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Determination of Body Measurements of a cow by Image Analysis

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Abstract: *In this study, the subject is to determine the body measurements of a Holstein cow from its photographs with image analysis. For this operation, an environment for taking the photograph, a platform and 18 points with certain coordinates were prepared. Afterwards, the photos of a Holstein cow was taken on the platform by a Nikon D100 CCD camera from various directions. The photos were analyzed by PhotoModeler 5 software. The results of this image analysis were compared to real results that were previously measured. It was found out that the real measurements and measurements obtained from photos are close to each other which shows that this method can be safely used*

Key words: *Image analysis, Close Range Photogrammetry, Holstein Cows*

INTRODUCTION

Seeing with computer is a science which allows information to be investigated by computer theoretically and algorithmically over a image or image sets. It includes concepts related with objects on the image, their positions and dimensions. Numerical image processing method has been applied in many fields including animal husbandry. Digital image processing and analyzing methods supported by computer have many advantages like saving time, accuracy and economy [1, 7].

In digital image analysis, generally a new image is not obtained as a result of the operations but classifications can be made and statistics can be produced related with the images. The parameters related with objects are measure with digital image analysis. (Shape, length, area, angle, relative location, grey-tone value, RGB colour values, etc...) [1].

In raw digital images, measurements such as area and length can be made in pixels. In order to make these measurements in metric system, the reference points on the image whose metric equivalents are known should be described by software (Spatial calibration) [1, 4].

In literature, there are many successful applications in husbandry field by using this method. Some of these are, comparing 5 horses by croup angle, monitoring the growth of a pig by measuring its area, the relation between body dimensions of alive pigs with their skeleton composition, the monitoring of pig development in means of size and shape, determination of carcass properties of broilers, determination of egg quality changes, obtaining 3D shapes of pigs with stereo photogrammetry, monitoring the daily growth amounts of broilers, determination of meat quality and weight of cattle [1-8].

In cattle breeding, weight can be considered as one of the indicators of the care, nutrient requirements and feeding level applied in the facility and the general condition of the animal. In figure (fig.) 1, the milk efficiency, bait consumption and weight changes of a cow between two birth periods. It is necessary nd important to monitor these periods. Getting out of these limits effect the immune system and economic efficiencies of the cows. Especially the negative changes in weight may object to health problems, inappropriate environment conditions and feeding faults [6, 19].

Weights of cows are determined with a scale. However sometimes a weighing place should be built in some facilities or weighing platforms should be placed on their way. Some problems may occur in operation or calibration of scales due to environmental conditions. Crew may be necessary to handle the animals during weighing operations. Although a weighing operation with low stress level is aimed, sometimes animals can even be wounded. For these reasons, facilities prefer to perform rarely or not to perform weighing operation in stead of sparing money and crew for it [10].

Due to the cost, crew, danger, stress problems in determining weight, method of guessing weight from dimensions is being applied for a long time [9].

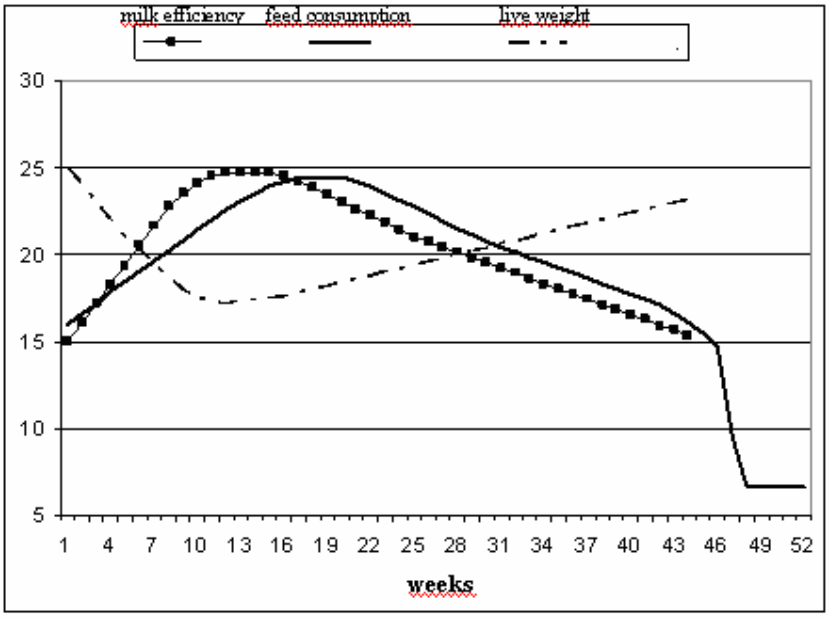

Fig. 1. Period between two births of a cow

The basis of this study is to prevent problems for cow and crew during weight determination. Especially in big herds, weight monitoring is a must and the aim of the study is making sure that the weight determination is made in necessary frequencies. For this purpose it is based on taking the photos of the cows from different distance and dimensions. The purpose is to find real body measurements and guessing the body weight by analyzing and evaluating the obtained digital images with the help of software formed by digital image analysis method.

