「FIMA」

-Fridge Intelligent Management Assistant

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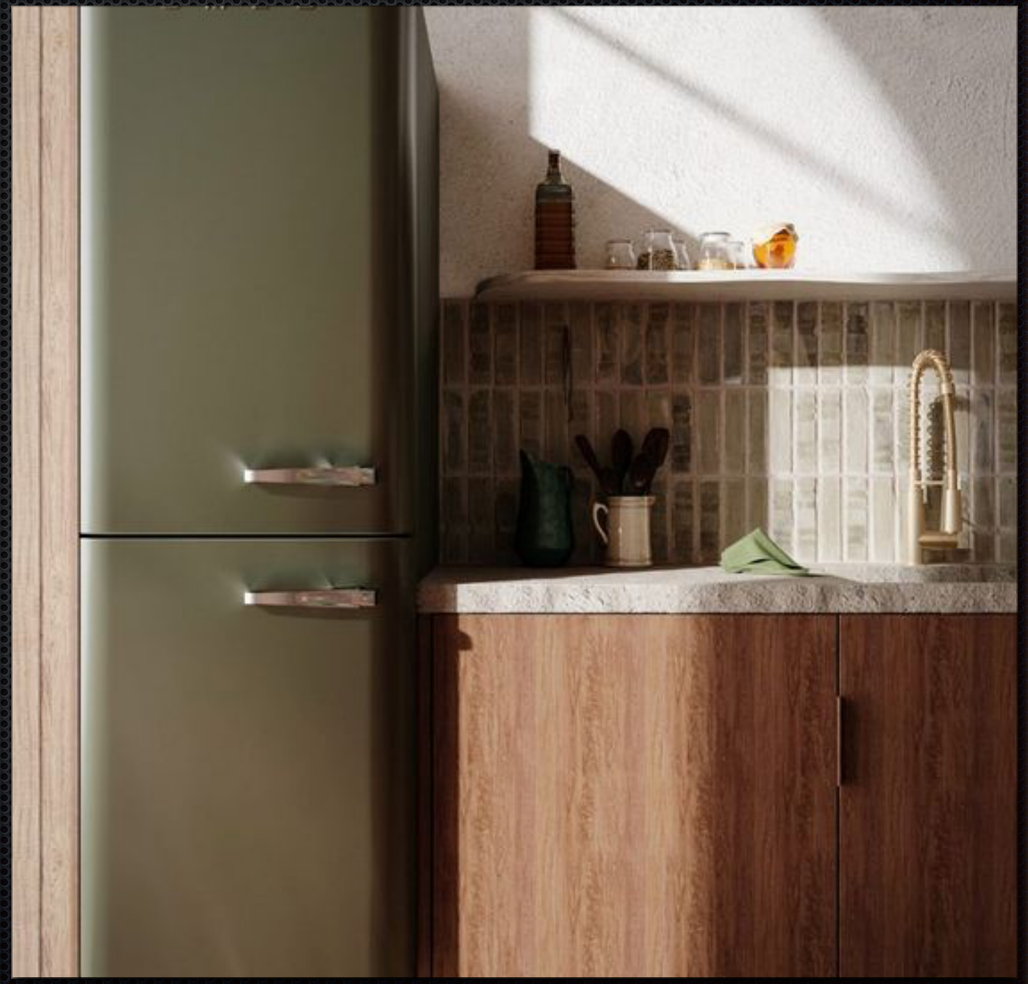
Streamlined your Life Healthily & Efficiently



Problems *FIMA* could solve:

- How much food is left in the fridge?
- When the food in the fridge will run out?
- What are the best conditions and duration for the preservation of food?

