جامعة الأمير محمد بن فهد
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering

Department of Electrical Engineering

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Senior Design Project Report

Smart Fridge system

In partial fulfillment of the requirements for the Degree of Bachelor of Science in Electrical Engineering

Team Members

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Abstract

Technology today is moving at the speed of light and it is not a secret that smart appliances have made their way into our homes. One of the main problems facing the world today is food wastage. As much as 40% of food gets thrown away due to expiration in the U.S alone and 165 billion dollars goes down the drain due to food wastage. The solutions being offered are smart refrigerators with the three main functions of keeping track of the food items stored inside the fridge (availability), keeping track of food items that are expired or soon to be expired food items (expiry), and keeping track of the amount of food stored in the fridge (quantity). Our project seeks to improve the lives of people in Saudi Arabia by creating a user friendly, low-cost smart fridge used in our daily lives.

Table of *Contents*

1. Introduction

1.1 Project Definition

The idea of the project is to redesign the regular refrigerator by making it into a smart refrigerator that is compatible with life in the modern day. The main design of the refrigerator is that it can keep track of the food items stored in the fridge, notify the client about missing food items stored in the fridge without manually checking the contents of the fridge, notify the client about food items about to expire, to be able to weigh tomatoes and bananas, count the number of tomatoes and bananas, count up to 5 eggs , and detect milk and juice.

1.2 Project Objectives

1. Increase public awareness about the economic impact of food wastage.
2. Introduce a new concept of smart refrigerators

1.3 Project Specifications

A. Weigh Tomato amount via weight sensor.
B. Weigh Banana amount via weight sensor.
C. Count Number of Tomatoes by weight sensor.
D. Count Number of Bananas by weight sensor.
E. Detect Milk, Juice, Eggs using IR sensor.
F. Count-up to 5 eggs via IR sensor.
G. Distinguish Edible vs. Non-edible Bananas via MQ2 sensor for expiry date information.
H. Display related information of the fridge such as temperature, humidity via Application.

1.4 Product Architecture and Components

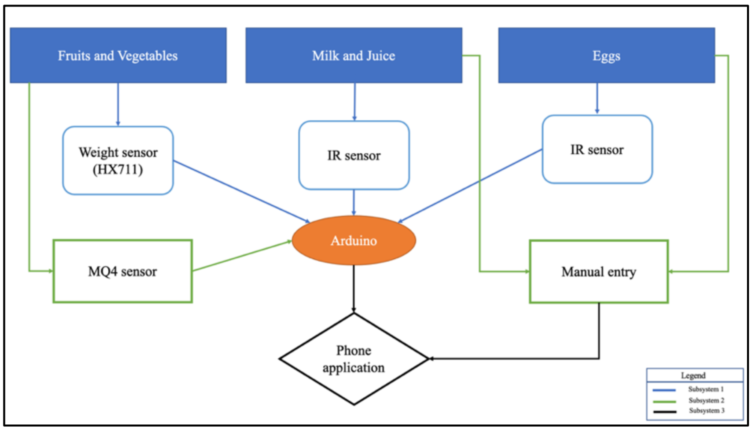


Figure 1.1: Block diagram of our project.

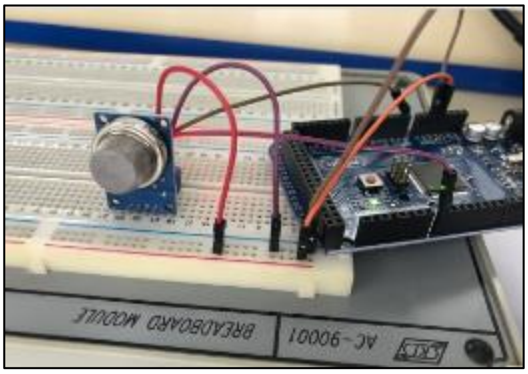


Figure 1.3: Testing out the MQ4 gas sensor.

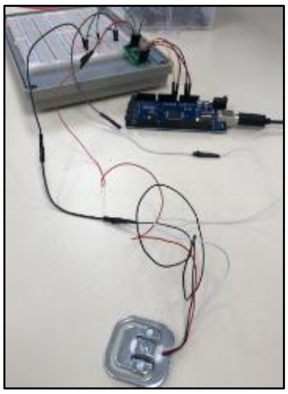


Figure 1.2: Testing out the weight sensor.

Figure 1.4: Implementation of the IR sensor for the juice and milk.

1.5 Applications

The smart refrigerator system can be used in different areas, and in different places who are seeking to upgrade their fridge into a modern-day fridge the suits the time we live in now as example:

- Regular small households
- Hotels (room)
- Restaurants (self-service)
- Juice shops (self-service)

Although our smart fridge is mostly aimed for induvial use in the mentioned above examples. For the hotels we would like to note out that some hotels use fridges that do sense when a food item has been used and the client gets charged when a specific food item is no longer in the fridge, these specific types of hotels use sensors within the fridge.

2. Literature Review

2.1 Project background

The main issues that researchers and engineers are trying to solve in terms of the fridge is developing it furthermore while considering the economic aspect to make it more economic. Other problems regarding the fridge are making the fridge Eco-friendly [1], smaller [2], smart and connected to the internet, to be able to tell the expiry date of the food items inside the fridge, to be able to tell the food items inside the fridge.
The fridge has not been revolutionized almost ever since it was invented, no new invention in the fridge has worked and is being used in everyday households. The first fridge connected to the internet was the LG DIOS fridge [3] the fridge was not a big success because of its cost and the client's needs for a smart fridge was low, not many people saw the reason to buy a smart fridge.

The suggested solutions for a fridge that is able to tell the food items is by using image processing and a camera, however this technique will be more costly however it can be accurate and will not require special compartments inside the fridge for the food items that will be bought. In order to have a low cost smart fridge a suggested solution is to place special compartments in the fridge for each food items [4] the reason for that is because each food item will have a designated area to place the food in and other sensors will be used to be able to detect the food items inside the fridge such as using IR sensors, Ultrasonic motion sensors or more.

Our project in respect to the previous solutions is that our project has an application and it uses the methane gas detection for the expired fruit and vegetable items, our project is low in cost, uses different techniques for the expiration detection and it has special compartments inside the fridge for the specified food items.

2.2 Previous Work

The previous work that has been done regarding a smart fridge is firstly the smart fridge connected to the IoT [3]. This **[5]** smart refrigerator system of product identification through the RFID technology, it'll help in identifying new products, identifying removed products, be able to notify the user about essential food items to add in the shopping listed connected to a web application, alerts (if a product is a about to expire, if a product has not been used for a long time), and finally the inventory of the fridge. As it is seen in Figure 2.1, which shows the block diagram of the system with the RFID Tags.

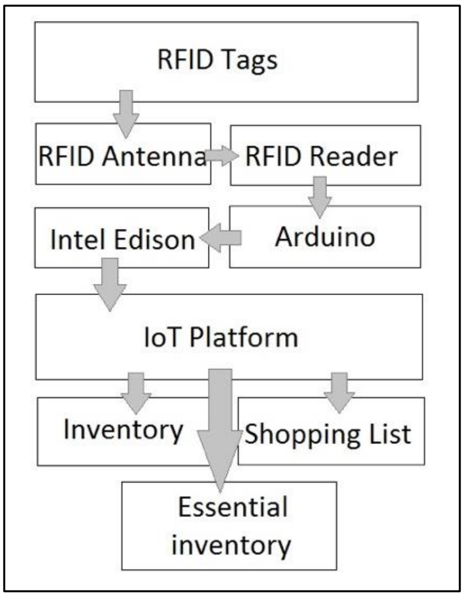


Figure 2.1: Block diagram.

The main idea of this fridge is that it is connected to the internet while also using the RFID technique to keep track of the food items stored inside the fridge instead of using manual entry via an application.

Another previous project relating to the smart fridge is the artificial intelligence fridge [1] which is a smart fridge system that has artificial intelligence being incorporated into the system this fridge has an image processing technique embedded into the system of the smart fridge, through artificial intelligence the fridge is able to discern the types of fruits and vegetables inside the fridge by a camera that it is trained to recognize the types of fruits and vegetables, however the extent that the fridge can image process is only limited to fruits and vegetables as it cannot process other contents of the fridge such as milk, juice, or other personalized food items for the user. The working principle of the image processing is seen in figure 2.2.

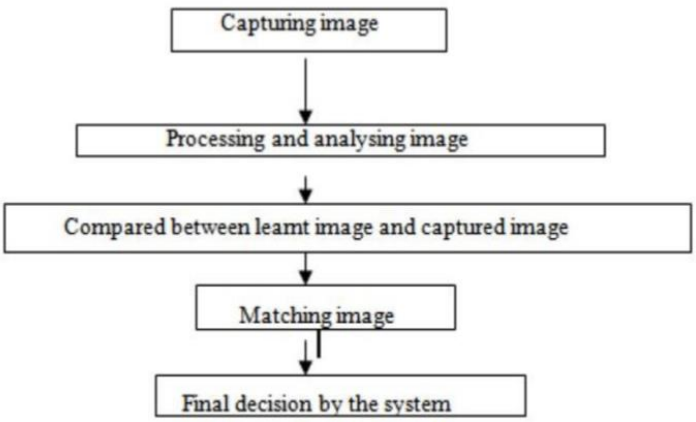


Figure 2.2: Block diagram.

The camera first captures an image of the fruit or vegetable, then after that it processes the image through a series of classes that is programmed inside the microcontroller. It is able to classifiy the fruit and vegetable by recognizing its color features, texture features, shape features, and size features and also be able to identify the ‘children’ class of the fruit and vegetable. Figures (2.3 & 2.4) show the grey scale image of Zucchini and beans to be able to tell the parent class and the children class of vegetable.

Figure 2.3: Colored image of zucchini (right) beans (left).

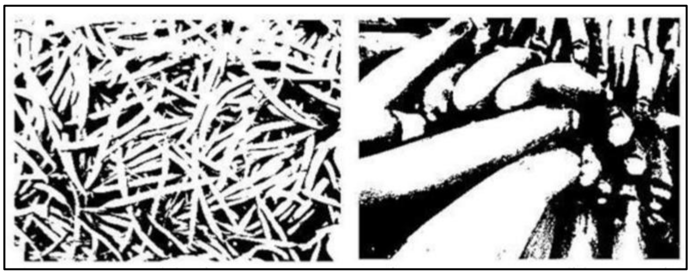


Figure 2.4: Grey scale image of zucchini (right) beans (left).

The grey scale technique is used in the image processing to further classify ‘children’, Where beans have larger connected components (white area) than the zucchini, after the parent/ child class classification there is the texture classification to be able to classify the image of the fruit/ vegetable of the captured image of the fruit or vegetable.

