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 Requirement: Item Registration & Tracking

Motivation: Determine scanned information **accurately and promptly**

Sub Requirements:

- Identify expiration date of item **within 4 seconds** of scanning the item **with at least 90% accuracy**
- Detect <u>when and what</u> items are taken in and out of a storage space
- Provide daily summary report **within 5 seconds** of the user's request

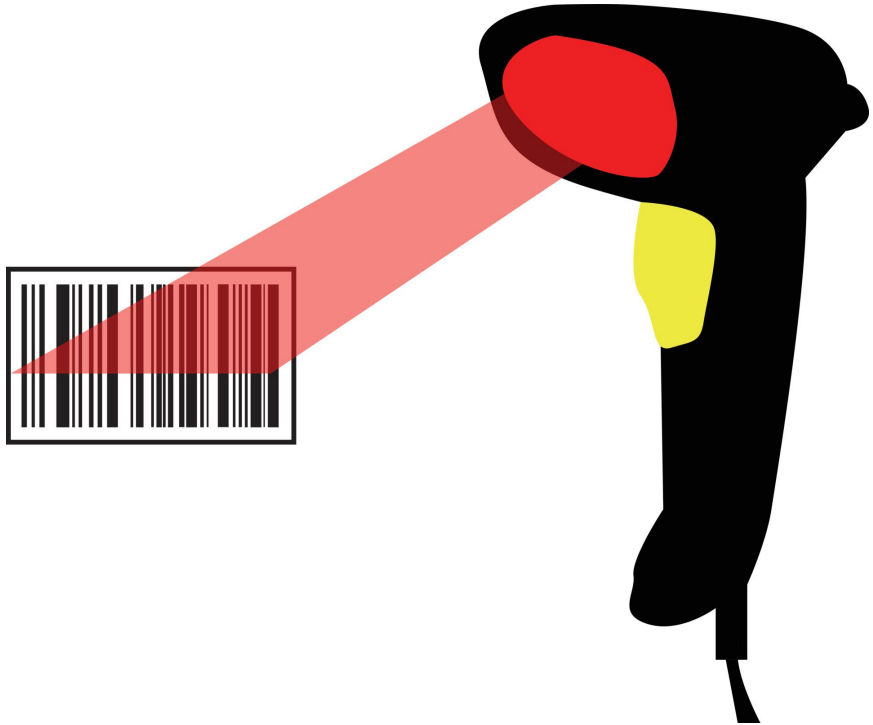


Image Source: https://static.vecteezy.com/system/resources/

Use-Case Requirement: Scaling

Motivation: Register all stored items in the house on the **same device network**

Sub requirements:

- Connect to other scanners in the network using a wireless protocol
- Handle up to **40 items per storage space** and up to **3 storage spaces** per network
- Synchronize data with the other scanners **within 10 seconds**
- Item data is not lost when hardware experiences anomaly or is turned off

Use-Case Requirement: Ease of Use

Motivation: Make product more **accessible** while providing a variety of features to the user

Sub requirements:

- Takes **<5 minutes** to set up each storage node.
- Alert user items that expire soon
- Store item information in the database **within 1 second** of scanning
- Display the information of each item **within 500ms** of the user's request

Image Source: https://www.gabefender.com/writing/touch-screens-dont-work-for-everyone

Technical challenges

1. Detection of **expiration date**
    - It’s already hard to see & distinguish as a human
    - Various fonts, text color, background color
    - When to capture camera data
2. Detection of **barcode**
    - Incomplete/Occluded Barcode
3. **Networking** across Nodes
    - Determining shared state between machines
    - Accounting for network failure/byzantine nodes

Image Source: https://tulsaer.com/do-food-expiration-dates-really-matter/

Solution approach (Scanning)

- Incomplete barcode
  - Use a camera to augment using optical character recognition (OCR).

- Detection of expiration date
  - Use a camera to capture the expiration date of the items using OCR
  - Addition of an option allowing users to manually fix possible errors during scanning process.

