Implementation of a smart trash box with Arduino Uno

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Article Information

Received: 15-11-2023
Revised: 30-11-2023
Published: 15-12-2023

Keywords
Arduino uno, smart trash box

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Abstract

The use of Arduino Uno in smart trash cans is an innovation that aims to increase the efficiency and sustainability of city waste management. By using a microcontroller system integrated with sensor technology, this smart trash bin can provide a smart and responsive solution to the challenges of city waste management. Container level sensors connected to Arduino Uno enable real-time monitoring of container levels.

1. Introduction

Current environmental crises such as air pollution, air pollution, climate change, and waste freezing are pressing global issues.One of the main aspects of this crisis is inefficient waste management. The accumulation of waste, especially in urban areas, poses serious environmental and public health problems. Household waste is an important source of waste in the waste management chain(Rahmayanti et al., 2018). Materials such as plastics, paper, metals, and organic waste from households contribute to waste accumulation and pollution. Increased consumption of consumer goods and changing lifestyles are accelerating the generation of household waste. Although many regions have waste management systems in place, there are still some challenges that need to be overcome(Fadel, 2017). Traditional waste collection and management systems are often inefficient and environmentally unfriendly. High stress on recycling and landfill facilities requires smarter, more innovative solutions. Technological solutions such as smart trash cans are emerging as a promising alternative in addressing the challenges of household waste disposal. The concept combines sensor technology, internet connectivity, and data analytics to create a smarter and more efficient waste management experience(Srikanth et al., 2019).

1.1 Literature Review

Central to the evolution of smart waste bins is their design and the incorporation of advanced technologies. Research by Chen and Zhang (2018) highlights the integration of sensors as a fundamental component, allowing these bins to detect fill levels and optimize waste collection routes. Moreover, the utilization of Internet of Things (IoT) technology enables real-time communication between smart bins and waste management systems (Alam et al., 2019). Artificial Intelligence (AI) algorithms, as discussed by Gupta et al. (2020), contribute to the predictive analysis of waste generation patterns, further enhancing the efficiency of waste collection and disposal(Wilson et al., 2019).

The adoption of smart waste bins offers a plethora of benefits across environmental, economic, and societal dimensions. According to Wang et al. (2017), the implementation of these bins has demonstrated a significant reduction in overflowing bins, leading to cleaner public spaces(Abidin et al., 2022). Additionally, the optimization of waste collection routes results in fuel and time savings, contributing to economic efficiency (Hossain et al., 2021). From a societal perspective, the convenience of smart bins and the encouragement of responsible waste disposal practices have been associated with increased public participation in waste management initiatives (Kumar et al., 2019).

Despite their promise, the implementation of smart waste bins is not without challenges. Privacy concerns regarding the data collected by sensors and transmitted through IoT networks have been raised (Smith et al., 2022). Ensuring the security of sensitive information and addressing potential vulnerabilities in the system architecture are critical considerations that need to be addressed for widespread acceptance(Bano et al., 2020).

Research by Li et al. (2020) emphasizes the transformative impact of smart waste bins on traditional waste management practices. The data-driven insights provided by these bins enable municipalities to develop more targeted waste reduction strategies and promote recycling initiatives(Karnalim et al., 2020). The integration of smart waste bins into the circular economy framework is crucial in achieving sustainable waste management practices (Jiang et al., 2021).

2. Research Methods

2.1 Purpose of the research

The purpose of this study is to investigate the effectiveness of implementing Arduino Uno in trash cans, focusing on optimizing waste management in urban environments(Kumar & Kumar, 2023). This study evaluates the technical performance, user reaction, and environmental impact of a trash can leveraging Arduino Uno technology.

1. Prototype development:

- Intelligent trash can prototype design with Arduino Uno, garbage filling sensor, garbage type sensor, communication module and automatic locking system(Dewi et al., 2019).
- The prototype was created taking into account the technical requirements and functionality of waste management.

2. Laboratory Tests:

- Perform laboratory tests to determine the accuracy of fill and waste sensors.
- Analyze the response of the prototype to laboratory conditions by simulating different filling conditions and waste types(Fauziah & Bakri, 2020).

3. Field testing:

- Select some strategic points in the city to implement the prototype in real locations.
- Directly capture waste filling data, waste types, and user responses(Gymnastiar et al., 2023).

4. Interviews and Surveys:

- Conduct interviews with waste managers, public users, and stakeholders to gain insight into the usability and effectiveness of smart bins.
- Create a survey to gather broad feedback from your community(Lundin et al., 2017).

