ESTIMATION OF CATTLE CARCASS WEIGHT USING LASER SCANNING

Rafael V. de Sousa [1*], Luciane S. Martello[1], Rubens A. Tabile[1], Ricardo Y. Inamasu[2] and Saulo L. Silva[1]

[1]Faculty of Animal Science and Food Engineering, University of São Paulo, Pirassununga-SP, Brazil;

[2]Embrapa Instrumentation, Brazilian Agricultural Research Corporation – Embrapa, São Carlos-SP, Brazil.

*Corresponding author email: rafael.sousa@usp.br

Abstract – The evaluation of the hot carcass weight of the cattle is an important parameter in animal production processes. The objective of this work was the development a sensor system based on laser scanner to estimate the hot carcass weight in advance. An experiment with 55 Nellore cattle confined was performed for allowing the 3D scanning of the dorsal part of which animal. A filtering algorithm and a predictive model based on artificial neural network were developed for estimation of hot carcass weight thirty days before slaughter. The correlation between the measured and estimated carcass weight was 0.9, evidencing the potential of the proposed platform as a non-invasive tool for estimating the carcass weight.

Key Words – non-invasive, 3D scanner, body measurement, artificial neural network, predictive model.

I. INTRODUCTION

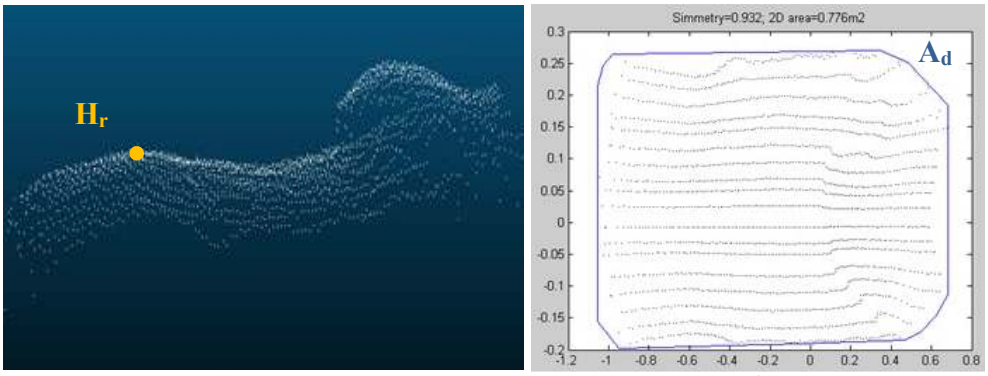
The possibility of estimating carcass weight weeks before slaughter has a great potential to contribute to increased profits for managers [1]. Earlier, some in vivo methods used animal body measurements for estimating live and carcass weight [2][3]. At present, some estimating live weight methods based on non-contact measurements are being investigated to avoid the stress behavior of animal. Specifically, the use of digital images captured by cameras has been successfully applied [4][5]. However, one of the challenges of using such technologies is the sensitivity of cameras to change in luminosity mainly in outdoor applications. In this case, laser scanner has potential of being used due to it uses emitted light, so it works independent of the ambient light. In addition, laser scanning approach provided more accurate results than image-based modeling [6]. The objective of this work was the development of a sensor system to estimate the cattle carcass weight based on body measurements by laser scanning during feedlot.

II. MATERIALS AND METHODS

A sensor platform based on a two-dimensional (2D) laser scanner associate with an encoder for allowing the three-dimensional (3D) scanning of the dorsal part of 55 Nellore cattle confined generating a cloud of points. The platform was installed at 3.0 meters from the floor in the access corridor of a cattle crush. Thirty days after the measurements, the animal were slaughtered and the weight of the hot carcass were measured. The cloud of points of each animal was manually filtered through the CloudCompare software (www.cloudcompare.org) to remove the points of objects from the scene and the points related to the head and the lower parts, keeping only the points of the back of the animal. An algorithm was constructed using Matlab software (The Mathworks Inc., Natick, USA) applying the functions “delaunay” and “convhull” for obtaining the cattle rump height H_r and the area of the dorsal top view in plane projection (A_d). Finally, a predictive model based on artificial neural network was developed for estimation of hot carcass weight (C_w). The neural model was non-feedback architecture, multi-layered and supervised learning. The supervised training was done with 60% of the data, taking as inputs the variables H_r and A_d to estimating the C_w output. The Levenberg-Marquardt method and a maximum of 1000 iterations were used for the training. The 10% of the data were used for the validation step and the remaining 30% for the test step (unseen data). The predictive model performance was evaluated by comparison between the estimated and measured values using the linear correlation (r).

