QUANTIFICATION OF COW'S BODY PARAMETERS USING COMPUTER VISION

D. W. Lee, H. T. Kim and Y.S. Kim

Dept. of Bio-Mechatronic Eng., Sung Kyun Kwan University
Suwon, Kyunggi-Do 440-746, Korea
E-mail : daeweon@yurim.skku.ac.kr

ABSTRACT

Recent mechatronics technology is the most appropriate high technology in the agricultural application to save repetitious labor. Cow's body parameters were measured by traditional several measurer. Image processing technology was used to measure automatically their parameters to reduce lots of labor and time.

The parameters were measured form a small model cow, which is easily measured, instead to a real cow. The image processing system designed and built for this project was composed of a Pentium PC, and TV frame card two cameras which were located on side and top of model cow. 11 parameters of cow's body were measured and the error between real data and the data by image processing was less than 10%. Based on the results of this research the parameters of a real cow could be measured in the future.

INTRODUCTION

Recent mechatronic technology for agriculture is still growing in number, there appears to be no definitive, economical, agricultural application, especially improvement of cow in livestock production facilities.

Image processing technology for cow to be measured the body parameters would be much more attractive if there was a way to assure that each cow's parameters were measured very well without a mistake. If they were easily measured by using image processing, they help to improve cow's quality and determine whether good or bad cow in their infancy. Currently, the parameters were not measured automatically by new high technology, by the way, they measured by hand with traditional measurer and pelvis measurer as shown in Fig. 1, Fig. 2. The method was required to take so much time and repetitious difficult labor.

Image processing plays an important role in the measurement of cow's parameters. So, the image processing system and image processing algorithms were designed and developed.

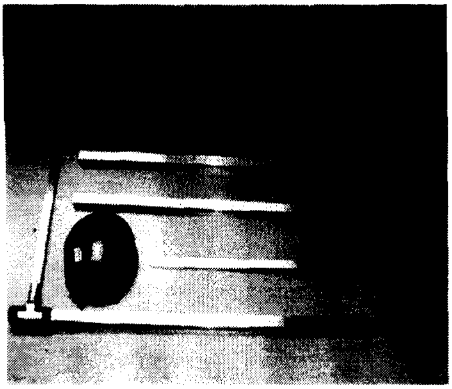

Fig. 1 Cow's Measurer

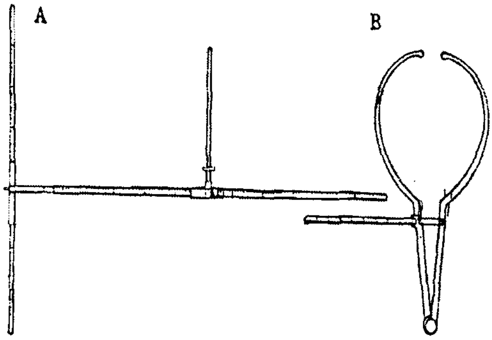

Fig. 2 Measurer (A), Pelvis Measurer (B)

MATERIALS AND METHODS

1. Image Processing System

This study was conducted to measure automatically cow's body parameters which was used for improvement of cow in livestock production facilities. Measurement of her body parameters, which was executed by hand with traditional measurer for her body parameters, needs to take so much time and labor. So, a computer image processing technique was used for a user to measure easily and automatically the parameters. Fig. 3 shows a image processing system which can be measure the parameters of model cow in our laboratory.

The parameters were measured form a small model cow instead to a real cow. A real cow could not be easily measured, since she does not stand but moves during she is measured her parameters. The image processing system designed and constructed for this project was composed of a Pentium PC, and TV frame grabber card two digital-matrix cameras as shown in Table 1. Cameras were set up on side and top of model cow as shown in Fig. 3. The top camera viewed an area 45cm by 25cm at a distance of 30 cm from the surface of the model cow. And also the side camera viewed an area 45cm by 25cm at a distance of 30 cm from its surface. The light source for image detection was overhead fluorescent lamps with 200V and 60W already mounted on the side and top side of the chamber in Fig. 3.

