IntelliStorage (D3)

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Use case

Provide a convenient method of keeping track of groceries at home

- For individuals who **do not have time** to organize their house
- For families who buy **groceries on a larger scale** and therefore harder to keep track of items
- **ECE Areas: Software & Hardware**

Use-Case Requirements

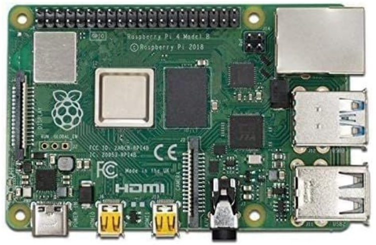
Requirement #1 (Item Registration & Tracking)	Requirement #2 (Scaling)	Requirement #3 (Ease/Accessibility of Use)
>90% read-in accuracy	**40 items** per storage space	Store information **<1 sec** of scanning
30 degree scanning angle	**>3 storage spaces** per network	Display info within **500 ms**
15-25cm scanning distance	**<10 sec** Synchronization	Daily report of expiring item
4 sec registration time	Data integrity	**<5 min** setup node

Solution (Hardware)

- WoneNice USB Laser Barcode Scanner
  - Augments and triggers item data acquisition
- NexiGo N60 1080P Webcam
  - Item data acquisition (exp. date)
- FREENOVE 5 Inch Touchscreen Monitor
  - User Accessibility
- Raspberry Pi 4
  - Post-data acquisition data processing

Source:
https://www.amazon.com/gp/product/B088TSR6YJ/

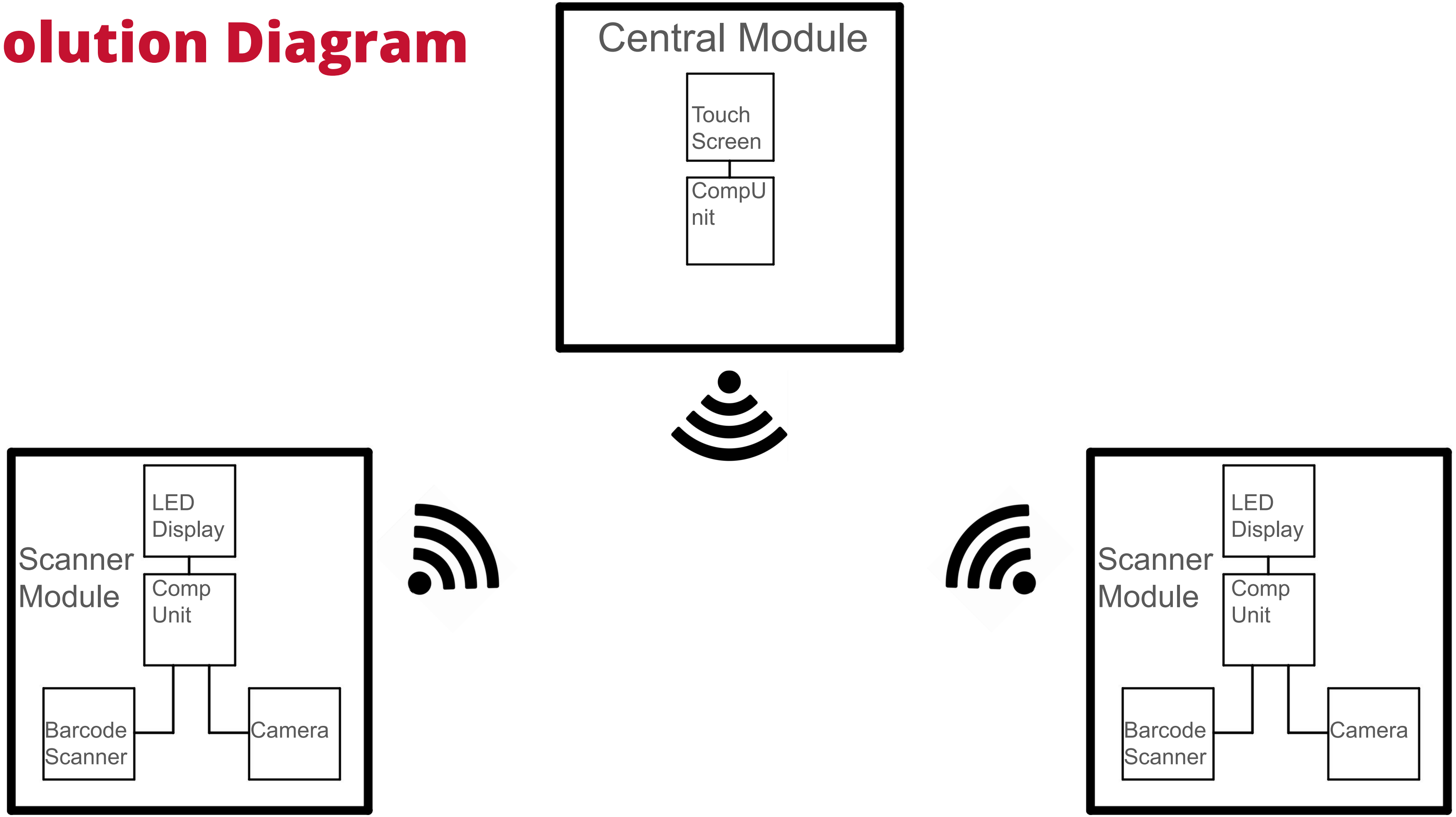
Source:
https://www.amazon.com/gp/product/B00LE5VV1C/