Along with the first and second previous work, the third previous work is a low-cost smart refrigerator [4]. [6]the main idea of this fridge is that is mainly focusing on being a smart and low in cost fridge, one of the reasons that it is low in cost is because of the special compartments of the fridge. The special compartments of the fridge have designated areas for each of the food items as seen below in the figure 2.5.

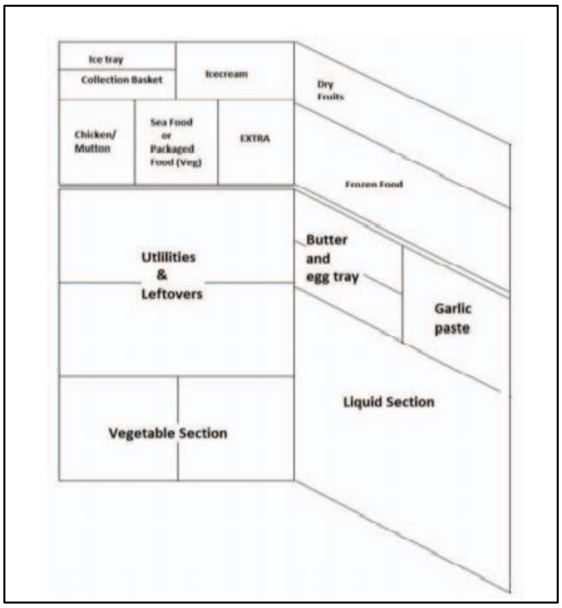


Figure 2.5: Special compartments illustration.

Each compartment in the fridge is for a specified food item such as the vegetable section, liquid section etc.
The special compartment always specified measurement techniques to know the available food items, the number of liters left in the liquids section and more instead of having the fridge being random and using an image processing technique which can be more expensive.

The fourth work which is a smart refrigerator with a focus on food management [6]. The smart fridge proposed in this paper is to create a network of the fridges in a neighborhood connected to a centralized IoT platform as seen in figure 2.6.

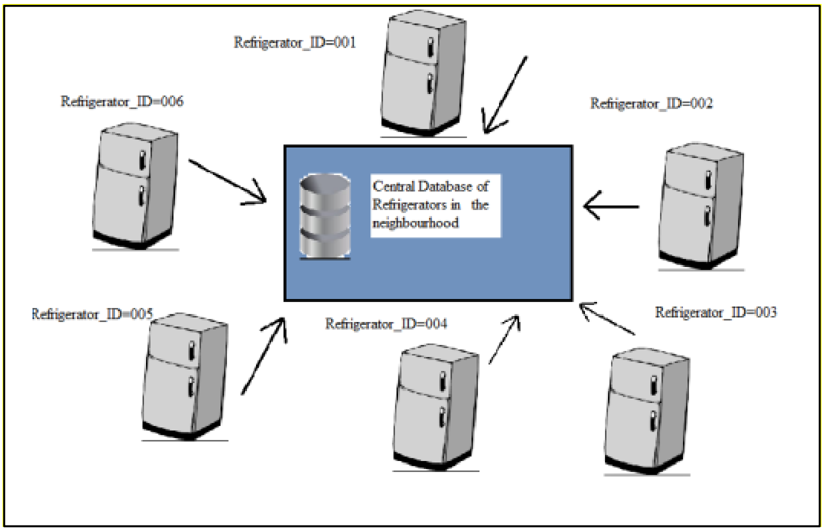


Figure 2.6: The central database connecting all the refrigerators in the same neighborhood.

The purpose of creating a network is to inform neighbors about the available food items in a household that can be passed on to a neighbor instead of it going to waste for effective food management.

The fifth paper is a smart fridge paper that uses the IoT and an android application it also sends a message to the user about soon to be expired food items by using a GSM shield. This previous project also uses IR sensors for the detection of the amount of liquid left (full/ empty) for the milk food items, this project also uses an ultrasonic sensor for the detection of the number of eggs in the fridge.

2.3 Comparative Study

The project of the smart fridge has not been made in our university by previous Electrical engineering students or other related engineering discipline students. We are the first to make a smart fridge system in our university. The summary of the previous projects from the literature and our project is summarized in table 1.

Table 1: Comparison between features of the smart fridge.

Our project	**Features**	**#1**	**#2**	**#3**	**#4**	**#5**
✓	Low Cost	✗	✗	✓	✗	✓
✗	RFID	✓	✗	✓	✗	✗
✗	Image processing	✗	✓	✗	✗	✗
✓	Connected to the IoT	✓	✓	✓	✓	✓
✓	Application	✗	✗	✓	✗	✗
✓	Expiration date	✗	✗	✗	✓	✓
✓	Availability	✓	Fruits & vegetables only	✓	✓	✓
✓	Special compartments	✗	✗	✓	✗	✗

Therefore, our project incorporates the technology of getting the expiration date of the food items, having an application, connected to the internet and is relatively low in cost.

3. System Design

3.1 Design Constraints

3.1.1 Design Constraints: Engineering Standards

The engineering standards seek to ensure desirable characteristics of products and services such as quality, environmental friendliness, safety, reliability, efficiency and interchangeability - and at an economical cost. In first subsystem: “Food detection & quantity count” the standards that we are planning to achieve is that we want this subsystem to be able to accurately detect the right amount that is there. The standards that we are seeking to achieve in the second subsystem is the NECA 400-2007. In the third subsystem the phone application, we are planning on meeting the standards for the Wifi standards of IEEE 802.11.

3.1.2 Design Constraints: Economic

The economic constraints in our project for the first subsystem: “Food detection & quantity count” is that our project is low in cost, reduces money wastage. To make our project as low cost as possible we apply the set of rules in the fridge (special comparts for each food item) that is why the fridge has limitations in the food amount that could be stored into the fridge. We are not using advanced image processing techniques which is high in cost, also we are adding our system into a ready fridge.

The economic constraints in our project for the second subsystem: “Expiry date” in order to be economically conscious, for our project we have avoided the use of a barcode scanner and a RFID tag reader we are using a MQ2 gas sensor for the fruits and vegetables and preferring the use manual entry of for the milk, juice, eggs instead of using the barcode scanner and RFID tag reader. The cost of the MQ2 gas sensor (13 SAR) is low in price compared to the barcode scanner (164 SAR). For the RFID tag reader, we would we need to add two databases one that we create, and another one connected to the internet which results in wasting time.

The economic constraints in our project for the third subsystem: “phone application & general info” we have decided on building an application which is more efficient, user-friendly, available outside the house instead of using a touch screen (160 SAR) it would only be available inside the house in compared to building the app which does not cost a lot of money.

In addition to our project being relatively low in cost, this is possible because we have applied the special compartments design in our project. The special compartments design is about the fridge having specified locations for the food items stored in the fridge which is a set of rules in the fridge) that is why the fridge has limitations in the food amount that could be put into the fridge and special places, we are not using advanced image processing techniques which is high in cost, we are adding our system into a ready fridge.

3.1.3 Design Constraints: Environmental

One of the main problems facing the world today is food wastage. As much as 40% of food gets thrown away due to expiration in the U.S alone and 165 billion dollars goes down the drain due to food wastage that is why we are seeking to take care of the environment by reducing food wastage. [7]For the first subsystem “Food detection & quantity count” we have the constraint of preserving the fruits and vegetables in the fridge that is why we are keeping count of the food items stored in in the fridge The environmental constraint being used in second subsystem “Expiry date” is that we are storing fruits and vegetables in order to avoid food wastage and alerting the user to consume the food item and an item has expired or is about to expire.
The environmental constraint being used in the third subsystem “phone application & general info” is that we are notifying the client about the general information of the items in the fridge instead of good food going bad and getting tossed out that would be environmentally unhealthy.

3.2 Design Methodology

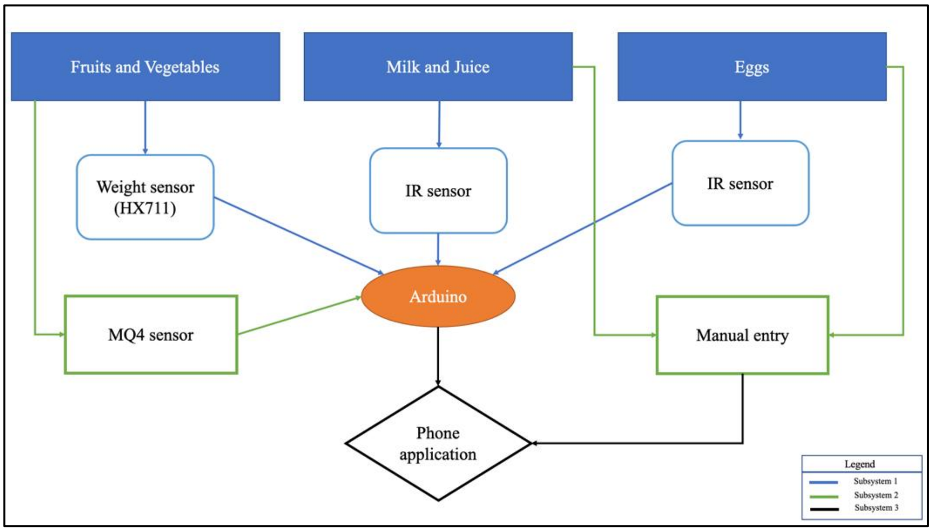


Figure 3.1: Project Architecture.

The methods that will be used to implement our design is that we will be using sensors, a microcontroller, and a phone application. Each sensor output will be feed into the Arduino microcontroller which will then communicate the information into the phone application (subsystem 3) in order to be user friendly and to interface the information of the sensors and what is being processed in the Arduino for decision making to the phone application. We will be both programming the Arduino and the phone application so that our fridge becomes smart and can receive information inputted by the user and be able to make decisions based on what is being put inside the fridge.

As for the design of how we are going to plan our project in terms of the timeline we will be splitting our project into two phases the first phase during this semester, the second phase will be during the assessment three course which is the continuation of the project. The third phase which will be in the summer we will do more work related to our project, and further improve our project, do more research, testing related to the project.

Phase 1

- Research, and get more information related to current refrigerators, and learn what needs to be redesigned and updated and see the literature.
- Read more about modern day smart refrigerators being produced and sold and get ideas about the technologies that they are using in their refrigerator and read more about smart refrigerators in the literature.
- Know the specifications that we will be using for the smart fridge system.
- Plan for the project by identifying the needed resources at PMU and the local market.
- Prepare project management plan with list tasks, time limit and team member responsible.
- Identify project subsystems and the alternatives ways to implement each one.
- Design subsystem I (tracking, detecting, notifying food items): The first subsystem is going to be implemented by the use of sensors in each compartment of the fridge for each designated food item group, the use of image processing might be considered for this subsystem. The Arduino microcontroller will be used for this subsystem to write the codes and to interface.
- Design subsystem II (recipe generation based on the contents of the food items): this subsystem is mainly software based it has to do with linking many of the recipes or a recipe database from the internet or a specified recipe database and linking it with the phone application.
- Integrate and test subsystems I and II and make necessary calibration and improvements.