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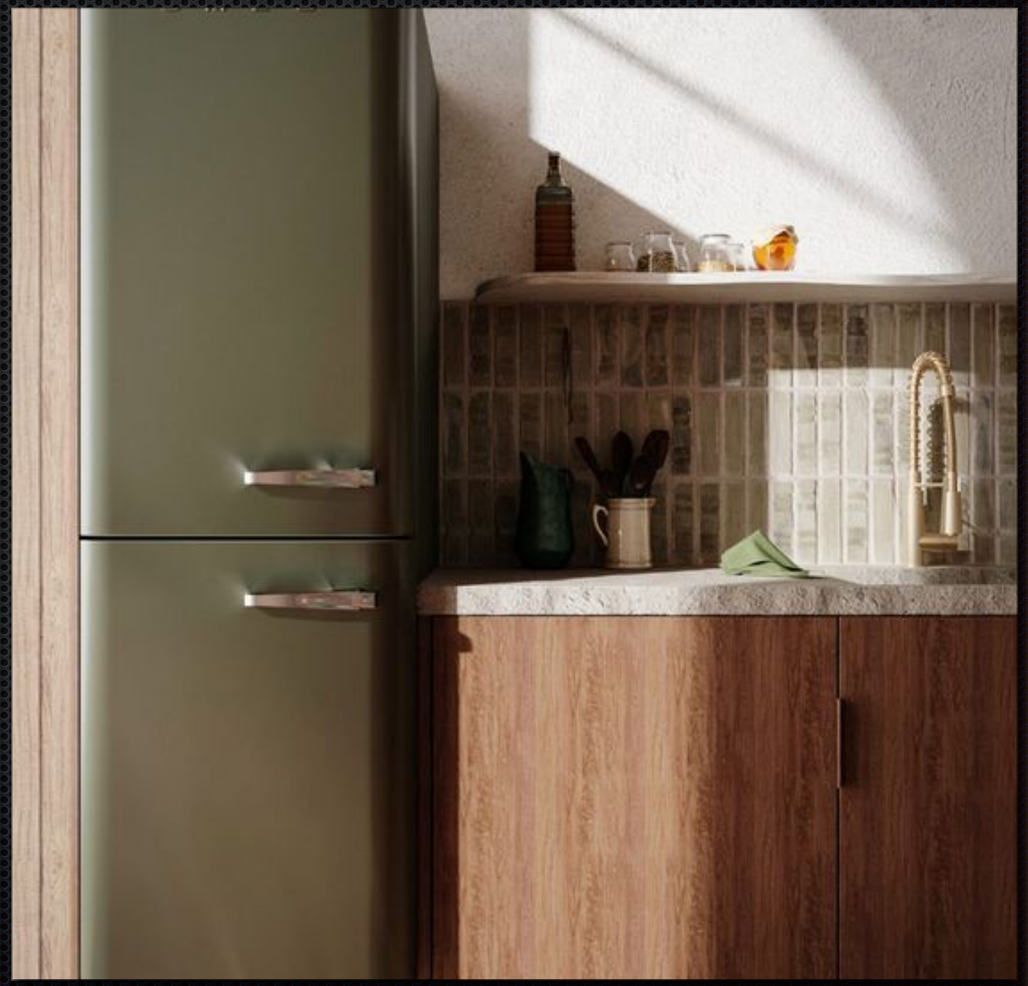
Business Case Analyzation

Potential benefits *FIMA* have:

- Almost all the families have **At Least One** fridge. The potential market is enormous.
- As an accessory, it is **Compatible** with all refrigerators, giving consumers an intelligent management experience at **A Lower Cost**.
- Related features can provide consumers with **Substantial Enhancements** in their lives, such as the convenience of monitoring household food inventory and avoiding storing medicines incorrectly.



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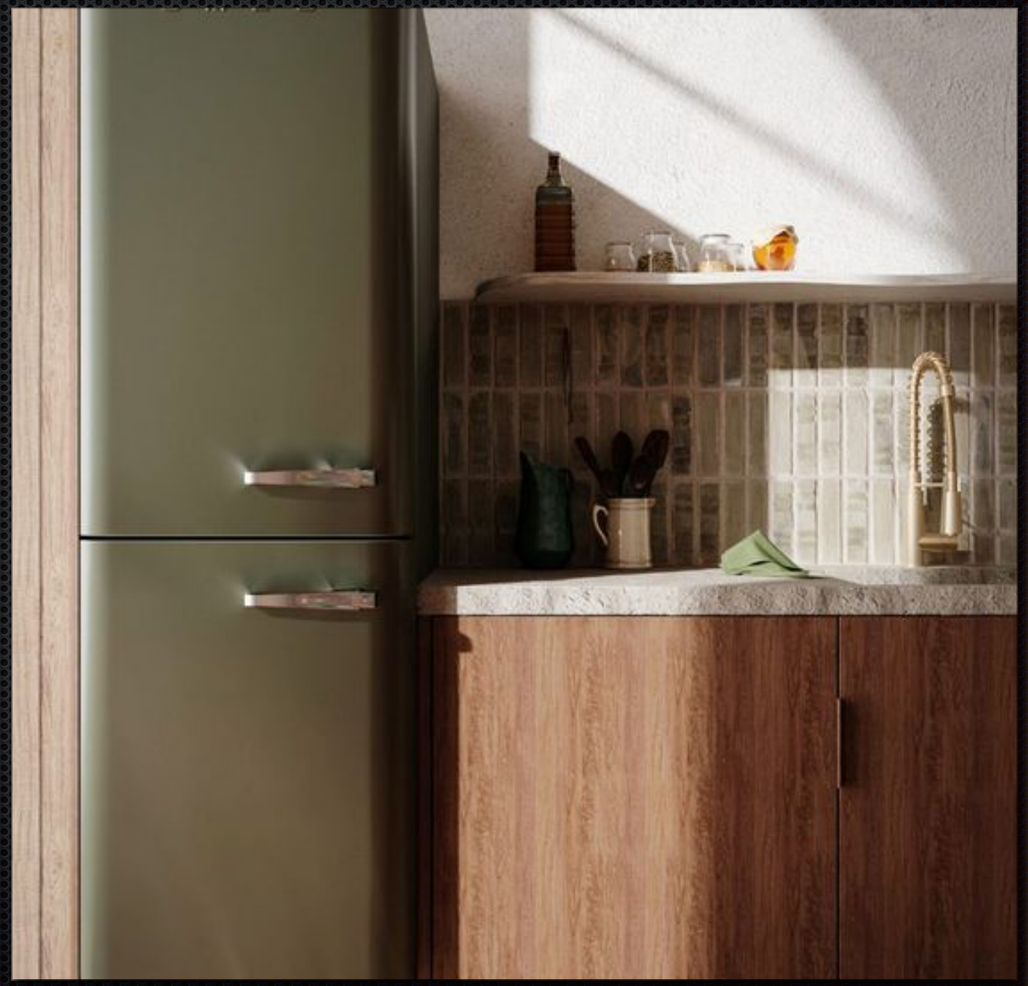
Business Case Analyzation