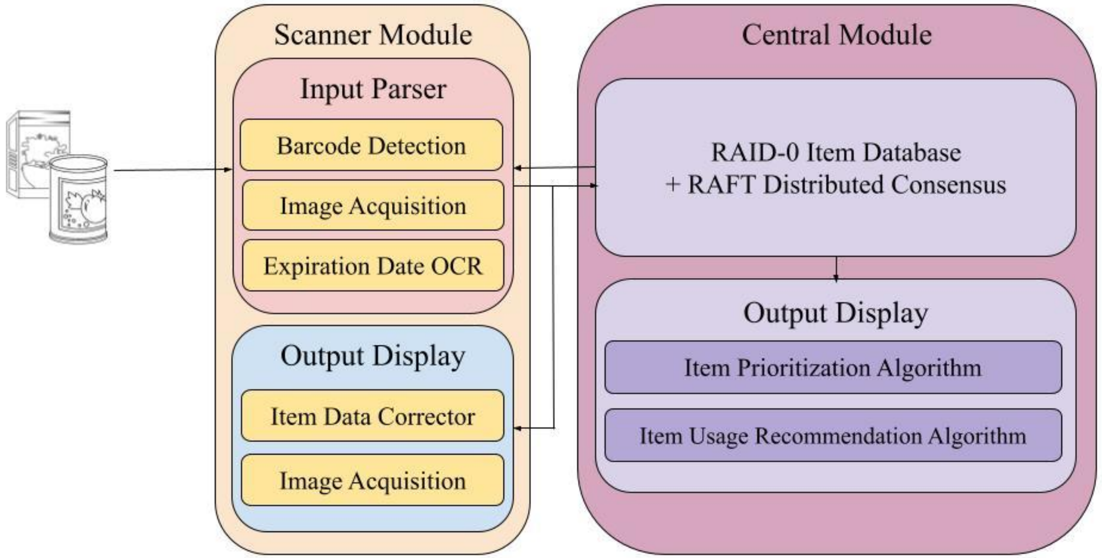
Source:
https://www.amazon.com/Raspberry-Model-2019-Quad-Bluetooth/dp/B07TC2BK1X/

Source:
https://www.amazon.com/gp/product/B0B455LDKH/

Solution Diagram



Solution Block Diagram



Scanner Module Implementation

Input Parsing Approach

Barcode:

While trigger is pulled, barcode scanner continuously scans for barcode.

When barcode has been scanned, item information is acquired via upcitemdb API

Expiration Date:

While trigger is pulled, camera continuously captures image.

Images ±1 second of when Barcode is detected and scanned are stored.

For every image, Pi reads each exp. Date and logs its confidence score. Pi stores exp. Date with highest confidence.