III. RESULTS AND DISCUSSION

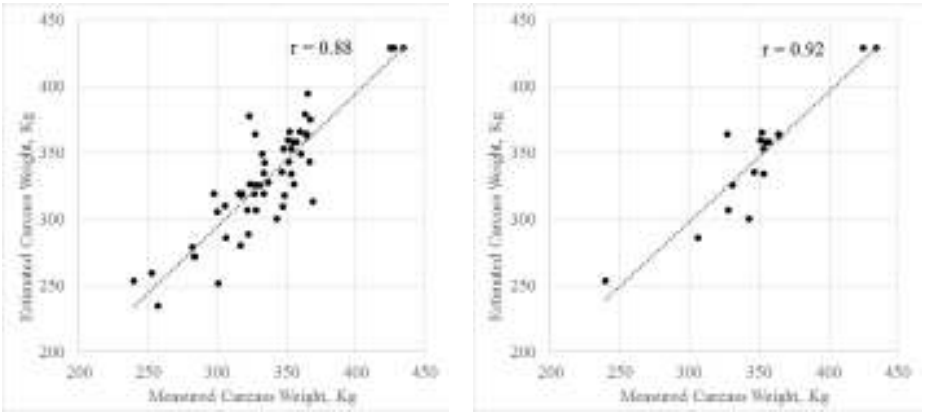
The Figures 1a and 1b illustrates respectively the 3D scanning and top view in plane projection of the cattle dorsal part after the process of manually filtering of the cloud of points. It is highlights the parameters H_r e A_d that are provided automatically by the developed algorithm.



(a) (b)

Figure 1. Cloud of point of the cattle dorsal part: (a) 3D scanning highlighting the rump height point - H_r; (b) the top view in plane highlighting the 2D area - A_d.

The result of the comparison of the Cw between measured and estimated value for all data is shown in Figure 2a (r= 0.88) and reinforces the feasibility of the proposed model. The Figure 2b is related to the unseen data (30%) of the test step. It presents linear correlation of 0.92 and shows the generalization capability related to its ability to have a persistent performance on unseen data.



(a) (b)

Figure 2. Relationship between estimated and measured carcass weight for (a) 100% of data and (b) 30% of data for test step.

IV. CONCLUSION

A sensor platform associated and a predictive model based on artificial neural network was proposed and evaluated for assessing the cattle hot carcass weight. The positive correlation between the measured and estimated carcass weight evidences the potential of the proposed platform as a non-invasive tool.

REFERENCES

1. Abdelhadi, O. M. A., Babiker, S. A. & Kijora, C. (2011). Estimation of zebu cattle carcass weight using body measurements. Livestock Research for Rural Development 23 (1).
2. Bennett, J. A. (1951). Value of body measurements for estimating weight and condition of steers. Farm Home Science (Utah Agriculture experiment station), 12-30.
3. Hedrick, H. B. (1983). Methods of estimating live animal and carcass composition. Journal of Animal Science 57: 1316–1327.
4. Indurain, G., Carr, T. R., Goni, M. V., Insausti, K. & Beriain, M. J. (2009). The relationship of carcass measurements to carcass composition and intramuscular fat in Spanish beef. Meat Science 82: 155-161.
5. Shi, C., Teng, G. Li, Z. (2016). An approach of pig weight estimation using binocular stereo system based on LabVIEW. Computers and Electronics in Agriculture 129: 37–43.
6. Golparvar-Farda, M., Bohnb, J., Teizerb, J., Savaresec, S., Peña-Morad, F. (2011). Evaluation of image-based modeling and laser scanning accuracy for emerging automated performance monitoring techniques. Automation in Construction 20 (8): 1143-1155.