Market Expectation and Profit Model:

- In 2022 alone, the global sales volume of refrigerators and freezers was **198.33 Million Units**. The market size of smart refrigerator products will be at the **Trillion Level**.
- The hardware composition of ***FIMA*** is very simple, and with mass production, the cost can be controlled to **A Very Low Range**. In the promotion and profit model of goods, **Free Hardware** and on-demand **Subscription Software Services** can be adopted.



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Design & Architecture

Legend

Hardware & Embedded

Protocol, Program & Function

Client (Phone)

App

Register Function

MQTT Publish & Subscribe

Wio Terminal

IMU Sensor

Temperature & Humidity Sensors

RFID Reader

MQTT Publish

Server

Database

Data Processing

MQTT Publish & Subscribe

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Processes & Integration Points

Legend

Hardware & Embedded

Protocol, Program & Function

Client (Phone)

Read the unique ID through the QR code on each RFID tag to create a new item

Scan the item that you want to add

Identifies items, correlates shelf life and storage conditions.

Publish the item's unique ID and its related information to the server via MQTT

Get the real-time temperature, humidity and inventorys by subscribing to the following MQTT topics

Monitor values on App

Get the notifications related to temperature, humidity and inventorys from the following MQTT topics

Getting notified on App

Wio Terminal

IMU monitors the door is open or not

Sensors monitor the condition

RFID reader identifies the items' IDs

Publish the MQTT topics

Lights up the backlight when the refrigerator door opens and reads RFID tags in this state for inventory updates.

Server

Database to store the inventorys and the storage requirement of each item

Publish the Inventory Warnings, Expiry Warnings and storage condition warnings to the MQTT topics

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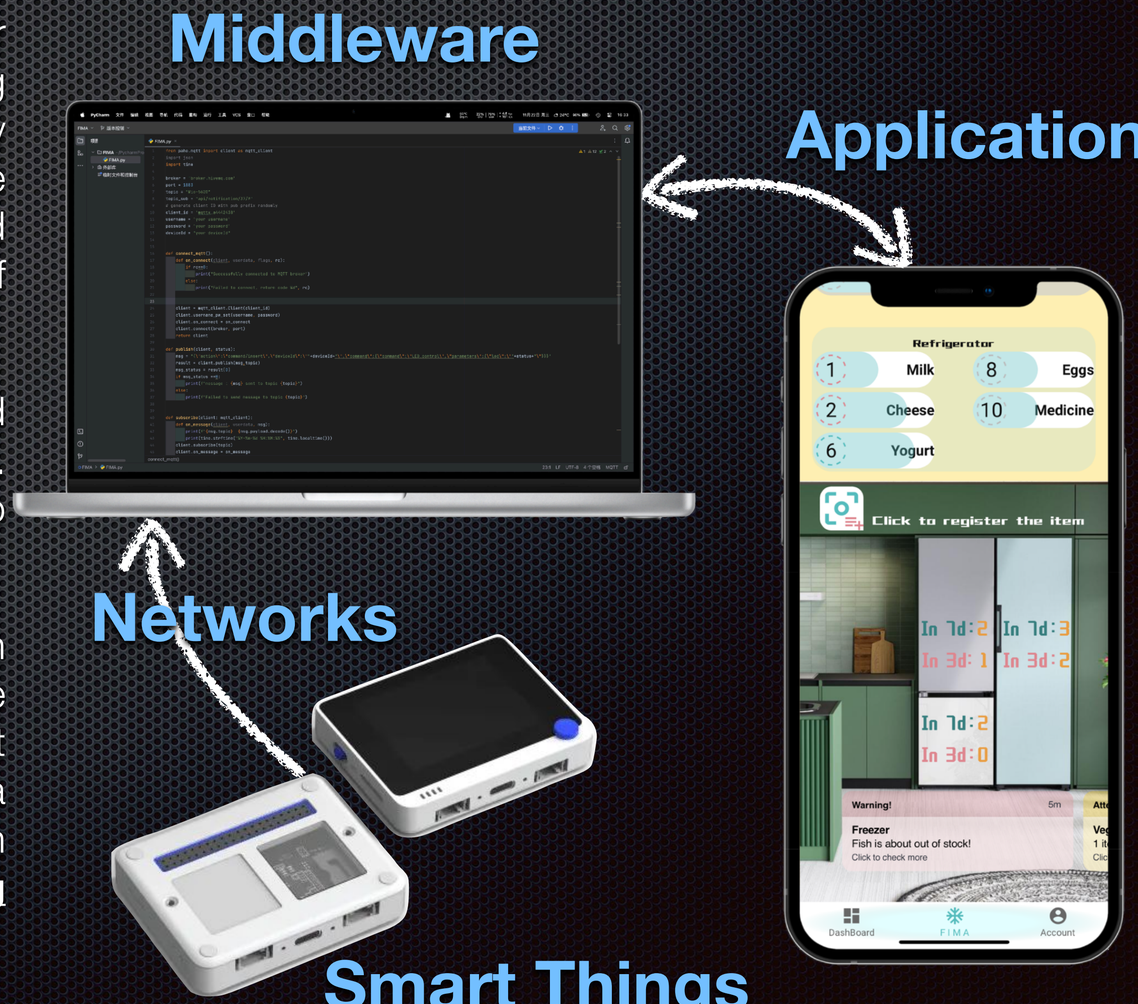
Something New Used on Solution Development

