SmolKat: A Smart Kitchen Assistant

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Application Area

Problem: Food waste is generated when perishable food is not used in time.

- People don't see the items at the back of the fridge, thus forget about them.
- People don't know a good recipe to use the food they bought.

Goal: Design a system to efficiently use ingredients available in the fridge.

- Track ingredients in the fridge
- Recommend recipes based on the food available
- Highlight food item for easy user experience

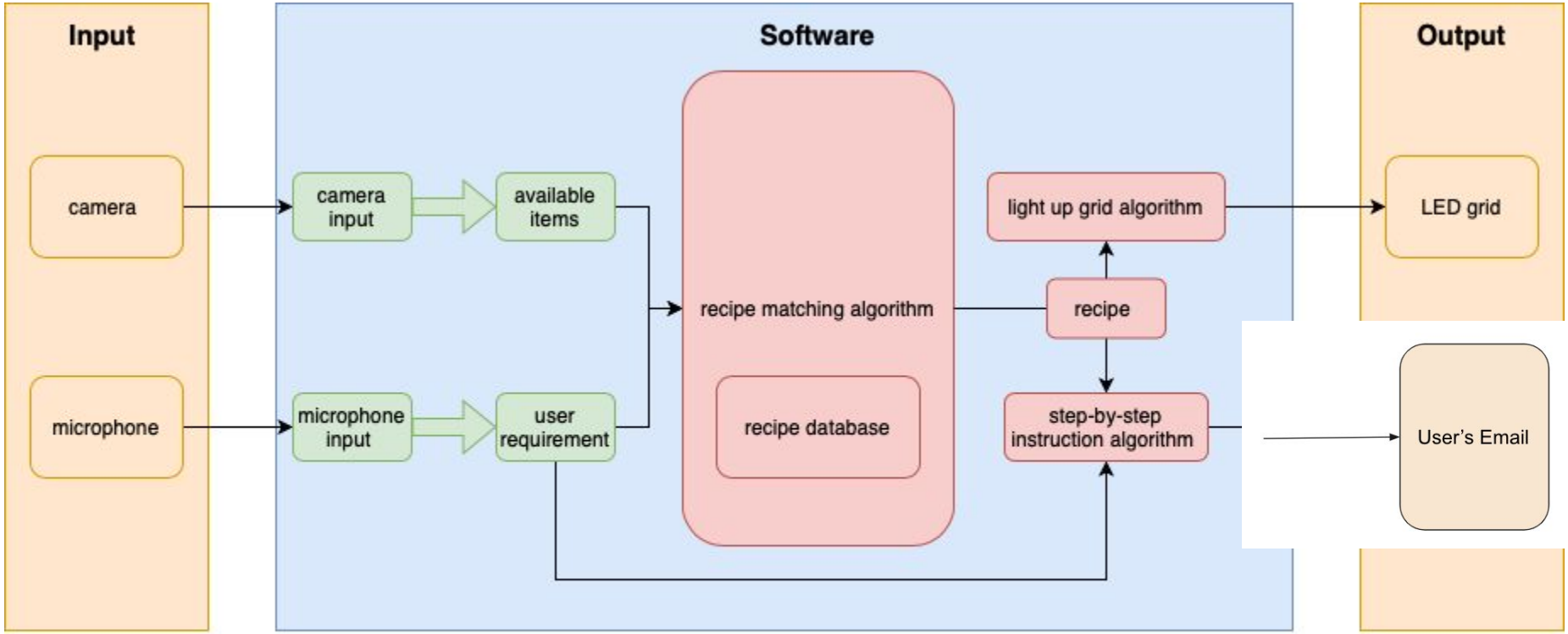
ECE Areas: Software, Hardware

Solution Approach

- **Speech Recognition:** Convert user speech input to words(requests, like “vegan”, “non-dairy”) as ML input
- **Image Recognition:** Camera takes pictures as input, return recognized ingredient names(“beef”, “squash”, “banana”) and object locations
- **Recipe Recommendation:** Takes the processed requests and ingredients list as input, filter out the appropriate recipes with instructions as output, and send instructions to user email
- **LED Grids:** The grids that holds the corresponding ingredients will light up for user to find them easily

