B6 Food Tracker

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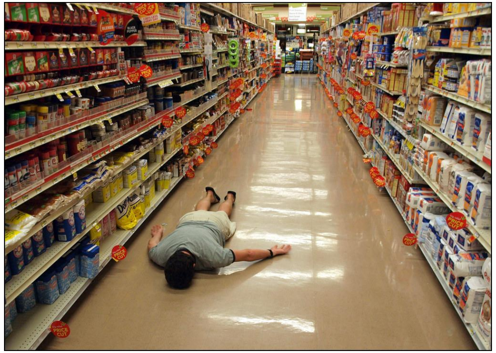
Use case (review)

- You’re grocery shopping, and you forgot to make a list of things to buy.
- You don’t remember whether you have milk, or eggs, or that one ingredient for that one recipe.
- You bought something and completely forgot about it, leaving it in the fridge for ages

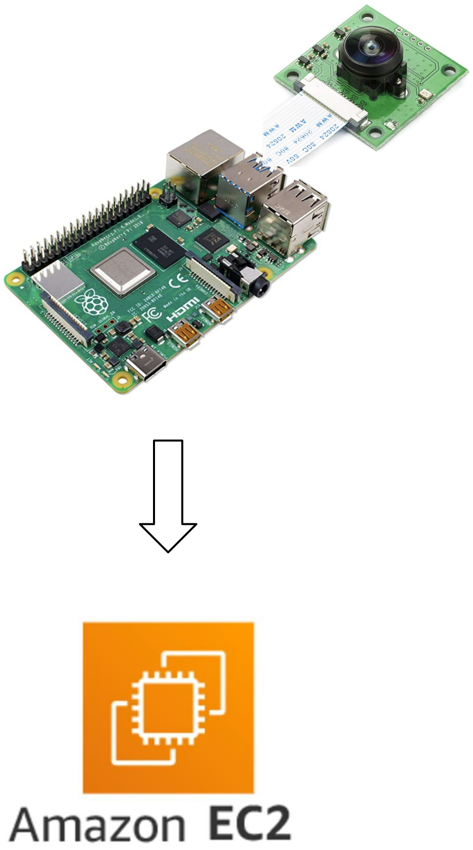


Use Case Requirements

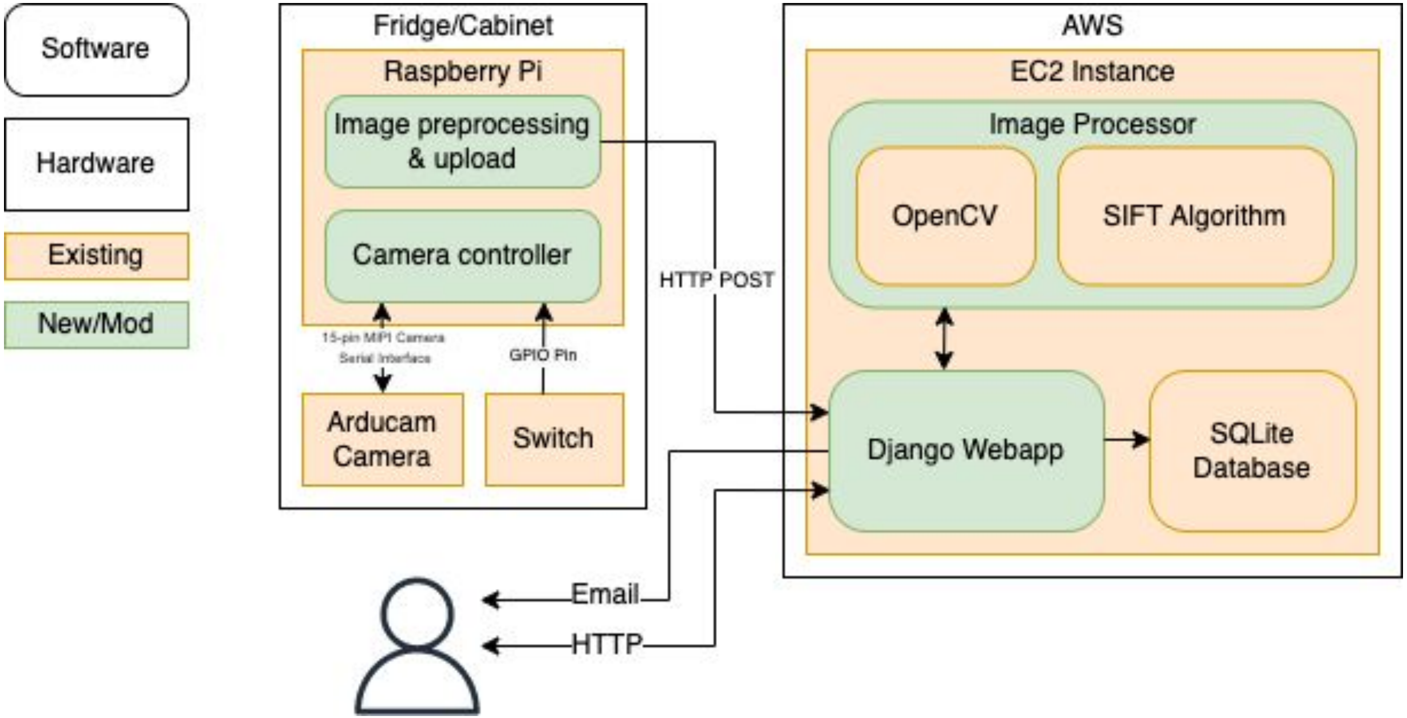
- Support 10 items: Applesauce, Baking Powder, Beans, Cereal, Ritz Crackers, Canned Tomatoes, Milk, Shredded Cheese, Spaghetti, and Yogurt
- Support multiple users
- Combined inventory from multiple source devices for any user
- Object identification accuracy > 85%
  - < 5% mis-identification (we prefer failure to identify over mis-identification)
- < 10s latency to update the inventory after the door closes
- < 1s latency between door close and taking the photo