MATERIAL AND METHOD

In this study, close range photogrammetry method was used in determination of body measurements of a cow.

Digital Close Range Photogrammetry

Photogrammetric techniques, measuring objects from photographs, have been utilized since the late 1800s. These methods are most commonly used for mapping large areas from aerial photographs. Digital close range photogrammetry is a technique for accurately measuring objects directly from photographs or digital images captured with a camera at close range. Multiple, overlapping images taken from different perspectives, produces measurements that can be used to create accurate 3D models of objects [11]. Knowing the position of camera is not necessary because the geometry of the object is established directly from the images.

Photogrammetry technigues allow you to convert images of an object into a 3D model. Using a digital camera with known characteristic (lens focal length, imager size and number of pixels), you need a minimum of two pictures of an object. If you can indicate the same three object points in the two images and you can indicate a known dimension you can determine other 3D points in the images [12-14].

The photogrammetric 3D coordinate determination is based on the co-linearity equation [15] which simply states that object point, camera projective centre and image point lie on a straight line. The determination of the 3D coordinates from a definite point is achieved through the intersection of two or more straight lines. Therefore, each point of interest should appear in at least two photographs (Fig. 2) [16]. Later, coordinates are measured from 3D model which is constituted by photogrammetric software.

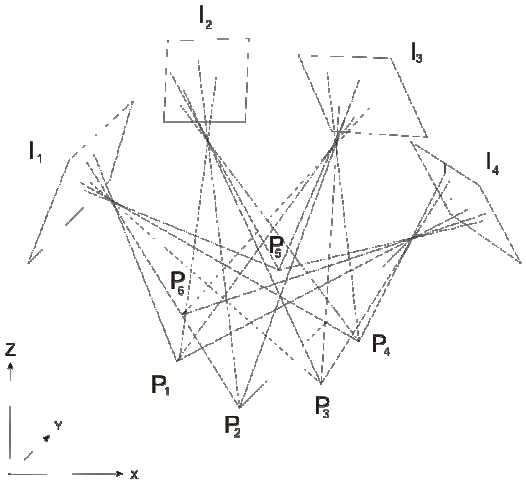

Fig. 2. Coordinate of object points (Pi) by triangulating bundles of observation rays from different image planes (Ii)

Compared to classical methods, digital close range photogrammetry is efficient and rapid, significantly reducing the time required to collect data in the field. Measurements collected in less than three days in the field would have taken 10 days in a classical survey. Second, it was considerably safer. All surveyors can able to obtain precise measurements without physically accessing each measurement point. Third, the method is non-intrusive, creating minimal impact on traffic flow. Finally, the process produced a comprehensive visual record of existing site conditions from which any identifiable features can be measured or geometrically assessed at a later date. Digital close range photogrammetric methods have been successfully applied to projects in archaeology, architecture, automotive and aerospace engineering, accident reconstruction and etc. disciplines [14, 17].

The same process can be used to obtain dimensional measurements efficiently on inaccessible structures such as tunnels and dams, and large or complex facilities such as refineries or water treatment plants. Digital close range photogrammetric measurements can be integrated with 3D modeling and reverse engineering processes. The acquired data is infinite and the cost savings substantial [13, 18].

The first operation is taking the photos or obtaining the photos to be analyzed. A platform was built in the Hollstein cow barn in Dairying and Animal Nursery unit of CUMPAS A.S.in Cumra district. A platform was built the first time in terrain so there were some difficulties. 18 points with certain coordinates were selected (Figure 3) and 3D XYZ coordinate measurements were made (Table 1). Then cow was placed in a location on the platform including the points. Photos of the cow were taken with a Nikon D100 camera from different directions and were recorded to computer. In the mean time real distances between points (Table 2) and dimensions of the cow (Table 3) were measured in order to verify the accuracy of the analysis results. The analysis of the photos was made by PhotoModeler 5 (Figure 3) programme by using photogrammetric methods. Analysis results were compared with the real results and it was seen that the two results are close to each other. (Table 2).

The next step was the determination of the real cow weight by using the measurements made by statistical regression equation Eq. (1) Body weight was guessed by only using the body length.

$$\text{Live Weight}=0{,}0005576*(\text{Body Length})^3-0{,}1714(\text{Body Length})^2+21{,}76*(\text{Body Length})-901{,}39 \quad (1)$$

Tablo 1. Determined Points ve 3D XYZ coordinates

Point number	X (m)	Y (m)	Z (m)
1	500,832	504,513	500,494
2	499,851	503,963	500,226
3	498,451	503,625	500,408
4	498,689	503,747	501,686
5	499,571	504,076	501,669
6	500,226	504,315	501,661
7	500,277	505,371	502,076
8	499,874	505,253	502,144
9	499,279	505,051	502,190
10	498,684	504,849	502,157
11	498,285	504,614	500,641
12	499,297	505,056	500,272
13	498,736	504,878	500,263
14	499,853	505,252	501,557
15	500,276	505,374	501,556
16	499,281	505,054	501,546
17	498,704	504,841	501,579
18	499,200	503,739	500,210

