Team A5

Dr. Green

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Problem

- According to the EPA, only **35%** of waste in the United States was recycled or composted[1]
- About **25%** of the recyclables was contaminated[1]
- Recycling rules also vary by region, making things trickier
- Common contaminants: Plastic bags, liquids, shredded paper[2]

[1] https://news.climate.columbia.edu/2020/03/13/fix-recycling-america/

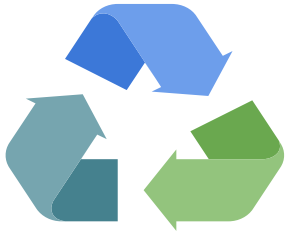
[2]https://www.colorado.edu/ecenter/2021/04/15/recyclings-most-common-contaminants

Use Case

Dr. Green: Smart Recycling Device for Schools

- Interactive education on recycling
  - Audio + Visual alert system
  - Customize rules per region

    *For this project, will focus on Pittsburgh



Education + Prevention

- Prevent recycling contamination
  - Schools → Large population, improvable existing set up

Areas: *Software Systems, Signal Processing, Hardware Design*

Use Case Requirements

General function: user places object on platform under camera, if recyclable, releases to bin, else alerts user to remove.

- Aim to reduce contamination by 85% per installed smart bin
- Overall time per object < 5s
- Detection & Classification: per object < 2s
- Trapdoor: opens if item is recyclable; remains closed otherwise
  - Typical op time ~1s
- Object detected → Camera captures after 2s (time for modification/UI)

Use Case Requirements

- Alerts for reinforcement
  - Speaker dings if item is recyclable, buzzes if not
  - LED green if recyclable vs. red if not (within 1s of classification)
  - Web App for more interactive set up, shows detected object, results, reasoning, and further info
- Monitor displays web app
- Flexible set up - compact, relatively easy to install/uninstall
- Trash Can: for throwing incorrectly recycled items

MVP

- The MVP will present a fully integrated audio and visual alert system.
  - Visual - LED
  - Audio - Speaker
  - Classification accuracy > 80%

Technical Challenges

Model Accuracy

Avoid recycling contamination

Mitigation: When in doubt trash, further train existing models

Speed

fast feedback for user to avoid disinterest

ML model requires large amounts of data processing

Mitigation: Powerful system, optimize, remove unnecessary computations

Memory Space

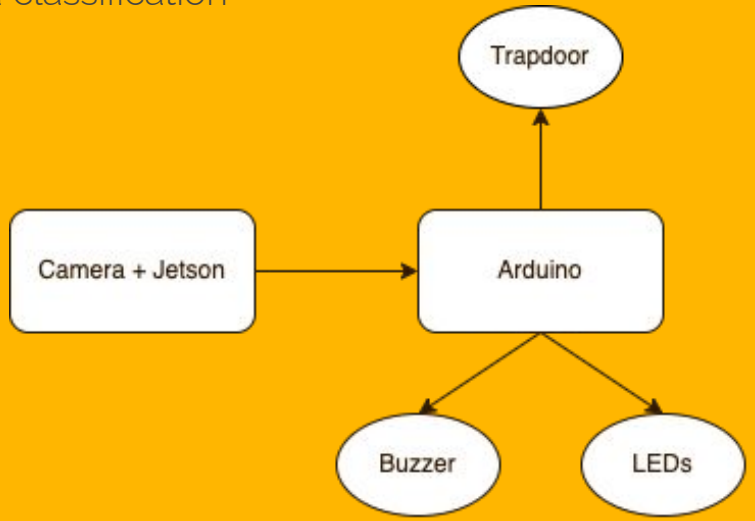
need independent system for each bin

Small and cheap often = less memory space (ex. Jetson rather than personal computer)

Mitigation: maximize computation, remove unused data

Solution Approach

- **Software**
  - YOLOv5 small on Jetson for detection and classification
  - Drinking Waste Classification dataset
  - Colab for training
- **Hardware**
  - Jetson Xavier NX
  - Webcam
  - LED and buzzer
  - Arduino
- **Mechanical**
  - Wooden slab and hinges (trapdoor)
  - Recycling bin



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Testing, Validation and Metrics

SOFTWARE

- Detection: best distance at which classifiable object can be detected without interference

