through Unsupervised Classification Technique (Case Study of Bangkalan Regency)". International Journal of Advanced Engineering, Management and Science, 3(8), 2017.

[6] M. T. Alkautsar, I. B. Hidayat, P. Ir, and S. Darana, "Estimation of Cattle Carcass Weight Based on K-Means Clustering Segmentation using Classification Support Vector Machine Multiclass Method," e-Procedding Eng., vol. 3, no. 2, pp. 1927–1936, 2016.

[7] S. Muliawati, I. Bambanghidayat, P. Ir, and S. Darana, "Carcass Weight Estimation Based on Graph Partitioning Segmentation with KNN Classification," e-Procedding Eng., vol. 3, no. 2, pp. 1895–1901, 2016.

[8] V. Ariesandi, I. B. Hidayat, P. Ir, and S. Darana, "Estimation of Cattle Carcass Weight based on Gabor Wavelet Method and Classification of Support Vector Machine Multiclass," e-Procedding Eng., vol. 4, no. 2, pp. 2084–2091, 2017.

[9] A. Riyanto, R. Kridalukmana, and I. P. Windasari, "Designing Applications for Estimating Cow Weight by Utilizing Cameras on Android-Based Smartphones," J. Teknol. dan Sist. Komput., vol. 4, no. 4, pp. 491–496, 2016.

[10] Nahari, R. V., Jauhari, A. & Alfita, R.," Implementation of Boundary-based Segmentation to Extract Madurese Cow Contour ". Kediri, UN PGRI Kediri, pp. 347-352, 2017.

[11] S. S. Dwika Putra Erwin, "Otsu Segmentation Capability Optimization on Indonesian Vehicle Number Plate Identification using the Gaussian Method," J. Pseucode, vol. IV, no. 44, pp. 47–60, 2017.

[12] N. Qurratu'ain, "Sumba Local Horse Body Weight Deviation Using Lambourne Formula on Body Weight Actual Deviation of Local Sumba Horse Body Weight Between Actual Body Weight Based on Lambourne Formula," Skripsi, pp. 1–13, 2016.

[13] P. Berbagai et al., "Journal of Animal and Plant Sciences," J. Ilmu Ternak dan Tanam., vol. 3, no. 1, pp. 35–40, 2013.

[14] Haifeng, Sima, and Liu Lanlan. "Clustering color image segmentation based on maximum entropy." The 2nd Int. Conf. on Comp. Application and Sys. Modeling. 2012.