Table 1. Specification of CCD camera

Item	Model	Specification	
CCD Camera	ICD-703 (NTSC)	Pickup Device	1/3" Interline Transfer CCD
		Picture elements	771*492, 380,000pixels
		Scanning system	525 lines/59.94Hz, 2:1 interfaced
		Frequency	H:15.734kHz, V:59.94Hz
		Horizontal Resolution	480 TV Lines
		S/N Ratio	50dB(p-p/rms)
		Shutter	1/60-1/80,000sec.
		Dimensions(WHD)	W70*H60*D140mm

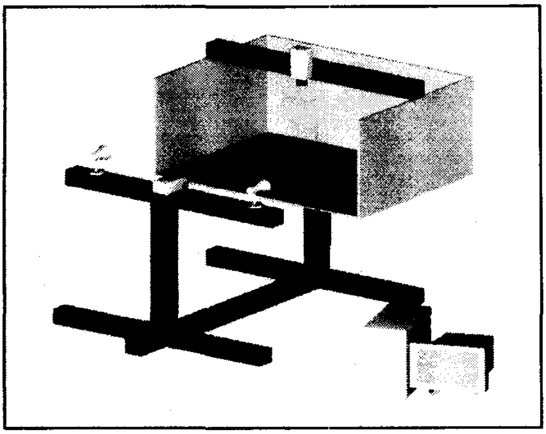

Fig. 3 Image Processing System

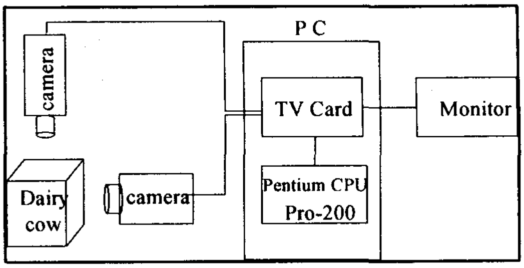

Fig. 4 Block Diagram of the Image Processing System

2. Materials

Compared a real cow with the model cow, the size of a model cow(see Fig. 5) in the laboratory is about one tenths of those of a real cow. The values of her body parameters were measured form model cow by using venire calipers and tapeline, is shown in Table 2.

Fig. 5 Model Cow

Table 2. Body Parameters of the Model Cow

Type	Chest girth	Withers height	Hip width	Chest depth	Slope body length	Thurl width	Rump length	Chest width	Pelvic arch height	Pin bone width	Body length
(cm)	25.0	15.1	6.2	9.0	18.0	5.8	5.9	6.0	14.2	3.0	16.5

3. Algorithm of cow body parameters

3-1. Subtractive calculation

The frame grabber board can digitize, display and process multiple images with spatial resolution of 640 x 640 pixels with 0 (black) to 255 (white) intensity levels. However, the computer monitor screen had a spatial resolution of 248 x 248 pixels. All image processing functions were performed on the whole image, even though the monitor could not display all of the resulting information.

Since the illumination was not evenly distributed across the image, it was necessary to compensate the intensity values of an image for the anomaly. In order to compensate the an image with noises, two cameras captured the first image from background, and then captured at once the second image of both cow and background. If the second image (which has both object and background mage) were subtracted the first image (which has only background mage), the subtracted image should be exited the background image. However, the subtracted image had not only the object image, but also the noise image.

The intensity value of a pixel, which was obtained a subtractive image, was less than the intensity value of the second original image, or less than intensity value zero. In the case of less than intensity value zero, it can not see the image in a computer monitor.

Subtractive calculation takes a role of diminishing brightness, since the intensity value of a resulted image is less than that of an original image. The image brightness could be represented in the monitor if the reduced value reached to minus. The Subtractive calculation function is represented as equation (1)

$$\text{Output}(x, y) = \text{Image I}(x, y) - \text{Image II}(x, y) \quad \cdots\cdots\cdots\cdots\cdots (1)$$

Where image I is the image with both object and background image, image II is the image with only background image, and x, y are the pixel position of the image.