Updated Solution Approach

- RPI with embedded camera for hardware component
  - No need for dedicated hardware
  - Infrequent usage (≈ # of times you open a fridge)
  - Use case is lag tolerant
- Camera is 5 megapixel, Arducam OV5647
- Open CV for software (now runs in the cloud on dedicated EC2 instance)
  - Usinging SIFT for feature detection
- Django for web-app
  - SQLite backend
  - AJAX frontend
- Communication will just be posting JSON
  - To avoid malicious actors, we will use HTTPS and password hashing



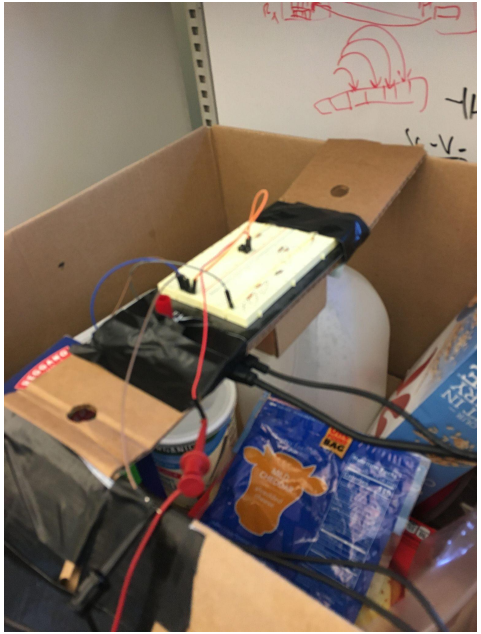
High level implementation plan

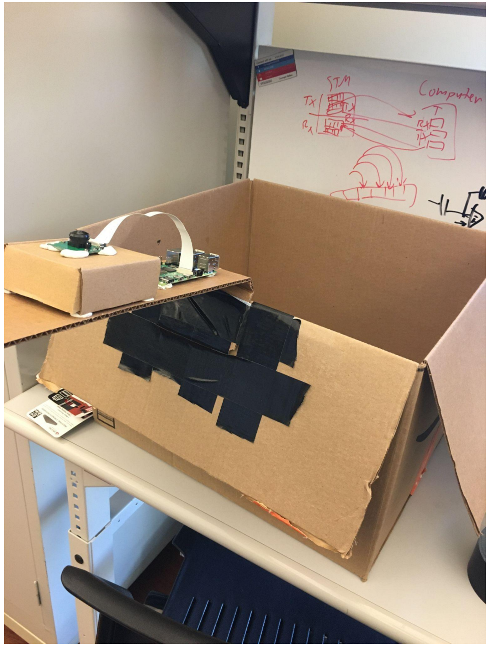


System Block Diagram

Implementation (hardware component)