- Classification: object identification accuracy
  - Target >85% accuracy rate

Testing, Validation and Metrics

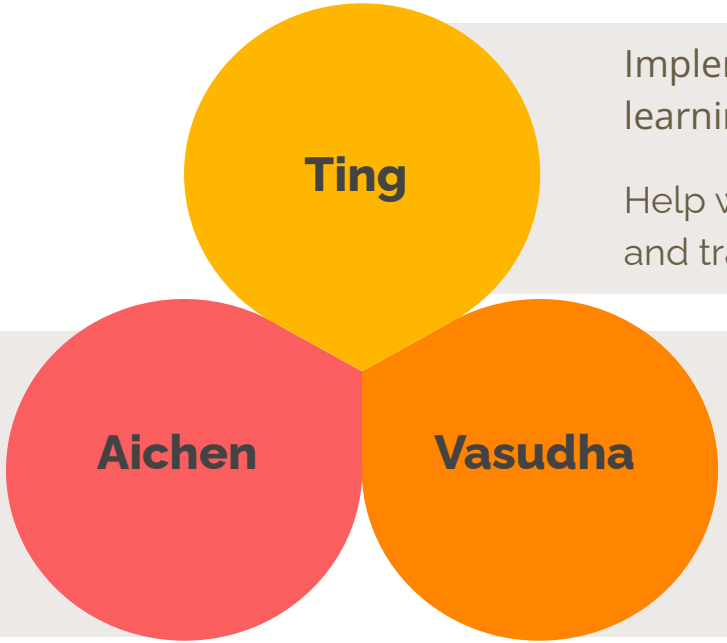
HARDWARE

- Camera: field of view
- Trapdoor: test different weights and shapes
- LEDs: Correct color per results
- Speaker: Correct sound

INTEGRATION

- Test recyclable and non-recyclable objects commonly found in schools
- Collect user response of ease of use and recycling guideline educational ability

Tasks/Division of Labor



Implement transfer learning for ML model

Help with integrating and trapdoor building

Integrate Jetson and webcam with circuit

Testing CV system

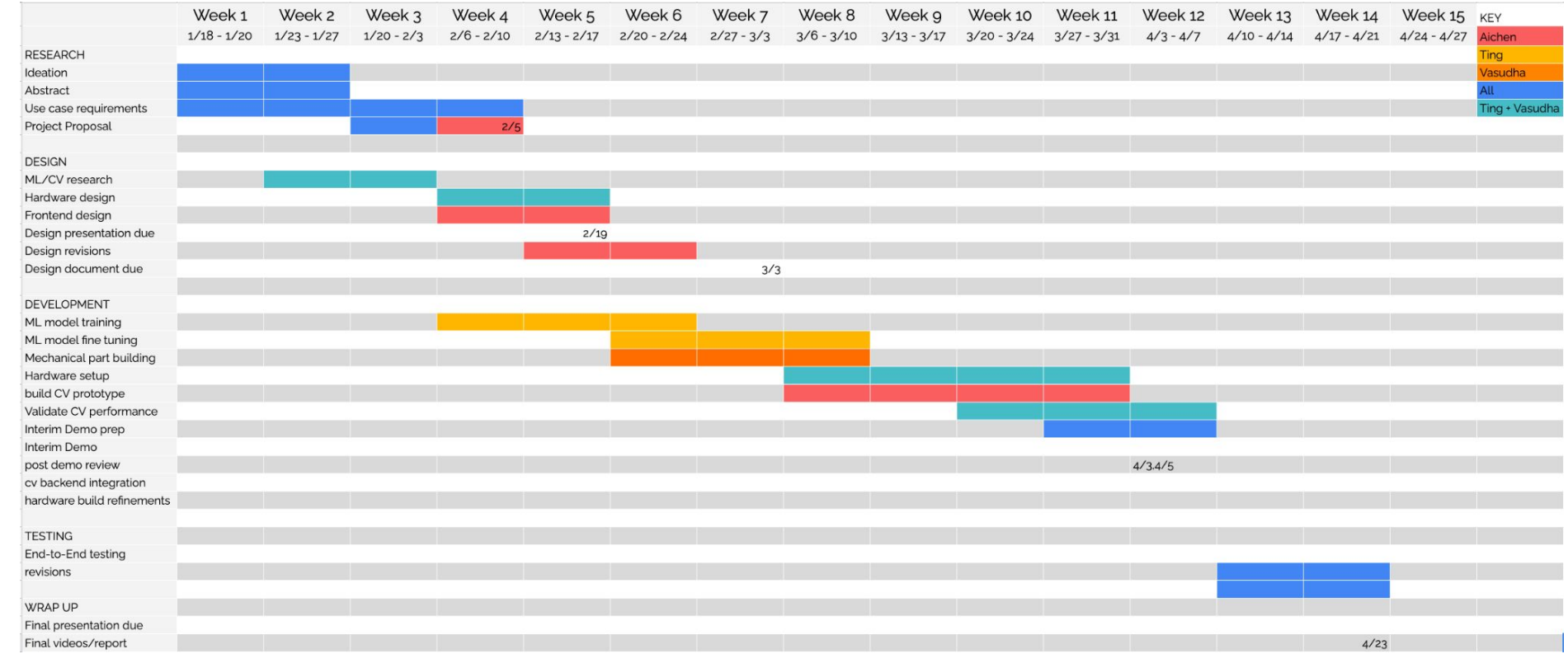
Trapdoor building

ML model research

Hardware programming (Arduino)

C optimization

Schedule



Link to chart: https://docs.google.com/spreadsheets/d/174Mu7XgYFkOeT6HJXxHjqjuLHQ9krh-IDPB63vQdztU/edit?usp=sharing

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