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Artificial Intelligence Technologies for Monitoring Poultry Pecking

Abstract

US Egg production is transitioning from the conventional cage to the cage-free system. While the cage-free system allows birds to perform natural behaviors such as dustbathing, foraging, and perching, an inherent challenge is feather pecking, one of the primary welfare issues in commercial cage-free hen houses as that can seriously reduce the well-being of birds and cause economic losses for egg producers. The objectives of this study were to develop a machine vision method and test the performance of new models in tracking the pecking behaviors and damages in cage-fee hens, and improve the detection accuracy of the model. Two deep learning models compared in tracking feather pecking behaviors/damages of cage-fee laying hens. According to the performance based on a dataset of 2000 images, the deep learning models have reached 85% accuracy. The model provides a basis for developing a real-time automatic model for tracking pecking damages in commercial cage-free houses to protect the health and welfare of hundreds of millions laying hens.

Keywords: Poultry production; laying hen; cage-free system; precision farming; deep learning

Introduction

US Egg production is transitioning from conventional cage to cage-free system (Chai et al., 2018, 2019; Oliveira et al., 2019). While the cage-free system allows birds to perform natural behaviors such as dustbathing, foraging, and perching, an inherent challenge is feather pecking, one of the primary welfare issues in commercial cage-free hen houses (Figure 1) as that can seriously reduce the well-being of birds and cause economic losses for egg producers. Figure 2 shows a bird with severe pecking damage (cannibalism) we observed in a commercial cage-free house. After beak trimming is highly criticized in Europe and the USA, alternative methods are needed for pecking monitoring and management. A possibility for minimizing the problem is early detection of pecking behaviors and damages to prevent it from spreading as feather pecking is a learned behavior. Artificial intelligence has been reported with the potential to monitor poultry well-being (Castro et al., 2023).

Figure 1. Hens with fewer feathers due to pecking in a commercial cage-free house (Photo credit: Lilong Chai).

Figure 2. A severely pecked hen in a commercial cage-free house (Photo credit: Lilong Chai).

Methods

The experiment was conducted in four research cage-free layer rooms (200 birds per room) in Athens, GA. Nest boxes, feeders, drinkers, and perches were equipped in each cage-free facility by following the sizes recommended by the Hy-Line management guides. Pine shavings were uniformly spread on the floor (5 cm depth) before bird arrival and commercial feed was provided ad libitum. The raising condition was controlled by the automatic environment system and the set points were following Hy-Line W-36 commercial layer management guides (e.g., air temperature was 21 – 23°C, light intensity was 20 lux during egg laying; and lighting was 18L:6D). We checked the growth and environmental conditions of hens every day as suggested by UGA Poultry Research Center Standard Operating Procedure Form. Animal use and management were approved by the Institutional Animal Care and Use Committee (IACUC) at the University of Georgia, USA. For pecking detection, four night-vision network cameras (PRO-1080MSB, Swann Communications USA Inc., Santa Fe Springs, LA, USA) were mounted above the drinking system, feeders, and perches at ~3 m above the ground to capture top-view videos.

The YOLOv5 (you only look once version-5) deep learning model was optimized for detecting pecking behaviors and damages of chickens in this study. The researchers at the University of Georgia developed a machine vision method based on YOLO (You Only Look Once) for detecting the hens (Figure 3) and their pecking damages (Figure 4) in cage-free facilities (Yang et al., 2022, 2023; Subedi et al., 2023a, 2023b).

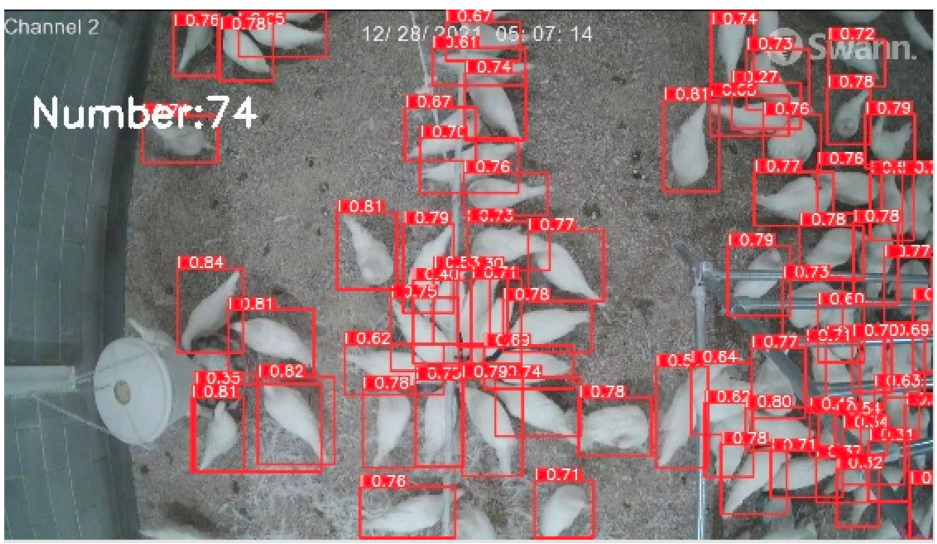

Figure 3. YOLOv5 model for monitoring cage-free hens (Photo credit: Lilong Chai).

