R³ — REDUCE REUSE RECYCLE

MESA Mathematics Engineering Science Achievement — JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

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Grade: Middle School (6th)
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Problem Statement

- As per a 2013 Environmental Protection Agency study, an average American wastes about 4.4lbs of materials per person every day. Majority of the recyclable items are filled in landfills.
- Based on our research, there is no distinct product that can identify all types of recyclable items with appropriate prompts to avoid intermix of trash and recyclable items.

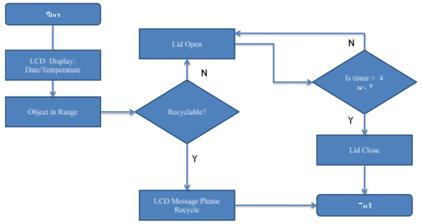
Objective

- Efficiently segregate recyclable items from trash to save energy and the environment

User Requirements (Goals/Constraints)

- Need a device to identify recyclable items and restrict recyclable items to be intermixed with trash.
- Needs to be weather proof and avoid damage from trash inside the container
- Needs to have display panel for friendly usability and buzzer prompting.
- Efficient proximity sensing of recyclable items.
- Scope is limited for home usage- needs further improvements for commercial usage.
- Recyclables should be fed individually to container.

Process Flow Diagram



Engineering Design Process

Ask:
- Durability of the device, condition of recyclables.
- Too many recyclable items in landfills can lead to pollution.
- Recycling can save a lot of energy.

Research/Brainstorming: We researched case studies on:
- How our community's recycling efforts are.
- How our community's trash ends up in landfills and affects the environment
- Researched on existing tools their capabilities and deficiencies

Imagine:
- We considered 3 solution approaches and shortlisted one option - Designed a device to identify recyclable items thrown in trash bin with lid

Plan:
- Design and development work is split into 3 modules - Metal Detector, Motion detector and Display Panel.

Create:
- Implement/Program above 3 modules and build corresponding circuits.

Test and Evaluate:
- Performed the unit test for each module separately and captured the test results for the relevant scenarios.

Improve:
- The prototype can be enhanced for greater range of detecting items.

Share Solution:
- The key strength of the current prototype model is uniqueness of the product to deliver metal detection, LCD display and auto lid open/close.

Science Connection: Environmental/Earth Science
- R³ reduces greenhouse gases and toxic chemicals from landfills

Math connection:
- Used Plane Geometrical math concepts like Dihedral Angles for the trash bin lid's open and close angles.
- R³ costs inexpensive product. Please refer the budget table below.
- R³ Efficiency = Successful Trials / Total Trials in percentage.

Input Devices:

Ultrasonic Sensor

Inductive Proximity Sensor

RTC

Output Devices:

LCD

Piezo Buzzer

DC-Servo

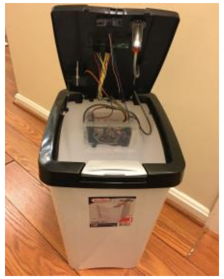
R³ Prototype

Arduino Mega 2560

Front View

Top View

Open View



Integrated Device Box

BUDGET

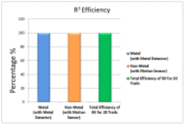
Part	Unit Dimensions	Retail Price	Price per Unit	Qty Used	Total Cost	Retail Source
Elegoo MEGA 2560	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Bread Board	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Inductive Proximity Sensor	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Ultrasonic Sensor (part of the Elegoo Upgraded 37 in 1 Sensor Modules Kit)	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Liquid Crystal Display (Elegoo Kit)	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Active Buzzer (Elegoo Kit)	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
360 Degree Continuous Rotation Servo Motor	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Potentiometer (set of 4)	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Energizer Batteries - 4 AA Battery	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Project Box	[illegible]	[illegible]	[illegible]	1	[illegible]	
Trash Can	[illegible]	[illegible]	[illegible]	1	[illegible]	
Metal Hinge Joint (saw tooth hangers 4 pack)	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]
Screws	[illegible]	[illegible]	[illegible]	2	[illegible]	[illegible]
Multi-colored Dupont Wires	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
				Total	[illegible]	

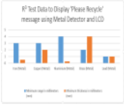
Reduce landfills, use R3 device, to save the environment

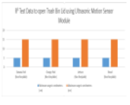
FACTS

- Recycling 1 ton of plastic can save an equivalent of 2 peoples energy for 1 year.
- Manufacturing products for recycled paper and plastic reduces water pollution by 35% and air pollution by 73%.
- One plastic bottle can save enough energy to power a 60 watts light bulb for 6 hours.
- It takes about 25 recycled bottles to make a fleece jacket.

Graphs







Conclusion

The device has foundational framework with focused capabilities but has potential to be fully extendable to meet broader diversified needs

Key Advantages
- Minimizes intermixing of recyclable with trash in turn helps
  - Reduction of chemical toxic gases generation from Landfills
  - Increased Opportunity on recycling and saves energy

Key Strengths
- Supports metal detection to avoid intermixing with trash and provides recycle opportunity
- The device is very user friendly - displays a LCD message and buzzer to prompt user to recycle the item
- If the item is recyclable, the lid does not automatically open

Recommendations

Consider below capabilities for future enhancements for multi iteration releases for full blown product
- Plastic, cardboard, paper and glass sensing are must have capabilities
- Notification to user's phone with recycled material data would be a valuable addition in the future.
- Extend product capabilities from residential to commercial usage.