



Automatic Sorting Trash Bin

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Goals and Objective

To develop a trash bin that can do automatic sorting for four different categories of trash with Raspberry Pi and stepper motors.

Background

In 2018, the U.S. threw out over 292 million tons of municipal solid waste (MSW). Estimated 62% of waste discarded was ultimately dumped into landfills or burned in incinerators. More surprisingly, 321 million trees are needed for the same amount of paper that was land filled or burned in 2018 alone. [1]. Despite there being many sorting trash bins everywhere, many people don't care about the correct classification for each trash.

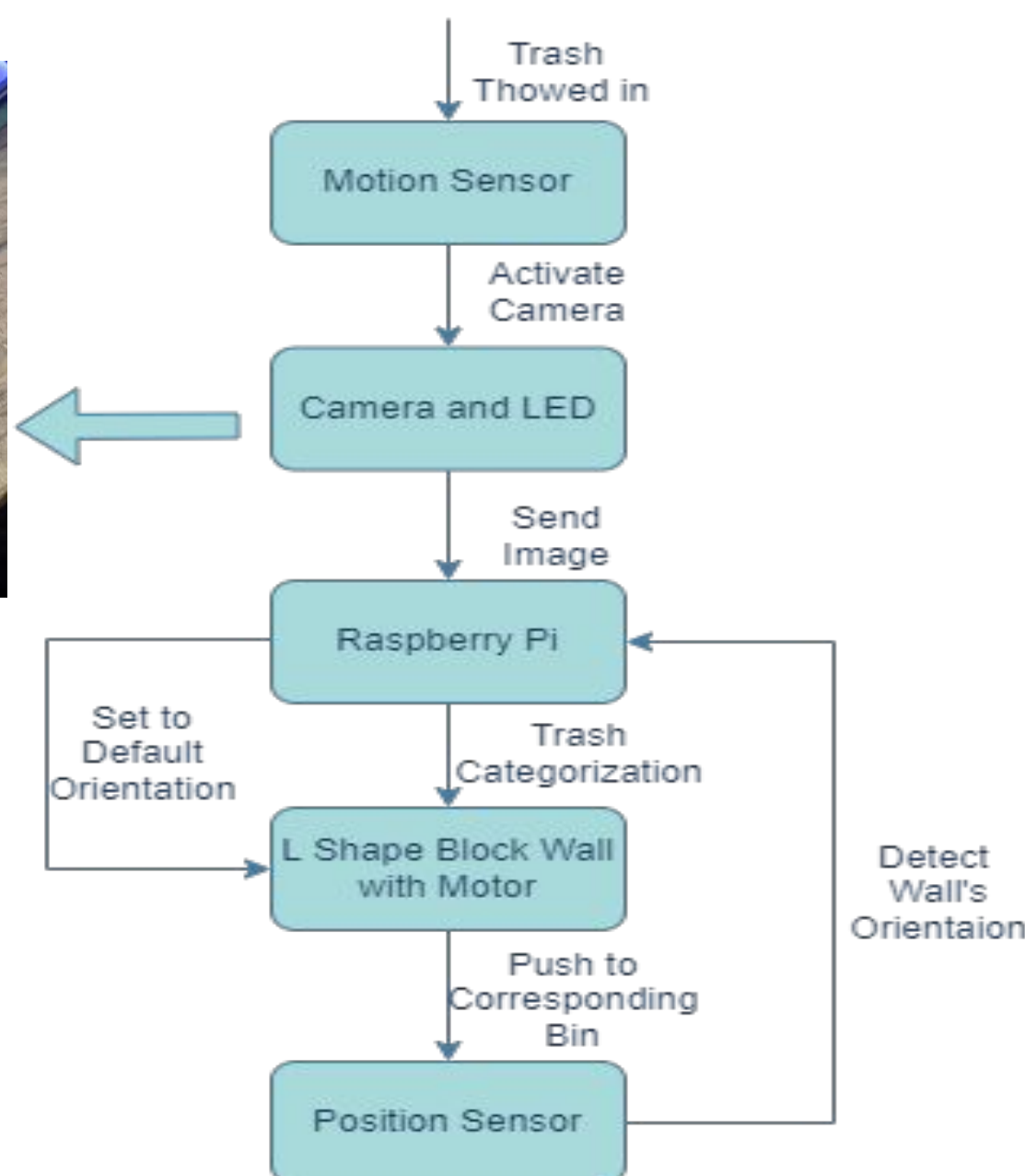
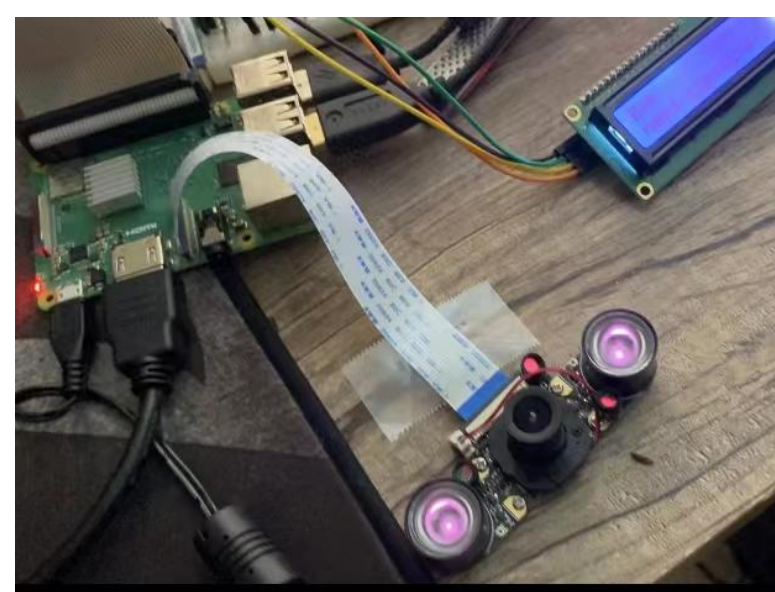
Results