Solution Approach

hardware peripheral | external library | our implementation | on board



Complete Solution

- A Mi
- Show
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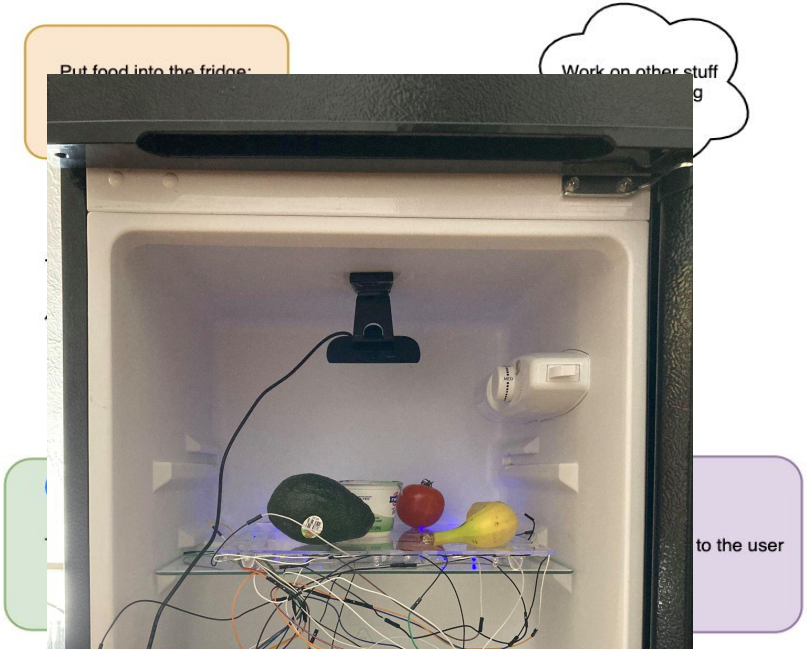

Testing, Metrics and Validation

1. Speech Recognition

- Expectation: 90% Accuracy on Recipe Requests
- User Survey: 21 Recorded Responses
- 95% of all requests are handled within 1.489 seconds, assuming normal response distribution

Recorded Responses	81% Accuracy
Average Response Latency	1.13 seconds
Response Latency Standard Deviation	0.218 seconds
Network Upload Bandwidth	23.80 Mbps

Testing, Metrics and Validation

2.a Image Recognition Accuracy

- Expectation: 90% Accuracy on Selected Ingredients
- Selected Recognizable Ingredients: beef, broccoli, strawberry, banana, Italian sausage, apple, tomato, squash, carrot, octopus, salmon, orange, egg

Test Data Set	Accuracy	Avg Latency
Random Single Ingredient	75%	N/A
Random Multiple Ingredients	72.7%	N/A
Selected Single Ingredient	100%	0.806s
Selected Multiple Ingredients	85.7%	1.302s

Testing, Metrics and Validation

2b. Image Recognition, LED Grid Lightening Correctness

- Expectations: Always light up the correct grids for recipe items
- Test: 10 tests with each test a list of different ingredients needed from the fridge
- Results: 100% Correct Grid Lighting

Testing, Metrics and Validation

3. Recommendation Correctness, Time Consumption

- Expectation: No false output for recipes
- 20 test requests, 10 valid, 10 invalid.
- Invalid request examples : non-existing tags, ingredients not recognized(“Food”, “Packaged Goods”)
- Result: 100% Correctness

- Expectation: < 1s Processing Time for Recommendation
- Test: Calculate the time difference at the beginning and the end of recommendation
- Result: < 0.001s Processing Time

Trade-offs In Project

- On Board vs Google Cloud API
- Object Localization API vs Cropping Images Manually
- Selection of Recognizable Ingredients
- Email Recipes vs Speaker Output Instructions

Specification Summary

Requirement	Result
Speech Recognition Accuracy	81%
Selected Ingredient Recognition Accuracy	100%(Single)/85.7%(Multiple)
Ingredient Located Grid Correctness	10/10 Tests with Correct Grids Lightened
Speech Request Latency (95th percentile)	1.489s
Processing Time for Recommendation	< 0.001s
Correctness of Recommended Recipes	20/20 Correct recommendations

Project Management