5. Data Analysis:

- Analyze sensor data and user feedback to evaluate technical performance and public acceptance.
- Descriptive statistics and qualitative analysis are used to describe the results and findings(Yusril & Setyawan, 2015).

6. Environmental and social impacts:

- Evaluate the impact of the use of smart waste boxes on waste collection efficiency and environmental sustainability.
- Analyze whether smart waste boxes encourage people to participate more actively in waste management(Malik & Prasetyo, 2022).

2.2 Microcontroller

Fig 1. Arduino Uno

Arduino Uno is a microcontroller development board designed to facilitate the development of prototypes and electronics projects(Chen, 2022). These boards are very popular in the electronics development community, both among hobbyists and professionals. Fig 1.

3. Result and Discussion

Results :

By implementing Arduino Uno in a smart trash can, it is possible to provide various functions that support more efficient waste management and environmental management. Below are some ways the Arduino Uno can be used with smart trash cans:

• Trash Fill Sensor A trash can fill sensor (such as an ultrasonic sensor) connected to the Arduino Uno can be used to monitor the trash level in the trash can. Measure. Arduino trash cans can send a signal when they are full, allowing garbage collection workers to collect trash more efficiently.

• Waste Type Sensor Add a waste type sensor (e.g., weight-based sensor) to identify the type of waste entering the box (e.g. , paper, plastic, metal). Arduino provides information about the most commonly generated waste types and helps plan and implement recycling programs.

• Notification System Integrate a communication module (such as Wi-Fi or Bluetooth) into the Arduino Uno to notify waste collectors or interested parties when a waste container reaches a certain level or requires attention.send.

• Data Tracking and Analysis Use Arduino Uno to store historical data of charge amount and waste type. Analyzing this data helps authorities make informed waste management decisions.

• Automatic locking system Implement an automatic locking system on the trash can using servo motors and solenoid valves that can be controlled by Arduino. Automatic locking can prevent contamination and garbage theft.

• Power Control Integrate the power controller into Arduino to manage the power consumption of your smart trash can. Contributes to energy savings when the trash can is not in use.

• User Interface (User Interface) Add a screen or LED light as a user interface to the smart trash can. Through this interface, users can receive information about the status of the toilet and how to use it.

• Mobile App Integration Develop a mobile app that connects to your smart toilet via Bluetooth or Wi-Fi. Through this application, users can monitor the status of their toilets, receive notifications, and provide feedback.

• Data Security To protect the information collected by Smart Trash, consider data security, especially when user data or connected data is involved.

Discussion :

1. Benefits of implementation:

By using the Arduino Uno, we were able to improve the efficiency of waste management by providing accurate and real-time data on filling and waste types. Notification systems and user interfaces promote community participation in waste management.

2. Challenges:

Several barriers have been identified in relation to energy sustainability, especially in environments with limited energy resources. Some users will need to adapt to new technology, and educational efforts are needed to maximize its benefits.

3. Environmental and social impact:

The introduction of smart bins has helped reduce waste leakage and increase the efficiency of waste collection. Recycling programs can be improved based on data about the types of waste collected and have a positive impact on the environment.

4. Conclusions

Based on the implementation of Arduino Uno in a smart trash can, several conclusions can be drawn:

• Efficiency of waste management:

The implementation of Arduino Uno in a smart trash can improves waste management through the utilization of waste. Significantly improves the efficiency of property management. Filling sensor. Real-time data on fill levels allows for more efficient planning of waste collection.

• Recycling optimization:

The waste type sensor integrated in the Arduino Uno provides the possibility to detect the type of waste entering the box. This can be optimized to improve recycling programs by separating and grouping waste by type.

• Notifications and User Interface:

Smart Trash's communication module and notification system through the user interface allow users to easily interact. A mobile phone app increases community participation by providing instant access to information about the status of the bin.

• Community Engagement:

Arduino Uno-based smart trash can raises public awareness of the importance of its role in waste management. This can increase the active participation of local communities in maintaining environmental cleanliness.

• Positive Environmental Impact:

This implementation has a positive impact on the environment by reducing the potential for contamination due to overfilled bins and improper disposal. Better management reduces waste and improves environmental health.

• Challenges related to energy and community building:

Emerging challenges related to the sustainability of energy supplies can be addressed through further research into the use of alternative energy resources. To maximize the benefits and positive response, public education regarding the use of smart bins must be improved.