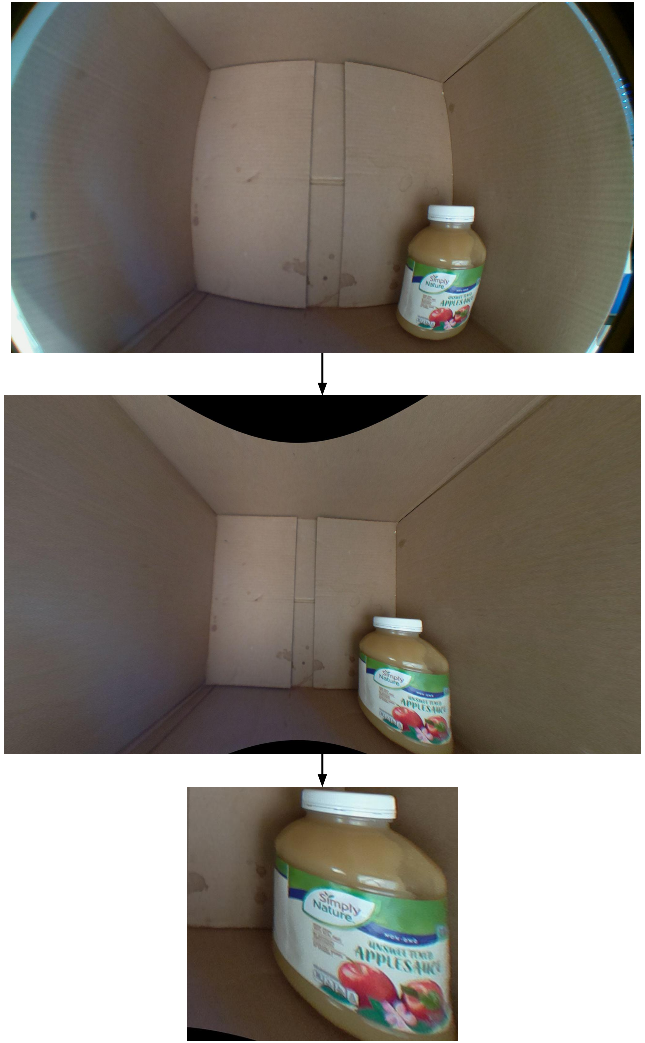
- RPI, camera, and breadboard taped to cardboard flap
- Takes/sends photo when switch is pressed
- Ideally would be built in to a smart device





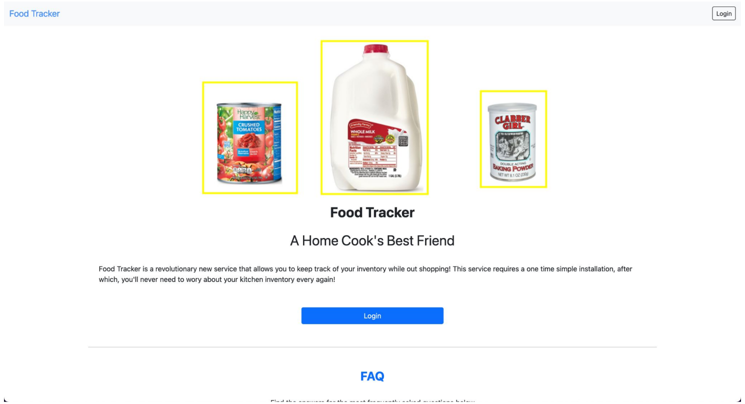
Implementation (CV component)

- Three steps
  - Undistort
  - Background diff/SSIM
  - SIFT/secondary checks
- Added several secondary checks for color/diff dimensions to resolve known confusions
  - Still working on these and would like to add more pre-live demo/paper



Finalized implementation (Website)

