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Towards an AI-based Smart Bin to Measure Food Waste

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Abstract

We have previously designed and deployed smart bins in a range of settings, including public-sector restaurants in elderly care homes and schools, commercial restaurant environments, and private households, with the objective of measuring and classifying food waste. The smart bin captures photographic images, which we analyse visually to assign discarded food items to predefined waste categories.
In this work, we present preliminary results towards an AI-based smart bin using YOLOv8 models for automated classification. The study focuses on serving waste (SW) generated during school lunches in a representative Swedish school and considers four categories: Composite Dish, Vegetable, Carbohydrate, and Meat. Other categories were excluded due to insufficient training data. To reduce class imbalance, 50 images were used per class, except for Meat (45 images).
In this work, we present preliminary investigations in which trained YOLOv8 models are applied for this classification task. The study examines serving waste (SW) from lunch in a representative Swedish school and focuses on four categories: Composite Dish, Vegetable, Carbohydrate, and Meat, as the remaining categories currently lack sufficient training data. Also, since there were only 45 images in the 'Meat' category that were available for training, 50 images were used from each of the other three categories to avoid class imbalance.
The impact of limited training data was investigated using (i) ensemble training with five YOLOv8 models initialized with different random seeds and (ii) K-fold cross-validation, where images were systematically rotated between training, validation, and test sets. Results from both approaches were consistent, indicating robustness despite the small dataset.
For example, for the system that included all of the four waste food categories, the precision, recall and mAP@0.5 converged to approximately 0.55, 0.51 and 0.51, respectively. Confusion matrix analysis shows reasonable agreement between predicted and true labels. Across five K-fold runs, the mean number of correct classifications (out of 10 images per class) was 7.4 for Composite Dish, 5.6 for Vegetable, 6.2 for Carbohydrate, and 7.8 for Meat. These values exceed the chance-level baseline of 2.5 per class, demonstrating that YOLOv8 shows promise for categorizing serving waste.

Keywords: AI, object detection, food waste measurement