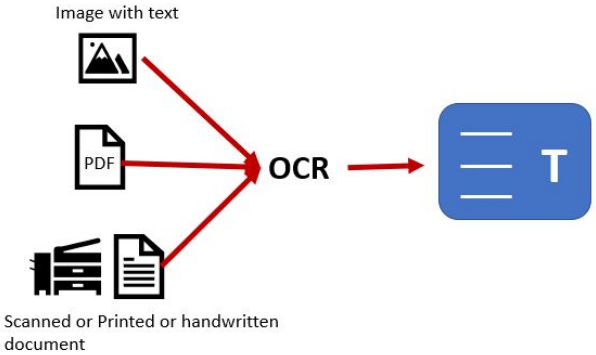


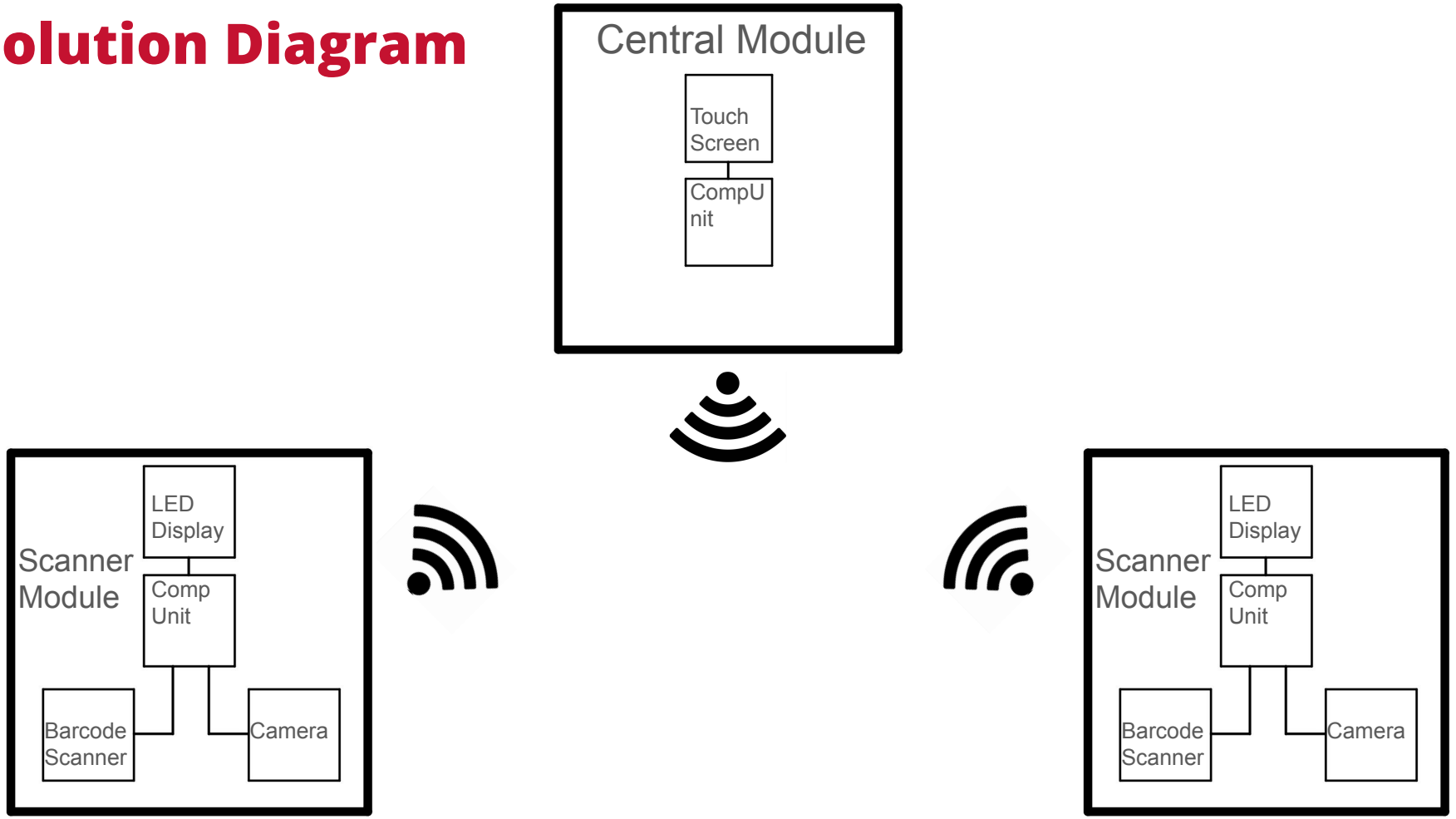
Image Source: https://towardsdatascience.com/

Solution approach (Scaling)

- Networking across Nodes
  - Have a central master node to sync states, use Wi-Fi module to receive and send data.
  - Implementing a distributed consensus algorithm to ensure safety and correctness of shared state

Image Source: https://www.cavalcode.com/en/service/web-application-development

Solution Diagram



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 one module and reboot, see if there is **consensus** between the shared state of the nodes.

