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Estimation of live muscle scores of pigs with RGB-D images and machine learning

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Muscle grading of livestock is a crucial component of valuation in the meat industry. In pigs, the muscularity of a live animal is traditionally estimated by visual and tactile inspection from an experienced assessor. In addition to being a time-consuming process, scoring of this kind suffers from inconsistencies inherent to the subjectivity of human assessment. Alternatively, accurate and noninvasive computer-driven methods exist for determining the carcass composition of a live pig, like MRI scans, CT scans, and dual-energy X-ray absorptiometry (DXA). These methods, however, are costly and time-intensive. And despite being non-invasive, they still require extensive handling of the animal by means of restraint or sedation. We propose a method that is fast, inexpensive, and non-invasive for grading the muscularity of pigs, using depth images and machine learning. We used morphological features extracted from depth images of the pigs to train a classifier that estimates the muscle scores given by the assessors. The images were obtained from a Kinect v1 device which was placed overhead an aisle through which pigs passed freely. The Kinect device contains an RGB camera and an infrared depth camera. The latter captures images in which pixel intensities correspond to the distance from the object to the camera. This leads to high contrast between the pig's body and the background, leading to easier separation and allowing further processing and feature extraction. The data came from 3246 pigs, each having 20 depth images, and assigned a muscle score from 1 to 7. Classification based on morphological features of the pig's body shape – using a gradient boosting classifier – resulted in an average classification accuracy of 0.45, and a mean absolute error of 0.65 in 10-fold cross validation. Notable is the fact that the majority of the errors correspond to pigs being classified in the adjacent muscle score of the ground truth label given by human assessors. Based on discussions with domain experts the results that we obtain are very promising and may be considered comparable to the human expert performance.