Image Source:https://www.upcitemdb.com/

OCR Implementation

1. Image input
    a. Taken from camera as png
2. Preprocessing
    a. Resizing image
    b. Contrast enhancement
    c. Color to grayscale adjustment
    d. Contour analysis to filter out non-text regions
3. Perform OCR (Use pyTesseract & OpenCV OCR library)
    a. Word/line finding
    b. Character classification
    c. Output confidence score

Process Flow

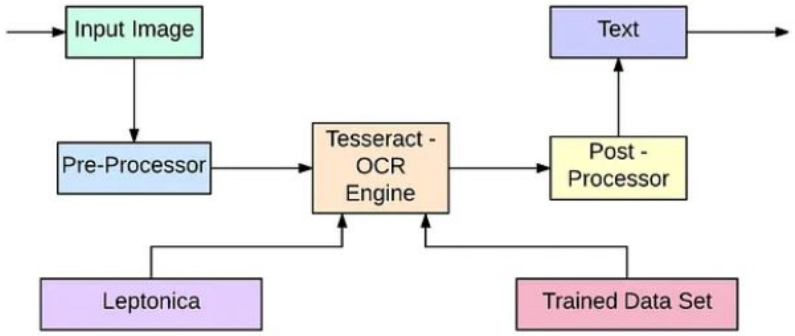


Image Source:https://medium.com/nanonets/a-comprehensive-guide-to-ocr-with-tesseract-opencv-and-python-fd42f69e8ca8

Central Module Implementation

- Central Computer is in RAID-0 configuration
- Overall system is pair of RAID-0 and RAID-5, allowing for ≤2 node failures
- Distributed Consensus Algorithm with scanner nodes, RAFT
- Item Prioritization/Use Recommendation Algorithm using heuristics with characteristics
    - Exp. Date
    - Purchase Date
    - Number of times it was taken in/out
    - Condition of Storage (temp, humidity, etc)

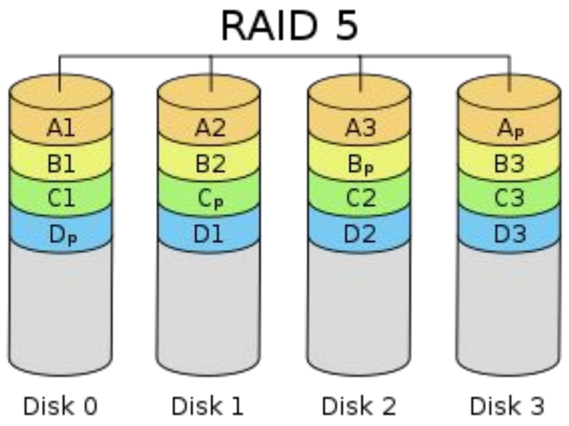


Image Source: https://en.wikipedia.org/wiki/Standard_RAID_levels

Testing, Verification, and Metrics

Single Module Testing

- Simulate a storage space by having a shelf and attach a scanning module. Use different items and do unit tests to see if system performs as expected
- Scan items in **every 4s** to see if system is not overwhelmed (data processed correctly, in-order)
- Confirm that item data is being processed **within 1s** correctly with **>90% accuracy**

