

# CPS project presentation: BottleSort

Leon Adomaitis

Jan Sirui Chen

Fabian Deigner

Bavly Kirolos

Hwanseo Lee

Anusha Reddy Mareddy

Enuri Maheshika Samaraweera

Yi Zhang

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# Problem statement

- 2.01 billion tonnes of waste is discarded each year
- Only 13% is recycled.
- Bottles are the most common item in landfills, but they can be recycled easily compared to other waste.



# Our solution

An automated approach is needed to detect material and sort them accordingly



A smart trash can that can sort glass bottles, plastic bottles, and metal cans.



Eliminates the labor-intensive task of sorting and increases efficiency and effectiveness.

# Approach

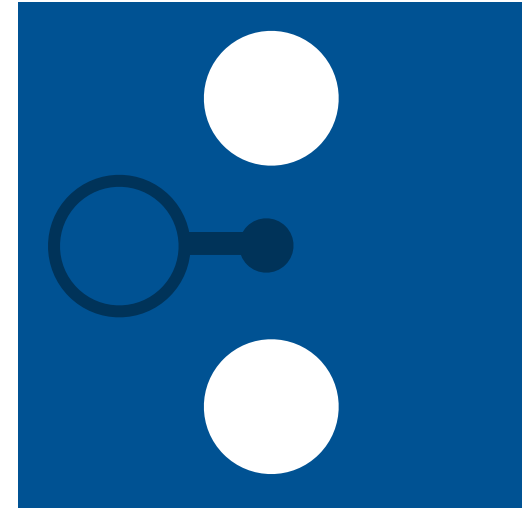
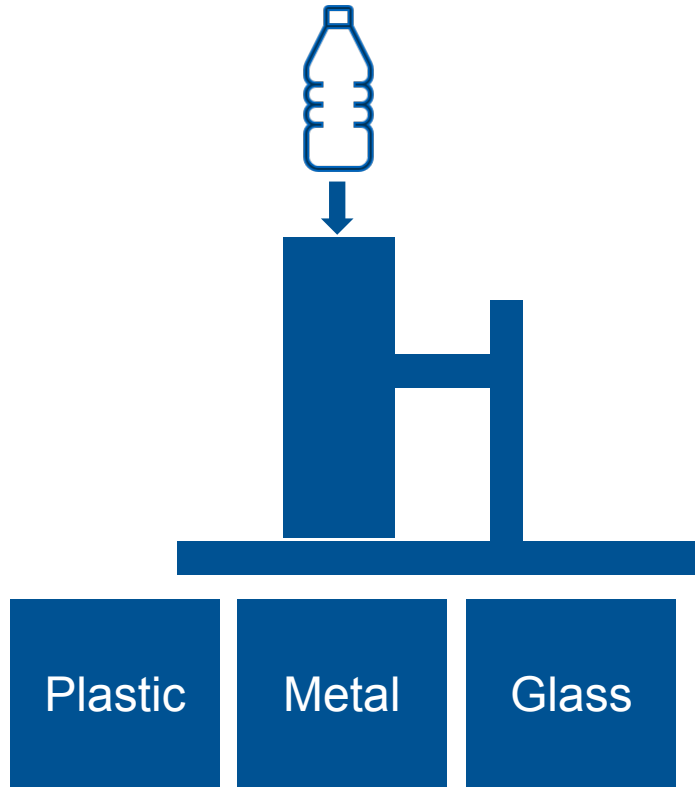
Testing of different sensors:

- NIR
    - Needs a somewhat controlled environment
    - Lighting
  - Camera
    - Lighting
  - Inductive proximity sensor
    - Only detects ferromagnetic materials
    - Small range -> Challenges with item placement
- Microphone
- Cheap and simple solution that relies on physical properties of the materials and can reliably differentiate between them