- Website here: https://b6foodtracker.com/
- Fully working AJAX and OAUTH
- Still some CSS/HTML cleanups we'd like to implement before live demo



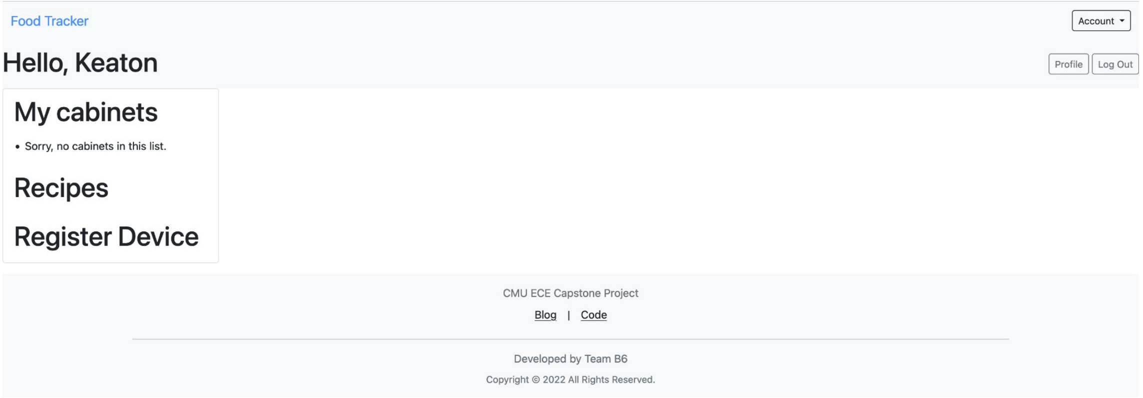
Food Tracker

A Home Cook's Best Friend

Food Tracker is a revolutionary new service that allows you to keep track of your inventory while out shopping! This service requires a one time simple installation, after which, you'll never need to wory about your kitchen inventory every again!

FAQ

Find the answers for the most frequently asked questions below.



Hello, Keaton

My cabinets

- Sorry, no cabinets in this list.