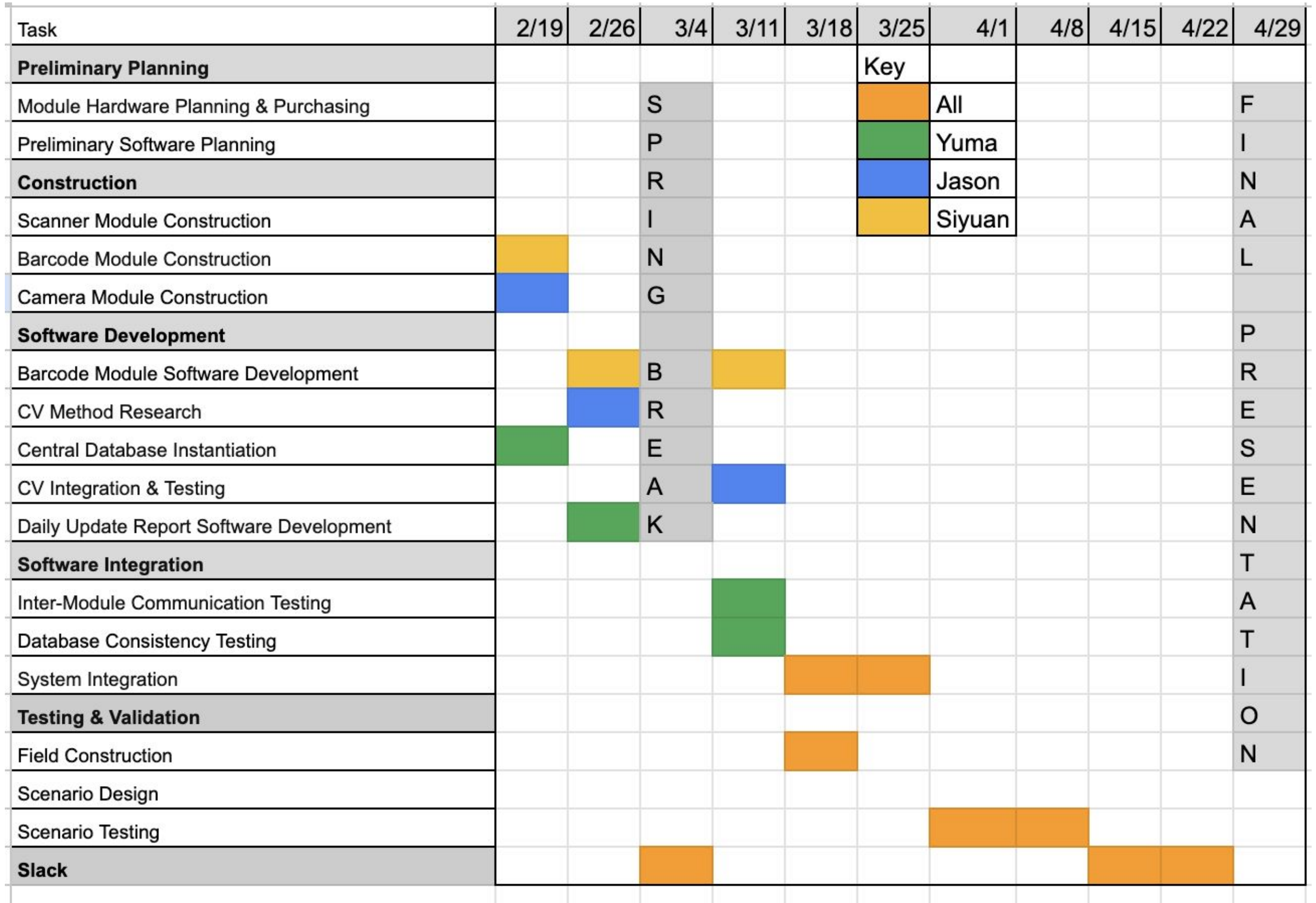
Multi-Module Testing

- Shut down two module and reboot, see if there is **consensus** between the shared state of the nodes.

Usability Testing

- Test the LED screen user interface and user experience with new users, ensuring ease of use and intuitivity
- Install a new node, making sure it is easy and intuitive to hit **<5min** installation time

Schedule



Task	2/19	2/26	3/4	3/11	3/18	3/25	4/1	4/8	4/15	4/22	4/29
Preliminary Planning						Key					
Module Hardware Planning & Purchasing			S			🟧	All				F
Preliminary Software Planning			P			🟩	Yuma				I
Construction			R			🟦	Jason				N
Scanner Module Construction			I			🟨	Siyuan				A
Barcode Module Construction	🟨		N								L
Camera Module Construction	🟦		G								
Software Development											P
Barcode Module Software Development		🟨	B	🟨							R
CV Method Research		🟦	R								E
Central Database Instantiation	🟩		E								S
CV Integration & Testing			A	🟦							E
Daily Update Report Software Development		🟩	K								N
Software Integration											T
Inter-Module Communication Testing				🟩							A
Database Consistency Testing				🟩							T
System Integration					🟧	🟧					I
Testing & Validation											O
Field Construction					🟧						N
Scenario Design											
Scenario Testing							🟧	🟧			
Slack			🟧						🟧	🟧	

Conclusion

- A handy system that...
  - Helps the user remember what's there and what's where
  - Provides suggestions for the user to prevent food loss
  - Makes your pantry less of a mess!

Image Source: https://kitchencabinetkings.com/glossary/pantry/