Tablo 2. The real and analysis dimensions between the points

Point number	Point number	Real dimension (cm)	Analysis result (cm)
1	2	115,3	114,4
2	3	77,9	78,5
2	18	68,6	67,3
3	4	130,5	131,2
4	5	94,1	93,0
5	6	69,4	70,6
7	8	42,5	42,0
8	9	63,0	62,1
9	10	62,6	61,3
14	15	43,7	44,5
14	16	60,7	61,7
16	17	61,4	61,8
12	16	128,0	128,8
15	17	165,8	166,9

Tablo 3. Real and Analysis dimensions of the Hollstein Cows

Measured region	Real dimension (cm)	Analysis result (cm)
Body length	160,2	161,1
Hip width	142,0	140,9
Wither height	135,6	136,4

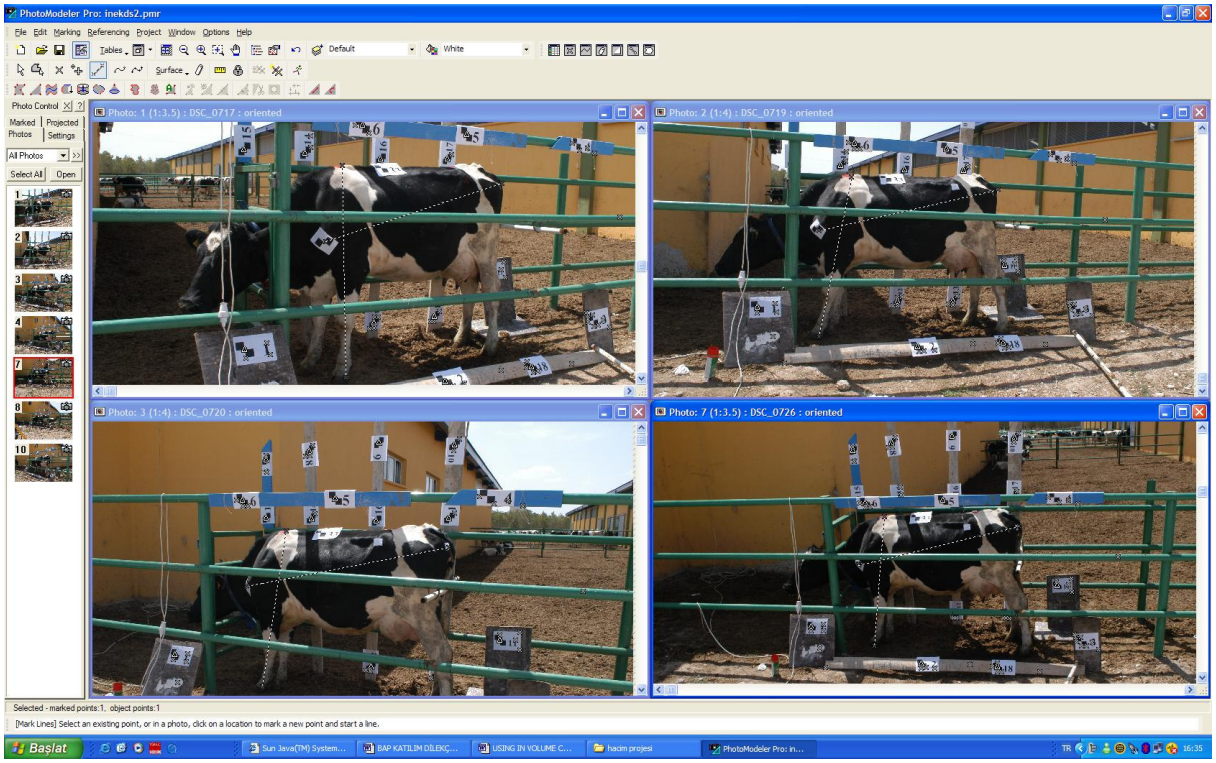

Fig. 3. Analysis made with PhotoModeler software

CONCLUSIONS AND FUTURE WORK

In this study, it was shown that real cow measurements can be obtained by using photogrammetric method and image analysis operation. The cost, difficulty, crew, danger and stress problems during weighing animals by scale will be solved by using numerical image analysis method. Especially it will be advantageous in big farms where animal growth has to be monitored daily by weighing

These advantages;

- Saving people from boring and time consuming work and being fast. (saving time)
- Automation of many operations which require manpower with high cost and being economic
- Saving continuous data which will allow future analysis.
- Removing the difficulties and stress during the weighing operation of the animals.

Photogrammetric methods may be considered as expensive and luxurious for people having few animals, but its advantages as an efficient alternative method, are certain for big facilities. Besides it can also be used for different disciplines and other animals. For weigh guessing from body dimensions, methods other than regression can be used such as artificial intelligence.

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