Software/Hardware Requirements Specification

for

Smart Fridge

Version 1.0 approved

Prepared by Ivan Chan and Chengyue Lin

Tuesday Electronics, Inc.

August 21, 2020

Table of Contents

Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

This document contains the specifications for Smart Fridge. This document explains how each feature in the Smart Fridge operates. This document also gives details on the materials that each feature in the Smart Fridge needs.

1.2 Document Conventions

n/a

1.3 Intended Audience and Reading Suggestions

n/a

1.4 Product Scope

In Scope:
The new refrigerator makes our life more convenient and keeps food for a long time. The refrigerator also prevents people from eating food past the expiration date. The refrigerator also controls the door by using voice. The refrigerator also suggests recipes.The scanner only notes types of items and expiration date.

Out of Scope:
The refrigerator does not connect to in-home assistants such as Google Home or Amazon Alexa. The voice sensor currently does not respond to any languages other than American English. The refrigerator can’t help us to cook dishes for us. The refrigerator also does not automatically defrost any food from the freezer in the refrigerator.

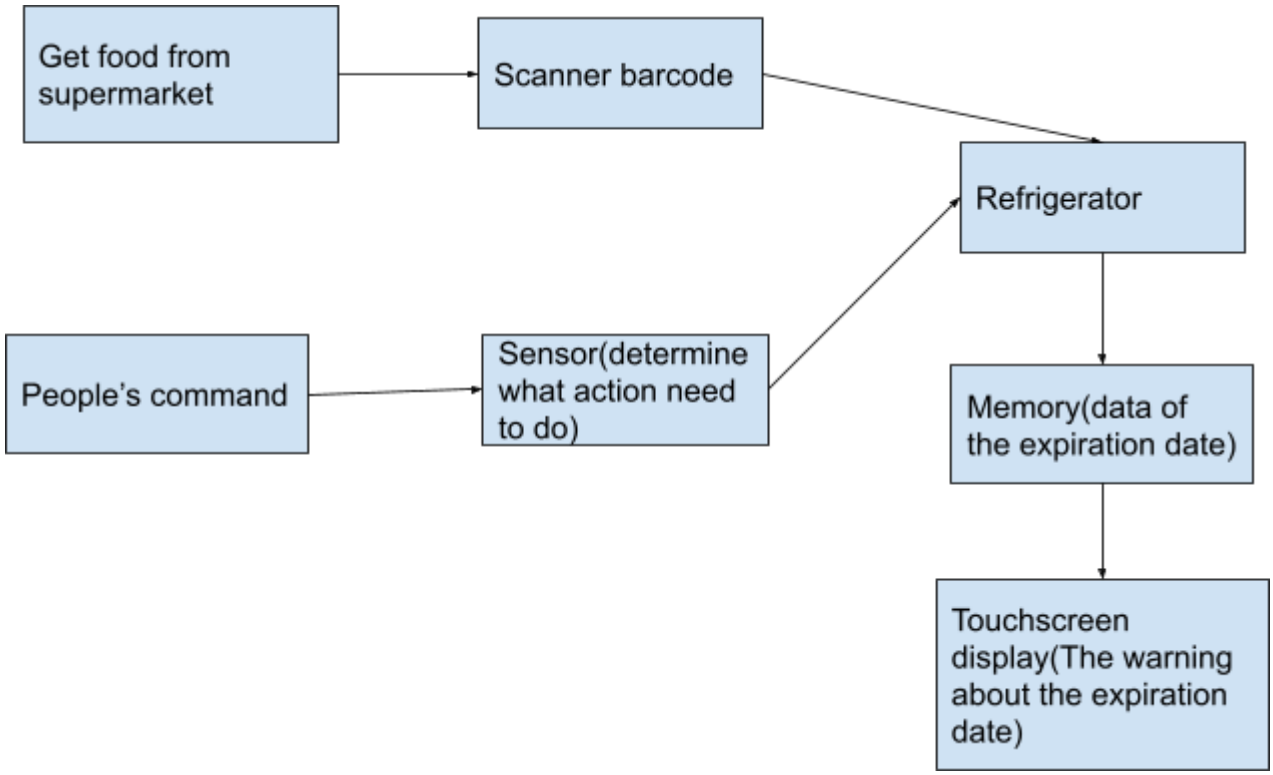
1.5 References

n/a

2. Overall Description

2.1 Product Perspective

Our voice sensor can suggest new recipes and respond to the users' verbal commands. Our refrigerator helps middle class and upper class people stay more healthy and keep food longer. Our refrigerator also allows people to have more recipes and to open and close the door more easily. People want this refrigerator because a growing number of people care about staying healthy.



2.2 Product Functions

- The refrigerator can grab food and move the food to different locations.
