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DETECTING AND REMOVING DEFECTIVE CARCASSES OF TAIWANESE NATIVE CHICKENS USING CONVOLUTIONAL NEURAL NETWORKS

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ABSTRACT

Poultry is one of the most important sources of meat worldwide. In 2023, the production value of poultry in Taiwan reached 59.8 billion NTD, accounting for 27.8% of the economic value of the animal husbandry industry. Among various chicken breeds, Taiwanese native chickens (TNC) are highly favored by consumers for their meat quality and flavor. As the demand for chicken increases, providing high quality meat to the market has become crucial. Unlike broilers, Taiwanese native chickens have diverse varieties among skin color and body size. Currently, there is no commercial equipment capable of automatically identifying defects on Taiwanese native chicken carcasses. As a result, defective carcasses are still manually identified and removed by workers on the production line. This manual process is time-consuming, labor-intensive, and prone to human error. Therefore, this study developed a defect carcass removal system that integrates two algorithms and two deep learning models to automatically eliminate defective carcasses from the production line of TNC slaughterhouses. The system includes components from carcass imaging to the removal mechanism. Blurry Image Classification Algorithm (BICA) filters out blurred images, and Silky Fowl Classification Algorithm (SFCA) excludes Silky fowl images. YOLOv7 detects body parts, while ResNetv2 identifies defects in those parts. Removal signals, determined by the combined outputs of the algorithms and deep learning models, are used to decide whether a carcass should be eliminated. BICA achieved 100% accuracy in filtering out blurred images, and SFCA achieved 100% accuracy in excluding Silky fowl images. YOLOv7 achieved an average precision of 98.9% in detecting chicken carcass parts, with an overall F1-score of 97.4%; ResNetv2 attained an accuracy of 96.5% in classifying defects in body part images. The results demonstrate the potential of using algorithms and deep learning methods to automate defect grading in TNC slaughterhouses.

KeyWords: Deep learning, Image processing, Defect detection, Meat grading

INTRODUCTION

Taiwanese Native Chickens (TNCs) are highly valued by consumers for their meat quality and flavor, carcass defects such as tear, bile pollution, scab, and bruise are frequently shown on the production line. The current inspection process relies mainly on manual checks, which are inefficient, labor-intensive, and prone to human error. To improve production line efficiency and ensure food safety, this study aims to develop an

automated inspection and removal system for real-time detection and removal of defective TNC carcasses.

MATERIALS AND METHODS

The experiment was conducted at LEADRAY slaughterhouse using Red-Feather, Black-Feather, and Golden Chickens as test subjects. The system architecture consisted of an image acquisition module, a Blurry Image Classification Algorithm (BICA), a Silky Fowl Classification Algorithm (SFCA), a YOLOv7-based Body Parts Detection Model (BPDM), and a ResNetv2_101x1_bitm-based Body Parts Defect Classification Model (BPDCM). Images were captured by two FLIR BlackFly Gige industrial cameras triggered by a photoelectric switch to obtain both front and back views of the carcasses. BICA applied Laplacian variance to exclude blurred images, while SFCA used grayscale value summation to exclude Silky Fowl images. BPDM was trained to detect four parts (wings, legs, back, breast), and BPDCM classified body-part images into normal or defective. The removal system, consisting of a pneumatic push-bar and a photoelectric switch controlled by a PLC, automatically removes defective carcasses from the production line.

RESULTS & DISCUSSION

SFCA and BICA achieved 100% classification accuracy using thresholds of a grayscale value summation of 65M and a Laplacian variance of 65, respectively. The YOLOv7-based BPDM achieved a mean Average Precision (mAP) of 98.9%, while the BPDCM reached 96.5% accuracy. Field testing of the integrated system confirmed its ability to effectively remove defective carcasses. However, phenotypic traits such as the yellow-backed-coloring could be misclassified as bile pollution, and pigmentation deposition might be mistaken for bruises in Red-Feather Chickens. These findings highlight the importance of accounting for breed-specific traits to minimize misclassification in practical applications.

CONCLUSIONS

This study successfully established an automated inspection and removal system capable of real-time detection and elimination of defective TNC carcasses on slaughterhouse production lines. SFCA and BICA achieved 100% accuracy, BPDM reached 98.9% mAP, and BPDCM achieved 96.5% accuracy, demonstrating the system's applicability in practice. Future work will expand the system to include Wenchang Chickens, and develop defect localization techniques to further enhance system performance and reliability.

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