Phase 2

- Design other system subsystems (comm. and control) and implement using appropriate components.
- Test and analyze each subsystem and make necessary improvements.
- Integrate all subsystems and perform final testing.
- Write the final report and presentation.
- Have a final working prototype.

3.3 Product Subsystems and Components

3.3.1 Product Subsystem 1: Food item Recognition and Quantity Count

The sensors that we are using for the first subsystem are the: IR sensors, weight sensors. We have chosen the weight sensors to identify the fruits and vegetable items. We are using two techniques in order to be accurate in detecting the correct number of fruits and vegetables. Other alternatives that we have considered are image processing for the fruits and vegetables however we have excluded this option because it is more complex, needs more time to accurately interpret the fruit/ vegetable the camera is processing also another reason for why we have disregarded the image processing is because that the image processing technique (if using programming was going to be done though MATLAB and raspberry pi) we would need

still images however our fridge is dynamic and new fruits and vegetables are being put into the fridge on a weekly bases almost.
For the milk & juice we have decided to use an IR sensor because it is low in cost and the most efficient technique to be used to detect the availability of the milk & juice. The IR sensor can also be used to identify if the juice or milk is finished or not [7] however the client needs to place the milk in a special container as seen in figures (3.2-3.3) [7].

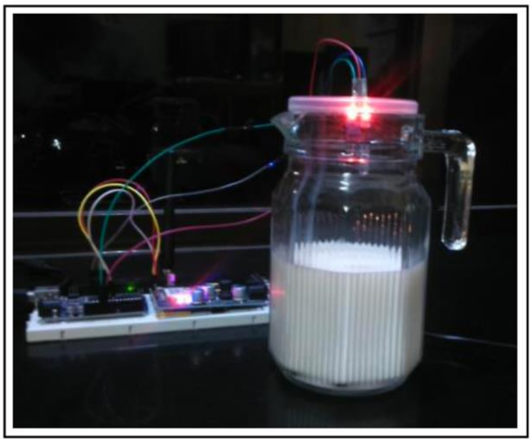


Figure 3.2: Milk container (full).

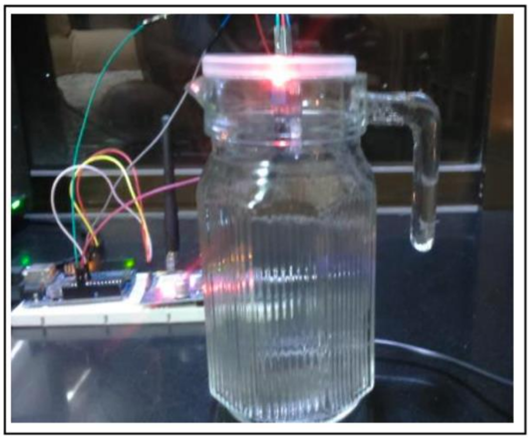


Figure 3.3: Milk container (empty).

As seen in the figures above this technique can recognize the amount of milk left in a jug, however it cannot describe the number of liters left in the milk, if an ultrasonic sensor was used instead of the IR, it would be more efficient.
For our project we will be using the IR sensor to indicate if a milk or juice is finished by the availability of the juice/milk containers not the amount of the liquid that is left as seen in figure 3.4 below.

Figure 3.4: IR sensor design for project.

3.3.2 Product Subsystem 2: Expiration date

The second subsystem for the expiration date we are using the MQ2 gas sensor to be able to detect the rotten fruits/vegetables in the fridge the reason for why we have chosen this sensor is because that it is known that rotten fruits and vegetables excrete methane gas when gone rotten. For the milk, juice and eggs we are using manual entry inputted by the user this technique is update to date from the user and is cost free, the other alternatives that have been considered is using the barcode scanner, and RFID tag reader we have dropped this alternative because of the cost of the both the barcode scanner and RFID tag reader, and because of the heavy data that the second technique requires.

3.3.3 Product Subsystem 3: Application

For this subsystem we chose a temperature and humidity sensor (DHT11) instead of 2 separate sensors to lower the costs and go with more of a simplistic approach. We also choose to go with an app instead of a touch screen to make it more cost friendly and reduces the cost as touch screens are relatively more expensive than a phone application.

3.4 Implementation

We have set our subsystems according to their functionalities, the first subsystem “Food detection & quantity count” detects the available food items of specified fruits and vegetables: tomatoes, cucumber, lemon, kiwi. In addition to approximately a set of dozen eggs, and 2 allocated compartments for the juice and milk food items, we have been able to implement this functionality by using weight sensors and a pixy camera (color recognition) for the fruit and vegetable food items, IR sensors for the egg, and liquids items. The weight sensors measures the amount of grams in total for the special compartment of the tomatoes, and average tomato weighs about 120-140 grams so if the scale in the tomatoes section weighs 600 grams it will calculate an average amount of 5 tomatoes (since 1 tomato is almost 120 grams) in order to decrease less accurate readings we will also be displaying to the user the amount of grams of the tomatoes if the average calculated amount is not precise, the purpose of the pixy cam is to also recognize the color of the fruits in the fridge and tell the user the fruits/ vegetables stored in the fridge. In order to execute the weight sensors method a code will need to be written for each of the fruits and vegetables that the fridge will be custom made for the client. The second “Expiry date” subsystem detects the expiration date of the fruits and vegetable food items by using a MQ2 gas sensor the working principle of this subsystem is that we will test and write out the range of values that the methane gas sensor it is detecting for two cases a well fruit and a rotten fruit. Each value will then be written in the Arduino code by using an IF condition statement if the condition statement meets the requirement, it will display the message of “normal fruit” if the fruit/ vegetable was rotten it will display the message of “rotten or soon to be rotten” message. For the egg, liquid food items the user will have to manually enter the date the food item was put into the fridge. The third subsystem “Application& general info” it will display general information of the fridge such as food items, soon to be expired food items, information related to the fridge such as the temperature, humidity of the fridge.

We have considered multiple alternatives such as an ultrasonic sensor to detect the number of eggs however we have dropped this option because of inaccuracy reasons meaning that if an ultrasonic sensor was used to detect the number of eggs left and one egg was put right in front of the ultrasonic sensor it would not be able to detect the eggs past the egg in front of it (blocking the distances in the back), therefore it will detect wrong. Other alternatives we have considered is the LM35 temperature sensor we have decided to go with the DHT11 temperature and humidity sensor for the purposes being that the DHT11 has a dual functionality (2 in 1) instead of two sensors one for the temperature and one for the humidity. We have selected these components to meet the specifications because the sensors that we are using and the microcontroller that we are using is all in the benefit to meet the specifications listed below:

I. To notify the client about missing food items, or soon to finish food items.

II. To notify the client about expired food items.

III. To be able to view all information related to the refrigerator via the client's phone application.

All the sensors and microcontroller work together as being programmed with multiple functions as it was explained above.

We have implemented our designs so far and have been able to test out the pixy camera, weight sensors, temperature and humidity sensor, gas sensor for now (during the beginning stages of the project). We have verified the system performance it by viewing the serial monitor readings and comparing it with the expected results in which we will transfer this information into the application by using the ESP8266 Arduino which has a Wifi module that can be connected to the internet or by using a GSM Wifi shield in order to connect our system to the internet, eventually we used the ESP8266 WIFI module .

4. System Testing and Analysis

4.1 Subsystem 1: Food item Recognition and Quantity Count

For the first subsystem the sensors that are used are the IR sensors, and the HX711 weight sensor. For each of the sensors we have used different methods to test out the working sensor in terms of the criteria of meeting the purpose that the sensor is designed and programmed to do. The two weight sensors will be used in the detection of and count (in grams and the approx. amount) of the selected fruits (tomatoes, bananas). IR sensors will be used for the detection of and count of the milk, juice, and eggs. The different tests that were used for the first subsystem was through trial and error for the calibration factor (CF) of the weight sensor, and trial and error was also used for the IR sensors.

Objectives:

Overall:

•Weigh Tomato amount via weight sensor.
•Weigh Banana amount via weight sensor.
•Detect Milk, Juice, Eggs using IR sensor.
•Count up to 5 eggs via IR sensor.

Specific:

•To be able to program the code of the egg detection& count
•To be able to set up the correct calibration value for each of the weight sensors
•To be able to have an approximate amount section reading for the detection and count of the fruits

Setup:
Starting with the IR testing, then with the weight sensor testing for each of the sensors we did the testing in different locations as seen in table 2.

Table 2: Sensor tests and Location of Tests for Subsystem 1.

Sensor	Location of Test
Weight Sensor (HX711)	PMU Lab
IR Sensor	Maha's Home

For the first subsystem we used the weight sensor (HX711) to weigh tomatoes, and IR sensor for milk, juice, and egg detection as well as for counting the eggs. The first subsystem should be able to count to 5 eggs via the IR sensor.

The test that was used for the IR sensor was adjusting the calibration to be able to have the right sensitivity in terms of detecting the eggs, juice milk in the placement of the food items inside the fridge. For the IR sensors the tools that were used are a ruler, screwdriver to adjust the calibration screw in the back of the sensor, a piece of paper to be detected by the IR, and a 3D printed cover to maintain the same environment conditions when placed inside the fridge because we will place the IR sensors in the fridge with the 3D printed cover as seen in figure 4.1, and gas sensor in figure 4.2 below.

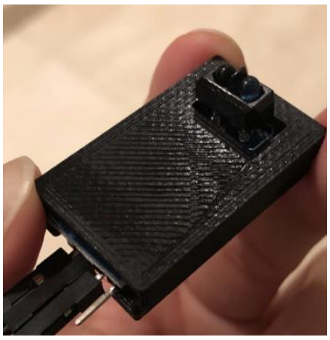


Figure 4.1: 3D printed cover IR sensor.

Figure 4.2: 3D printed cover gas sensor.

The instruments and tools that were used for each sensor are seen in table 3 below:

Table 3: Sensors, instruments& tools.

Sensor	Instruments and tools	Method
IR	Ruler, paper, screwdriver, serial monitor readings.	Measurement, calibration adjustment
Weight sensor (HX711)	The serial monitor readings, weight (we used post-it notes as our weight 91.2 grams), an electronic scale.	Trial& Error

The setup of the IR sensor test is seen in figures 4.3- 4.6 below:

Figure 4.3: detection at 1cm.

Figure 4.4: Detection at 3cm.

