Smart farming solutions: AI-based image recognition system for melon powdery mildew

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Background

Plant disease significantly declines crop growth leading to economic losses and increased management costs. In this study, we focuses on Cucurbitaceae powdery mildew which severely affects crop productivity. Conventional monitoring methods are labor-intensive and inefficient, often resulting in excessive pesticide use and environmental concerns. This study employs multispectral and RGB imaging to develop an image recognition system with deep learning method and integrate it into a smart farming decision support application.

Method

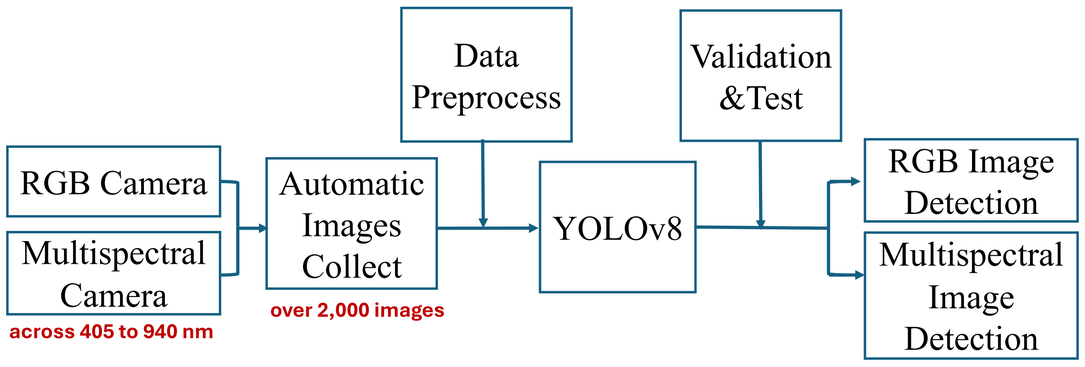

Figure 1. Training process of RGB and multispectral image recognition system

Result

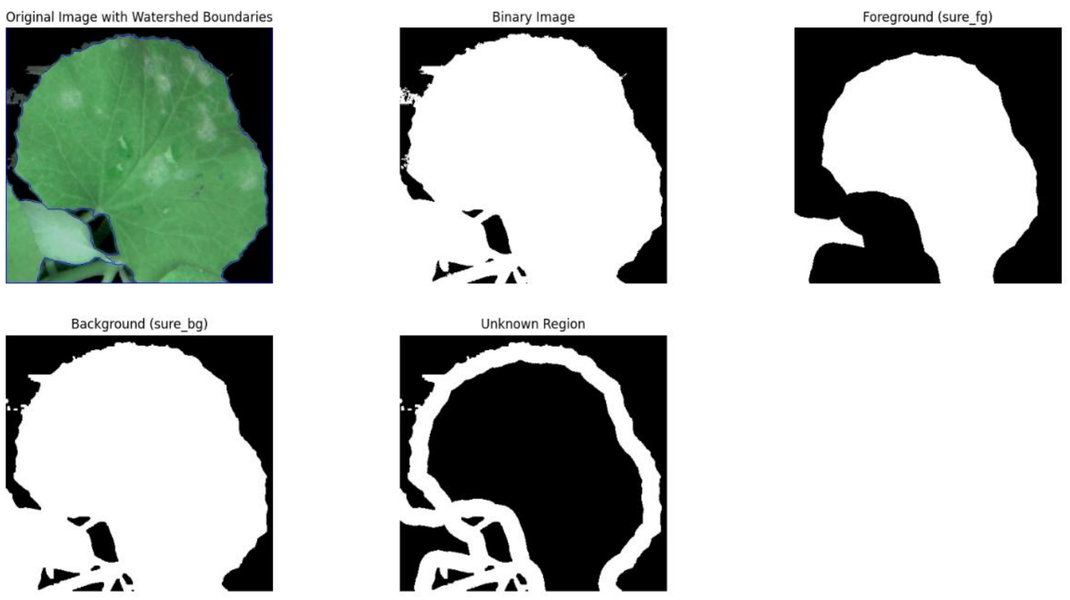

Figure 2. The leaf surface and background regions were preliminarily segmented by integrating color filtering with the watershed algorithm, enabling detection of leaf boundaries under complex imaging conditions.