- The **Detection** of the opening and closing status of the refrigerator door is based on the **Built-in IMU** of Wio, Each opening and closing action leads to a change of acceleration in the Z-axis. So, by analyzing the data of the Z-axis, we can get the status of the fridge door. Corresponding **Anti-False-Trigger Functions** are developed to complete the successful detection of the opening and closing of the door.
- Developing an **App** for the user to monitor the conditions and provide interaction could dramatically enhance the user experience. So, I used the **MockingBot** UX design tool to achieve the app simulation.
- Wio will not communicate with the Phone directly. All the information Wio gets will be uploaded to the server first. All data will be processed on the **Server** before being given to the cell phone. Not only does this allow for **Unlimited Expansion** of the system's data storage and processing capabilities, but Wio is not involved in receiving any data from the Internet, which gives Wio **Strong Security**.



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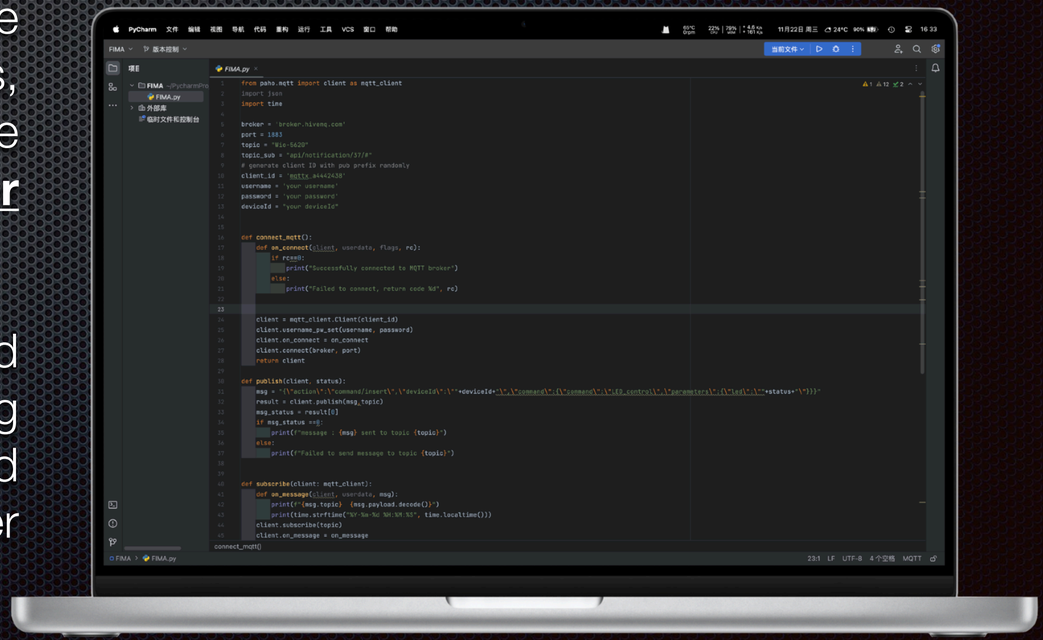
Solution Development

Realization part:

- The **Detection** of the opening and closing status of the refrigerator door is based on the **Built-in IMU** of Wio,
- Only when the refrigerator door is opened the **Backlight** of the Wio screen will be lit to facilitate user interaction. Besides, **Updates** on the inventory increase or decrease will only be available at the open time, which can effectively **Reduce Power Consumption and Prevent Misoperation**.
- All the item-related information, like preservation conditions and expired time, is stored on the **Server**, and all the data processing is realized on the server. The server can also subscribe and publish the data via the MQTT protocol. I used my own computer and Python to develop the program to deliver those functions.