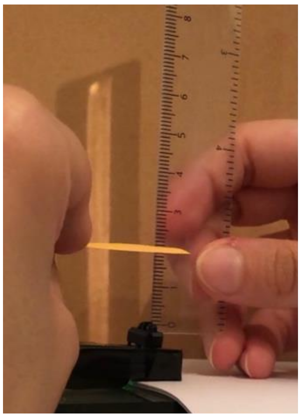


Figure 4.5: Detection at 2cm.

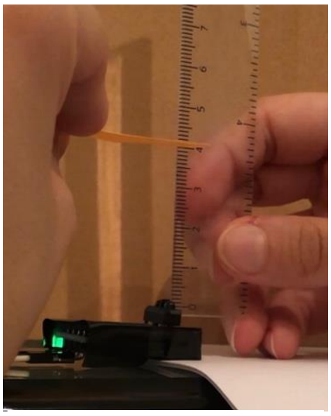


Figure 4.6: Detection at 4cm.

As for the setup of the weight sensor (HX711) is seen in figures 4.7-4.8 below:

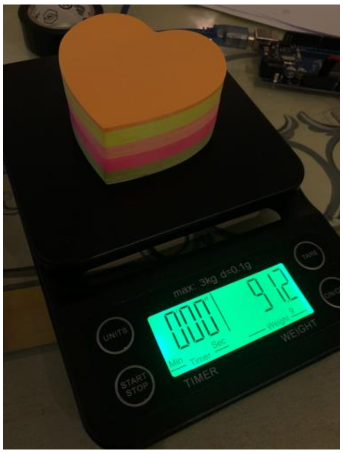


Figure 4.8: Control weight.

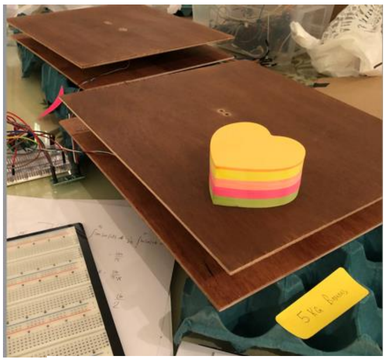


Figure 4.7: testing control at the weight sensors one at a time.

Results:
The results that we have obtain for the IR sensors testing was the detection range in terms of distance after placing the paper which is our selected object in front of it. The results are summarized in table 3 below.

Table 4: Distance and Detection Table for IR Sensor.

Distance [cm]	Detection
1 cm	YES
2 cm	YES
3 cm	NO
4 cm	NO

With the serial monitor readings as seen in figures 4.9& 4.10 below.

Figure 4.9: within the detection range.

Figure 4.10: within the undetected range.

For the weight sensor Maha had to do it two times the first time was with the 1kg weight sensor, the second time was with the 5kg weight sensor. I started with the 1kg weight sensor then continued with the 5kg weight sensor in the same day. Ironically the 5kg weight sensor is considered to have a better calibration value (more accurate with more fluctuating numbers "jumpy numbers") than the 1kg which will be discussed in detail in the overall results, discussions analysis section.

Table 5: Overall results testing for 1kg weight sensor.

Calibration factor	Control (Weight in electronic scale) [grams]	Experimental (Our weight sensor) [grams]	issue	Action Item
-100000	91.2	-	Initial starting value	Setup
-787380.06	91.2	91.67 – 91.68	Weight is higher by almost 0.5 grams	Figuring out how it works, decreased calibration factor value
-787400.06	91.2	91.75-91.77	Weight is higher by almost 0.6 grams	Decreased calibration factor value
-789100.06	91.2	91.63-91.61	Weight is still higher	Need to decrease calibration factor value
-792100.06	91.2	91.27-91.28	Weight is close enough	Close enough (if wanted to improve accuracy decrease calibration factor value)

The test that we made is firstly by starting with the code using the calibration factor of -787380.06 that we have selected. then we changed the number to a smaller calibration factor value which is -787400.06 to see what will happen then we still haven't fully understood the relationship between the calibration factor and the weight, so we changed the calibration factor again to -789100.06 we realized that the weight became larger, so we understood that we need to make the calibration factor larger in value (absolute value) then add the minus sign, thus resulting in the selected calibration factor of -792100.06.

Therefore, the relationship between the calibration factor and the weight is an inversely proportional relationship for weight sensor that we have installed with the base (our conditions).

After finishing with the 1kg weight sensor, we started working on the 5kg weight sensor, however because of the difficulty in dealing with the inversely proportional relation when adjusting the calibration factor values. Maha has decided to change the calibration factor into a positive value, and it worked out fine and better and was easier to deal with finding a more correct, accurate calibration factor however the numbers are more jumpy in the 5kg weight sensor however still more accurate in terms of being close to the weight value of the electronic scale. The results are summarized in table 6 below.

Table 6: Overall results testing for 5kg weight sensor.

Calibration factor	Control (Weight in electronic scale) [grams]	Experimental (Our weight sensor) [grams]	issue
-100000	91.2	-	Initial starting value
170800	91.2	93.56/93.24/93.89	Weight was lower than actual value
172322	91.2	91.04/91.12/90.90	Weight was correct

More details will be explained in the overall results, discussions analysis section.

4.2 Subsystem 2: Expiration date

For the second subsystem the original plan was to use MQ4 gas sensor to distinguish between good and bad bananas, but the sensor did not give us any reliable readings, so we switched to the mq2 sensor. The tests that were being used to make the sensors work accordingly to its design purpose is through 1) Selecting different gas sensors that detect rotten fruit gasses, 2) changing the selected fruit to fruits that suit one of the sensors, 3) placing the fruit in a confined space to get more concentration of the gas.

Objectives:

Overall:

•Distinguish Edible vs. Non-edible Tomatoes via MQ4 sensor for expiry date information.
•Manual entry of expiration date for (Eggs, Juice, Milk).

Specific:

•To have good readings of the good fruit& rotten fruit (no fluctuating numbers for each)
•To detect an accurate range of the good fruit (edible)
•To detect an accurate range of the rotten fruit (non-edible)
•To be able to fulfil the ranges in the codes and get accurate results

Setup:

Table 7: Instruments and Location of Tests for Subsystem 2.

Instrument	Location of Test
MQ4 Gas Sensor	Maha's Home
MQ2 Gas Sensor	Maha's Home

Subsystem 2 is able to tell between edible and non-edible food using an MQ2 gas sensor. After extensive research, we realized that we needed to preheat the gas sensor to get accurate readings. So, we preheated for 36 hours and sure enough, we finally started getting consistent readings as seen below.

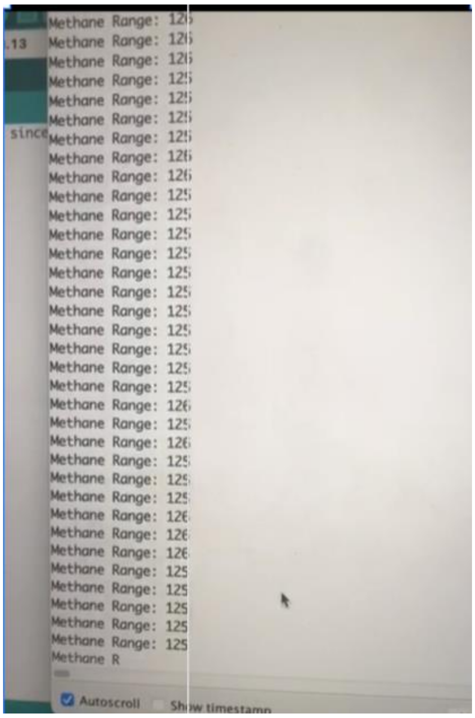


Figure 4.11: methane range detection.

4.3 Subsystem 3: Application

Objectives:

Overall:

•Display related information of the fridge such as temperature, humidity via Application.

Specific:

•To be able to have the application connected to the internet (WiFi)

Setup: Blynk app

Subsystem 3 is the phone application connected to fridge via WiFi module. It displays information in relation to fridge such as temperature, humidity, etc. We have also included an extra feature which is the expiration date manual entry feature for the milk, juice, and eggs. We decided to use the BLYNK to make our app and it has a built-in server and that will make building the app much easier. We started with downloading the Blynk app libraries into the Arduino IDE and added it to every existing code from the previous subsystems. The table below will showcase each widget we chose and its purpose in the app. As seen in table 8 below.

Table 8: Widgets used in Blynk APP& data type.

Data type	Widget
Milk	LCD Screen
Juice	LCD Screen
Eggs	Terminal
Tomatoes	Terminal
Bananas	Terminal
Humidity/Temp	Gauge
Edible Vs Non-Edible bananas	LCD Screen

The results of subsystem 3 testing are seen in figure 4.12.

Figure 4.12: Blynk app data using the LCD widget.

After thorough research, we learned that the LCD widget can only display either just letters or just numbers, not both at the same time. So, for the eggs, tomatoes and bananas we decided to go for the terminal widget which prints different characters, and the results can be seen in the figure below.

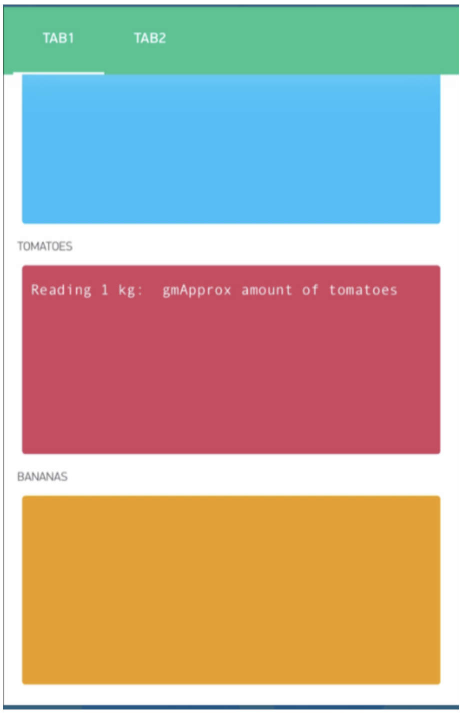


Figure 4.13: Blynk app after we added the terminal widget.

We then faced another complication, which was that once we ran the code and started the app, the text would only be displayed for a very short amount of time (less than a second) and after trying different methods we found that removing the terminal.clear line in the loop resolved the issue and the results can be seen below.

Figure 4.14: Blynk App after resolving the issue.

4.4 Overall Results, Analysis and Discussion

The overall results can be summarized in figures 4.16 for the IR sensors, and figures 4.17-4.18 for the weight sensors below.