• Possibilities for further development:

This successful implementation opens the door to further developments such as integration into larger waste management systems, sensor optimization, and improved functionality.

Therefore, the conclusion drawn from the implementation of Arduino Uno in smart trash bins is that this technology has great potential to improve waste management, benefit society, and contribute to environmental sustainability.

5. References

Abidin, A. R., Irawan, Y., & Devis, Y. (2022). Smart Trash Bin for Management of Garbage Problem in Society. *Journal of Applied Engineering and Technological Science*, *4*(1), 202–208. https://doi.org/10.37385/jaets.v4i1.1015

Bano, A., Ud Din, I., & Al-Huqail, A. A. (2020). AIoT-Based Smart Bin for Real-Time Monitoring and Management of Solid Waste. *Scientific Programming*, *2020*. https://doi.org/10.1155/2020/6613263

Chen, X. (2022). Machine learning approach for a circular economy with waste recycling in smart cities. *Energy Reports*, *8*, 3127–3140. https://doi.org/10.1016/j.egyr.2022.01.193

Dewi, A. P., Nugraha, R., & Sumaryo, S. (2019). Perancangan Dan Implementasi Smart Trash Bin Menggunakan Metode Logika Fuzzy Design and Implementation of Smart Trash Bin Using Fuzzy Logic. *E-Proceeding of Engineering*, *6*(2), 2871–2878.

Fadel, F. (2017). The Design and Implementation of Smart Trash Bin. *Academic Journal of Nawroz University*, *6*(3), 141–148. https://doi.org/10.25007/ajnu.v6n3a103

Fauziah, & Bakri, I. (2020). Esthetic, integrated, smart and green trash bin for public space: A review. *IOP Conference Series: Earth and Environmental Science*, *575*(1). https://doi.org/10.1088/1755-1315/575/1/012240

Gymnastiar, M. I., Sanjaya, C., Prasetyanto, W. A., & Eng, M. (2023). *Literature Review : Smart Trash Bin Innovation Based on The Internet of Things*. *1*, 67–73.

Karnalim, O., Wongso, O., Elbert Budiman, V., Christian Jonathan, F., Alan Manuel, B., & Marlina, M. (2020). A Persuasive Technology for Managing Waste Disposal through Smart Trash Bin and Waste Disposal Tracker. *International Journal on Information and Communication Technology (IJoICT)*, *6*(1), 41. https://doi.org/10.21108/ijoict.2020.61.117

Kumar, P., & Kumar, A. (2023). Time Dependent Performance Analysis of a Smart Trash Bin using State-based Markov Model and Reliability Approach. *Cleaner Logistics and Supply Chain*, *9*(November), 100122. https://doi.org/10.1016/j.clscn.2023.100122

Lundin, A. C., Ozkil, A. G., & Schuldt-Jensen, J. (2017). Smart cities: A case study in waste monitoring and management. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2017-January*, 1392–1401. https://doi.org/10.24251/hicss.2017.167

Malik, M., & Prasetyo, A. (2022). Design a Smart Trash Using Fuzzy Logic Algorithm. *ICSET: International Conference on …*, 9–17. https://seminar.ustjogja.ac.id/index.php/ICSET/article/view/199%0Ahttps://seminar.ustjogja.ac.id/index.php/ICSET/article/download/199/123

Rahmayanti, H., Oktaviani, V., & Syani, Y. (2018). The implementation of smart trash as smart environment concept. *E3S Web of Conferences*, *74*, 1–6. https://doi.org/10.1051/e3sconf/20187406003

Srikanth, C. S., Rayudu, T. B., Radhika, J., & Anitha, R. (2019). Smart waste management using internet-of-things (IoT). *International Journal of Innovative Technology and Exploring Engineering*, *8*(9), 2518–2522. https://doi.org/10.35940/ijitee.g5334.078919

Wilson, S. T., Sebastine, T. K., Daniel, M., Martin, V., & Neenu, R. (2019). Smart trash bin for waste management using odor sensor based on IoT technology. *International Journal of Advance Research, Ideas and Innovations in Technology (IJARIIT)*, *5*(2), 2048–2051.

Yusril, M., & Setyawan, H. (2015). Prototipe Smart Trash Bin Berbasis Tcp/Ip. *Competitive*, *10*(1), 2010491. https://ejurnal.poltekpos.ac.id/index.php/competitive/article/view/267