# An Intelligent Recycle Bin for Smart Cities

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## CCS CONCEPTS

• **Applied computing** → **Environmental sciences**; • **Computer systems organization** → *Embedded systems*; • **Hardware** → *Sensor applications and deployments*; *Wireless integrated network sensors*;

## 1  ABSTRACT

Factors influencing recycling behavior include container size and style, pick-up frequency, deposit refunds and much more. Recycling behavior depends on convenience, social norms, age and attitudes toward recycling. For example, younger adults (aged 18 to 29) are less likely to recycle common household materials than older adults [3].

Our system is designed for smart sorting of mixed-type drink containers planned to be recycled. It encourages recycling through a user-friendly and individualized platform that is connected to a smart city's municipal platform. It has an easy-to-use interface and a quick and reliable sorting mechanism that automatically sorts drink containers by their basic materials (plastic, aluminum and glass).

Comprehensive applicative information is provided to the user regarding the cumulative quantity being recycled, cumulative credit rewards being redeemed, and much more. A major achievement of our system is its elimination of the need to read barcodes, as in most smart garbage collection bins [2]. In the latter system, to improve recognition accuracy, there must be a high contrast between the bars and the background, which is not always possible.

## 2  DESIGN

We designed and built a sophisticated product combining a smart recycle bin and an Apple iOS based mobile application. The smart recycle bin sorts drink containers made of different materials automatically using light and weight attributes while the mobile application scans the recycle bins' QR codes
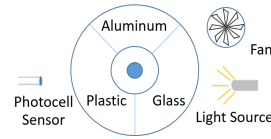
**Figure 1: The Smart Recycle Bin Scheme**

and measures a) the amount of drink containers being recycled in the bin; b) the amount of drink containers being recycled by the user using such smart recycle bins; c) the user's cumulative credit and d) rewards being redeemed by the user. Our system aggregates the usage parameters using WEMOS ESP8266 based wireless transmission between the smart bin and the smart city management service.

The smart recycle bin is equipped with a small shelf where the item should be placed. As depicted in Figure 1, first, the system checks if the recycled material is aluminum (i.e., by attempting to pass a light through the item) using a small light source and photocell sensor. If indeed it is made of aluminum, the system pushes it into its assigned compartment. Otherwise, in order to differentiate between glass and plastic materials, a small fan pushes the item if it is lightweight (i.e., made of plastic) into the plastic assigned compartment. If the item remains on the shelf (i.e., made of glass), it is pushed into the glass assigned compartment.

One of our challenges was to design an optimized travel agent algorithm for smart bins evacuation. Our heuristic greedy algorithm uses the combination of the distance and the merit of the next bin to be evacuated. The merit of each bin takes into account the value and the amount of its multiple content. The distances between the smart bins are calculated using Dijkstra's shortest distance algorithm [1].

Our compact bin is unique and innovative. It presents a new recycling scheme for smart cities that enhances users' willingness to recycle and advance a green environment. In a survey done on our campus among 127 students, 85% of 59 students, who already recycle, said they would use it, and 87% of 68 students that do not recycle said that would start to recycle and use it, if it were available.

## REFERENCES

[1] E. W. Dijkstra. 1959. A note on two problems in connexion with graphs. Numerische Mathematik 1.

[2] J. Liukkonen and H. Hyyti. 2015. Machine vision system for a reverse vending machine. Master Thesis, School of EE, Aalto University.

[3] J-D.M. Saphoresa and H. Nixon. 2014. *How effective are current household recycling policies? Results from a national survey of U.S. households.* Resources, Conservation and Recycling Volume 92.