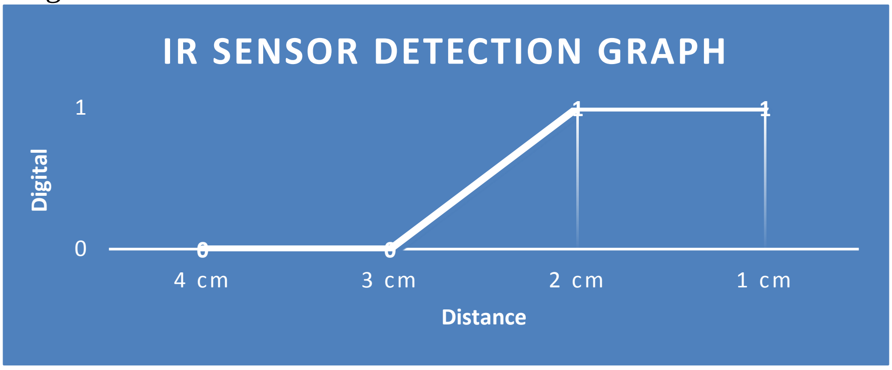


Figure 4.15: IR sensor graph.

Figure 4.16 results refer to the IR sensor detection graph in terms of distance and the range of detection as it shown for the 4-3cm distance the IR sensor does not detect the presence of the object within this range. However, between the 3-2cm distance ranges there is a slight possibility of detection to increase accuracy we could test the presence of the objects in the 2.5cm, 2.75cm and test it in terms of the tenth's decimal places.

The two second graphs (figures 4.17-4.18) were done accordingly to trials of testing where 1,2,3,4 refers to the number of times the calibration value was adjusted which can be summarized in table 7.

Table 9: selected calibration value for each trial test (1kg weight sensor).

Number of trials	Calibration value selected
1	-787380.06
2	-787400.06
3	-789100.06
4	-792100.06

Thus, resulting in following graph (figure 4.17).

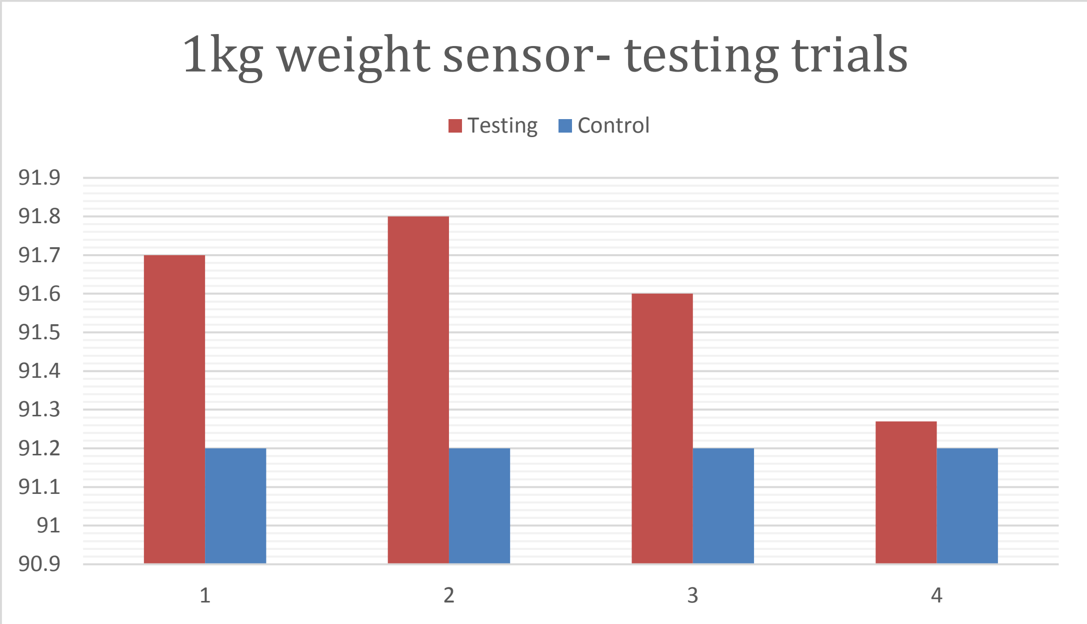


Figure 4.16: 1kg weight sensor test vs. control column graph.

For the 5kg weight sensor the selected calibration values for each trial is summarized in table 8 below.

Table 10: selected calibration value for each trial test (5kg weight sensor).

Number of trials	Calibration value selected
1	170800
2	172322

Thus, resulting in the following graph (figure 4.18).

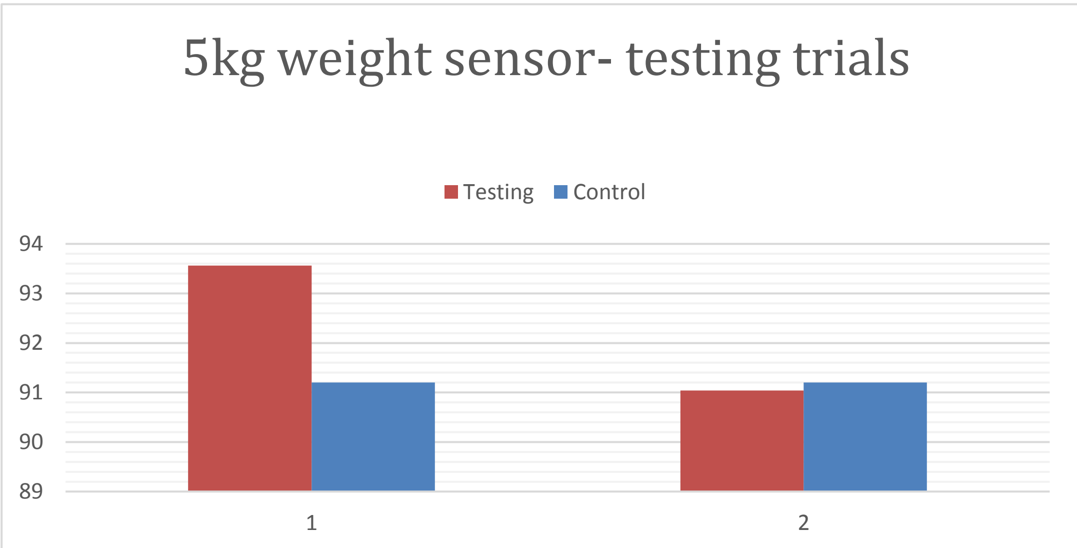


Figure 4.17: 5 kg weight sensor test vs. control column graph.

Analysis:
As shown in the figure above (4.16). The IR sensor has been adjusted to only work within a close range to prevent confusion in the detection process. We did this to make it as accurate as possible. The IR sensor provided incredible accuracy for the eggs, milk, and juice detection. For the weight sensor, we had to adjust the calibration factor multiple times for both the 1kg sensor and the 5kg sensor. For both sensors, we started at (-100000) and noticed that it failed in delivering the right number, so we adjusted for (-789100.06) on the 1kg sensor and noticed that the weight is still higher thus needed to decrease the calibration factor value to (-792100.06) and got better more accurate results. We used the same method of trial and error for the 5kg sensor but changed the calibration factor into a positive value and found that (172322) was the correct calibration to get the most accurate numbers. However, we still do not know why the 5kg weight sensor has more jumpy numbers. Is it because of the calibration factor adjustment into a positive number? We are still not sure. however, what we are sure of is that as of now the 5kg weight sensor is more accurate in detecting the weight (relative to true weight) with more fluctuating values withing the correct weight. As for the 1kg weight sensor it does not have the issue of the slightly fluctuating numbers, but it is not as accurate as the 5kg weight sensor. To improve both weight sensors for the 1kg we recommend decreasing the calibration factor value “make it smaller” to get a lower weight (close to real weight). For the 5kg it is pretty close enough however if wanted to make it more accurate it is recommended to decrease calibration factor selected because that one that we have selected can make it under its actual weight, as for the jumpy numbers issue as seen in figures (4.23-4.24) the problem may have stemmed from the tightness of the screw or something related to the installment of the weight sensor in respect to the bases, or because we have changed the calibration factor values into a positive calibration factor value. We made the calibration factor value positive because after dealing with the negative numbers in the 1kg weight sensor it made more sense to use positive values and is more intuitive. The serial monitor reading range is seen in figures (4.19-4.22) for the 1kg.

```
Reading 1 kg: 91.66 gm
Reading 5 kg: 0.86 gm
Reading 1 kg: 91.69 gm
Reading 5 kg: 0.93 gm
Reading 1 kg: 91.68 gm
Reading 5 kg: 1.04 gm
Reading 1 kg: 91.67 gm
Reading 5 kg: 0.27 gm
Reading 1 kg: 91.67 gm
Reading 5 kg: 0.35 gm
Reading 1 kg: 91.65 gm
Reading 5 kg: 0.69 gm
Reading 1 kg: 91.68 gm
Reading 5 kg: 0.27 gm
Reading 1 kg: 91.68 gm
Reading 5 kg: 0.08 gm
Reading 1 kg: 91.67 gm
Reading 5 kg: 0.13 gm
Reading 1 kg: 91.68 gm
```

Figure 4.18: sample readings of the(-787380.06) CF.

```
Reading 5 kg: 0.18 gm
Reading 1 kg: 91.77 gm
Reading 5 kg: 0.32 gm
Reading 1 kg: 91.77 gm
Reading 5 kg: 0.30 gm
Reading 1 kg: 91.75 gm
Reading 5 kg: 0.44 gm
Reading 1 kg: 91.76 gm
Reading 5 kg: -0.02 gm
Reading 1 kg: 91.75 gm
Reading 5 kg: 0.61 gm
Reading 1 kg: 91.76 gm
Reading 5 kg: 0.39 gm
Reading 1 kg: 91.77 gm
Reading 5 kg: 0.41 gm
Reading 1 kg: 91.78 gm
Reading 5 kg: 0.31 gm
Reading 1 kg: 91.77 gm
Reading 5 kg: 0.34 gm
Reading 1 kg: 91.76 gm
Reading 5 kg: 0.37 gm
Reading 1 kg: 91.75 gm
Reading 5 kg: -0.16 gm
```

Figure 4.19: sample readings of the (-787400.06) CF.

```
Reading 1 kg: 91.61 gm
Reading 5 kg: 0.88 gm
Reading 1 kg: 91.62 gm
Reading 5 kg: 0.44 gm
Reading 1 kg: 91.65 gm
Reading 5 kg: 0.39 gm
Reading 1 kg: 91.63 gm
Reading 5 kg: 0.50 gm
Reading 1 kg: 91.64 gm
Reading 5 kg: 0.18 gm
Reading 1 kg: 91.63 gm
Reading 5 kg: 0.02 gm
Reading 1 kg: 91.62 gm
Reading 5 kg: -0.01 gm
Reading 1 kg: 91.60 gm
Reading 5 kg: -0.05 gm
Reading 1 kg: 91.61 gm
Reading 5 kg: -0.12 gm
Reading 1 kg: 91.62 gm
Reading 5 kg: 0.27 gm
Reading 1 kg: 91.60 gm
Reading 5 kg: 0.29 gm
```

Figure 4.21: sample readings of the (-789100.06) CF.

```
Reading 5 kg: 0.39 gm
Reading 1 kg: 91.24 gm
Reading 5 kg: 0.60 gm
Reading 1 kg: 91.31 gm
Reading 5 kg: -0.05 gm
Reading 1 kg: 91.29 gm
Reading 5 kg: -0.02 gm
Reading 1 kg: 91.25 gm
Reading 5 kg: 0.40 gm
Reading 1 kg: 91.28 gm
Reading 5 kg: 0.57 gm
Reading 1 kg: 91.27 gm
Reading 5 kg: -0.05 gm
Reading 1 kg: 91.27 gm
Reading 5 kg: -0.32 gm
Reading 1 kg: 91.28 gm
Reading 5 kg: 0.15 gm
Reading 1 kg: 91.27 gm
Reading 5 kg: 0.12 gm
```

Figure 4.20: sample readings of the (-792100.06) CF.

