DEEP LEARNING-BASED DETECTION AND QUANTITY OF LIVESTOCK CARCASSES

Ching-Hung Chuang[1]*, Yu-Chieh Chen[2], Ku-Shou Chou[3] and Yao-Chuan Tsai[1]

[1] Department of Bio-Industrial Mechatronics Engineering, National Chung Hsing University, Taiwan
[2] National Taiwan University, Institute of Applied Mechanics, Taiwan
[3] Animal and Plant Health Inspection Agency, Ministry of Agriculture, Taiwan

*Corresponding Author: ms22886612@gmail.com

Abstract

In recent years, livestock farming in Taiwan has gradually expanded. However, due to geographical constraints and regulatory restrictions, local farms are not permitted to bury or burn culled livestock carcasses on their own. As a result, farms must commission rendering trucks to collect and transport the carcasses to centralized rendering plants for processing. At the rendering plants, the manager are required to recount the number of carcasses. However, the large quantity and irregular arrangement of carcasses make it difficult to inspect each one individually, and close contact with the remains poses a risk of disease transmission. To address these challenges, this study proposes a deep learning-based detection and quantity of livestock carcasses. High-resolution IP cameras are installed at the rendering plants and integrated with embedded systems and network equipment. The embedded system is equipped with a YOLOv7-tiny model to detect rendering trucks and automatically trigger video recording of the carcass dumping process. When a truck is detected, the system initiates recording and captures snapshots for image data transmission, thereby automating the collection of dumping footage and avoiding prolonged video recording that may lead to insufficient storage capacity. For the carcass counting algorithm, this study develops and compares two models: You Only Look Once (YOLO) and Density Map Regression. Preliminary results indicate that the YOLO algorithm tends to misidentify or miss detections when objects are heavily overlapped or occluded. In contrast, the Density Map Regression method demonstrates superior recognition performance under such conditions. To further validate this observation, we compared the performance of both methods in carcass counting tasks. The results show that the YOLOv9-segment and CSRNet models achieved mean absolute errors (MAE) of 10.95 and 5.4, respectively, confirming that the Density Map Regression approach offers higher accuracy and better applicability in scenes with densely overlapped carcasses.

Keywords: Deep Learning, Image Recognition, YOLOV9 , Density Map Regression, Livestock Carcass

INTRODUCTION

Due to Taiwan's legal restrictions and limited land, farms must send animal carcasses to rendering plants instead of handling them on-site. During collection and dumping, managers must count carcasses, which is difficult due to limited monitoring and their heavy weight. A

sudden increase in carcasses may indicate an infectious disease outbreak, highlighting the need for an automated early warning system.

MATERIALS AND METHODS

In this study, an image collection system consisting of high-resolution network cameras, PoE, a router, an NVR, and a Jetson Nano embedded system was installed at a rendering facility, as shown in Figure 1. The system was used to collect images of rendering trucks and livestock carcasses. These images were then used to train a rendering truck detection model, which was deployed on the on-site embedded system for real-time vehicle detection and data transmission. Furthermore, to accurately estimate the number of dead livestock, the study compared two image recognition methods: instance segmentation and density map regression. Finally, Mean Absolute Error (MAE) was used to evaluate the performance of both methods for quantity estimation in highly overlapping scenarios.
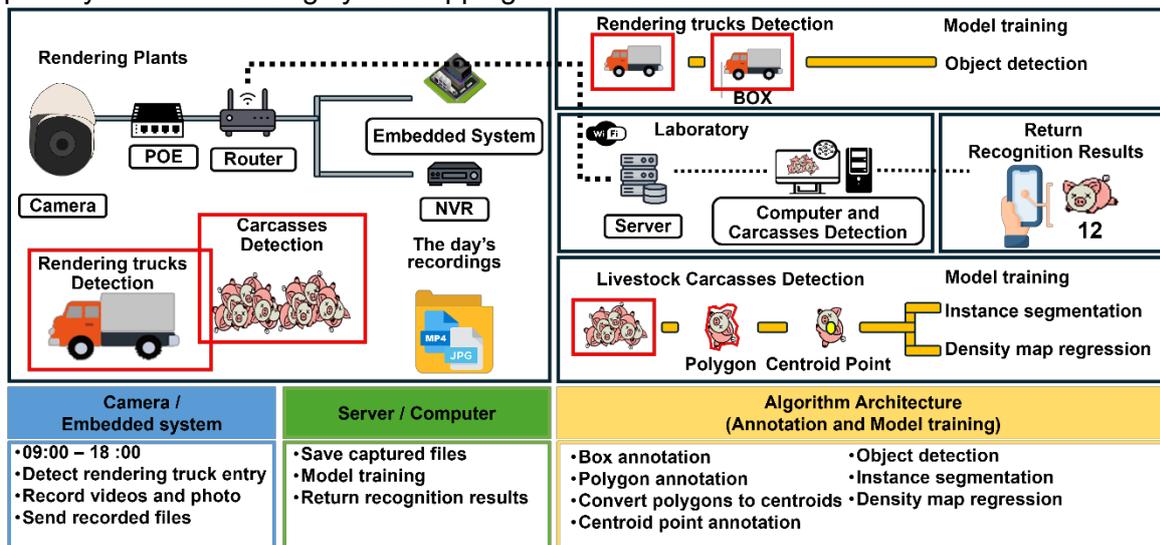

Fig.1   Research Framework

RESULTS & DISCUSSION

Two algorithms were developed: one for truck detection and another for livestock counting. The YOLOv7-tiny model, trained on 1,350 images, achieved a 99% F1-score. For livestock counting, instance segmentation reached 77% F1, while density map regression, with CSRNet and larger kernel parameters, performed best. CSRNet achieved an MAE of 5.4, compared to 10.95 for instance segmentation, proving more effective in overlapping carcass scenarios.

CONCLUSIONS

A camera-embedded system was installed at the rendering plant, and two algorithms were developed for truck detection and livestock estimation. Truck detection reached 99% precision, recall, and F1-score. For livestock estimation, density map regression achieved higher accuracy in overlapping scenarios, offering a foundation for automated monitoring and epidemic management.

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