Precision Farming Technologies for Sustainable Egg Productions

UGA Department of Poultry Science

IIPA – Precision Poultry Farming Lab

Poultry production plays a critical role in feeding the increasing world's population with affordable protein (i.e., chicken and eggs). The United States is currently the world's largest broiler producer and 2nd largest egg producer due to continuous innovation in animal breeding, nutrition management, environmental control, and disease prevention, etc. However, US poultry and egg farms are facing several production challenges such as animal welfare concerns. For instance, the fast growing broiler chickens were reported with leg issues or lameness. Major restaurants and grocery chains in the United States have pledged to buy cage-free (CF) eggs only by 2025 or 2030. While CF house allows hens to perform more natural behaviors (e.g., dust bathing, perching, and foraging on the litter floor), there are some particular challenges for cage-free systems such as high mortality and injury rate and floor eggs. Dr. Lilong Chai's lab is applying precision poultry farming technologies to address those issues for sustainable poultry and egg productions.

Pecking is 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. 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 or increasing as feather pecking is a learned behavior. Machine vision methods were developed and tested in tracking chickens' floor and spatial distribution (**Figure 1**), and identifying pecking behaviors of hens and potential damages (**Figure 2**) in research cage-free facilities at UGA. The YOLOv5x-pecking model was tested with a precision of 88% in tracking pecking.

Figure 1. Number of chickens identified at different angles by a machine vision system: horizontal angle (a) and vertical angle (b).

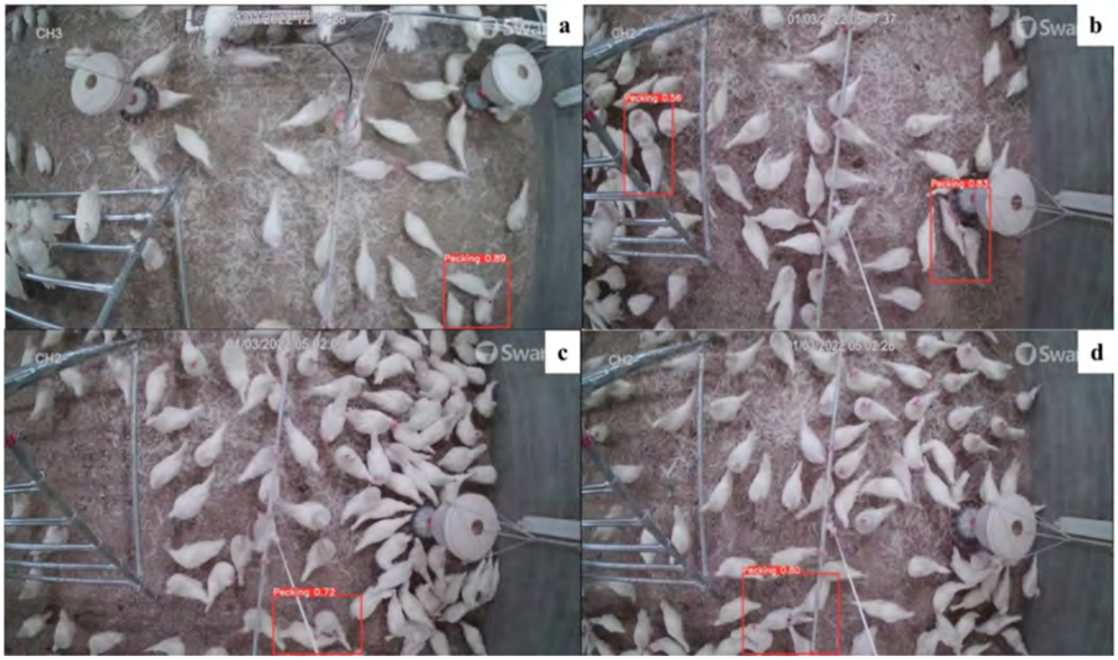


Figure 2. Performance of YOLOv5-pecking deep learning model in pecking detection: a – pecking in a rest zone, b – pecking in a feeding zone, c – pecking in a drinking zone; d – two birds are pecking one bird (i.e., the same bird in c was pecked by the two birds at the same time).

Besides, the team developed several deep learning methods that can be used to detect floor eggs and mislaying behaviors with 90% of precision (**Figure 3** and **Figure 4**).

Figure 3. Floor egg scanning with machine vision.