For figures (4.23-4.24) are the serial monitor readings for the 5kg weight sensor.

```
Reading 5 kg: 93.56 gm
Reading 1 kg: 0.06 gm
Reading 5 kg: 93.10 gm
Reading 1 kg: 0.03 gm
Reading 5 kg: 93.24 gm
Reading 1 kg: -0.01 gm
Reading 5 kg: 93.10 gm
Reading 1 kg: 0.01 gm
Reading 5 kg: 92.92 gm
Reading 1 kg: -0.01 gm
Reading 5 kg: 92.88 gm
Reading 1 kg: 0.00 gm
Reading 5 kg: 92.89 gm
Reading 1 kg: 0.01 gm
Reading 5 kg: 92.68 gm
Reading 1 kg: 0.05 gm
Reading 5 kg: 92.74 gm
```

Figure 4.22: sample readings of the (170800) CF.

```
Reading 1 kg: 0.11 gm
Reading 5 kg: 90.84 gm
Reading 1 kg: 0.12 gm
Reading 5 kg: 90.96 gm
Reading 1 kg: 0.09 gm
Reading 5 kg: 91.23 gm
Reading 1 kg: 0.08 gm
Reading 5 kg: 90.97 gm
Reading 1 kg: 0.12 gm
Reading 5 kg: 91.09 gm
Reading 1 kg: 0.11 gm
Reading 5 kg: 90.90 gm
Reading 1 kg: 0.14 gm
Reading 5 kg: 91.12 gm
Reading 1 kg: 0.08 gm
Reading 5 kg: 91.04 gm
Reading 1 kg: 0.12 gm
Reading 5 kg: 90.90 gm
Reading 1 kg: 0.14 gm
Reading 5 kg: 90.98 gm
Reading 1 kg: 0.12 gm
Reading 5 kg: 91.43 gm
Reading 1 kg: 0.14 gm
Reading 5 kg: 90.89 gm
```

Figure 4.23: sample readings of the (172322) CF.

On the other hand, the mq4 gas sensor showed us incorrect results and the numbers kept jumping around with no real results to be mentioned. In contrast, the preheated MQ2 gas sensor showed reliable numbers and we made the obvious decision to stick with it for subsystem 2.

For the third and final subsystem, we used the Blynk application and expanded it's widgets to work for our project the way we want. We chose Blynk mainly for the fact that we don't have to build our own server as Blynk already has a server ready to use. The app user interface can be seen below

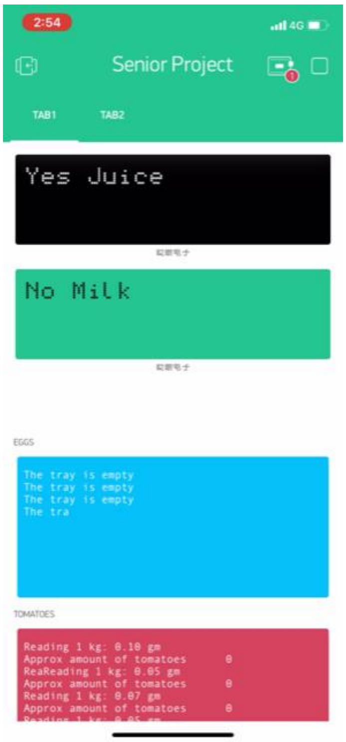


Figure 4.25 app tab 1

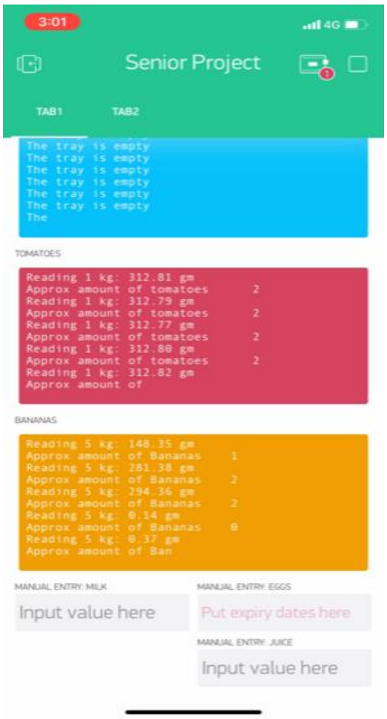


Figure 4.26: app tab 1 part 2

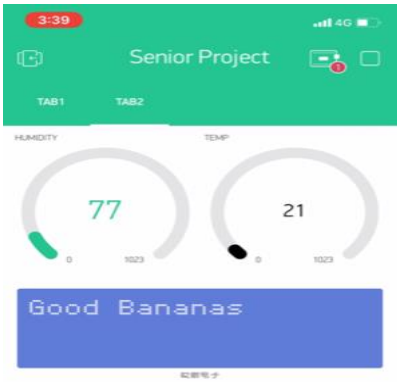


Figure 4.27: app tab 2

This project, our project 'Smart Fridge System' is very heavily based on long lines of coding and many wirings, Sensors. The number of wires that have been used is almost 43 wires (2.5 meters long) and additional male extension wires, and female extension wires that we have cut and used according to the pins of the sensors which also account to 43 wires because we have used them as an input to the breadboard and Arduino Mega board.

Table 11: Pins and Sensors used description.

Pins	Pins used	Pin Names	Sensor Type	Used for	Purpose
3	3	Signal, VCC, GND	IR	Milk& Juice	Detection& Count
4	3	Analog, VCC, GND	IR	Eggs	Detection& Count
3	3	Signal, VCC, GND	DHT11 (Tempreture& Humidity)	Air	Tempreture& Humidity
10	8	E+,E-,A+,A-,GND, DT, SCK, VCC	HX711 (1 kg weight sensor)	Tomatoes	Detection& Count
10	8	E+,E-,A+,A-,GND, DT, SCK, VCC	HX711 (5 kg weight sensor)	Bananas	Detection& Count
4	3	Analog, VCC, GND	MQ2 (Gas)	Bananas	Expiration date

The soldering that has been done for all of our project, taking into consideration the pins that were used and the number of wires going from the sensor pins to the breadboard then from the breadboard to the Arduino Mega. The amount of soldering that has been done for all 11 sensors, as seen in table 11. Accounts to 107 times that we have soldered, for each of the pins and sensor quantity that has been used it, we have also account for 1 extra amount of MQ2, and DHT11 just in case if anything happens during the demonstration day

7 IRs*3 Pins = 21

2 HX711* 4 Pins = 8
2 DHT11* 3 Pins = 6
2MQ2* 4 Pins = 8

Which totals up to 43 soldered wiring that we have done only from the sensor itself to the long wire without the extension of the male Arduino wire that will be used for the breadboard however when we account for soldering that has been from the long wire to the Arduino male wire extension it adds up to 86 solders that this project took. Plus, the testing that we have done for IRs used for the egg and milk& juice. For the IRs (eggs) we have made a mistake of not testing the IR sensors (eggs) after using the super glue to seal the 3D printed covers on to make sure the IRs are not damaged, we didn't test them using the serial monitor we have only saw the LED of the IR itself, but it wasn't enough because the LED could be damaged even if the LED of the IR lights up. So, we had to do extra soldering of 15 wire extensions (male Arduino wires connected to the breadboard) for testing. Also during the same period we were also working on the app so we had to solder 6 male Arduino wires to the IRs (milk& juice) this was needed because we didn't fit the and measured the final length that will be needed for the wires when we finally glue the IRs in the fridge and tape them on the sides and know where the final wiring will be that is why the additional testing wires were needed. Therefore, the total amount of wiring that was done for the testing and final placement of the sensors and breadboard is 43 + 43 + 15 + 6 = 107 times that we have soldered from the pins of our sensors to the long wire into the male Arduino extension wire into the breadboard/ Arduino Mega.

The total amount of sensors that has been used is seen in table 11.

Table 12: Total Sensors used.

	Quanitity	Sensor	Notes
	7	IR	Both 4-pinned, 3-pinned IR's are included
	2	HX711	Both 1 Kg, 5 Kg are included
	1	DHT11	-
	1	MQ2	-
Total	11		

5. Project Management

5.1 Project Plan

Table 13: project plan table.

List of Tasks	Time Duration (by week)	Team member responsibility M= Maha Y=Yasmin
Implement Weight Sensor: Fruit Detection& Count	1	M
Implement IR Sensor: Milk and Juice Detection & Count	1	M
Implement IR Sensor: Egg Detection& Count	1	M
Run Code for Weight Sensor	2	M
Run Code for IR Sensors	3	M
Implement MQ4 Gas Sensor: Fruits	3	Y
Run Code For MQ4 Gas Sensor	4	ALL
Prepare Manual Entry Feature of Rest Of (Juice, Milk, Eggs)	5	Y
Prepare Midterm Presentation	3	ALL
Prepare Refrigerator Hardware	2	Y
Test Subsystem 1+2 in the Fridge	4	ALL
Testing Subsystem 3: Application	2	Y
Running The Codes	1	ALL
Prepare Final Report	2	Y
Prepare Final Presentation	2	ALL
Prepare Project Demo	3	ALL
Submit Rpt/PPT/Brochure/Video…etc.	2	ALL

5.2 Contribution of Team Members

Table 14: Contribution of Team Members.

Task	Maha	Yasmin	Task Total
Subsystem 1	80%	20%	100%
Subsystem 2	60%	40%	100%
Subsystem 3	20%	80%	100%
Presentation+ Poster	70%	30%	100%
Final Report	30%	70%	100%

5.3 Project Execution Monitoring

To execute this project in the best manner possible, we made sure to meet with our advisors at least once a week in person. We also try to hold meetings through Zoom to make things easier since one our advisors was out of the country during the beginning of the semester. Additionally, we hold team meetings once a week to go over the tasks that need to be done during the week. Our team tries to work on things separately and in parallel to try to accomplish as many tasks as possible and get everyone to work in their area of expertise. Furthermore, testing was usually done at Maha's house to reduce travel time and get more things done without the need to go to university however once we started testing the hardware inside the fridge, we moved to the lab to test in a safer environment.

