RESEARCH ABSTRACT
ANIMAL SCIENCE

Title: Accurate and Rapid Assessment of Pig Body Weight **– NPB #19-208**

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Scientific Abstract

Body weight measurement of pigs is essential for monitoring performance, welfare, and overall production value. Substantial economic and production losses occur when marketed pigs are too heavy or too light. Direct weight measurement provides the most accurate results; however, it is time-consuming, often leads to increased animal stress, and decreases overall production performance. Additionally, common subjective visual evaluations, even when conducted by an experienced caretaker, lack consistency and accuracy. Optical sensing systems using 3D cameras have been proposed as alternative methods for estimating pig weight, but studies examining these systems only focus on top-view images. A multitude of methods have historically been tried and evaluated in terms of accuracy and practicality. These include but are not limited to body measurements, individual or pen scales, human observation, and cameras. Ultimately, producers need a simple method that requires minimal human input, minimizes stress on the pig, and is accurate enough to reduce sort loss. The objective of this study was to validate new weight measurement technologies and determine their usefulness on swine farms. Accuracy of three methods were evaluated: human observation, a walk-across platform scale (CIMA; Correggio, Italy), and PigVision mounted cameras (Asimetrix Inc.; Durham, NC). Additionally, the application of a novel, handheld, portable RGB & stereo vision system for estimating pig body weight rapidly using images from various angles was also evaluated. In the first study, a trained individual selected pigs estimated to be market weight at two sites. Site one had 468 pigs and an accuracy of 84.4%, site two had 522 pigs and an 82.5% accuracy. Accuracy was measured by whether the pig was marked correctly in the market weight range. In addition, both RGB and depth data were collected using an Intel RealSense camera from these pigs. Our proposed method then used maskRCNN for pig detection and region of interest (ROI) definition using the collected RGB data. The maskRCNN output was then applied to depth maps to compute cloud points for each region. A 3D generative model was used to identify latent features from each point cloud, which were then used to estimate pig weights. Three regression models (SVR, MLP and AdaBoost) were examined and compared to two

baseline models (median prediction and linear regression between heart girth and weight). Using 10-fold cross validation MAE, all three models performed better than the median prediction model (MAE = 27.109), but worse than the linear regression between heart girth and weight (MAE = 8.954). Out of the three models under consideration, SVR performed best with an MAE of 20.440, and when tested on unseen data had an MAPE of 7.5442% and an R^2 of 0.4167. However, this still fell short when compared to the linear regression (heart girth and weight) baseline model (when tested on unseen data, MAPE = 3.3468%, R^2 = 0.8621). A 16-week study was then conducted to determine PigVision camera accuracy over time from placement to market. Cameras were mounted above 12 pens. Weights were validated every two weeks. PigVision and the walk-across scale accuracy were measured by the difference in the recorded weight from the device and the calibrated scale weight. The accuracy for pigs that weighed 32.7 kg (87.7%) was lower ($P < 0.05$) than the accuracy for pigs that weighed 117.5 kg (97.6%) or 125.7 kg (96.6%). The overall accuracy from placement to market was 94.1%. A final study at market compared visual evaluation, the walk-across scale, and PigVision. A total of 91 pigs were weighed with each method. The accuracy for the walk-across scale was 98.2%. The walk-across scale did not register a weight for six pigs. Final accuracies were 88.2% for visual evaluation, and 96.6% for PigVision. Human observation is the chosen method in many operations today yet offers the lowest accuracy. The walk-across scale is easy to operate but requires tactical animal movement. PigVision is the least arduous option, provides constant data, but does require maintenance. The research improved rapid pig body weight estimation methods by combining both deep learning outputs and handcrafted features to provide economic benefits to swine producers through the development of a novel, handheld, mobile technology.