KMUTT REVERSE VENDING MACHINE

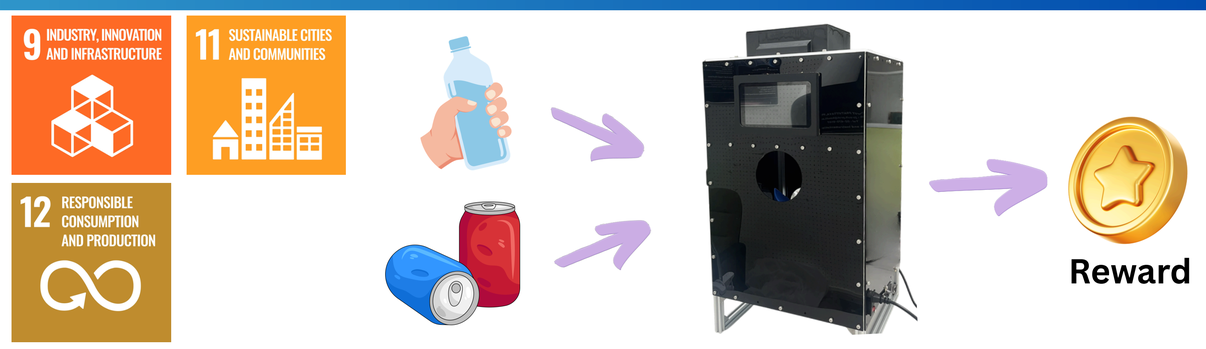
CONTROL SYSTEMS AND INSTRUMENTATION ENGINEERING PROGRAM
Ms. Praravee Treepattarachayakorn, Mr.Panuphan Rattanavadi
Advisor: Dr.Jiravit Pratvittaya

Abstract

This project presents the development of an automatic Reverse Vending Machine designed to promote waste separation behavior within university environments. The main goal is to encourage students to recycle bottles and cans by rewarding them with activity hours. The system methodology integrates a YOLOv8-based deep learning model on a Raspberry Pi 4 and a Logitech C270 webcam to perform real-time classification of recyclables. To ensure the purity of the recycling stream, the machine utilizes a capacitive liquid level sensor to detect and reject items containing liquids. Experimental results demonstrate performance, achieving a mean average precision (mAP@0.5) of 0.921 and real-time processing speeds of 21–37 FPS. In conclusion, the proposed RVM enhances waste management efficiency and promotes sustainable recycling behavior, providing a scalable solution for sustainable urban waste management in educational institutions.

Overview

This project introduces an automated Reverse Vending Machine (RVM) designed to efficiently collect Bottles and Cans using advanced computer vision and sensor technology. The system aligns with Sustainable Development Goals (SDG) by promoting circular economy practices and reducing environmental waste. To encourage community participation, the machine features an intuitive interface that returns a reward to the user, turning the simple act of recycling into a fulfilling and impactful habit.



Method

The methodology for this project integrates automated hardware and deep learning software into a cohesive sorting system. The physical structure is built around an aluminium profile, utilizing a gravity-fed chute to guide recyclables past the inspection zone. This design relying instead on a Raspberry Pi 4 to manage the interaction between a Logitech webcam for vision and a non-contact capacitive liquid sensor.