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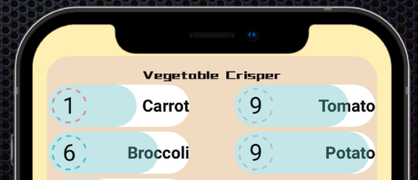
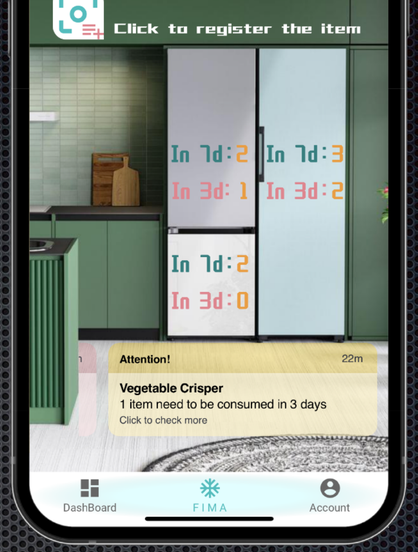
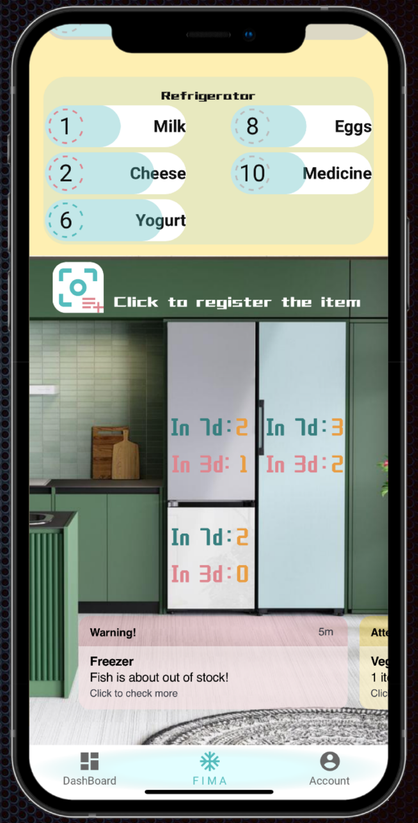
Solution Development

Simulation part:

- I could not find a suitable **RFID Device**, so the identification of RFID is a simulation.
- The workload of using an **ML Model** to identify each item via camera and to find their preservation conditions is too high, so this part is a simulation.
- The App on the phone is a simulation. Several **Interfaces of The APP** are shown on the right. This App can help users monitor their fridge's environmental condition and master their food inventory with just a click.







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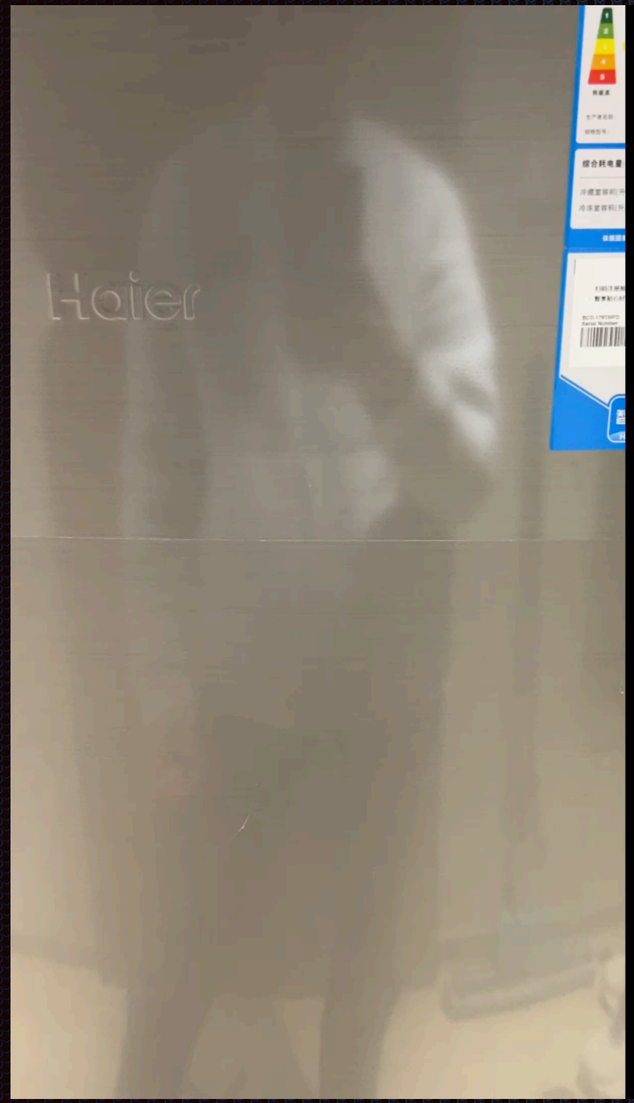
Overall System Development Showcase



