Ecological Innovations in Sports Venues: A Robotic Revolution for Sustainable Waste Management in Sports Stadiums

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Background

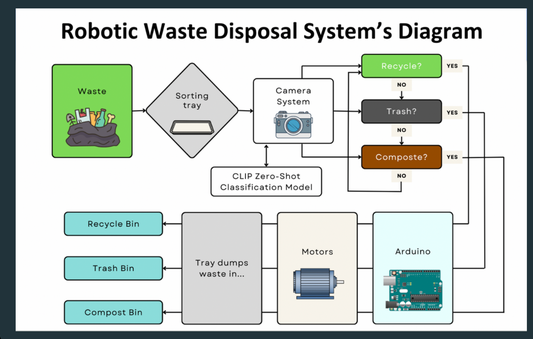
Engineering Need

The waste management operations in sports stadiums have become a pressing environmental concern due to the significant amount of waste generated during events. Current disposal methods often lack sustainability and contribute to environmental degradation, and as a result, pose a threat to the surrounding ecosystems. Addressing this issue is vital to mitigate the environmental footprint of sports stadiums and promote a more sustainable future.

Engineering Goal

The overall aim of this project is to mitigate the environmental impact of sports stadiums by implementing a comprehensive recycling and composting program facilitated by a robotic waste disposal system. By developing this technology, the project seeks to not only smoothen the waste collection process but also efficiently sort the waste into appropriate bins for recycling and composting. This project hypothesizes that the implementation of such a robot in venues will significantly reduce waste sent to landfills, ultimately leading to a reduction in CO_2 emissions into the atmosphere.

Graphical Abstract

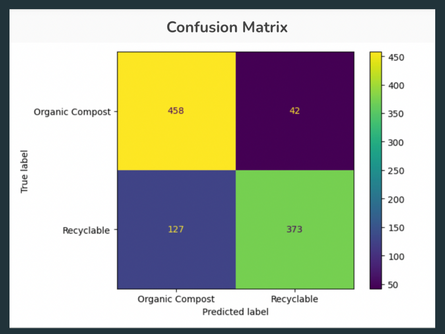


Analysis/Discussion

- The statistical tests conducted, including the calculation of basic accuracies and F1 scores, illustrate the extent to which the project was successful in reaching the overall goal.
- Notably, despite the limited finetuning, the model demonstrated relatively high accuracy rates for both organic compost and plastic recyclables.
- The construction of confusion matrices further clarified the areas of strength and weakness within the classification process.

Methods

Results



Decision Matrix

Criteria	Level	Weight	Robotic Waste Disposal System (my design)	Regular waste disposal methods	Smart waste bin (US11702280B2)
Accuracy of waste sorting	1	10	9	3	10
Safety measures	1	9	9	10	8
Speed/efficiency	2	8	8	8	9
Environmental impact	2	7	8	4	8
Cost-effectiveness	2	5	7	9	4
User interface/control	3	4	7	8	6
TOTAL			**354**	289	344

F1 Score, Precision, and Recall

	precision	recall	f1-score	support
Organic Food Compostable Waste	0.78	0.92	0.84	500
Plastic Glass Metal Cardboard Recyclable	0.90	0.75	0.82	500
accuracy			0.83	1000
macro avg	0.84	0.83	0.83	1000
weighted avg	0.84	0.83	0.83	1000

Future Works

- Development of more sophisticated machine learning models tailored specifically for waste classification tasks
  - While the CLIP zero-shot classification model has proved to be sufficient, further refinements and optimizations could enhance its accuracy and robustness across a wider range of waste categories.
  - Exploring novel approaches such as ensemble or deep reinforcement learning could yield an even more accurate and adaptable waste classification model.
- Waste disposal system was not built in this project, using the model and classification developed in this project, a waste disposal system could be built and deployed for use in sports stadiums.