Recipes

Register Device

CMU ECE Capstone Project

Blog | Code

Developed by Team B6

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Metrics and Validation

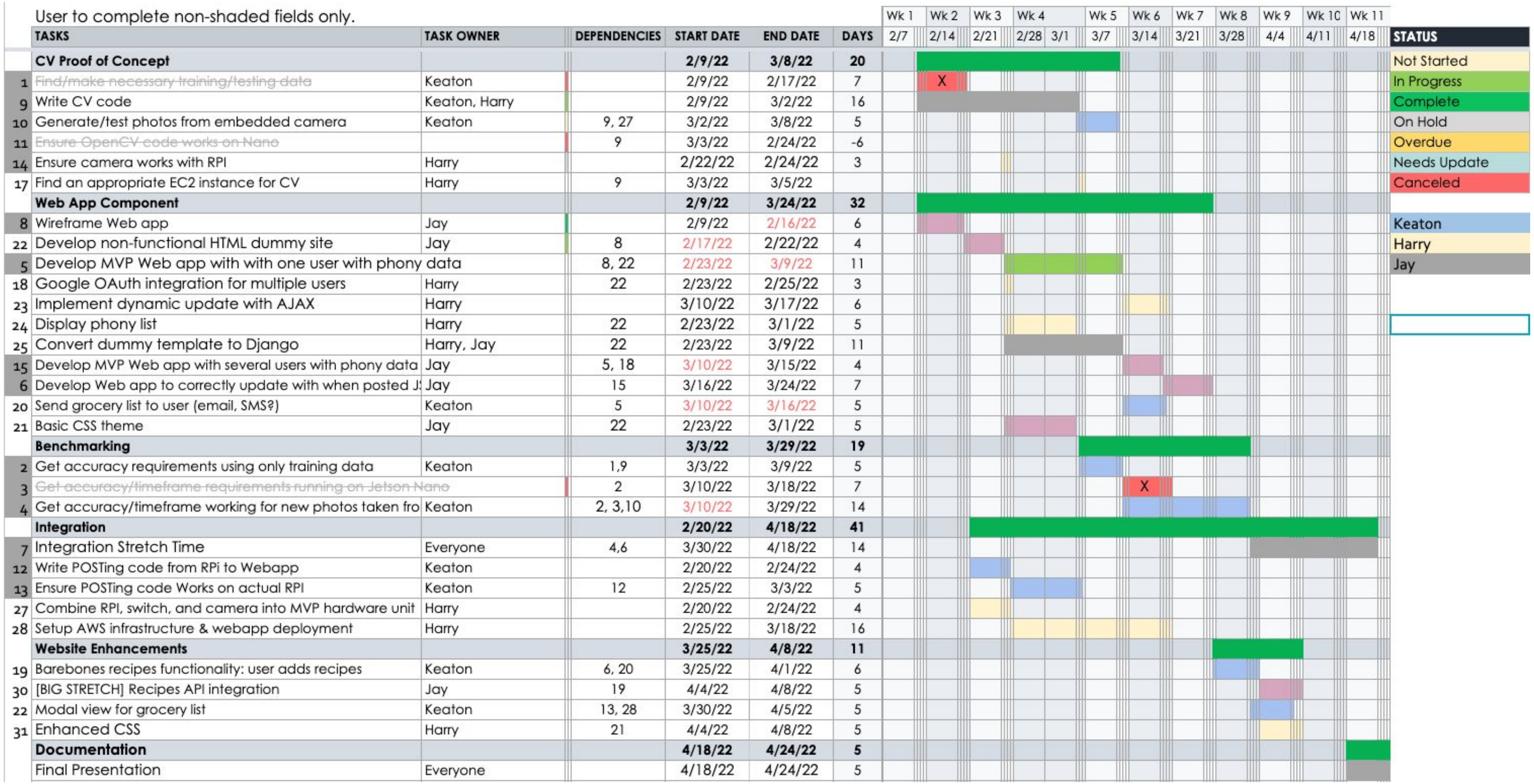
Requirement	Metric	Verification Method
System latency	< 10s	During testing, record the time between closing the fridge door and receiving the AJAX data from the server
Hardware latency	< 1s	During testing, record the time between closing the fridge door and the image being saved in the RPi file system, verify that the image taken matches the current inventory
CV accuracy	> 85% accuracy < 5% mis-ID	Randomly add and remove items from “shelf” unit and check that the results are valid. Repeat until we have seen every item at least 10 times. Record results.
Support multiple users	100%	Test with two users, each registered with one fridge. Update items for one fridge and check if only the owner’s inventory is updated
Support multiple devices	100%	Register one user with two fridges, update items for both fridges, and check if the user’s inventory is updated accordingly

Results

Requirement	Metric	Results
System latency	< 10s	Average latency of **7.092231875** seconds 1 case out of 271 trials where latency exceeded 10s (12.825)
Hardware latency	< 1s	Unable to due to meet this constraint due to needed exposure time for camera
CV accuracy	> 85% accuracy < 5% mis-ID	Successful identification ratio: **0.9375** Misidentification ratio (object of type A identified as type B): **0.0625** Failure to identify (Object of type A identified as an unknown item class): **0**
Support multiple users	100%	Successful
Support multiple devices	100%	Successful

Results, Contd

- Hardware latency was unavoidable, camera need ~2 seconds to get proper exposure
  - There is a method to pre-configure exposure, but it performed like crap, and it’s unreasonable to expect an end user to do the configuration
- System latency is within 10 seconds for general case
- Still some problematic confusions for CV component, confident in our ability to fix it before final demo
  - Applesauce, specifically with tomato can since it’s more difficult to do a color diff