We have developed an automatic trash bin to help sorting trash more efficiently. It automatically detects trash thrown in and takes a picture, then our image recognition program would pass the type of trash to the control system, and the motors will sort the trash into corresponding sub-bin.

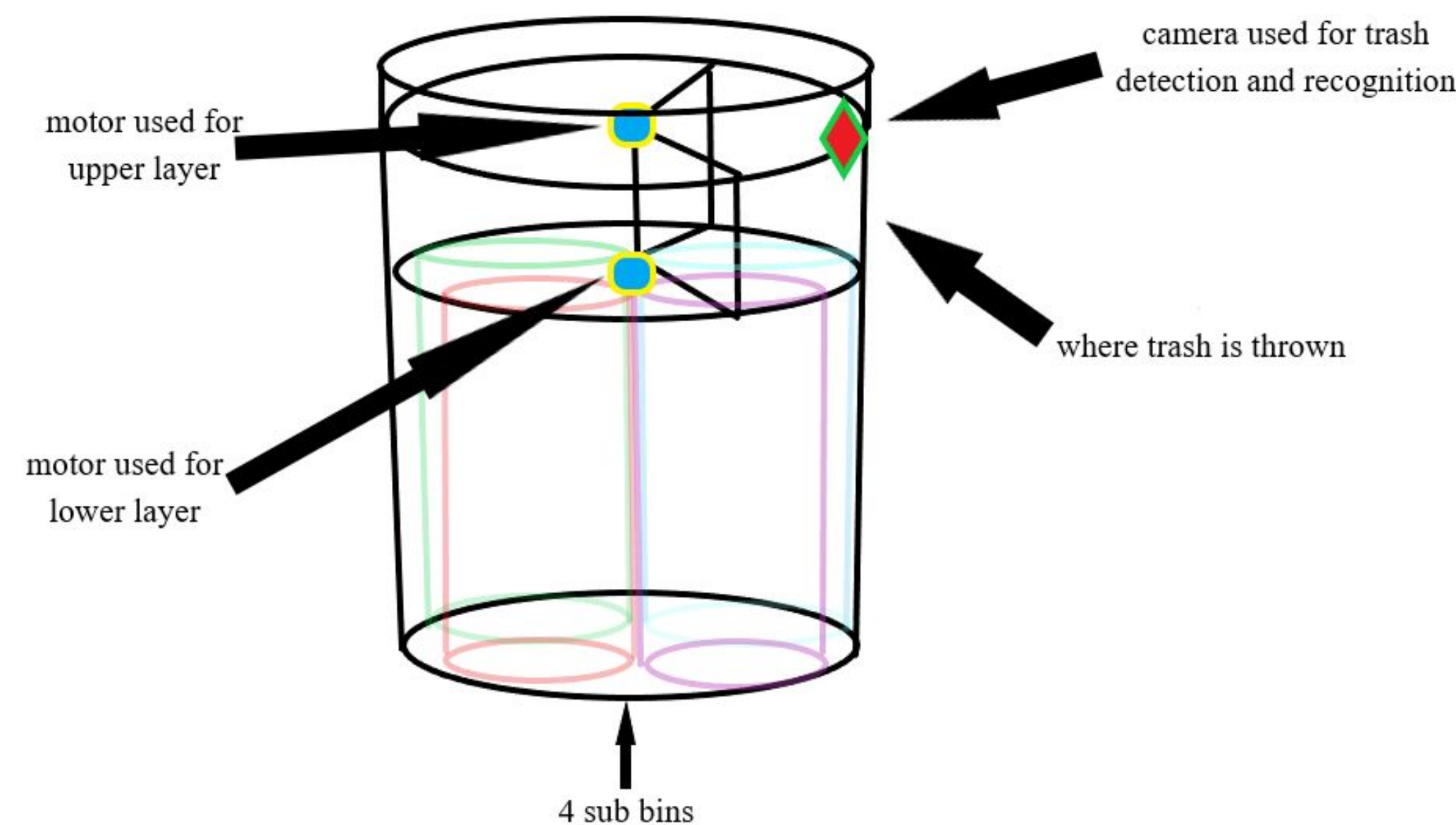
Improvements

Automation in our project could be further improved by adding sensors like distance or weight sensors to precisely determine whether a sub-bin is full and needs cleaning. We could also develop an APP to monitor the trash bins in real time. On the other hand, the mechanism and image recognition program can be further improved as well.

Control System Design



Mechanical Design



Implementation

- **Image recognition:**
 - based on convolutional neural networks (CNN).
 - EfficientNet B0 [2] to be the backbone of the classification model
 - According to the paper, 8.4x smaller and 6.1x faster on inference than the best existing ConvNet [3] (by 2019) while maintaining the test accuracy on the ImageNet Dataset [4].
 - Use Arcface loss [5] for the loss function.
 - To generate very high inference accuracy on recognition dataset. We also implemented some image augmentation techniques and adversarial defense algorithms to level up the accuracy and robustness of our model.
- **Raspberry Pi:**
 - Activates LED/camera once motion sensor is triggered
 - uses machine vision to deal with image RGB data
 - sends signals to stepper motors, LCD
 - reads data from distance sensor and updates remaining space of sub-bins.
- **Stepper motors:**
 - Two stepper motors will each precisely drive one layer of our trash bin and does the physical waste classification using external 9V batteries.
- **Sensors:**