- The refrigerator can execute some commands.
- The refrigerator can adjust temperatures to keep food fresh.
- Buttons and touchscreen are waterproof and shatter resistant.
- The refrigerator gives a warning of the expiration date.
- The refrigerator gives some recipes about what foods people choose.

2.3 User Classes and Characteristics

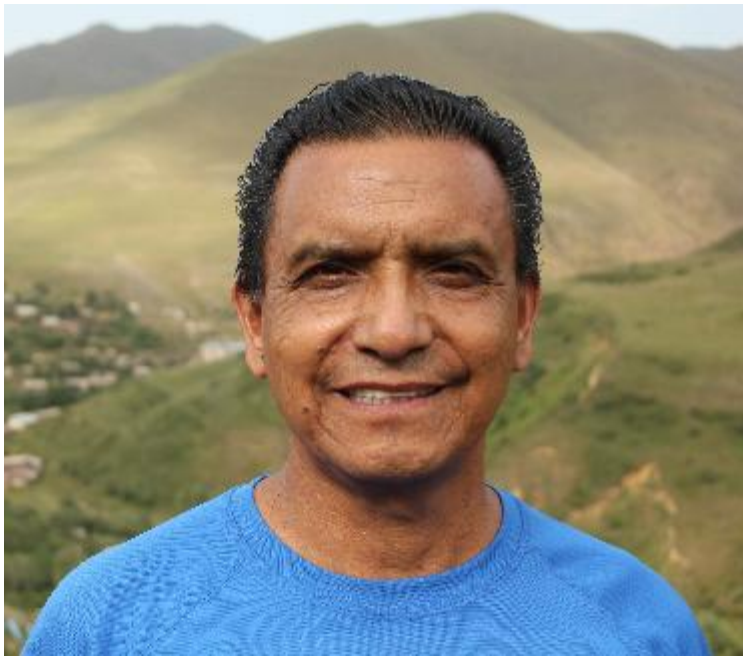
Mary Marshall is 41 years old. She possesses a bachelor's degree in accounting from the University of California, San Diego. She is married to her husband, Jim Smith. Her husband is a finance director in a business company. She has three children, a boy aged 15 years and two girls aged 13 and 12.

She is a clerk in a medium-sized accounting firm. She loves her family. She has many hobbies, such as hiking, riding bicycles, and traveling with her family. She likes spending a lot of time with family and playing with her children.

She likes to cook. However, every time before she starts cooking, she stands in front of the refrigerator and thinks about what to cook for a long time. She often uses her cell phone to find recipes based on what is left in the refrigerator. The hardest thing for her is thinking of the recipe she cooks for her family.

Although Mary and Jim have a good company and a good income, they need to pay their loans every month. They need to pay off their housing loan, their car loan and their children's private-school tuition fees.

They have a great financial burden, so they need to reduce unnecessary expenses. They do not want food in the refrigerator to spoil because the food is past its expiration date.



Antonio Gonzalez is 57 years old. He holds a B.S. in Computer Science from Georgia Institute of Technology. His wife Camila is 59 years old. Antonio and Camila live in a 2-story house in a suburb near Washington, D.C.