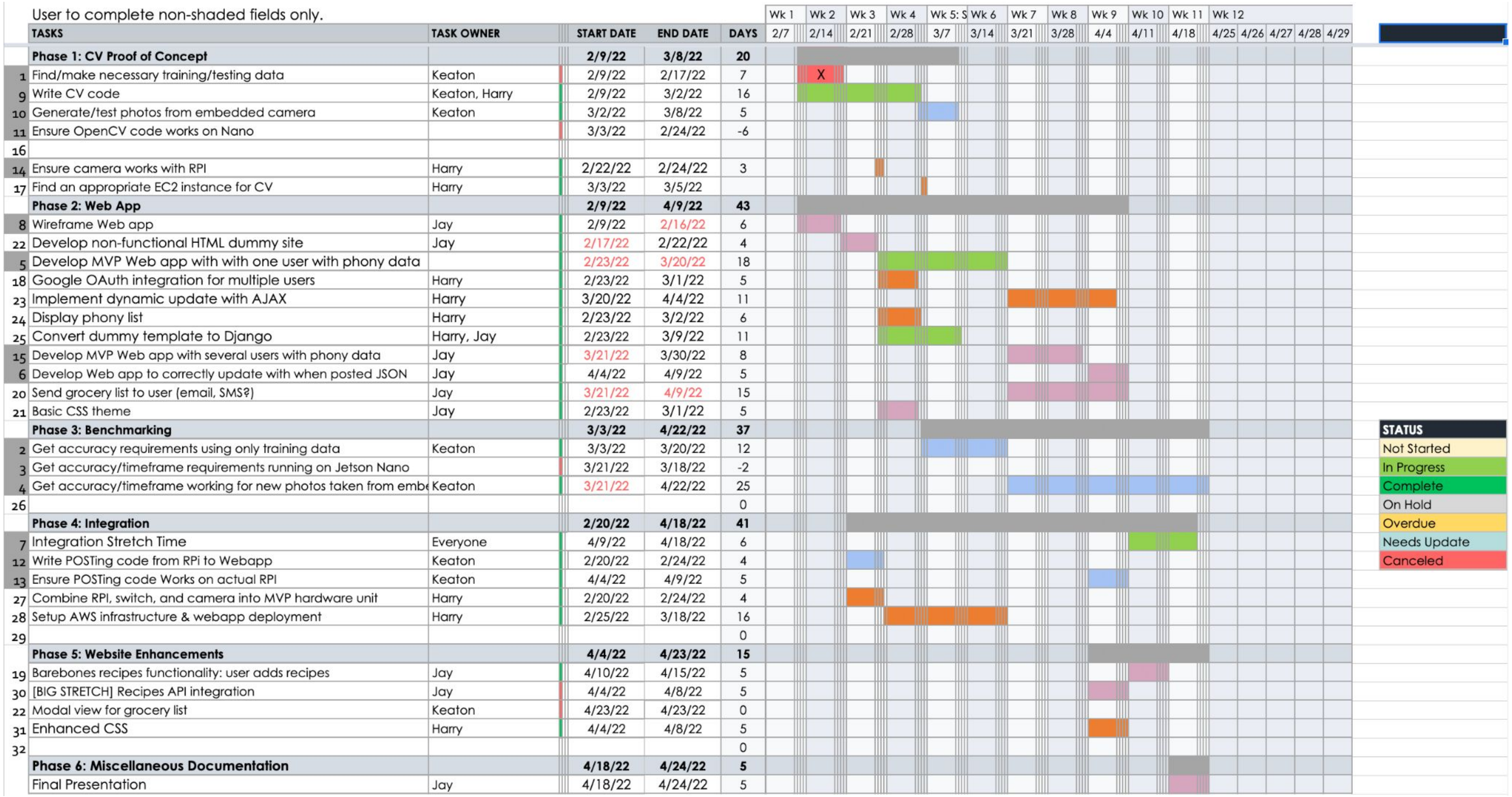


User to complete non-shaded fields only.

