‘Smart’ Buffalo Weight Estimation via Digital Technologies: Experiences from South Italy

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Abstract. The present work aims at describing a viable “protocol” for unobtrusive direct/indirect monitoring of biometric parameters for the estimation of body conditions on Mediterranean Buffalo populations, using low-cost automated systems i.e., smart cameras endowed with depth perception capabilities.

Keywords. Public Health Informatics, Precision Livestock Farming, Mediterranean buffalo, Smart cameras, 3D/2D image analysis

1. Introduction

Precision Livestock Farming (PLF) is reported as a declination of Public Health Informatics \cite{1,2} focused on the application of process engineering principles and techniques to livestock farming in order to an automatic supervision, modelling, and management of animal production. About one ninth of the global cattle population is composed by an essential domestic bovid, the so-called water (or river) buffalo (\textit{Bubalus bubalis}) \cite{3}. In South Italy the whole Buffalo–related dairy production and supply chain represents a leading sector of the entire Agri–food arena, and the awareness is currently increasing about the importance of a data-driven livestock management to cope with the complexity of decision-making processes. The present study a set of Machine Learning–based algorithms were deployed on the set of measurements obtained by a combination of three low-cost smart cameras endowed with depth perception capabilities, and compared with traditionally hand-performed measurements, on Mediterranean Buffalo calves from the birth to their complete weaning.

2. Materials and Methods

The trial lasted 90 days (13 weeks) and was carried out in the period June-September 2022. A longitudinal observational study was conducted on 30 female buffalo calves, from their birth up to the weaning phase. To predict body weight, for each of them every

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week the following three biometric measurements were taken: (i) height at the withers (WH) i.e., vertical distance between the withers (highest point of the back, between the neck and shoulder blades) and the ground; (ii) body length (BL) i.e., oblique distance between the tip of the buttock (apophysis of the ischium) and the tip of the shoulder (shoulder joint); (iii) chest girth (CG) i.e., minimum value measured just behind the shoulders. Two Intel® RealSenseTM cameras (Depth camera D415 and LiDAR camera L515) along with a RICOH® WG–60 photo camera, were used for measuring WH and BL. Three different models – Multiple Linear and Polynomial Regression (MLR/MPR), and Artificial Neural Network (ANN) – were implemented (and compared) to predict the progression of calves’ body weight during the trial, starting from the body measurements taken [4].

3. Results

2195 single evaluations of WH, BL, CG, and body weight were performed. Mean Squared Error (MSE), Root MSE (RMSE), and Pearson’s R² goodness-of-fit criteria were used to evaluate the performance of the model. For what concerns WH the lowest values for both MSE and RMSE appear to be those related to L515 (AVGMSE=11.41; AVGRMSE=3.02). The result is only apparently better, given the smaller number of measurements taken with this tool, thus returning more reliable values than those from D415 (AVGMSE=15.03; AVGRMSE=3.72). BL features instead an overall better trend of D415 (AVGMSE=29.78; AVGRMSE=3.99). Besides the manual measurements, the best prediction is the one performed by means of ANN, starting from the measurements taken with the Stereo camera D415.

4. Discussion and Conclusions

The experimentation conducted aimed at proposing, formalizing, and testing a viable "protocol" for unobtrusive direct/indirect monitoring of biometric parameters for the estimation of body conditions on Mediterranean Buffalo populations, in order to: (i) figure out the most timely measurement tools to be used to correctly estimate and predict the weight trajectories; and (ii) verify the suitability of the adoption of an electronic measurement system to achieve best practices in Precision Livestock Breeding, thus showcasing that the continuous improving of the Smart Farming sector is meant to widen Public Health Informatics policies and strategies [5].

References