Antonio is the founder of a small educational-technology business. Antonio loves running, weight-resistance training, and racing performance cars. Camila is an artist who often travels to the Midwest and New England to showcase her masterpieces.Thus, Antonio is the only person in his home for up to 6 weeks each year.

Antonio and Camila have a 37-year-old daughter , Julia, and a 34-year-old son, Fernando. Julia lives in New York City and Fernando lives in Pittsburgh. Several times each year, Julia and Fernando bring their families to their parents' house.

Antonio loves cooking. He cooks all types of dishes. He regularly tries cooking new food.

When he cooks meat, he wants to grab items from the refrigerator. However, he does not want bacteria from the raw meat to land on the refrigerator door. He washes his hands every time he opens the refrigerator. He finds that washing his hands before touching the refrigerator door is repetitive and time-consuming.

2.4 Operating Environment

n/a

2.5 Design and Implementation Constraints

n/a

2.6 User Documentation

n/a

2.7 Assumptions and Dependencies

n/a

3. External Interface Requirements

3.1 User Interfaces

n/a

3.2 Hardware Interfaces

n/a

3.3 Software or Hardware Interfaces

n/a

3.4 Communications Interfaces

n/a

4. System Features/Functions

This section describes the features and functions of the product.

4.1 Barcode scanner

The barcode scanner is a part of the computer assembly.

4.1.1 Description and Priority

Priority 1

What

The barcode scanner scans the objects and determines the expiration date. The scanner uses a database that is on the Internet.

Why Care

Mary doesn't want to cook bad food for her children. Mary tends to forget expiration dates. The barcode scanner automatically determines expiration dates. Thus, Mary cooks fresh food.

How

The barcode scanner is outside of the refrigerator. The scanner is at the same height as the door handle. The door handle is at the middle of the left side of the refrigerator. The barcode scanner also is above the icemaker dispenser.

The scanner has a red line on the bottom. The red line determines the existence of food.

The scanner finds food through a database that stores the expiration dates of each food. The scanner determines the approximate expiration date of the food.

What wrong

Mary may scan the object incorrectly. Mary may show a barcode that the scanner cannot read. The touchscreen asks Mary to rescan. Mary may re-scan the object multiple times. If the object successfully scans, the touchscreen stops asking Mary to rescan.

In addition, Mary may manually enter the object via the touchscreen. The scanner searches the database to suggest expiration dates. Mary may write the expiration date via the touchscreen.

Scanner may give an incorrect expiration date. Mary can use the keypad to correct the expiration date on the computer.

4.1.2 Stimulus/Response Sequences

Stim	*Responses*
The barcode scanner is off. Mary presses the on/off button on the barcode scanner.	The barcode scanner turns on. A red light checks for barcodes.

Mary inserts a barcode of an object underneath the red light.	The barcode scanner gives one beep. The beep alerts Mary immediately after the barcode scanner scans one object.
	The touch screen displays the name of the food and the food's expiration date.
The barcode scanner is on. Mary presses the on/off button on the scanner.	The barcode scanner turns off. The red light associated with the barcode scanner turns off.
	The on/off button does not control whether the touchscreen display is on.

4.1.3 Functional Requirements

REQ-1: Barcode scanner must receive power.
REQ-2: Barcode scanner must attach to the computer.
REQ-3: Speaker in the barcode scanner must beep.
REQ-4: Barcode scanner needs wi-fi.

4.2 Touchscreen Display

The touchscreen display is a part of the computer assembly.

4.2.1 Description and Priority

Priority: 1

What
The touchscreen display allows Antonio to view information about the food. The touchscreen display allows Antonio to change the description of the food.
Why Care
Antonio needs to use the refrigerator in a non-confusing manner.
How
The touchscreen display is 2 inches above the topmost part of the barcode scanner.
The touchscreen display does not have any buttons.
The touchscreen display does not extend more than 250 micrometers from the rest of the refrigerator door.