	TASKS	TASK OWNER	DEPENDENCIES	START DATE	END DATE	DAYS
	CV Proof of Concept			**2/9/22**	**3/8/22**	**20**
1	~~Find/make necessary training/testing data~~	Keaton		2/9/22	2/17/22	7
9	Write CV code	Keaton, Harry		2/9/22	3/2/22	16
10	Generate/test photos from embedded camera	Keaton	9, 27	3/2/22	3/8/22	5
11	~~Ensure OpenCV code works on Nano~~		9	3/3/22	2/24/22	-6
14	Ensure camera works with RPI	Harry		2/22/22	2/24/22	3
17	Find an appropriate EC2 instance for CV	Harry	9	3/3/22	3/5/22	
	Web App Component			**2/9/22**	**3/24/22**	**32**
8	Wireframe Web app	Jay		2/9/22	2/16/22	6
22	Develop non-functional HTML dummy site	Jay	8	2/17/22	2/22/22	4
5	Develop MVP Web app with with one user with phony data		8, 22	2/23/22	3/9/22	11
18	Google OAuth integration for multiple users	Harry	22	2/23/22	2/25/22	3
23	Implement dynamic update with AJAX	Harry		3/10/22	3/17/22	6
24	Display phony list	Harry	22	2/23/22	3/1/22	5
25	Convert dummy template to Django	Harry, Jay	22	2/23/22	3/9/22	11
15	Develop MVP Web app with several users with phony data	Jay	5, 18	3/10/22	3/15/22	4
6	Develop Web app to correctly update with when posted J:	Jay	15	3/16/22	3/24/22	7
20	Send grocery list to user (email, SMS?)	Keaton	5	3/10/22	3/16/22	5
21	Basic CSS theme	Jay	22	2/23/22	3/1/22	5
	Benchmarking			**3/3/22**	**3/29/22**	**19**
2	Get accuracy requirements using only training data	Keaton	1,9	3/3/22	3/9/22	5
3	~~Get accuracy/timeframe requirements running on Jetson Nano~~		2	3/10/22	3/18/22	7
4	Get accuracy/timeframe working for new photos taken fro	Keaton	2, 3,10	3/10/22	3/29/22	14
	Integration			**2/20/22**	**4/18/22**	**41**
7	Integration Stretch Time	Everyone	4,6	3/30/22	4/18/22	14
12	Write POSTing code from RPi to Webapp	Keaton		2/20/22	2/24/22	4
13	Ensure POSTing code Works on actual RPI	Keaton	12	2/25/22	3/3/22	5
27	Combine RPI, switch, and camera into MVP hardware unit	Harry		2/20/22	2/24/22	4
28	Setup AWS infrastructure & webapp deployment	Harry		2/25/22	3/18/22	16
	Website Enhancements			**3/25/22**	**4/8/22**	**11**
19	Barebones recipes functionality: user adds recipes	Keaton	6, 20	3/25/22	4/1/22	6
30	[BIG STRETCH] Recipes API integration	Jay	19	4/4/22	4/8/22	5
22	Modal view for grocery list	Keaton	13, 28	3/30/22	4/5/22	5
31	Enhanced CSS	Harry	21	4/4/22	4/8/22	5
	Documentation			**4/18/22**	**4/24/22**	**5**
	Final Presentation	Everyone		4/18/22	4/24/22	5

STATUS
Not Started
In Progress
Complete
On Hold
Overdue
Needs Update
Canceled
Keaton
Harry
Jay

Gantt Chart (Original)



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						Wk 1	Wk 2	Wk 3	Wk 4	Wk 5: S	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11	Wk 12				
	TASKS	TASK OWNER	START DATE	END DATE	DAYS	2/7	2/14	2/21	2/28	3/7	3/14	3/21	3/28	4/4	4/11	4/18	4/25	4/26	4/27	4/28	4/29
	Phase 1: CV Proof of Concept		**2/9/22**	**3/8/22**	**20**																
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	Phase 2: Web App		**2/9/22**	**4/9/22**	**43**																
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	Phase 3: Benchmarking		**3/3/22**	**4/22/22**	**37**																
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	Phase 5: Website Enhancements		**4/4/22**	**4/23/22**	**15**																
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32					0																
	Phase 6: Miscellaneous Documentation		**4/18/22**	**4/24/22**	**5**																
	Final Presentation	Jay	4/18/22	4/24/22	5																

STATUS
Not Started
In Progress
Complete
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Needs Update
Canceled

Final Gantt Chart

Major changes in Gantt chart (summary)

- CV adjustments/tweaks continued throughout and during integration
- Several smaller items that could be delayed until the live demo were pushed back
  - Actual hardware button
  - CSS/HTML improvements
- Ajax took much longer than expected, and there were several bugs

Lessons learned

- Integration took longer than expected
- Look to see if someone else has done it better, don’t reinvent the wheel unless you have too.
- Frick Ajax bugs