 - Motion sensor activates LED/camera image recognition program.
 - Distance sensor reads remaining space of trash bins.

Materials

- Sensors/Wires/Adapter
- Raspberry Pi Microprocessor
- Stepper Motors/Drivers
- LEDs/LCD
- Camera
- Wood/nails

Timeline

Summer 2021:

- Team formation.
- Design, functionality plan ahead. Risk management.

Fall Quarter 2021:

- Week 1-2: Finalize project idea and general design.
- Week 3-6: Order all parts and write signal control codes.
- Week 7-9: Build general trash bin construction/plan on wiring.
- Week 10: Continue building switch/power circuit and control codes.

Winter Quarter 2022:

- Week 1: Complete switch/power circuit.
- Week 2-3: Complete trash bin construction.
- Week 4: Take pictures/retrain AI.
- Week 5-8: Testing/debugging software/hardware.
- Week 9-10: Finalize product/documentation/presentation.

Team Info

Software

Yang Xiang(yxiang10@uci.edu):
Control system

Xiangbo Gao(xiangbog@uci.edu):
Image Recognition

Hardware

Yang Xiang(yxiang10@uci.edu):
Sensors/Trash bin mechanics

Jinghui Qiu(jinghuq1@uci.edu):
Trash bin mechanics
Stepper motor control

Jiajun Liang(jiajul7@uci.edu):
Circuit Design

References

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- [2] Tan, Mingxing, and Quoc Le. "Efficientnet: Rethinking model scaling for convolutional neural networks." *International Conference on Machine Learning*. PMLR, 2019.
- [3] Deng, Jia, et al. "Imagenet: A large-scale hierarchical image database." *2009 IEEE conference on computer vision and pattern recognition*. Ieee, 2009.
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- [5] He, Y., Lin, J., Liu, Z., Wang, H., Li, L.-J., and Han, S. Amc: Automl for model compression and acceleration on mobile devices. *ECCV*, 2018.



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