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DEVELPOMENT OF BAGGED GUAVA QUALITY GRADING SYSTEM USING IMAGE RECOGNITION AND GENERATIVE ADVERSARIAL NETWORKS(GANS)

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ABSTRACT

Taiwan's warm climate and abundant sunlight make it highly suitable for guava cultivation, making guava an important economic crop. However, current quality grading still relies on manual inspection, which is labor-intensive, inconsistent, and affected by bagging practices. To address this, we propose an automatic grading system using deep learning and generative adversarial networks. The framework collects images of bagged and bare guavas, applies YOLOv9 for fruit detection and background removal, and uses Pix2PixHD to reconstruct bag-free appearances. YOLOv9 then performs grading classification, enabling automated and standardized production. Experimental results show the LPIPS between generated and real images decreased to 0.081, while grading precision and recall reached 60.8% and 60.4%, validating the effectiveness and potential of the system.

Keywords: deep learning system, generative adversarial network (GAN), guava, grading, bagging occlusion

INTRODUCTION

Guava is a key economic fruit in Taiwan, with 8,006 hectares planted in 2023 and an annual yield of about 170,000 tons. Farmers use bagging to protect fruits and enhance appearance, but it obscures surface features and makes manual grading slow and inconsistent. This study proposes a deep learning and GAN-based system to eliminate bagging interference, improving grading efficiency and accuracy.

MATERIALS AND METHODS

The framework of this study consists of three stages: data collection and image processing, model training, and automated grading of bagged guavas. First, images of guavas in different conditions such as intact, damaged, wounded, and overripe, with and without bags, were collected and processed with background removal. Then, YOLOv9 was used for object detection and defect classification into four grades A to D, while Pix2PixHD generated bag-removed images to simulate real bag removal and improve grading accuracy. Finally, these methods were integrated into a complete automated grading system for bagged guavas, as shown in Figure 1.

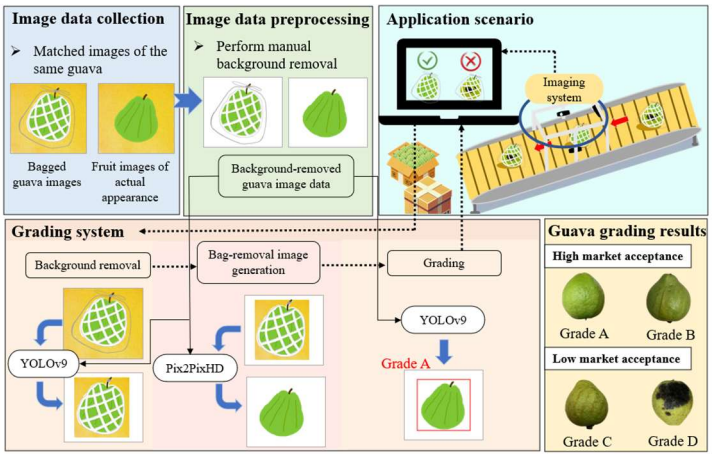

Figure 1. Research Framework

RESULTS & DISCUSSION

The LPIPS metric was used to assess generation quality. Without background removal, guava boundaries were blurred with a value of 0.4526, while background-removed data improved clarity with a value of 0.1201, and further enhancement was achieved with more images, reaching 0.0810, as shown in Figure 2. Using 30 bagged fruit images and 122 synthetic samples, grading performance was evaluated with Precision, Recall, F1-score, and confusion matrices. Results showed that Grades A, B, and D reached about 60 percent in Precision and Recall, while Grade C was more difficult to distinguish between B and D, as shown in Table 1 and Table 2.

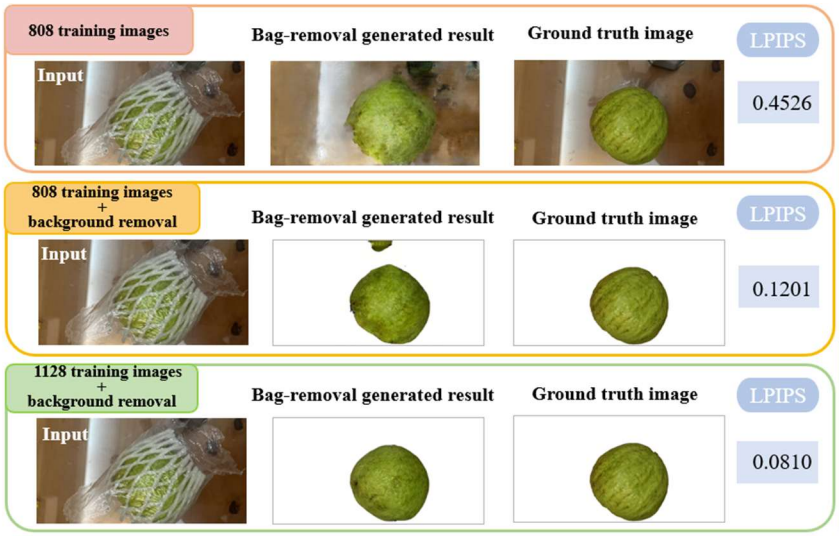

Figure 2. Generation Result

Grade	Precision	Recall	F1-score
A, B	0.692	0.75	0.719
C	0.383	0.562	0.455
D	0.75	0.5	0.6

Table 1. Grading result

CONFUSION MATRIX		Actual		
		A, B	C	D
Predicted	A, B	0.68	0.37	0.20
	C	0.27	0.53	0.33
	D	0.03	0.09	0.47

Table 2. Confusion Matrix

CONCLUSIONS

This study developed a bagged guava grading system using GANs and deep learning. The LPIPS between generated and real images decreased to 0.081, while the system achieved 60.8% Precision and 60.4% Recall.

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