



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 3, March 2025

General Waste Segregation using Artificial Intelligence

Nandhu Krishnan C¹, Ubaid M V², Anshad C V³, Razin Ahamed K⁴, Fathima Sapna P⁵

U.G. Students, Department of Electrical and Electronics Engineering, AWH Engineering College, Calicut,
Kerala, India¹²³⁴

Associate Professor, Department of Electrical and Electronics Engineering, AWH Engineering
College, Calicut, Kerala, India⁵

ABSTRACT: This paper presents a pioneering development powered by a linear actuator. The proposed waste segregation system utilizes supervised machine learning algorithms to categorize waste into 4 types: glass, metal, paper, and plastic. The process involves data collection, audio preprocessing, and detection of audio signals of each waste particles. The system achieves an efficiency of 80% in testing and eliminates human intervention in the segregation stage, offering a potential solution to improve waste management accuracy and efficiency.

KEYWORDS: Arduino Nano 33 BLE Rev 2, TMC 2208 Stepper motor driver.

I. INTRODUCTION

Waste management is a continuous process of the collection, transport, treatment and disposal of waste. Monitoring and regulation are a very important part of the waste management process. With the increasing amount in the waste generation, it is imperative that we make the process of waste disposal and treatment as efficient as possible.

Disposal method includes collection of waste by the government authorities at the door step of the people. But most of the time the waste is not segregated properly, which effects the further segregation stages in a negative manner. Our goal is to find an efficient and a cost effective method to segregate waste at the lowest possible level. According to the Solid Waste Management Rules 2016, the generators of waste are supposed to segregate the waste into 4 parts plastic, paper, glass and metal. The advantage of this type of segregation is the ease of segregation and also the accuracy of the segregation of waste.

II. LITERATURE SURVEY

Recent studies have explored the application of artificial intelligence (AI) in waste segregation systems. In [1], a smart trash box with four chambers was developed, utilizing AI and various sensors to achieve an accuracy of 80% in waste classification. The system aims to reduce manpower, save time, and ensure proper garbage collection. Another study [2] presented a smart bin system that not only classifies waste with an accuracy of 98.9%, but also predicts waste generation. This system demonstrates a significant improvement over existing waste management systems. A comprehensive review of AI applications in waste management was conducted in [3]. The study highlights the potential of AI in revolutionizing waste segregation practices, including waste prediction, sorting, and smart waste classification. The use of AI is shown to improve efficiency and sustainability in waste management systems.

III. SYSTEM ARCHITECTURE

3.1 BASIC STRUCTURE & DETAILS

In order to collect audio data of the rubbish objects, we need to first build the minimal hardware necessary as shown in the below pictures, this makes sure that the collected data will be similar to the real scenario. At this stage we don't need a functional smart bin, so it is ok to just use a sticky tape to keep the trapdoor and some acrylic parts in place. The frame is build by 25mm iron bars. The dimensions of the frame height 750mm, length and width 600mm. The inverted

pyramid shaped acrylic sink can be mounted to the top as shown below.