What wrong

Excessive force can shatter the touchscreen display. The touchscreen display shall withstand forces of at least 14 psi.

4.2.2 Stimulus/Response Sequences

Stim	*Responses*
The touchscreen display is off. Antonio presses his finger on the touchscreen display.	The touchscreen display turns on. The display shows a menu with rectangular buttons.
Antonio does not touch the touchscreen display for X minutes. The default time for X is 10 minutes. Antonio sets X. X can be between 30 seconds to 2 hours.	The touchscreen display goes into “sleep” mode.
	The touchscreen display turns off immediately.

4.2.3 Functional Requirements

REQ-1: Touchscreen display may not be underneath any module that can pour liquid onto the touchscreen display.
REQ-2: Touchscreen display must receive power.
REQ-3: Touchscreen display must detect force of fingerprint push.
REQ-4: Touchscreen display must be made of shatter-resistant material.
REQ-5: Length is horizontal, and width is vertical.
REQ-6: The length of the touchscreen display must be between 6 and 8 inches.
REQ-7: The width of the touchscreen display must be between 4.5 and 6 inches.
REQ-8: The ratio of length to width must be between 1.34 and 1.6.

4.3 Temperature sensor module

The temperature sensor module is part of the food-preservation module.
Note: The fans that prevent the food from rotting are Priority 1.

4.3.1 Description and Priority

Priority:2

What

The temperature sensor module detects the temperature of each cabinet. The temperature sensor module increases, maintains, or decreases the temperatures of cabinets.

Why Care

The temperature sensor prevents Mary's food from spoiling.

How

The temperature module turns on the fan to keep the food at the desired temperature. Every fan rotates its blades in a clockwise direction.

What Wrong

The food may get too hot because the refrigerator receives no power for more than 3 hours. The temperature-sensor module needs to run the fan at full speed to keep the food from spoiling too soon.

4.3.2 Stimulus/Response Sequences

Stim	*Responses*
The refrigerator receives power. The refrigerator is just on following a power outage. The temperature inside the cabinet of the refrigerator is above 50 degrees.	The fans that control the refrigerator cabinet immediately increase fan speed to 100% capacity.
	When the sensor receives power, the temperature sensor immediately messages the computer. The message contains the temperature and date (up to the millisecond).
	Fan returns to normal operating speed when the temperature is normal.
The temperature sensor detects that the temperature is too low.	The fan speed slows down or stops.
The temperature sensor detects that the temperature is too high.	The fan speed increases. The fan speed must never be greater than 100%.
The temperature sensor notices a reduction/ elimination of power.	The temperature sensor cuts off power to the fans (no more than 10% per 200 milliseconds)

	Temperature sensor turns off after fan speed becomes 0%.

4.3.3 Functional Requirements

REQ-1: The temperature sensor must check temperature at minimum once per thirty seconds.

REQ-2: The temperature sensor must have electricity.

REQ-3: The temperature sensor is connected to the computer.

4.4 Interior lighting

The interior-lighting module is part of the hardware assembly.

4.4.1 Description and Priority

Priority: 1

What

The interior lighting is all the lights inside the refrigerator. The lighting illuminates the food that is in the refrigerator.

Why Care

Antonio needs to see the contents of his refrigerator. Antonio expects a refrigerator to have its interior lighting on when Antonio opens the refrigerator door.

How

Antonio can choose whether the interior lighting turns on. If Antonio enables interior lighting, opening the door turns on the interior lightning. Interior lightning turns off when the door closes.

What Wrong

Antonio may only partially open the refrigerator door. The interior lighting only turns on if the door is open sufficiently.