Install magnets on the back of Wio Terminal, allowing easy attachment similar to a refrigerator magnet.

Daily-scenario Use of FIMA

https://nottinghamedu1-my.sharepoint.com/:v:/g/personal/ssylz1_nottingham_edu_cn/EeBiskVTvlNHiRraJZwlwCEBzltN_im0c1ps6rcYoysl3g?e=rba1aQ

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Challenges Faced on Project Deployment

- **Privacy Concerns:**
  - **Data Collection and Sharing:** ***FIMA*** may collect and transmit data about users' eating habits, preferences, and food inventory. Concerns about how this data is used and stored and whether it is shared with third parties without user consent can exist.
  - **Data Protection Regulations:** Various regions have stringent data protection laws (e.g., GDPR in Europe) that regulate the collection, processing, and storage of personal data. Smart fridge manufacturers must comply with these regulations to avoid legal issues.
- **Interoperability and Standards:**
  - **Lack of Industry Standards:** There might be a lack of standardized communication protocols and interoperability among different smart devices. This can lead to compatibility issues and limit the seamless integration of intelligent fridges with other smart home devices and systems.

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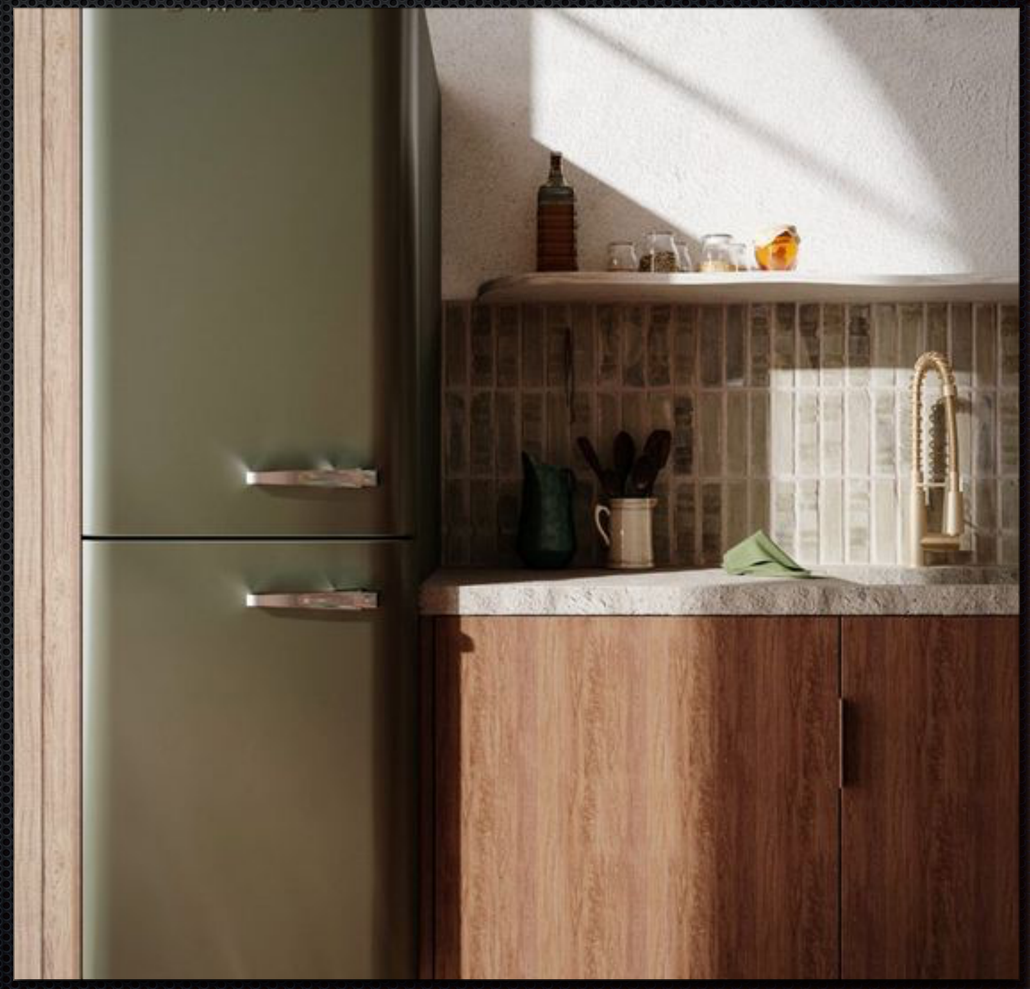
Challenges Faced on Project Deployment