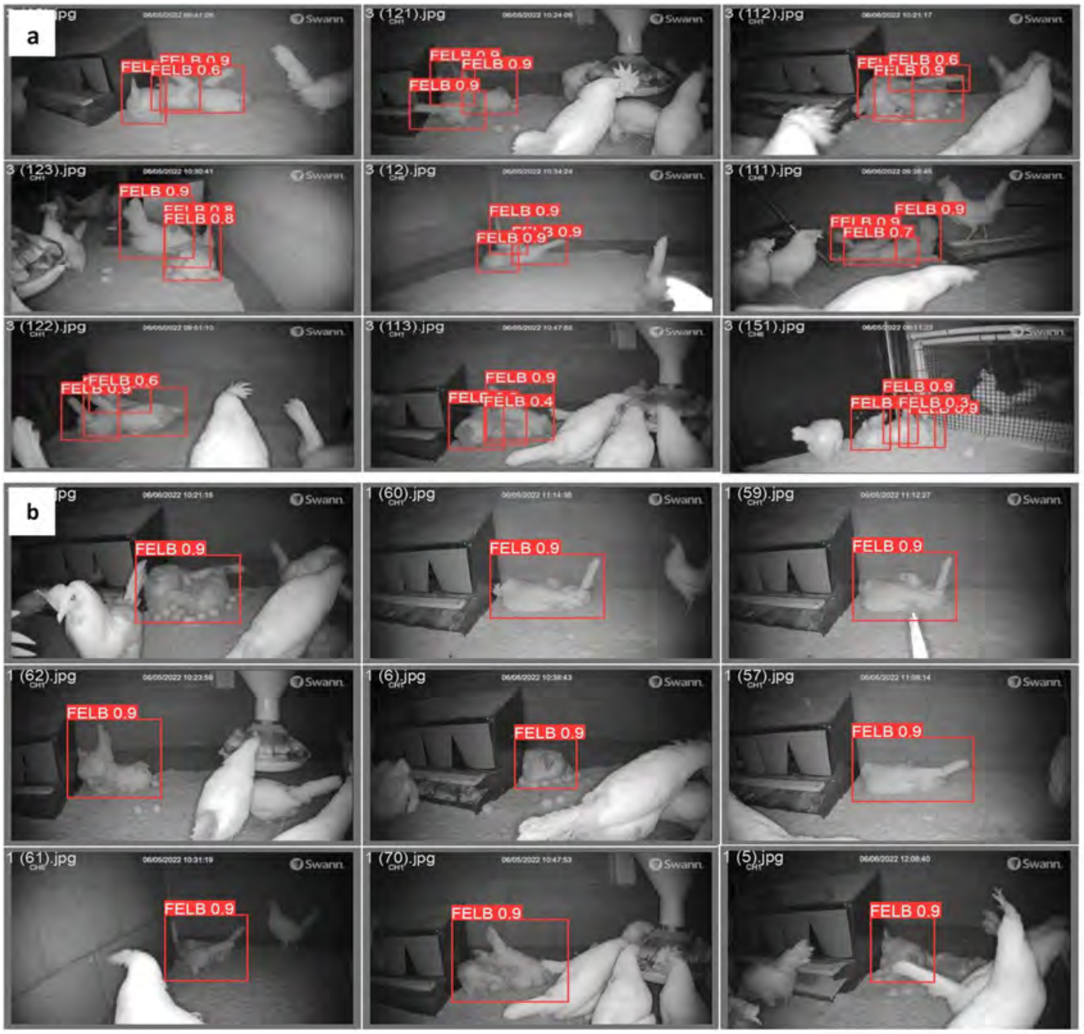


Figure 4. The floor egg laying behaviors detected in test data using the YOLOv5s model for different hen proportions: a) individual hen detection; and b) group hens detection.

Different machine vision or deep learning methods were developed at the University of Georgia's poultry science department to monitor broiler and cage-free layers' welfare and behaviors. Those findings provide references for developing precision poultry farming systems on commercial broiler and egg farms to address poultry production, welfare, and health associated issues for sustainable production.

