

ABSTRACT

Global demand for strawberries is continuously increasing, with annual production reaching over 8 million tons, driven by their popularity and high nutritional content. This high economic value demands efficient harvesting and sorting processes to maintain fruit quality. However, the strawberry industry still heavily relies on manual selection processes based on visual observation by workers. This traditional method is subjective, inconsistent, and prone to human error, often leading to a decline in crop quality and economic losses. The main problem faced is the absence of an objective, fast, and accurate method for standardizing the identification process of strawberry ripeness and quality.

To address this problem, this research proposes a solution in the form of an automatic identification system based on deep learning. The system was developed by integrating the You Only Look Once (YOLOv11) nano variant object detection model to precisely localize the fruit's position and determine its ripeness and quality level. This entire architecture is implemented in an Android-based mobile application connected to the cloud for real-time image processing, enabling users to obtain classification results quickly and efficiently directly from their devices.

Based on testing results, the developed YOLOv11-Nano model demonstrated excellent detection performance, achieving a Mean Average Precision (mAP) value of 0.96 at an IoU threshold of 0.5. Overall, the model recorded a precision value of 0.919 and a recall of 0.885, indicating a high capability for making accurate predictions with a low number of missed object detections (false negatives). The confusion matrix analysis shows that the model is capable of classifying the five strawberry ripeness classes with high accuracy, where the HRB (Half-Ripe Grade-B) class even achieved a perfect accuracy of 100%, while other classes like FRA (Ripe Grade-A) reached 94%. These quantitative results are supported by training graphs indicating that the model learned stably without overfitting. Thus, this YOLOv11-Nano-based detection system is proven to be accurate, reliable, and ready to be implemented for the automation of the real-time strawberry sorting process.

Keywords: deep learning, mobile application, ripeness, strawberry, YOLOv11-Nano