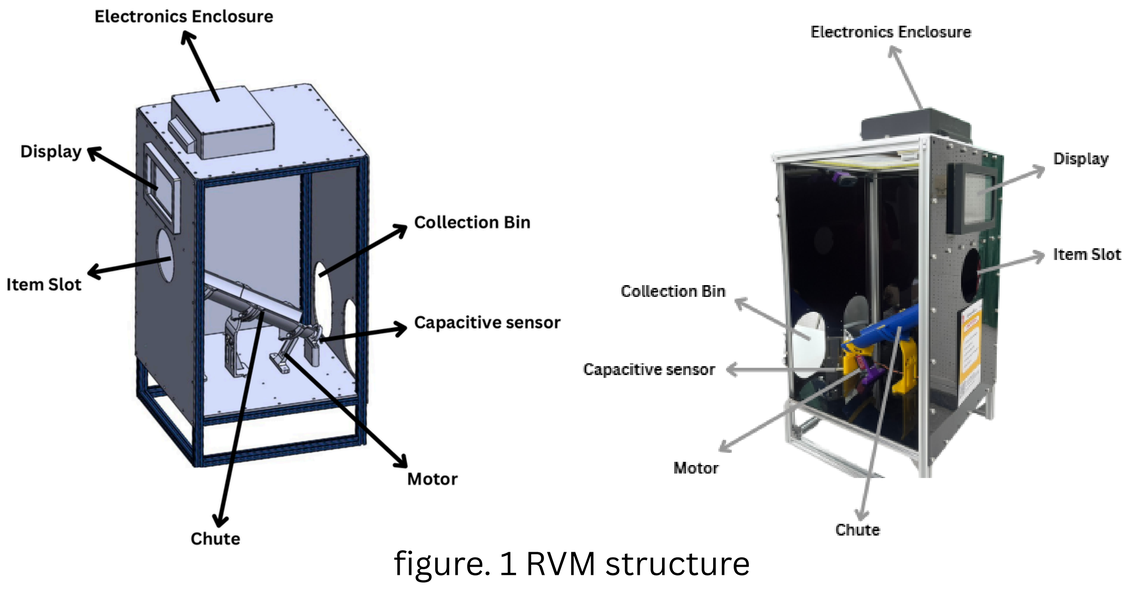


figure. 1 RVM structure

The system's intelligence relies on a YOLOv8 model optimized through quantization to run efficiently on the Raspberry Pi's CPU. Trained on a dataset of over 1,200 images, this model provides real-time binary classification to distinguish between aluminum cans and plastic bottles based on visual features rather than just weight or size.

The operational workflow follows a sequence of detection, validation, and sorting. Once a user logs in, the vision system identifies the material while the capacitive sensor checks for residual liquids. If the item is valid, a digital servo motor rotates the chute to the correct bin (left for cans and right for bottles), updates the user's points, and resets for the next item.