# Challenges when using a microphone

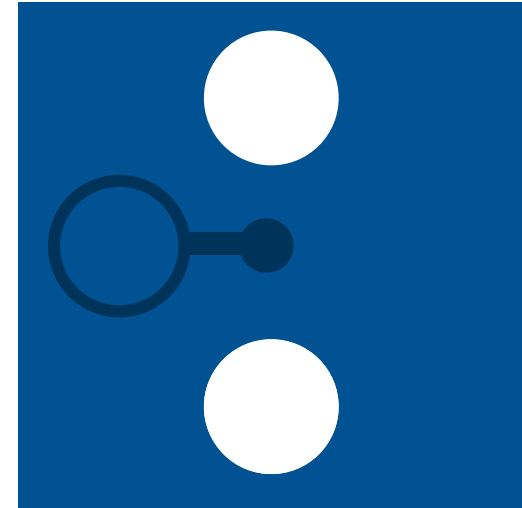
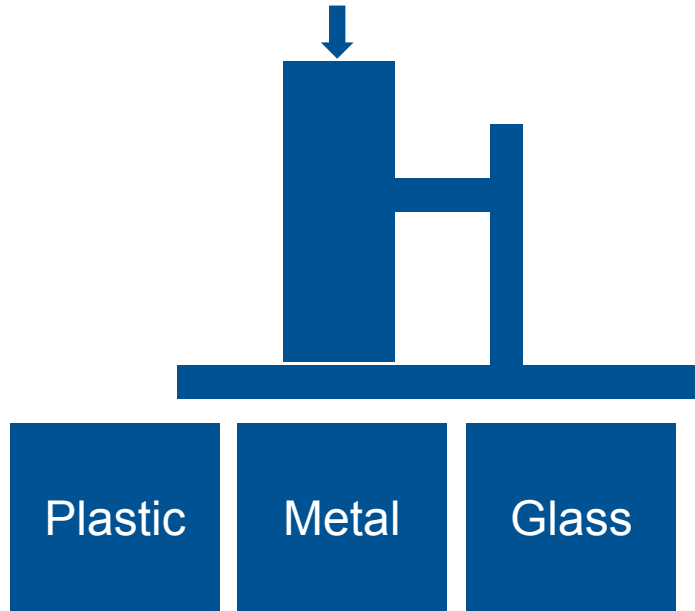
- How to reduce noise?
- How do you produce the sound, such that it is consistent, and you get good data for model training?

# Physical approach



# Physical approach

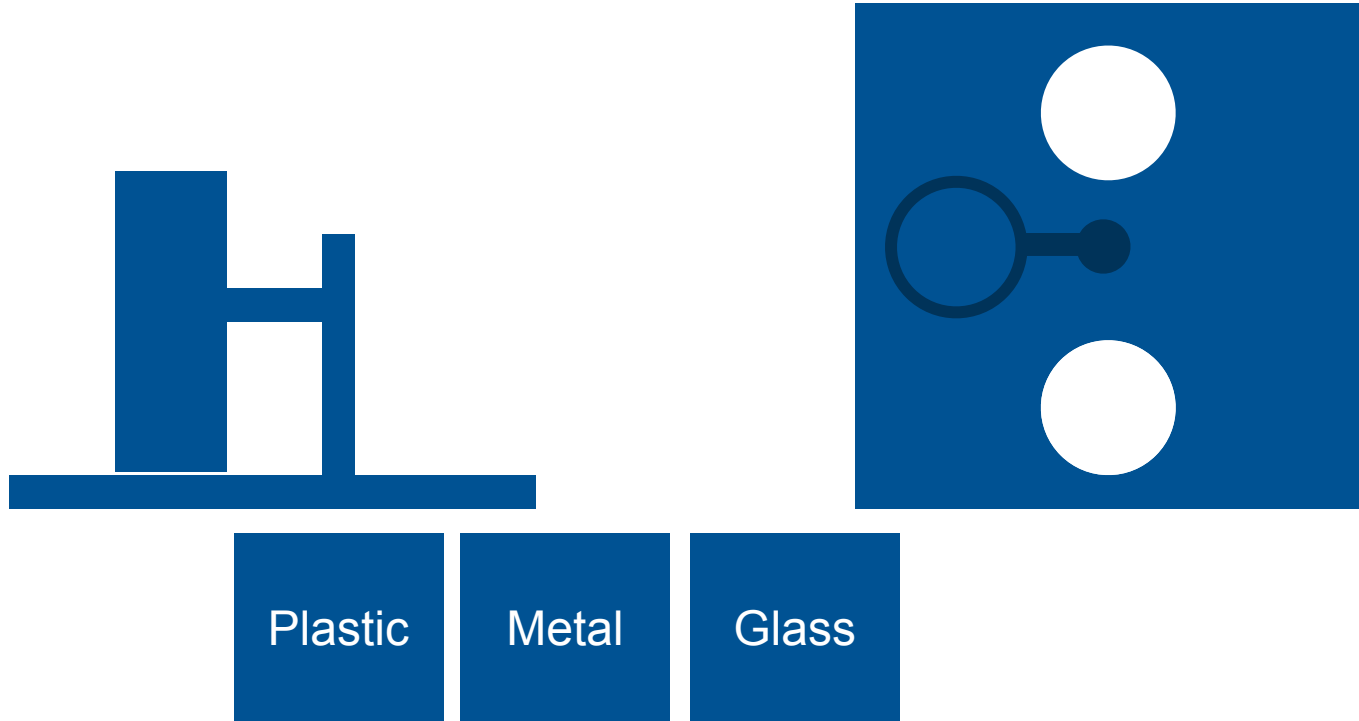
Recording sound and classifying results ....