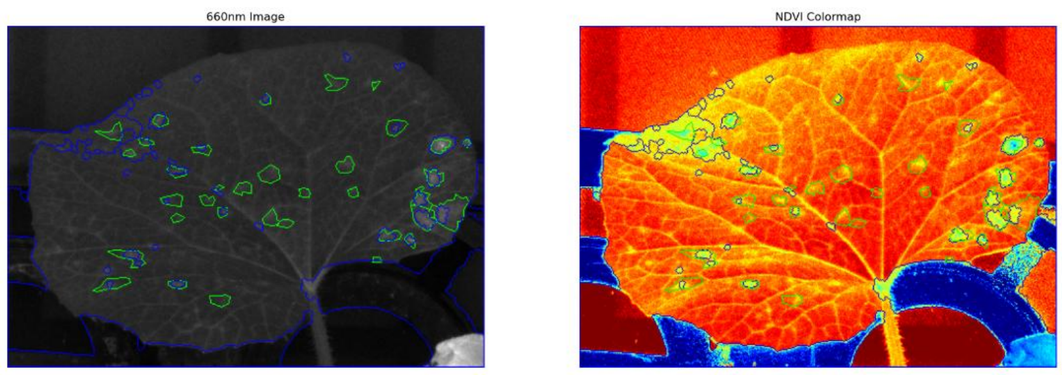

Figure 3. Comparing the watershed regions (blue) with the manually annotated ground truth (green), revealed that lower NDVI values partially corresponded to areas with powdery mildew, but were also influenced by light reflection. The watershed algorithm could not account for all these variations, making manual annotation necessary to achieve the desired accuracy.

	Presion	Recall	mAP50	Map50-95
Multispectral	0.896	0.837	0.924	0.725
RGB	0.829	0.671	0.773	0.574

Table 1. Validation for RGB and multispectral image recognition models trained by YOLOv8.

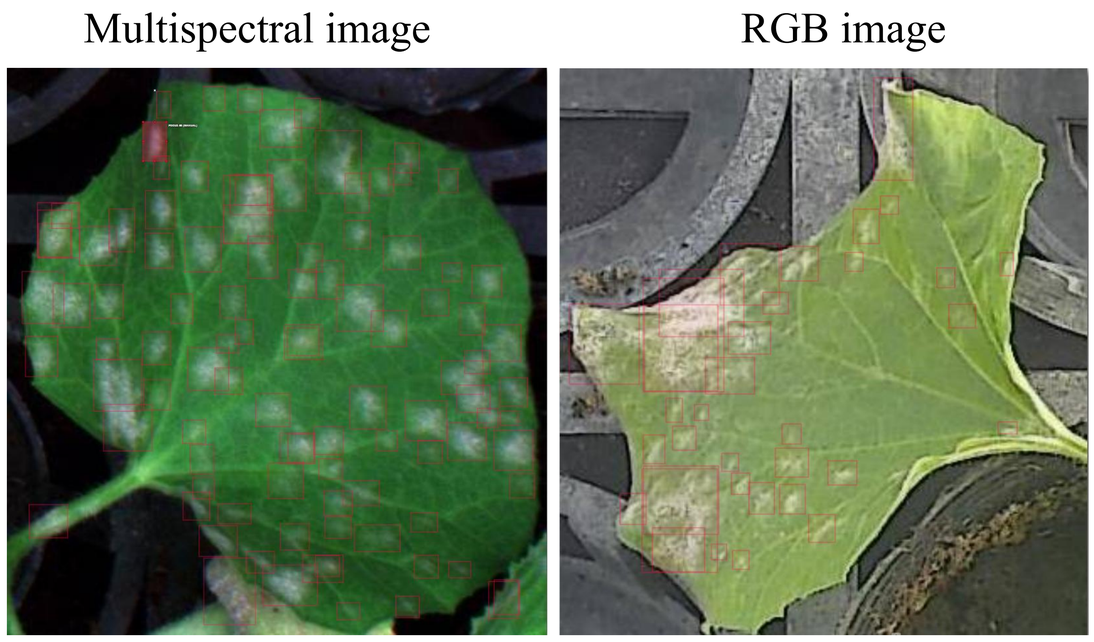

Figure 4. Visualization of RGB and multispectral image recognition models. The models automatically highlight the symptomatic regions, and the severity of powdery mildew on melon leaves is then quantified based on the ratio of symptomatic area to total leaf area.

Figure 5. Integrating image recognition system into Smart Farming Decision Support application.

Conclusion

The YOLOv8-based multispectral and RGB image recognition model for powdery mildew both achieve precision above 0.8 and mAP@50 of 0.924 and 0.773, respectively. Providing real-time disease severity assessments within a smart farming application, this system facilitates informed decisions on pesticide use and crop management. This system is being tested for accuracy within experimental greenhouses in Miaoli to improve crop yield and quality.

Reference

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