5.4 Risk Assessment and Management

For our project we have decided on five potential risks that could cause serious harm to the success of our plans. The first being “whole system failure” which in turn could cause our entire project to be considered unsuccessful. The second and third being “Fruit identification failure” and “Application connection failure”, which in both of these scenarios would cause subsystem 1 and 3 to fall short and fail. The fourth being “Components delay” which is self-explanatory but when you are building a senior project you want to be on schedule and this issue leads to testing being halted. The fifth and final scenario being “water damage” may come from the fact that we are working with circuits inside of a refrigerator and that is a huge risk to could lead to a short circuit and has the potential cause harm to individuals.

Table 15: Risk assessment.

#	Risk Assessment	Impact
1	Whole system failure	Unsuccessful project
2	Fruit identification failure	Incompetent subsystem 1
3	Application connection failure	Incompetent subsystem 3
4	Components delay	Implementation postponement
5	Water damage	Short circuit

The first serious issue we ran into while making this project is the weight sensor (HX711) delivering incorrect readings. We tried to change the code but nothing was working, we also tried another type of a weight sensor but that also did not work, finally we asked our lab technician to help us with this complication and he suggested we add a washer piece to our weight sensor and thankfully we were able to get more accurate readings. The other difficult problem we ran into is the MQ4 sensor not giving us any real results or readings to consider. The numbers keep jumping around from one extreme to the other. We adjusted the sensitivity of the sensor as well as tried to modify the code a bit and it still gives inaccurate results. We decided to try the MQ2 gas sensor instead and preheat it for 36 hours and finally it gave us consistent reliable readings.

Table 16: Risk management.

#	Risk Description	Risk Management	Impact
1	Weight sensor incorrect reading	Added washer piece	Accurate readings
2	MQ4 sensor numbers jumping around with no real readings	Switched to MQ2 and preheated it	Consistent numbers

5.4.1 COVID-19

We had several obstacles operating on campus as a result of the Covid-19 health issue. While most senior design projects are completed on campus, we had to work remotely and meet less frequently than usual. We had to become used to working from home and on our own on different portions. The crisis was also responsible for the delay of several of our components, therefor a lot of the testing was postponed. Moreover, we had to settle for meeting our advisors through zoom instead of meeting in person. On the plus side, these problems made our team more accountable for the project and gave us greater autonomy.

5.5 Challenges and Decision Making (ABET Outcome: 4b)

Due to the covid-19 health crisis, we were met with a lot challenges in regards to working on campus. While teams would normally work on campus for their senior design project, we had to work remotely and meet less than usual. We had to get used to working from home and working individually on separate parts. Another factor that causes challenges is the delay of components, just last week we had one our sensor shipments randomly canceled for no apparent reason, this caused a delay in sensor testing and hardware implementation. Moreover, a big issue facing our project was the calibration of the MQ4 gas sensor. We tried so many ways but the accuracy is still not where we needed it to be. So me made the decision to switch to the MQ2 gas sensor and preheat it for 36 hours and that finally gave us the results that we were looking for. On the bright side, these challenges made our team more responsible towards the project, it also caused us to have more autonomy towards the project.

5.6 Project Bill of Materials and Budget

Products	Quantity	price (SAR)
Fridge (Small)	1	1029
Arduino (Mega)	1	186
Gas sensor (MQ4)	1	13
IR sensor	9	153
Weight sensor(HX711)	2	45
BreadBoard	1	11
Jumper wires	1 pack	9
Blynk app	3 widgets	26.25
Brochure/Roll up/ stickers		309
	Total = 1784.25 SAR	

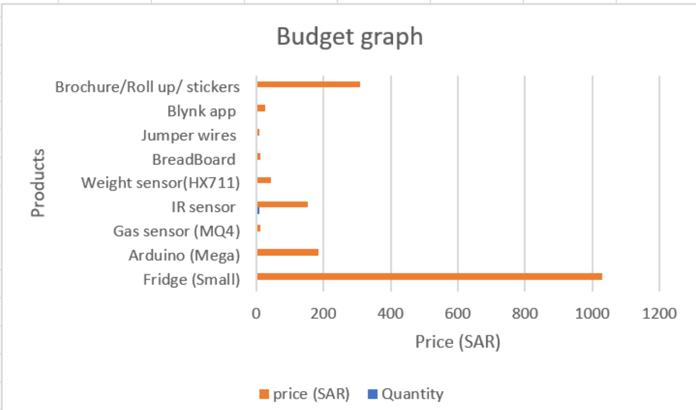


Figure 5.1: project bill and budget.

As can be seen in the figure above (5.1), this is the project budget as it stood at the end of project. The fridge will be taking up most of our budget with 1029 SAR with Arduino mega being the star of our project at 186 SAR. The total comes to 1784.25 SAR.

6. Project Analysis

6.1 Life-long Learning

We have acquired so many new skills that truly solidify our electrical engineering learning processes. First, we learned how to calibrate HX711 weight sensors, our team has never worked with this type of a sensor before, so it was a new experience for us. Second, we learned about app building; we use apps all the time in our everyday lives, so it was super exciting to finally see how the magic happens in the app making industry. Due to unforeseen circumstances, our senior design project team is much smaller than average, with only two students we had to learn to work with a smaller team and work with them for a whole year and learn how to be more organized and more detailed oriented. In the earlier stages of making the project we did a lot of literature review, that was a fun time for us because we got to see how engineers before us approached this idea and we took important notes from their papers for our project.

6.2 Impact of Engineering Solutions (ABET Outcome: 4b)

Food waste is one of the world's most pressing issues today. In the United States alone, 40 percent of food is thrown away due to expiry, resulting in a waste of 165 billion dollars. Therefore, we are working to protect the environment by minimizing food waste. We have the limitation of preserving fruits and vegetables in the fridge for the first subsystem "Food detection & quantity count," which is why we maintain track of the food items placed in the fridge. The environmental constraint employed in the second subsystem, "Expiration date," is that we are keeping fruits and vegetables to reduce food waste and to warn the user to eat the food item. As for the economic impact of our project, we plan on making it as low cost as possible. To keep our project as low-cost as feasible, we use a set of regulations in the fridge (specific compartments for each food item), which means the fridge has a restriction on the amount of food that can be stored. We are not employing complicated image processing techniques, which are expensive, and we are also integrating our technology into a ready-to-use refrigerator.

6.3 Contemporary Issues Addressed (ABET Outcome: 4b)

Saudi Arabia on its on wastes 33% of food each year with 40 billion SAR lost annually from waste. That is a real problem we hope our project can tackle. We feel our smart refrigeration system can be one of the most important Saudi made products that deals with a problem on this scale at such a low price. Our project aims to make the consumers aware of how much they actually eat and finish instead of just buying food for the sake of buying it with no real need and eventually throwing it out after it expires.

7. Conclusions and Future Recommendations

7.1 Conclusions

The goal of the project is to transform a traditional refrigerator into a smart refrigerator that is suitable with current life. The refrigerator's main design is that it can keep track of the food items stored in the fridge, notify the client about missing food items stored in the fridge without having to manually check the contents of the fridge, notify the client about food items about to expire, display the temperature and humidity of fridge in the phone application. Our team feels like we achieved our desired goals that we have set for ourselves in the planning stages of the project. We believe we produced results that satisfy our beginning objectives.

7.2 Future Recommendations

We suggest the following:

1- A fridge connected to supermarket.
2- Advanced image processing techniques.
3- Connected to local internet network.
4- A feature that preserves food for longer.
5- Make a new app without the use of Blynk but using a new server.
6- Generate recipes based on the available food in the fridge.
7- Waterproof the inside of the fridge so sensors don’t get damaged.
8- Create a shopping list for user for food items that are missing from fridge.

For the future recommendations we suggest decreasing number of sensors being used in the eggs compartment if the fridge will be used for a large number of people. This can be achieved by using one camera that can count the number of eggs that are placed inside the fridge and if sensors must be used the mounting of the sensors should be placed inside the shelve itself as in a built-in sensor and should not be standing out as this will help the shelve have more space and will be more efficient in terms of space, less damage on the sensors. Another recommendation that we recommend is addressing the moisture issue that can be faced inside a cold fridge environment such as a fridge, this could be solved by either having a cover on the sensors or having them placed within the fridge where no moisture could affect the sensor parts therefore not causing any damage. Some of the key observations that we have when using gas sensors, the preheating time must be for almost above 24 hours as this would help in getting accurate concentrations of gas (methane, ethylene) up 97% accuracy we have used MQ2. Other recommendations include having the gas sensor with the weight sensor together as in they are built together so that the fridge would be able to do 2 in 1 when getting the expiry date and be able to count. We also recommend having another technique of expiry date for the fridge instead of manual entry such as using RFID or a camera that is able to have a feature where it could register the date and type of food item and when it was inserted inside the fridge.

8. References

Works Cited

[1] V. Chaudhari, M. Kulkarni, S. Sakpal, A. Ubale and A. Sangale, "Eco-Friendly Refrigerator Using Peltier Device," in *2018 International Conference on Communication and Signal Processing (ICCSP),* Chennai, India, 2018.

[2] N. Linden, S. Popescu and P. Skrzypczyk, "How small can thermal machines be? The smallest possible refrigerator," *Physical Review Letters,* vol. 105, no. 13, p. 130401, 2010.

[3] A.-D. Floarea and V. Sgârciu , "Smart refrigerator: A next generation refrigerator connected to the IoT," Ploiesti, Romania, 2016.

[4] H.-H. Wu and Y.-T. Chuang, "Low-Cost Smart Refrigerator," in *IEEE International Conference on Edge Computing (EDGE)* , Honolulu, 2017.

[5] S. A.S, "Intelligent refrigerator using ARTIFICIAL INTELLIGENCE," in *11th International Conference on Intelligent Systems and Control (ISCO)*, India, 2017.

[6] S. Hossain and A. Abdelgawad , "Smart Refrigerator Based on Internet of Things (IoT): An Approach to Efficient Food Management," in *the 2nd International Conference on Smart Digital Environment*, 2018.

[7] A. Das, V. Dhuri and R. Pal, "Smart Refrigerator using Internet of Things and Android," *arXiv preprint,* 2020.

Appendix A: Progress Reports

Design Methodology & Project Management
Instructor: Dr. Samir El-Nakla

Spring 2021

<u>Progress report #1</u>

Smart Refrigerator System (with a supported phone app)

Team:

Maha Hammad #201701149
Yasmin Alnassar #201600065

Date submitted: March 3, 2021

Advisor: Dr. Saifullah Shafiq
Co-Advisor: Dr. Sadiq Alhuwaidi

I. Project Summary

The project is proceeding gradually as we are in the beginning, we have decided on our three subsystems so far which are: 1) fridge sensors integration, 2) RFID tags, 3) the phone application. So far in terms of the whole project for this semester 10% has been completed as we have found our idea, our three main subsystems. The number of tasks that are remaining is purchasing the components, testing the components on the sensors level, and assembling the first two subsystems, so far the problems that we have faced is finding the techniques that we will be using the refrigerator functionalities and finding the exact way of how to implement them, with more reading, testing, and troubleshooting these challenges will be overcome.