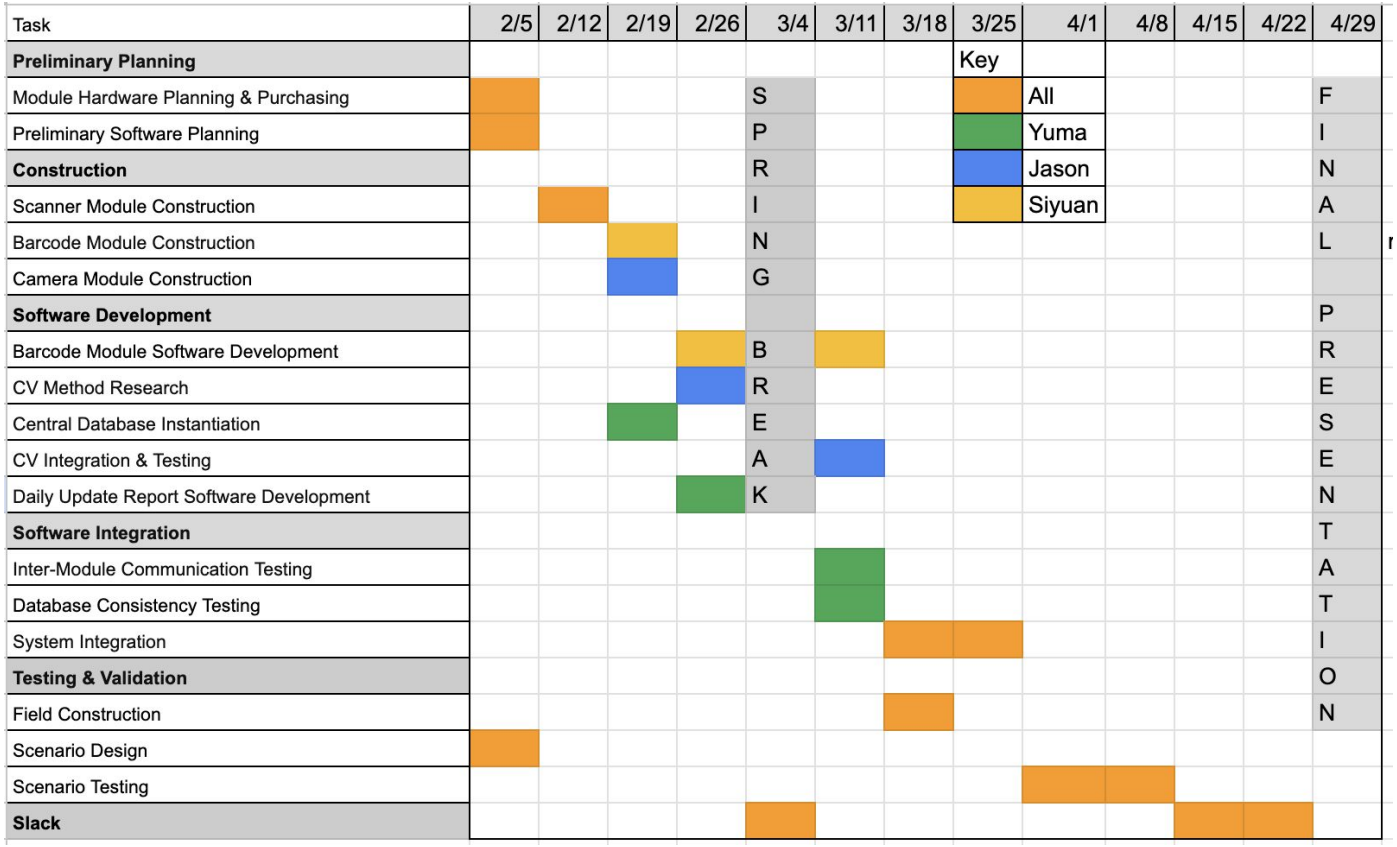
Usability Testing

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

Division of Labor

- Preliminary Hardware & Software Planning (All)
- Hardware Construction (All)
- Barcode Scanner Integration (Siyuan)
- OCR/Vision System Integration (Jason)
- Central Database Integration (Yuma)
- System-wide Integration (All)
- Scenario Design & Testing (All)

Schedule


Task
2/5
2/12
2/19
2/26
3/4
3/11
3/18
3/25
4/1
4/8
4/15
4/22
4/29
Preliminary Planning
Module Hardware Planning & Purchasing
Preliminary Software Planning
Construction
Scanner Module Construction
Barcode Module Construction
Camera Module Construction
Software Development
Barcode Module Software Development
CV Method Research
Central Database Instantiation
CV Integration & Testing
Daily Update Report Software Development
Software Integration
Inter-Module Communication Testing
Database Consistency Testing
System Integration
Testing & Validation
Field Construction
Scenario Design
Scenario Testing
Slack
Key
All
Yuma
Jason
Siyuan
SPRINGPRESENTATION

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/