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Multiple Behavior Classification of Cage-Free Laying Hens Using Deep Learning

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Abstract

The welfare status of hens in cage-free houses is associated with different behaviors they perform, such as feeding, drinking, pecking, perching, bathing, preening, foraging, etc. We developed and tested a deep-learning method to track and classify poultry behaviors using the models we developed. YOLO (You Only Look Once) is an advanced object detection technology with many advantages, like high accuracy, fast speed, and small size. It has been used in face recognition, image recognition, and object detection. A YOLO-based deep learning model, i.e., YOLOv5s_BH, YOLOv5x_BH, and YOLOv7_BH, was developed to track the poultry behaviors of laying hens in cage-free facilities. A dataset of 1500 training images, 500 validation images, and 50 test images was collected to build the model for tracking behaviors. After training our model on the behavior dataset, results show that the model can automatically and effectively detect poultry behaviors with a predicted bounding box, including an objectness score ranging from 0 to 1 in test images. The YOLOv5s_BH shows good precision performance, achieving 78.1%, which is higher than both the YOLOv5x_BH and YOLOv7_BH by 1.9% and 2.2%, respectively. On the other hand, the YOLOv5s_BH has a recall of 71.7%, which is better than both the YOLOv5x_BH and YOLOv7_BH by 1.9% and 2.8%, respectively. Additionally, the YOLOv5s_BH has a mean average precision (mAP) of 74.6%, which is higher than the YOLOv5x_BH and YOLOv7_BH by 2.6% and 9%, respectively. All models performed well with high detection precision; however, model performance is affected by the stocking density, varying light intensity, and images occluded by equipment like drinking lines, perches, and feeders. This study provides a reference for cage-free producers that poultry behaviors can be monitored automatically.

Keywords: Poultry Behaviors, Cage-free housing, animal welfare, precision monitoring.