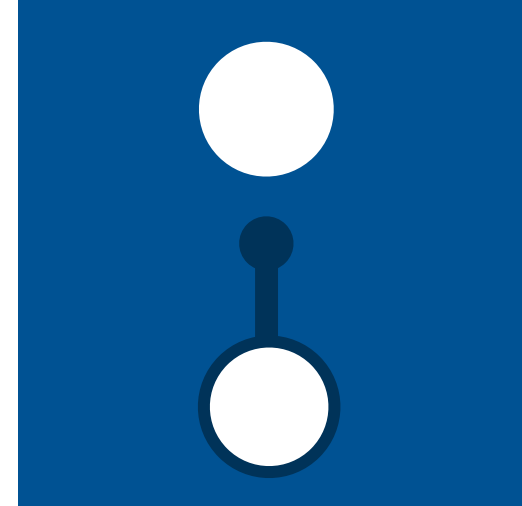
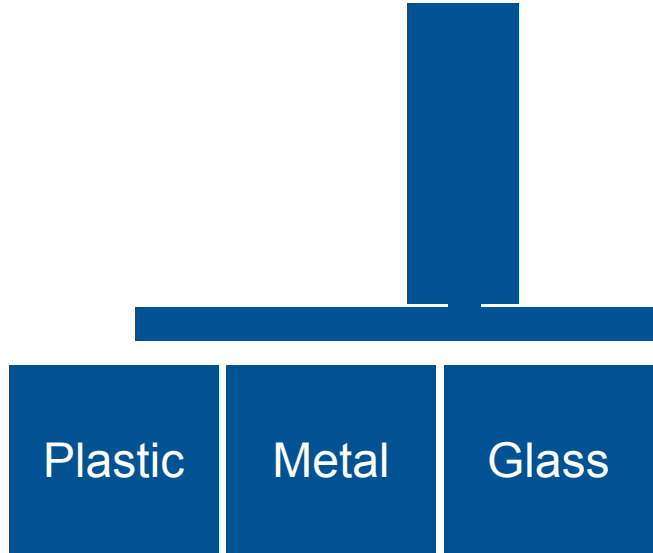
# Physical approach