- **Limited Infrastructure:**
  - **<u>Internet Connectivity:</u>** In some areas, particularly in rural or developing regions, there may be limited access to the Internet. ***FIMA*** heavily relies on internet connectivity for data updates and real-time monitoring, which could pose a challenge in such areas.
- **User Education:**
  - **<u>Lack of Awareness:</u>** Consumers may not fully understand the capabilities and benefits of ***FIMA***. Manufacturers need to invest in educating users to enhance acceptance and encourage the use of advanced features.

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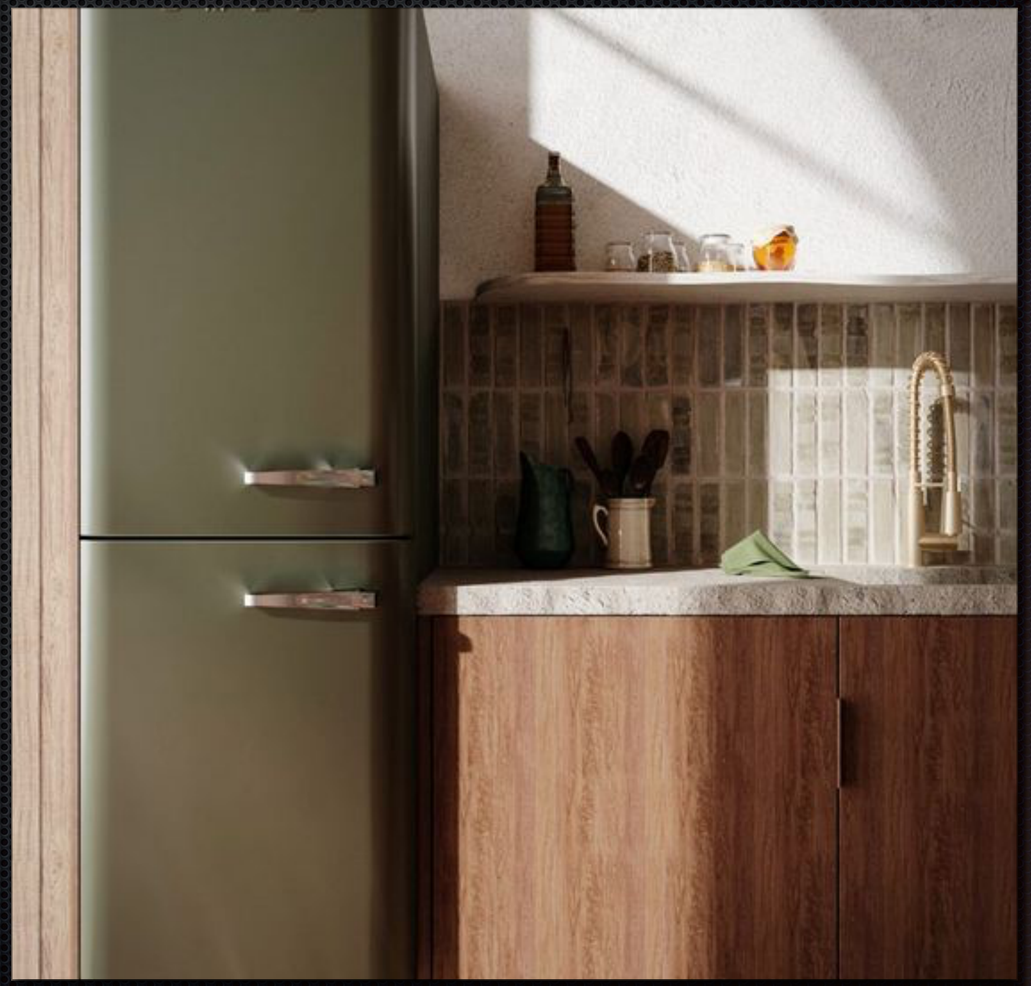
Project Sustainability

- **Software Updates and Obsolescence:** Regular software updates are typical for ***FIMA*** to maintain the system and handle the customer. However, managing these updates is essential so they don't prematurely render the device obsolete. Balancing technological advancements with the longevity of the product is critical for sustainability.

- **User Awareness and Behavior:** Educating users about energy-efficient practices and optimal usage of smart fridges can contribute to sustainability. For example, users can be encouraged to plan food stocks well to avoid waste and optimize the organization of the fridge to improve efficiency.