3.2 IMAGES OF THE FRAME



Fig(1) Top view



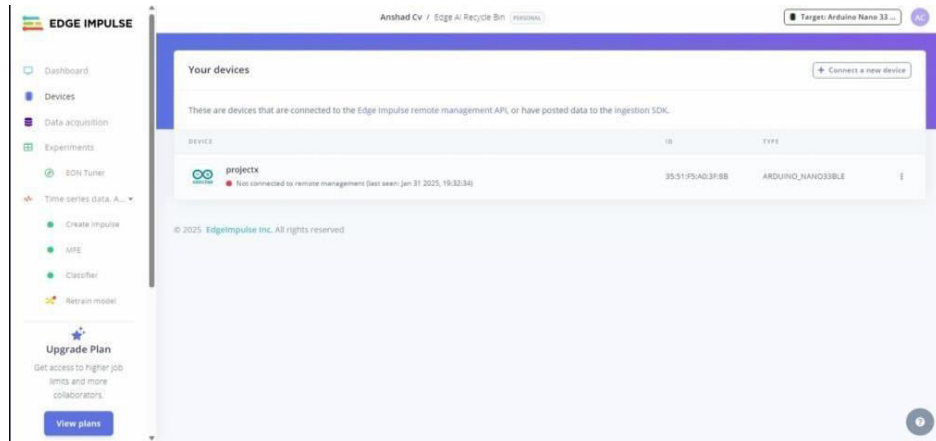
Fig(2) Side view

3.3 SOFTWARE DETAILS

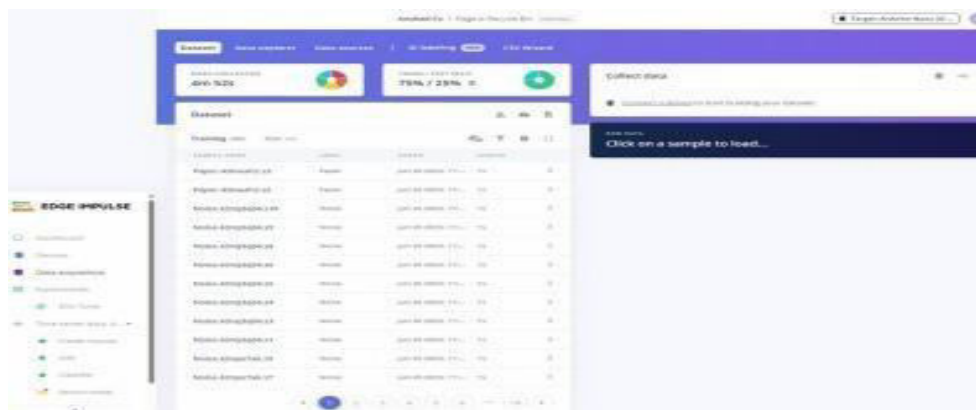
Edge Impulse is a software platform that enables developers to design, develop, and deploy machine learning (ML) models on edge devices. It provides tools for data collection, labeling, and model training, and supports a wide range of edge devices. Edge Impulse reduces latency, improves security, and increases efficiency by processing data locally on edge devices. It has various applications in industrial automation, smart homes and cities, healthcare, and autonomous vehicles.

Arduino BLE with the system, create a new project and go to the Edge Impulse "Data acquisition" tab and start collecting audio data. Choose Device: Arduino BLE Sense, Sensor: Microphone Frequency set up to 16,000Hz, Sample length: 19,000.

After this process, we open the Arduino IDE software to upload the program into the BLE Nano 33 sensor. Then, data acquisition takes place on the Edge Impulse software. Additionally, we can train the BLE Nano 33 sensor to recognize new audio signals using Edge Impulse.