Subtractive calculation between the intensity values of two images divided by two methods. One is absolute value that subtracts the value of one image from another image. The other is to remove unwanted values, which are more than 256, or less than 0 values. Two method of subtractive calculation can be obtained from the equations (2) and (3).

$$\text{Output}(x, y) = \left| \text{Image\_1}(x, y) - \text{Image\_2}(x, y) \right| \quad \cdots\cdots\cdots (2)$$

$$\text{Output}(x, y) = \text{Image\_1}(x, y) - \text{Image\_2}(x, y) \quad \cdots\cdots\cdots (3)$$

On processing of calculation with pixel in the computer image processing, The output value is made by using the way of Saturation and Wrap shown in Fig. 6.

Saturation method is the way to be expressed the value 255 for the value over 255, Wrap method is the way to repeat from 0 to 255 value in the cycle of 0~255.

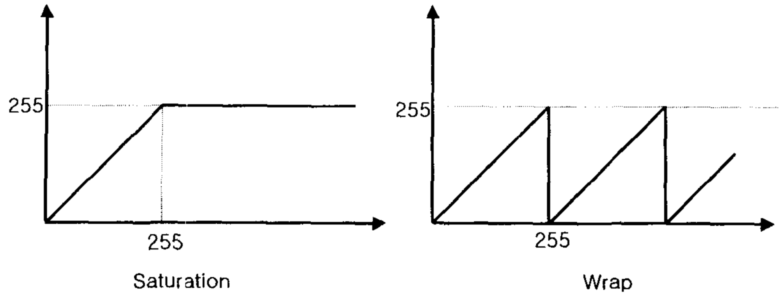

Fig. 6 The Methods of Saturation and Wrap

In this study, cow's body parameters were calculated by using subtractive calculation in the use of each pixel's intensity value information. It made easily not only to decrease unwanted image but also to decrease the noises that were made for processing the cow image.

3-2. The Algorithm for Removing Noises.

In the process of removing the unwanted components of images, the image techniques made the noises and blurred edges and other sharp detail. Development of this algorithm grew out of the need to study ways to bur them and remove noises generated by small noise particles in this study.

Two intersecting lines, one vertical and one horizontal, appeared on the screen of the monitor. Both the number of pixel of one vertical line and one vertical line were 248. As processing a image with subtractive calculation, the image divided by two part image, object image and the background image. In the one vertical line, the first pixel and the last pixel that were included the object image was found. And then, the first pixel and the last pixel were connected on the vertical line. Whole pixels between the first pixel and last pixel were connected was made to contain them in the object image. The whole vertical lines was processed by using the same method, like those in shown in Fig 7.

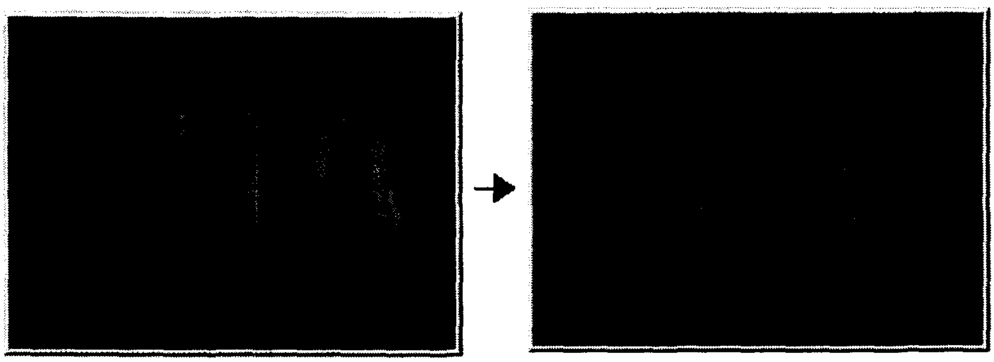

Fig. 7 Comparison of the effect of the image and the processed image

This method helped to quantify cow's body parameters, and reduced noise and other spurious effects that occurred in images as a result of quantifying, transmitting or disturbances in the environment during acquisition. However, the use of this method results in the loss of background image data.