Moving to the according trashcan

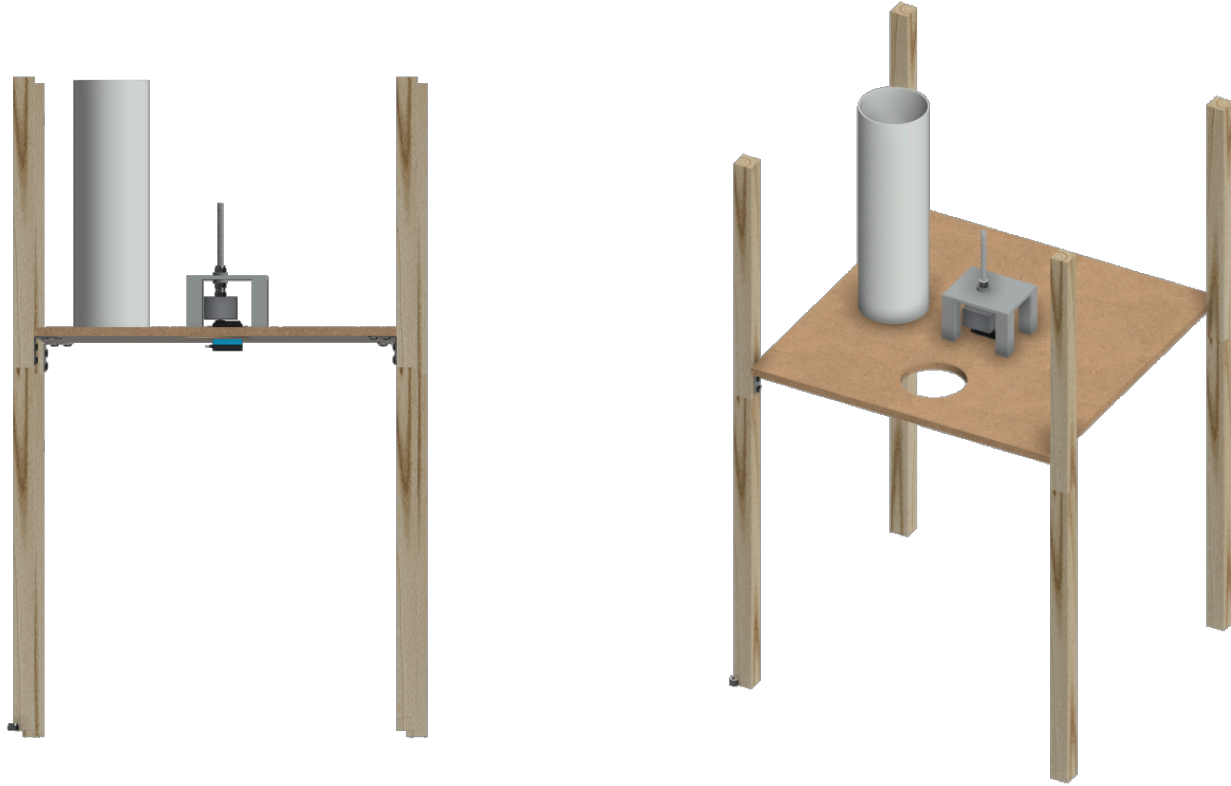


# Physical approach

Dropping the bottle into the trashcan that was determined by the classification



# CAD rendering



- The microphone is attached to the board, outside the pipe. It will sense the vibration caused by the impact on the wooden board
- The microcontroller will process these vibrations and classify them using a trained model

# Implementation

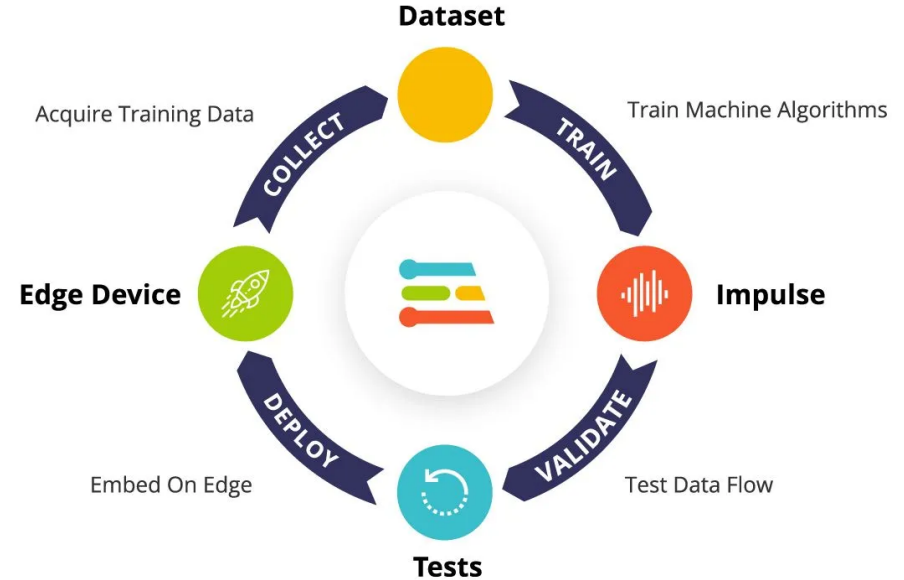
# Hardware used

- Raspberry pi 5
- Arduino
- Microphone for recording the sound
- Stepper Motor for moving the trash cans
- Stepper Motor Driver for controlling the stepper motor
- Servo Motor for rotating the pipe
- Power Supply (Motor) - 24V DC DC Power Supply (within 9-42V range for TB6600 Driver)
- Power Supply (MCU) 5V via USB for Raspberry Pi
  
- Structural Material 8mm and 10mm MDF Wood

# Software Implementation - AI

For our AI model, we used Edge Impulse, which is a platform for data collection, training and deployment.

The classify method will be called when the microphone picks up a sound with an amplitude above a certain threshold.



Source: <https://www.edgeimpulse.com/>

- The output of the model is a list of scores for each label, from which we choose the label with the highest score
- The selected label then determines the positions that the tube and the tray with trash bins need to be in
- This information is sent from Raspberry Pi via serial communication (PySerial) to Arduino that's connected to motors, which move the tube and the tray to the correct positions in the correct order (tray first, then the tube)
- After a fixed period of time, messages are sent to Arduino again to move them back to their original positions



# Next steps

- A more aesthetically pleasing and robust design could be used for the physical structure
- A wider range of materials detected could be achieved by using more sensors
- A wider range of bottle types and shapes could be supported by changing the tube used
- An automatic lid with a proximity sensor could be added

# Summary

We developed and implemented an automatic trashcan sorting between plastic bottles, glass bottles, and metal cans by using methods we learned in this lecture.