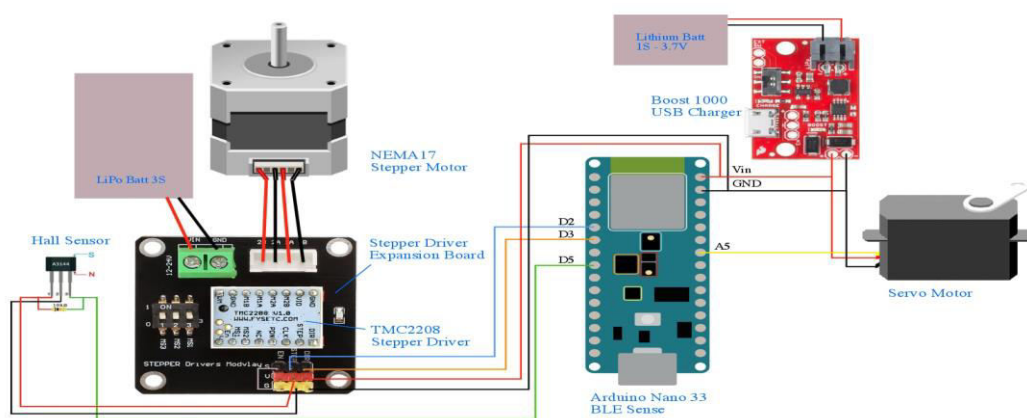


Fig(3) Device connecting



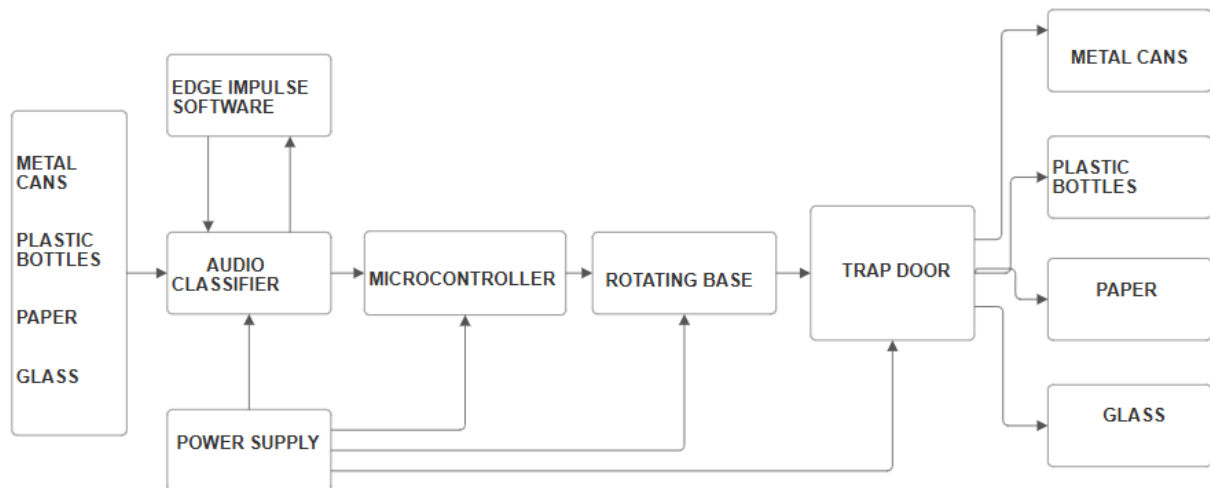
Fig(4) Data acquisition

3.4 CIRCUIT DIAGRAM



Fig(5) Circuit diagram

3.5 FLOW CHART



Fig(6) Flow chart

1. Trash Items (Metal Can, Plastic Bottle, Paper, Glass):- Represents the various recyclable materials that users dispose of into the recycling bin.
2. Audio Classifier:- This component employs AI and audio recognition technology to analyze the sounds produced by different materials when dropped in the bin. It classifies these sounds into categories corresponding to the type of trash (e.g., metal can, plastic bottle, paper and Glass).
3. Microcontroller:- Serves as the central processing unit that coordinates the rotational actions of the system based on the outputs from the audio classifier. It communicates with other components to initiate appropriate responses.
4. Edge Impulse Software:- A software module running on the edge impulse (locally on the device) that interfaces with the audio classifier and microcontroller. It processes the classification results and triggers subsequent actions.
5. Rotating Base:- A mechanical component that facilitates the rotation of the recycling bin. When triggered by the system, it rotates the bin to allow the categorized items to move towards specific partitions for further sorting.
6. Trapdoor:- Located at the top of the recycling bin, the trapdoor opens based on the classification results. It allows the sorted items to move to the next stage of the sorting process.
7. Partition:- Divides the interior of the recycling bin into sections corresponding to different types of recyclable materials. Each partition directs items to the appropriate collection area.
8. Power Supply:- Provides the necessary electrical power to all components, ensuring continuous and reliable operation of the system.

IV. CONCLUSION

The Smart Dust-Bin, based on an AI-powered audio classifier, is an innovative project that combines artificial intelligence and waste segregation. The project's scalability through distributed processing offers a promising solution for waste classification across diverse settings. However, challenges such as limited processing power, storage constraints, and security considerations underscore the need for a balanced approach in deployment. Despite these challenges, this project represents a significant step toward leveraging advanced technologies for sustainable waste management. As technology evolves, addressing these limitations will be crucial for the widespread success of similar

initiatives, contributing to a more efficient and environmentally conscious future.

V. FUTURE SCOPE

The future scope for smart dustbins incorporating AI audio classifiers is extensive, presenting opportunities for significant advancements in waste management technology. Ongoing research and development in machine learning algorithms promise enhanced accuracy in recognizing and categorizing diverse types of waste, improving the efficiency of segregator. Integration within larger IoT ecosystems within smart cities is a foreseeable progression, fostering seamless communication between smart devices and waste management systems for optimized urban efficiency. Future iterations may provide real-time monitoring and analytics on waste disposal patterns, offering valuable insights for city planning and resource allocation. In summary, the future of AI audio classifier-based segregator is dynamic, promising impactful contributions to sustainable and efficient waste management practices in urban environments. Ongoing innovation and collaboration will play pivotal roles in shaping this future landscape.

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