3-3. Calculation of the size of the image pixel

In the image processing system, a CCD camera was used lens of 4.8mm 1:1.8. Fig. 8 shows relationship between pixels of whole image and the actual size of a cow's body parameters to compare the distance between the camera and actual cow.

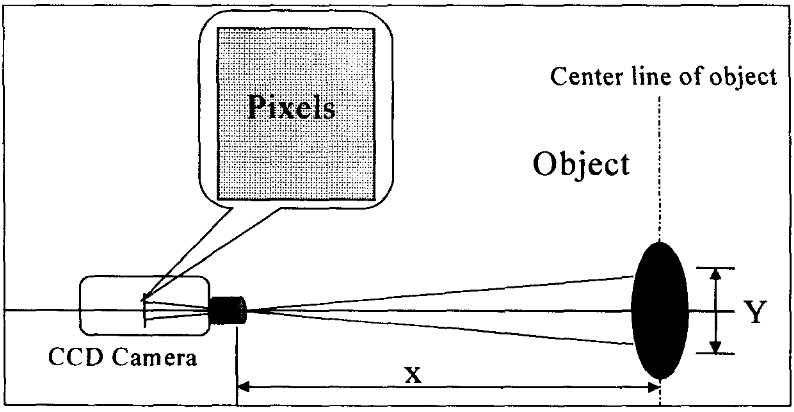

Fig. 8 Camera Calibration

Correlation between pixel number and actual distance from camera to cow can be obtained from the equation (4).

$$Y = e^{(0.0693x-3.8712)} \quad \cdots\cdots (4)$$

where,

Y = actual size per one pixel (cm/pixel)

X = distance between camera lens and center of cow's body (cm)

Using the equation (4), we measured the model cow's body parameters in the use of the distance between the camera and cow.

4. Detection of a Cow's Body Parameters

Software, written in visual C+ + of Microsoft, combined the functions of image capture, image processing, and measurement of cow's body parameters. The program was a menu driven program to measure body parameters of model cow's body. In order to detect her parameters, the line like those in shown in Fig 10, which a threshold point between background image and object image was connected was used. Four critical points were obtained by using of the first order differential (inclination) of the line. Four vertical lines in Fig. 9 were used to quantify her parameters. The projective area of one parameter was obtained the numbers of pixel within her one parameter in the object image. Fig. 10 gives the flow chart showing the sequence of operations followed in calculating the model cow's body parameters.

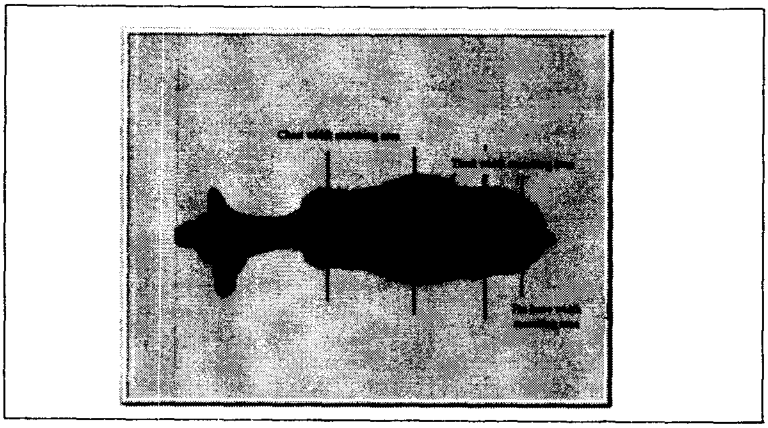

Fig. 9 The Projective Object Image form Top View Camera with Four Characteristic Lines