Relevent publications:

Bist, R.B., Yang, X, Subedi, S, L. Chai (2023). Mislaying behavior detection with deep learning technologies. Poultry Science, 102729. https://doi.org/10.1016/j.psj.2023.102729

Subedi, S, Bist, R.B., Yang, X, L. Chai (2023). Tracking Pecking Behaviors and Damages of Cage-free Laying hens with Machine Vision Technologies. Computers and Electronics in Agriculture, 204 (1), 107545. https://doi.org/10.1016/j.compag.2022.107545

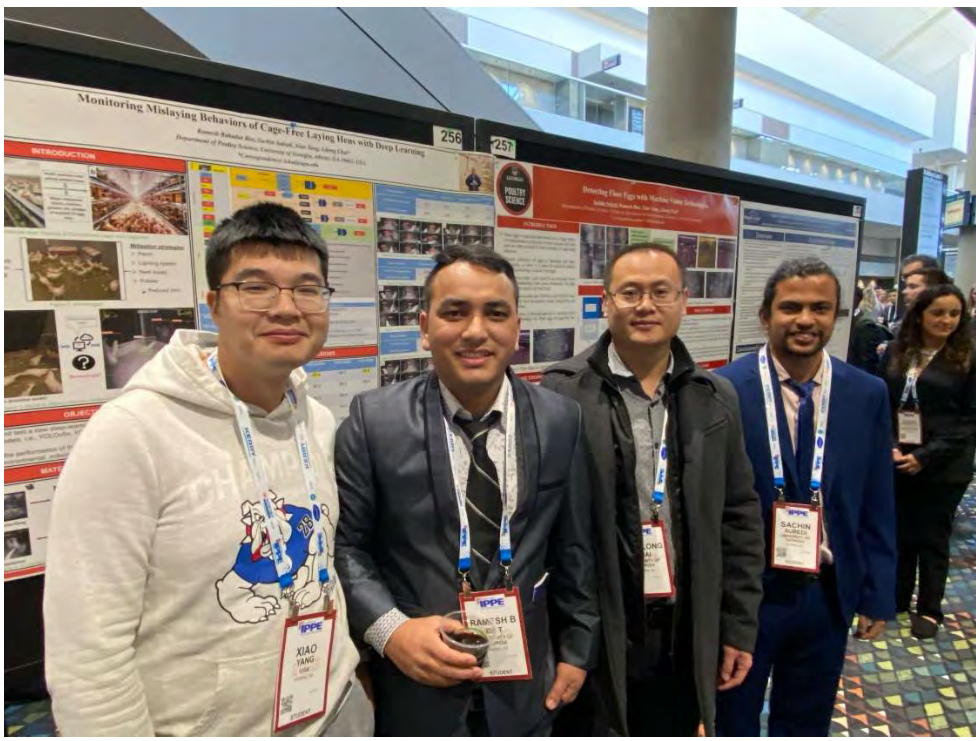
Subedi, S., Bist, R. B, X.Yang, L. Chai (2023). Tracking Floor Eggs with Machine Vision in Cage-free Hen Houses. Poultry Science, 102637. https://doi.org/10.1016/j.psj.2023.102637

Yang, X., Chai, L., Bist, R. B., Subedi, S., & Wu, Z. (2022). A Deep Learning Model for Detecting Cage-Free Hens on the Litter Floor. *Animals*, 12(15), 1983. https://doi.org/10.3390/ani12151983

Yang, X., R. Bist, S. Subedi, L. Chai (2023). A Deep Learning Method for Monitoring Spatial Distribution of Cage-Free Hens. *Artificial Intelligence in Agriculture*, 8: 20-29. https://doi.org/10.1016/j.aiia.2023.03.003

Yang, X., R. Bist, S. Subedi, Z. Wu, T. Liu, L. Chai (2023). An automatic classifier for monitoring applied behaviors of cage–free laying hens with deep learning. *Engineering Applications of Artificial Intelligence* In Press.

UGA Precision Poultry Farming Extension publications: https://site.caes.uga.edu/precisionpoultry/



Chai lab members (Left to right: Xiao Yang, Ramesh Bist, Lilong Chai, Sachin Subedi**)**

Chai's lab just received a three-year USDA-NIFA AFRI grant to continue aforementioned research and Extension works (2023-2026: Precision farming practices for sustainable egg productions; $300,000; PI: Dr. Lilong Chai; Co-PIs: Drs. Casey Ritz, Woo Kim, Harshavardhan Thippareddi, Claudia Dunkley).

In addition, Chai's innovation team (**PoultryE**) was selected by Georgia Research Alliance (GRA) to participate in the Georgia Greater Yield program (Cohort 3) with the venture fund support ($50,000; PI: Dr. Lilong Chai; Co-PI: Dr. Tianming Liu).