4.4.2 Stimulus/Response Sequences

Stim	*Responses*
The refrigerator-door module messages the interior-lighting module. The message states that the door is open more than 15 degrees. The	All LEDs inside the door immediately turn on.

	interior lightning module may turn on the LEDs.	
	The refrigerator-door module messages the interior-lighting module. The message states that the door is open more than 15 degrees. The interior lightning module may not turn on the LEDs.	All LEDs inside the door continue to be off.
	The computer tells the interior lightning module that the door is closed.	If LEDs are on, the LEDs immediately turn off.
		If LEDs are off, the LEDs remain off.

4.4.3 Functional Requirements
REQ-1: Interior-lighting module must have power.
REQ-2: Interior-lighting module must connect to the computer.

4.5 Refrigerator-door module

The refrigerator-door module is part of the hardware assembly.
The refrigerator-door module relies on messages from the voice sensor (4.7) for the automatic opening/closing of the refrigerator doors.

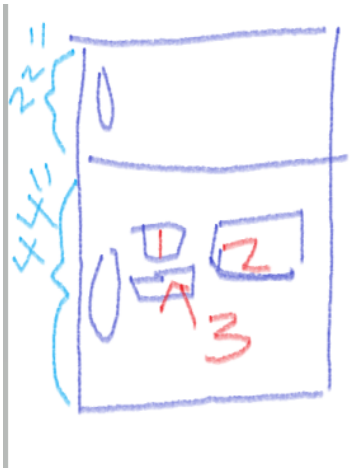
4.5.1 Description and Priority
Priority:2

What

The doors on the refrigerator have magnets that keep the door closed. The magnets that keep the door closed are the only magnets that come with the refrigerator.

In addition, Antonio may have magnets that do not come with the refrigerator. Antonio can place these magnets on most parts of the doors. Antonio cannot place magnets on the icemaker, touchscreen display, and barcode scanner.

Antonio can manually open or close each door. Antonio can use the voice sensor to direct each door to automatically open or close.



Key:
1 - Barcode scanner
2 - Touchscreen Display
3- Icemaker machine

Why Care
Antonio can manually or automatically open and close the refrigerator doors. The motors do not assist Antonio while he manually opens and/or closes the door.

How
The voice sensor gets the command from the user.

For example, assume the name “Smartbot” activates the voice sensor. Antonio says, “Smartbot, open the door”. Then the magnets that keep the door shut discharge. The door automatically opens to 100 degrees or until the door collides with an object..

What Wrong
If the motor for a refrigerator door breaks down, the computer disables the automatic opening feature for that door. The computer requires Antonio to manually open the door until the motor works again.

When doors open or close automatically, the doors do not detect the presence of obstacles. The motors of the door immediately stop upon colliding with an obstacle.

Note: If only one motor is not working, the working motor functions as if both motors work. Antonio can automatically open the door with the working motor.

4.5.2 Stimulus/Response Sequences

Stim	*Responses*
Antonio's hand pulls on the refrigerator door handle with a force of at least 3 psi. The force points away from the refrigerator.	The door opens immediately. The motors by the door do not assist Antonio as he opens the door.
	The door monitors the degree between the door and the rest of the refrigerator.
Antonio opens the door more than 15 degrees.	The door module messages the interior lighting system. The message instructs the interior lighting module to turn on the lights.
	The method of opening the door may not switch from manual to opening via the voice sensor.

4.5.3 Functional Requirements

REQ-1: The refrigerator door must communicate with the computer.
REQ-2: The refrigerator door must have at least two hinges on the right side.
REQ-3: All hinges are on the right side of the refrigerator door.
REQ-4: The door handle must be on the left side of the refrigerator door.
REQ-5: The refrigerator is 66 inches (5'6") tall.
REQ-6: The top door is the freezer. The bottom door contains all non-frozen food.
REQ-7: The top door is 22 inches (1'10") tall. The bottom door is 44 inches (3'8") tall.

4.6 Icemaker

The icemaker is a part of the computer assembly.

4.6.1 Description and Priority

Priority 2

What

The icemaker produces ice for the user. The icemaker assumes Mary has a container directly underneath the icemaker machine. The icemaker does not check for the existence of a container underneath the icemaker.