Figure 4. Pecking damages observed in a poultry image (Photo credit: Lilong Chai).

Two YOLOv5 based deep learning models, i.e., YOLOv5s-pecking and YOLOv5x-pecking, were developed and compared in tracking pecking and damages. Each YOLOv5 model has a backbone for feature extraction, a neck for feature fusion, and an output for object detection.

Results and Discussion

According to the performance based on a dataset of 1924 images (1300 for training, 324 for validation, and 300 for testing), two deep learning models (i.e., YOLOv5x-pecking and YOLOv5s-pecking) have reached up to 85% of precision in identifying birds' pecking behaviors. YOLOv5x-pecking model had a 3.1%, 5.6%, and 5.2% higher performance in precision, recall, and mAP than YOLOv5s-pecking model, respectively. However, YOLOv5s-pecking model size is 80% smaller and thus used 75% less GPU memory and 80% less time in model training than YOLOv5x-pecking model for the same dataset. Therefore, YOLOv5s-pecking model was considered to have superior performance.

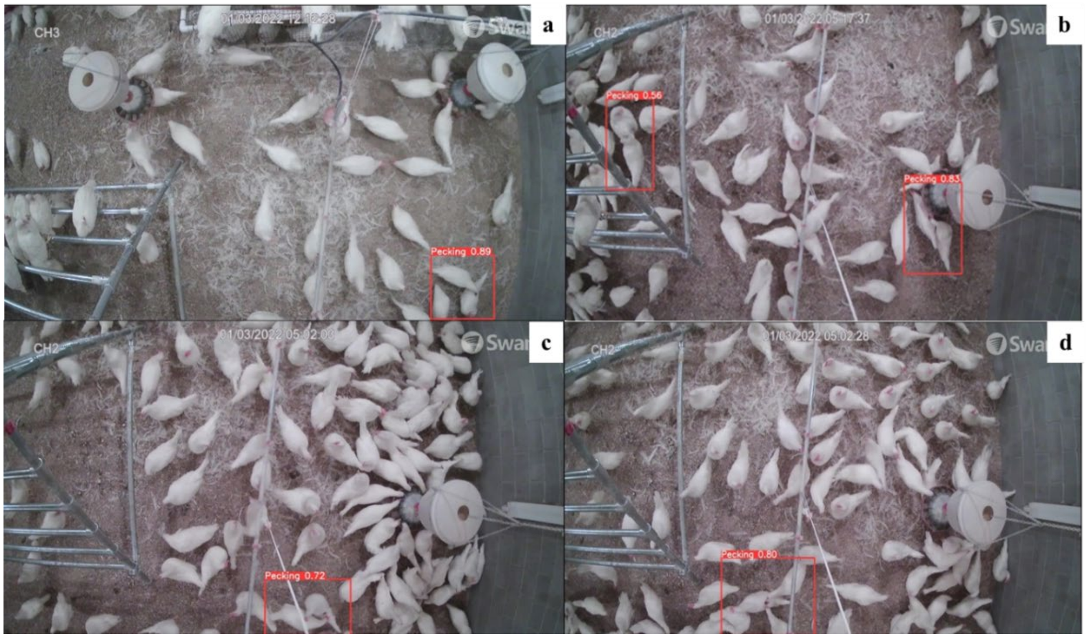

Figure 5. Performance of YOLOv5-pecking deep learning model in pecking detection:

a – pecking in a rest zone,
b – pecking in a feeding zone,
c – pecking in a drinking zone;
d – two birds are pecking one bird (i.e., the same bird in c was pecked by the two birds at the same time).

(Photo credit: Lilong Chai)

Conclusions

In this study, we demonstrated that the YOLOv5 models can be applied to track poultry pecking and damages in the cage-free hen house, an emerging laying hen housing system in the USA and EU countries. It is predicted that 70% of total laying hens in the US (320 million hens) and 100 % of hens in EU countries (370 million hens) will be under cage-free production by 2030. Severe feather pecking has been estimated to occur in 40%-50% of cage-free flocks. Therefore, the model provides a basis for developing a real-time automatic model for tracking pecking damages in commercial cage-free houses to protect the health and welfare of hundreds of millions laying hens.

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