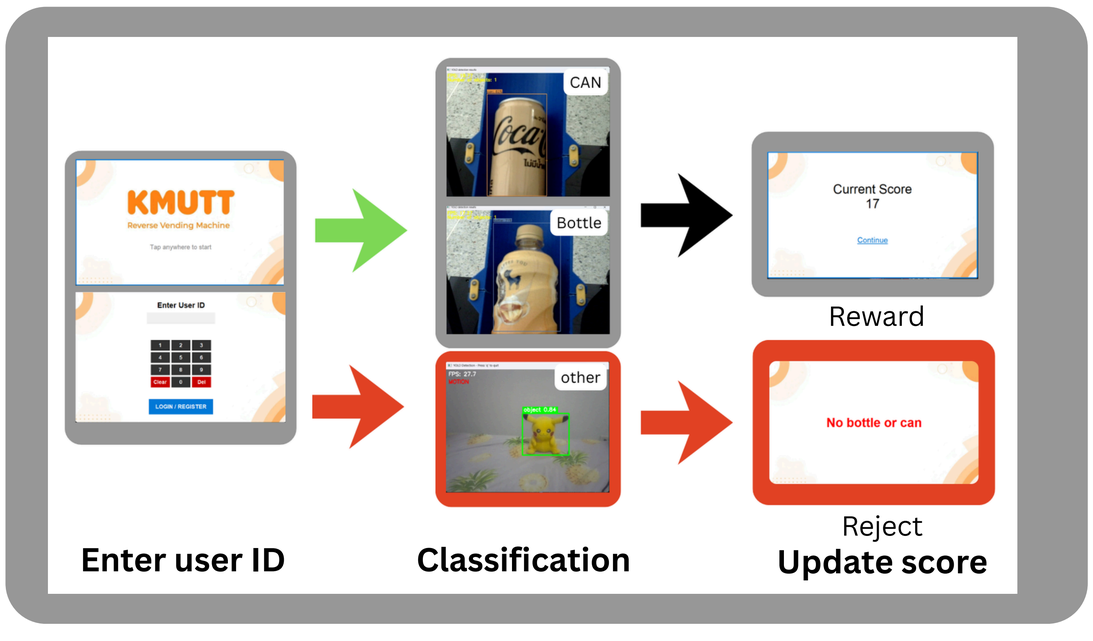


figure. 2 UI diagram of RVM screen

Result

The system achieved high accuracy using the quantized YOLOv8 model, reaching a mean Average Precision (mAP@0.5) of 0.921. Specifically, the model correctly identified 96% of aluminum cans and 87% of plastic bottles, proving that vision-based classification is highly effective on low-power hardware like the Raspberry Pi 4. In terms of performance, the machine maintained a processing speed of 21–37 FPS, ensuring near-instantaneous detection and a smooth user experience. The integration of the capacitive sensor successfully filtered out items with residual liquids, keeping the storage bins clean and improving the overall quality of the collected recyclables.

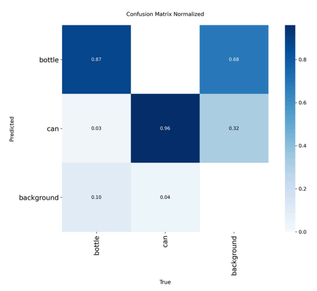


figure. 3 confusion matrix

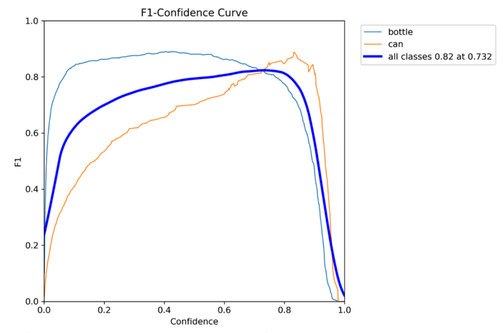


figure. 4 F1-confidencecurve

Real-user testing shows the system is effective, user-friendly, and capable of promoting sustainable waste sorting behavior.

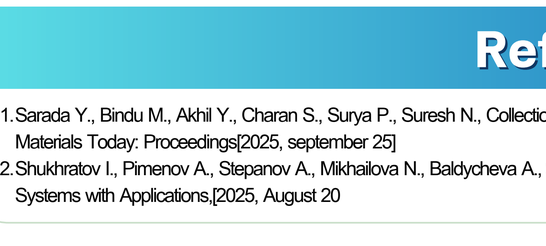


figure.5 User Satisfaction Results

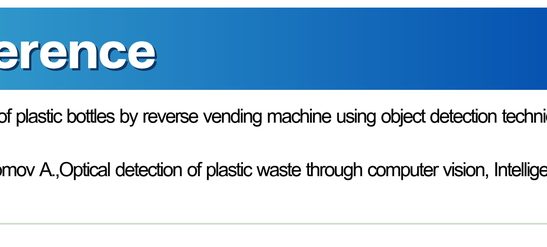


figure. 6 Reverse Vending Machine test

Conclusion

The project successfully demonstrates that a quantized YOLOv8 model integrated with a Raspberry Pi 4 can accurately sort plastic and aluminum recyclables in real-time. By combining computer vision with a capacitive liquid sensor, the machine ensures high material purity and prevents bin contamination. This low-cost, automated solution provides a scalable framework for improving waste management and supporting circular economy initiatives.

Reference

1. Sarada Y., Bindu M., Akhil Y., Charan S., Surya P., Suresh N., Collection of plastic bottles by reverse vending machine using object detection technique, Materials Today: Proceedings[2025, september 25]
2. Shukhratov I., Pimenov A., Stepanov A., Mikhailova N., Baldycheva A., Somov A.,Optical detection of plastic waste through computer vision, Intelligent Systems with Applications,[2025, August 20