Why Care
Mary wants ice for her drinks.

How
There is an on/off button for the icemaker. When Mary presses the button, ice cubes immediately fall from the icemaker. When Mary presses the button again, ice cubes stop falling from the icemaker.

What Wrong
The icemaker may have little to no ice. The touchscreen displays a warning. The warning is “Refill icemaker”.

4.6.2 Stimulus/Response Sequences

Stim	*Responses*
The icemaker is in the off position. Mary presses the on/off button.	The icemaker immediately turns on. The icemaker immediately begins dispensing ice.
The icemaker is in the on position. Mary presses the on/off button.	The icemaker immediately stops dispensing ice. The icemaker turns off.

4.6.3 Functional Requirements

REQ-1: The icemaker must have ice (user adds ice).
REQ-2: The icemaker must connect to electricity.
REQ-3: The icemaker must connect to the computer.

4.7 Voice Sensor

The voice sensor is a part of the computer assembly.
In Section 4.7, “SmartBot” refers to the voice sensor’s name.

4.7.1 Description and Priority

Priority 1

What

Voice sensor receives people’s command then opens/closes the door.

Why Care

Mary often cooks at home. She often needs to open/close the door by hand. She doesn’t want to use her hand to open/close the door. Thus, she wants to use her voice to control the door to open/close.

How

The voice sensor has a name. The voice sensor’s name alerts the voice sensor that Mary is giving it a command. Using the touchscreen display, Mary may change the voice sensor’s name. By default, the name is “SmartBot”.

The voice sensor receives Mary’s commands. For example, Mary may say,“SmartBot, open the fridge door” or “SmartBot, close the fridge door”.

For each command, the name “SmartBot” tells the voice sensor to record the commands. The voice sensor hears the commands “Open the fridge door” and “Close the fridge door”. The door automatically opens/closes by receiving Mary’s command.

What Wrong

Mary may speak the wrong command. For example, when the door closes, Mary says “SmartBot, close the fridge door .” Then the touchscreen displays that the door closes, error command.

Mary may speak an invalid command. For example, Mary may say, “Smartbot, give me that”. The voice sensor interprets the command “Give me that” as an invalid command. The touchscreen display immediately says “Invalid command”.

4.7.2 Stimulus/Response Sequences

Stim	*Responses*
The fridge door closes. Mary says “Open the fridge door”.	The voice sensor does not activate. The voice sensor makes no noise.
The fridge door closes. Mary says, “SmartBot, open the fridge door”.	The word “SmartBot” activates the voice sensor.

	The voice sensor records the command “Open the fridge door.” The door automatically opens.
The fridge door opens. Mary says, “SmartBot, close the fridge door”.	The word “SmartBot” activates the voice sensor.
	The voice sensor records the command “Close the fridge door.” The door automatically closes.
The fridge door opens. Mary says, “SmartBot, give me that”.	The word “SmartBot” activates the voice sensor.
	The voice sensor does not understand the command “give me that”.
	The voice sensor tells the touchscreen, “Invalid command”.

4.7.3 Functional Requirements

REQ-1: Voice sensor must receive power.

REQ-2: Voice sensor must attach to computer

4.8 Get-Recipes Module

The Get-Recipes module is part of the software assembly.

4.8.1 Description and Priority

Priority 2

What

The Get-Recipes module can help Mary to get some recipes.

Why Care

Mary has no idea what to cook for her family. Every time she needs a long time to decide what to cook for her family. Thus, she needs a fridge to get some recipes for her.

How

Depending on Mary's choice of food, the touchscreen displays some recipes for Mary.

What Wrong

There is no food or not enough food to make recipes. A refrigerator with "not enough food" displays on the touchscreen "Error. Not enough food to make a recipe."

If there is only one ingredient, the recipe is that ingredient.