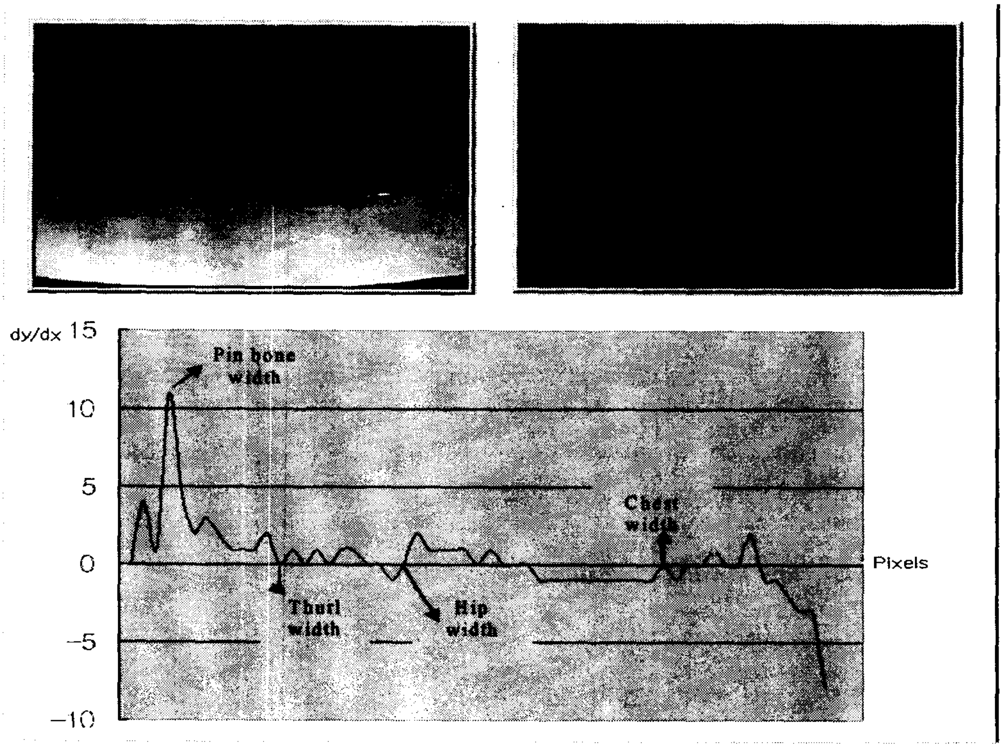

Fig. 10 Intensity Profiles Taken from the Prospective Line in the Top-view Image

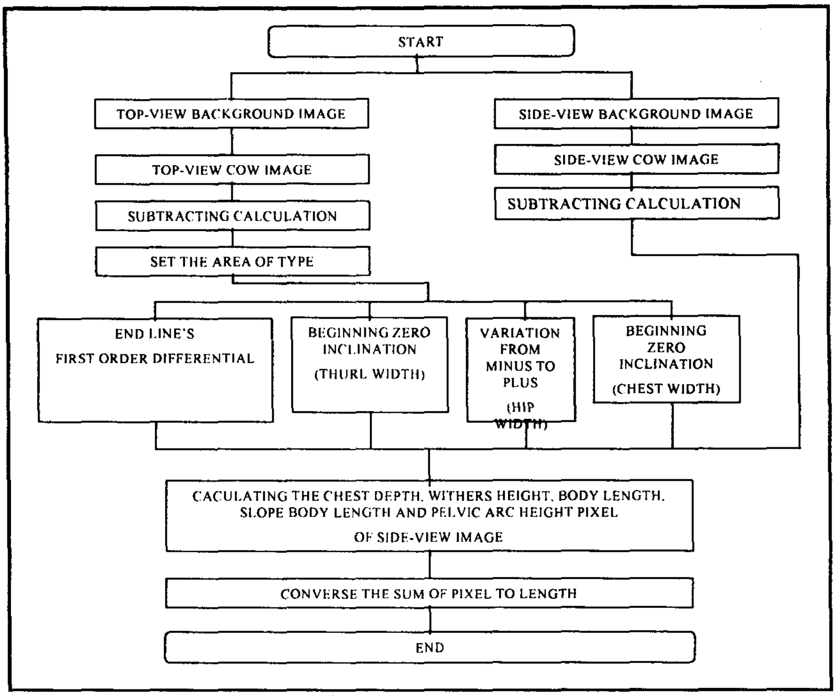

Fig. 11 Algorithm of detecting program

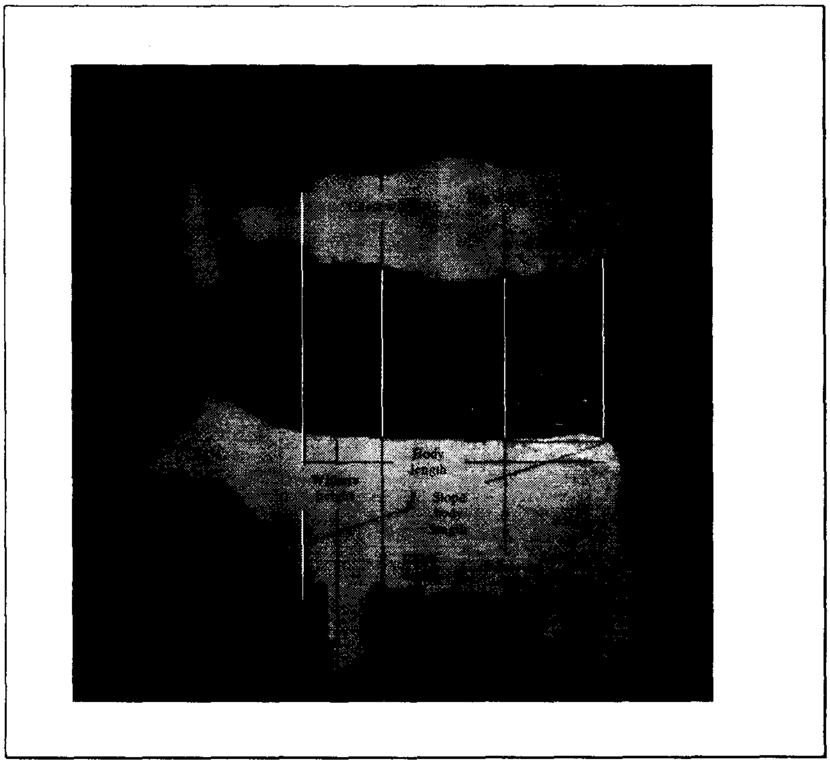

Fig. 12 Detection of Characteristic Cow's Parameters of the **Projective Object Image with Four Characteristic Lines**

RESULTS AND DISCUSSION

Three image processing techniques were used to enhance computer vision detection of model cow's body parameters in the computer processing system in the image processing laboratory. Table 4 shows eleven body parameters of model cow were measured in the image processing system .

Table 3. Cow's Body Parameters Measured with the Model Cow

Parameter	Chest girth	Chest depth	Withers heights	Body length	Slope Body length	Rump length	Chest width	Hip width	Thurl width	Pelvic arch height	Pin bone width
Measured value (cm)	25.0	9.0	15.1	16.5	18.0	5.9	6.0	6.2	5.8	14.2	3.0
Calculated value (cm)	24.2	8.9	15.4	17.0	18.6	6.2	5.6	7.1	6.1	14.9	3.5
Aberration	0.8	0.1	-0.3	-0.5	-0.6	-0.3	0.4	-0.9	-0.3	-0.7	-0.5

CONCLUSIONS

Body parameters of cow are important element to select and breed cow. However, the measurement of parameters needs to take a lot of labor and time. Cow's body parameters were conducted to measure by using digital image processing with the image processing algorithm. Based on the results of this research the following conclusions were made:

1. The errors between measured values of 11 parameters of the model cow and calculated value by the image processing algorithm were within 10%. They did not exceed the errors that generated to measure them by hand.

2. Compared the hip width by hand with by image processing, It had much more different than any other parameter. In order to diminish error of body parameter of cow.

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