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Project Security

Threat Example	Threat Type	Security Control	Threat Target	Possible Attack	Security Measures
An attacker uses social engineering to trick a user into revealing their smart fridge credentials by posing as a customer support representative.	Identity Spoofing	Authentication	user accounts and associated data	Manipulating user trust through fake alerts or notifications.	1. Implement robust authentication mechanisms (e.g., multi-factor authentication). 2. Educate users about recognizing and avoiding phishing attempts. 3. Monitor for unusual account activity to detect potential identity spoofing.
An attacker tampers with the inventory data in the smart fridge, causing it to display incorrect expiration dates for certain products.	Data Tampering	Integrity	Data which stored in the server	Intercepting and modifying data during communication (Man-in-the-Middle attacks).	1. Implement encryption to protect data during transmission. 2. Regularly audit and validate data integrity within the system. 3. Use secure coding practices to prevent vulnerabilities that could lead to tampering.
A malicious actor floods the smart fridge's communication channels, disrupting its ability to receive updates or connect to online services.	Denial of Service (DoS)	Availability	The availability and functionality of the smart fridge.	Exploiting vulnerabilities to crash the smart fridge's software.	1. Implement network-level defenses (firewalls, intrusion detection systems) to mitigate DoS attacks. 2. Use rate limiting to control the amount of incoming traffic. 3. Regularly update and patch software to address vulnerabilities that could be exploited for DoS attacks.

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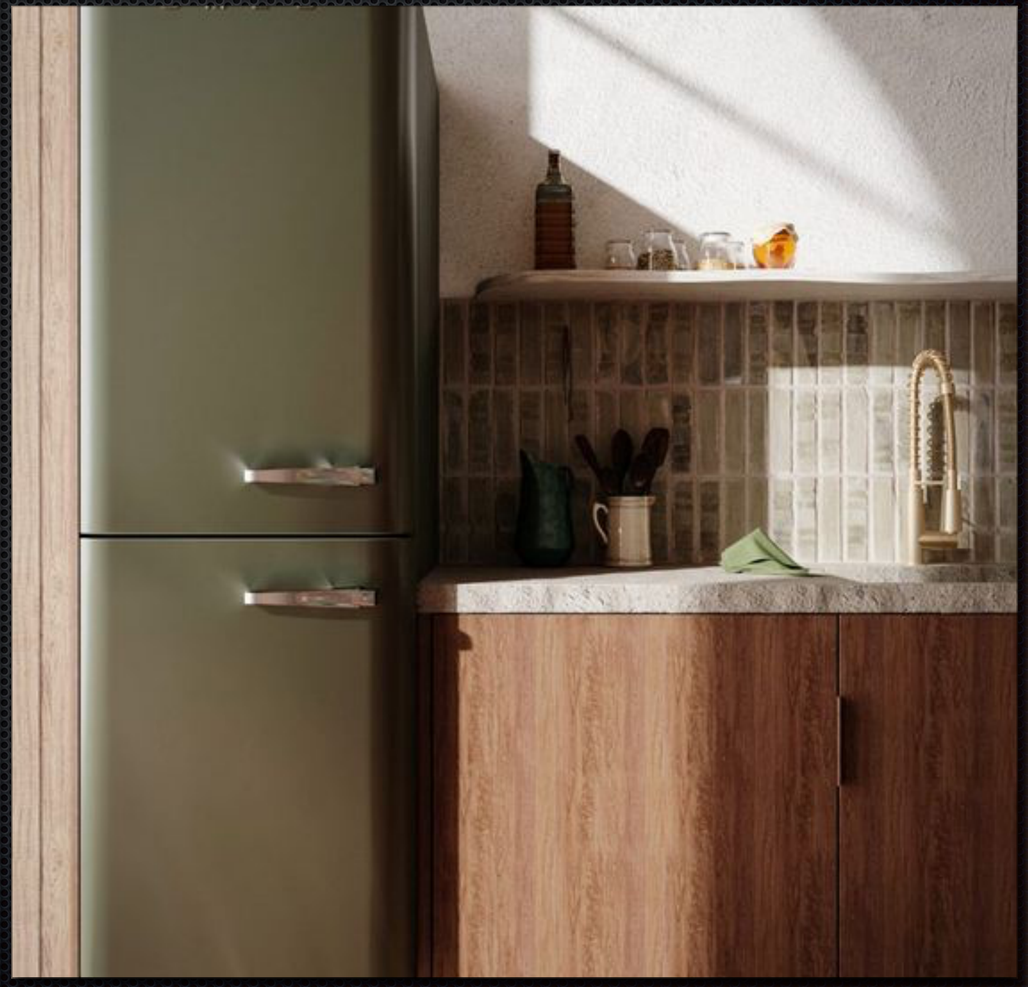
DEMO



Thanks for your listening!