4.8.2 Stimulus/Response Sequences

Stim	*Responses*
Mary chooses some food that she wants to cook. Then she presses the "recipe" button on the touchscreen.	Touchscreen asks Mary some questions about the ingredients. For example, the touchscreen may display "Do you have red pepper?", "And do you have basil?" etc.
	Mary asks all the questions shown on the touchscreen. Then the touchscreen displays some recipes for Mary.
Mary has little or no food in the refrigerator. Mary presses the "recipe" button.	After Mary presses the "recipe" button, the touchscreen says, "Error. Not enough food to make a recipe."

4.8.3 Functional Requirements

REQ-1: The Get-Recipesmodule must receive power.
REQ-2: The Get-Recipes module must attach to the computer.
REQ-3: The Get-Recipes module needs Wi-fi.

4.9 Memory

The memory is a part of the computer assembly.

4.9.1 Description and Priority

Priority 2

What

Memory stores all the data of the food. For example, memory stores the expiration date and the quantity of each food.

The memory also stores recipes for the users. The memory can load old recipes for users to cook again.

Why Care

Mary cares about expiration dates. Memory keeps tracks of the food. Memory can tell Mary the food that she needs to buy.

How

The barcode scanner tells the memory the food that enters the refrigerator. The memory stores the values of the food.

Mary needs a recipe. The memory gathers recipes from the Internet and/or recipes that it already has. The memory sends the desired recipe to the touchscreen display.

What Wrong

Mary uses more than one food item (such as 2 eggs). The memory asks Mary, “How many eggs do you need?” Mary enters the number of eggs she needs. The memory adjusts the number of eggs.

4.9.2 Stimulus/Response Sequences

Stim	*Responses*
Mary selects food for a recipe on the touchscreen.	The touchscreen asks Mary “How many do you want?”
Mary inputs the quantity of food.	The memory immediately updates the quantity of that food.

The barcode scanner tells the memory about the new food.	The memory immediately updates the quantity of the foods that the barcode scanner noted.

4.9.3 Functional Requirements
REQ-1: Memory needs power.
REQ-2: Memory connects to touchscreen display.
REQ-3: Memory connects to wi-fi.

4.10 Eco-Saving Module

The eco-saving module is part of the software assembly.
4.10.1 Description and Priority
Priority 2

What
The Eco-Saving Module adjusts the power settings of the refrigerator.

Why Care
Mary wants the refrigerator to not use unnecessary electricity.

How
Mary selects how energy-efficient her refrigerator can be. Mary can choose from 3 modes: Eco-Plus, Eco, and Performance. A button represents each mode. The name of the mode is on the button for that mode.

Eco-Plus uses the least electricity. Eco-Plus mode saves electricity as much as possible. Eco mode is a compromise between features in Eco-Plus mode and Performance mode. Performance mode uses the most electricity. Performance mode puts keeping food as most important.

What Wrong
Under certain situations, the refrigerator may override the energy-efficiency settings. Overriding occurs if food is at high risk of spoiling. Overriding includes running the fans faster than usual to cool food faster. When the food is not at risk of spoiling, the settings go back to the energy-efficient settings .

4.10.2 Stimulus/Response Sequences

Stim	*Responses*

	Mary selects the “eco-saving” button on the touchscreen.	The touchscreen displays the several options for energy efficiency.
	Mary changes the mode in the energy-saving. (such as Performance to Eco)	The settings immediately change to the new settings. For example, the settings for Performance change to the settings for Eco.

4.10.3 Functional Requirements

REQ-1: Eco-Saving module needs power.
REQ-2: Eco-Saving module communicates with touchscreen.
REQ-3: Eco-Saving module communicates with temperature-sensor module and interior lighting.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

n/a

5.2 Safety Requirements

n/a

5.3 Security Requirements

n/a

5.4 Software or Hardware Quality Attributes

n/a

5.5 Business Rules

n/a

6. Other Requirements

n/a

Appendix A: Glossary

n/a

Appendix B: Analysis Models

n/a

Appendix C: To Be Determined List

n/a