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Investigating the Behavior and Responses of Cage-Free Laying Hens Using a Laser Disturbance System

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Abstract

Growing attention to animal welfare is accelerating the shift to cage-free housing, but floor eggs remain a persistent problem. Eggs laid on the ground are easily soiled, broken, and can transmit disease; they also raise labor and time costs because they must be collected quickly. Once floor laying becomes habitual, correction is difficult. We propose a laser-based disturbance system that uses non-invasive light cues to guide hens toward raised platforms and nest boxes. Deployed on an embedded controller, the system modulates laser position and timing to discourage floor laying. The study tracks daily egg production, floor-egg counts, body weight, and feed intake while systematically varying laser parameters to identify optimal settings. By shaping movement and nesting behavior, the approach aims to improve laying patterns, reduce contamination, and enhance both production efficiency and animal welfare in cage-free systems.

Keywords: deep learning, chicken flock, reaction ability, laser stimulus

INTRODUCTION

With growing awareness of animal welfare, many countries are adopting cage-free systems. Hens show strong attraction to laser stimuli, making lasers a practical guidance cue. In cage-free houses, however, birds must be trained from the pullet stage to use nest boxes and raised slatted platforms, and staff must keep patrolling during lay to collect floor eggs. These tasks are labor-intensive, and eggs laid on manure-contaminated floors are easily soiled or broken, causing hygiene risks and economic loss. We therefore propose a laser-based disturbance system that integrates deep learning and runs on an embedded controller in a cage-free experimental house. By projecting a movable laser spot to guide hens, the system substitutes for manual training, strengthens spatial recognition of nest boxes and platforms, reduces floor eggs, and lowers labor demand.

MATERIALS AND METHODS

Laser Disturbance System

Overview of the laser disturbance system(Fig.1). A visible-light camera acquires scene images, while an embedded system performs on-device hen detection and AI edge inference. The embedded system schedules the laser module to project spots at fixed intervals, and edge analytics compute metrics of hens' laser-response intensity. Processed data are transmitted to a cloud database.

Density-Based Method

The study employed YOLOv7 to train a hen-detection model. Training data comprised top-down (overhead) images of the flock with manual hen annotations. After training, we computed a laser-response score using

a density-based method: for each frame captured by the camera, we calculated the change in per-unit-area hen density between the one-second interval immediately preceding the frame and the one-second interval immediately following it. This density change quantified the hens' laser-response score (Fig. 2).

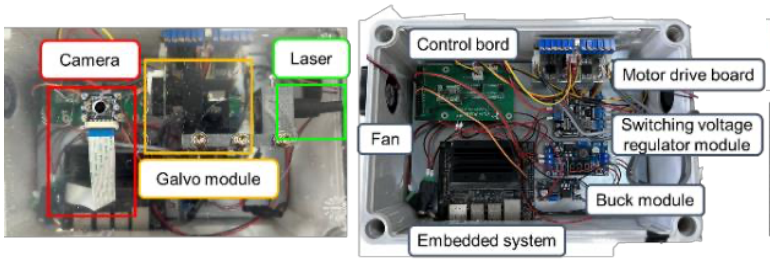

Fig. 1 Laser Disturbance System

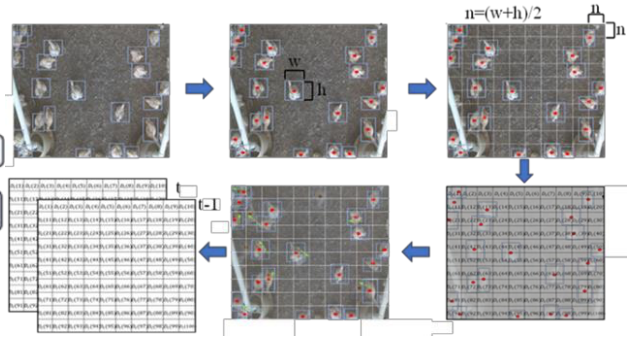

Fig. 2 Density-Based Computation Workflow

RESULTS & DISCUSSION

As shown in Fig. 4, the laser-response score increased markedly, indicating that the laser effectively perturbed the hens. Consistent with this, Fig. 5 shows that the laser successfully guided hens from the floor to the raised platform, with approximately 50% of birds relocating to the platform in response.

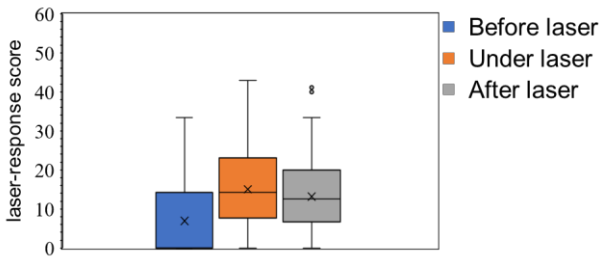

Fig. 4 Laser-Response Score

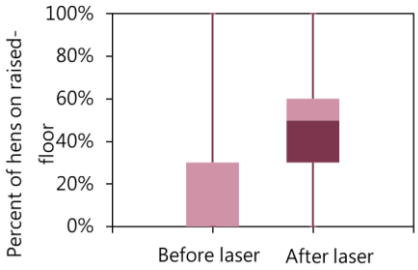

Fig. 5 Percent of Hens on Raised-Floor

CONCLUSIONS

The study built and field-validated a laser disturbance system that guided hens to raised platforms and nest boxes. Next, we will deploy it in larger houses to gather more laser-perturbation and floor-egg data, refine models further, and add functions such as automated scheduled imaging for nest-box use and algorithm updates.

REFERENCES

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