II. Project Status

a. **Details of Tasks Completed:**

The number of tasks that we have completed so far is doing the project proposal, researching about previous projects regarding smart refrigerator systems, doing the literature review, we have come up with our three subsystems which are: 1) subsystem_1: all the Sensors integrated, 2) subsystem_2: RFID tags, 3) subsystem_3: Phone Application. The purpose of each of the subsystems is as follows: The first subsystem is concerned with the detection of the missing food items whether the food item exists in the refrigerator or not combined with Arduino coding and programming a lot can be achieved, also another purpose of the first subsystem is to gain more information about the fridge such as adding a temperature sensor, or an oxygen sensor which can be viewed via (subsystem 3 the phone application). The purpose of the second subsystem is to keep a record of the food items when they were put inside the fridge and to give an estimated expiry date based on the date the fridge will register the food item. The purpose of the third subsystem is to have an interface between the information related to the fridge and the user. The other tasks that we have completed from the beginning of the semester are we had an online zoom meeting with Dr. Saifullah for being our advisor on January 31, 2021 and on Feb 3, 2021 we had an online zoom meeting with Dr. Sadiq for being our co-advisor. Also, the team members of this project had a meeting on zoom to discuss the three main subsystems that will be done for this project as the three main subsystems are explained above.

b. **Preliminary Results:**

The stage that we are in we have not completed any testing so far as we are in the beginning of the project.

c. **List of Tasks Remaining:**

The tasks that remain to be completed is to find other techniques for detecting fruits, and vegetables other than the technique that we have, so far that techniques that we will be using for subsystem 1: sensors integrated is seen in table 1.

Table 17: Sensors for subsystem 1.

Eggs	Weight sensors
Juice, milk bottles	IR sensors
Fruits and vegetables	Weight sensors

The tasks that are remaining is seeking to find other techniques for the fruits and vegetables detection and reading more about the RFID tags (subsystem_2) and learning about how to implement them.

d. **Budget status:**

The budget status is on hold at the moment, as we have not purchased the components however we have looked at the type of refrigerator we want to buy, we are considering to buy the (ClassPro Single Door Compact Refrigerator) its size is 1.6 Cu.ft which fits our project standards for a small fridge. Its price rage is almost 449 SAR. We have not made the purchase, yet we are looking at our different options and what works with our project.

III. Project Plan

I would rate our progress so far as according to schedule however I would like to learn more about the project and learn more about how to implement it, so in terms of work schedule we are on plan however in terms of learning how to implement the project I would still say we are on schedule but we have a lot to learn about and a lot to test, therefore more work must be done and more time must be spent in terms of learning how to execute the project.

We did some changes to our original plan in terms of the budget pricing and the type of components that we are going to buy.

The outlook for the remain tasks seem feasible, but more effort should be done in order to have a better and more clear vision of what is needed from us as a team to know how to make the project work, and work efficiently, reliably and importantly in a smart way.

IV. Contribution of Team Members

Team member contribution so far: The project proposal has been written by Maha and Yasmin, and the literature review has also been written by Maha and Yasmin. Yasmine choose and wrote about the following articles: Low cost Smart Refrigerator, Challenges Faced Smart Refrigerator Based on Internet of Things (IoT) An Approach to Efficient Food Management. Maha has wrote about the following articles: Intelligent refrigerator using ARTIFICIAL INTELLIGENCE, Carbon nanotube based gas sensor for expiration detection of perishable food, Smart refrigerator: A next generation refrigerator connected to the IoT. The Gnatt chart, project plan is being done by Yasmin, the first progress report is being done by Maha (the next one Yasmin will take it and vice versa). Each team member is doing the assigned tasks when being assigned to the task.

V. Challenges Faced

The challenges faced so far was with time management so far, we had to get used to arranging meeting with the team, with the advisors.

Also, other challenges that we have faced are coming up with ideas for the project but the more we do the projects more ideas will rise up.

VI. Conclusions

The overall status of the project is good, we are progressing at a normal pace we have also started on preparing the final presentation by just putting the names, name of the project so that we when do eventually get to doing the presentation having done something in the beginning related to the presentation it will help us to have a basis to work with, the status of the project is well we came up with the three main subsystems, some of the components that we are planning on purchasing, and a well idea on how to execute the project.

Design Methodology & Project Management
Instructor: Dr. Samir El-Nakla

Spring 2021

<u>Progress report #2</u>

Smart Refrigerator System (with a supported phone app)

Team:

Maha Hammad #201701149
Yasmin Alnassar #201600065

Date submitted: March 17, 2021

Advisor: Dr. Saifullah Shafiq
Co-Advisor: Dr. Sadiq Alhuwaidi

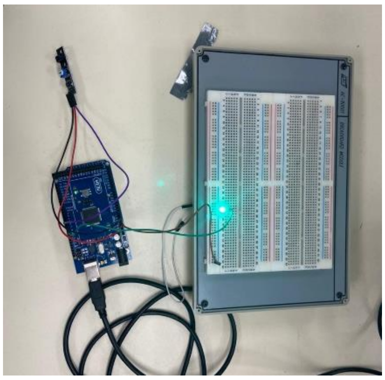
I. Project Summary

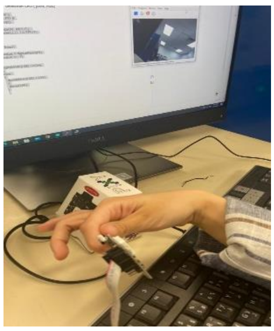
The project is proceeding gradually as we are in the beginning, we have decided on our three subsystems so far which are: 1) fridge sensors integration, 2) Pixy cam 2, 3) the phone application. So far in terms of the whole project for this semester 15% has been completed as we have found our idea, our three main subsystems , started testing the components on the sensor level , as well as started purchasing the components. The number of tasks that are remaining is purchasing the rest of components and assembling the first two subsystems, so far the problems that we have faced is finding the techniques that we will be using the refrigerator functionalities and finding the exact way of how to implement them, with more reading, testing, and troubleshooting these challenges will be overcome.

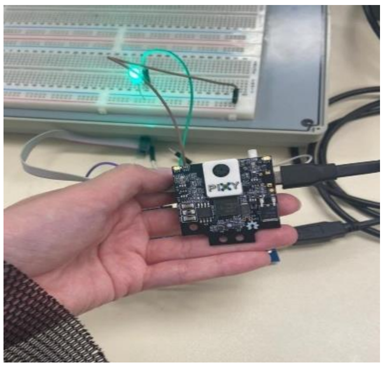
II. Project Status

a. Details of Tasks Completed:

The number of tasks that we have completed so far is doing the project proposal, researching about previous projects regarding smart refrigerator systems, doing the literature review, we have come up with our three subsystems which are: 1) subsystem_1: all the Sensors integrated, 2) subsystem_2: Pixy cam 2 , 3) subsystem_3: Phone Application. The purpose of each of the subsystems is as follows: The first subsystem is concerned with the detection of the missing food items whether the food item exists in the refrigerator or not combined with Arduino coding and programming a lot can be achieved, also another purpose of the first subsystem is to gain more information about the fridge such as adding a temperature sensor, or an oxygen sensor which can be viewed via (subsystem 3 the phone application). The purpose of the second subsystem is to keep a record of the food items when they were put inside the fridge and to give an estimated expiry date based on the date the fridge will register the food item. The purpose of the third subsystem is to have an interface between the information related to the fridge and the user. The other tasks that we have completed since our last report is that we had a meeting with Dr.saifullah on Monday march 8th 2021. We also went to the lab on Wednesday march 10th 2021 to start testing components such as the IR sensor and started getting familiar with the pixy 2 cam. We went to the lab again on Monday march 15th 2021 to start training the pixy cam for food recognition. We also had our midterm presentation on Wednesday march 17th 2021 and it was a success. Below are pictures from our lab session:







b. Preliminary Results:

We have just started testing the components and getting familiar with the items. The IR sensor works ok but the pixy cam still needs adjustments.

c. List of Tasks Remaining:

The tasks that remain to be completed is to find other techniques for detecting fruits, and vegetables other than the technique that we have, so far that techniques that we will be using for subsystem 1: sensors integrated is seen in table 1.

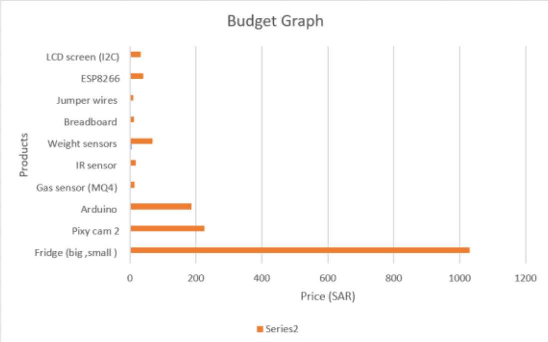
Table 18: Sensors for subsystem 1.

Eggs	Weight sensors
Juice, milk bottles	IR sensors
Fruits and vegetables	Weight sensors + Pixy cam 2

The tasks that are remaining is seeking to find other techniques for the fruits and vegetables detection and reading more about the pixy cam (subsystem_2) and learning about how to implement it.

d. **Budget status:**

Products	Quantity	Price (SAR)
Fridge (big ,small)	1	1029
Pixy cam 2	1	224.65
Arduino	1	186
Gas sensor (MQ4)	1	13
IR sensor	1	17
Weight sensors	4	68
Breadboard	1	11
Jumper wires	1 pack	9
ESP8266	1	39
LCD screen (I2C)	1	33
	Total= 1629.65 SAR	



So far we bought the IR sensor, MQ4 sensor, breadboard, jumper wires, and the Arduino.

III. Project Plan

I would rate our progress so far as according to schedule however I would like to learn more about the project and learn more about how to implement it, so in terms of work schedule we are on plan however in terms of learning how to implement the project I would still say we are on schedule but we have a lot to learn about and a lot to test, therefore more work must be done and more time must be spent in terms of learning how to execute the project.

We did some changes to our original plan in terms of the budget pricing and the type of components that we are going to buy.

The outlook for the remain tasks seem feasible, but more effort should be done in order to have a better and more clear vision of what is needed from us as a team to know how to make the project work, and work efficiently, reliably and importantly in a smart way.

IV. Contribution of Team Members

Team member contribution so far: Yasmin bought the breadboard and the MQ4 sensor. Maha bought the Arduino and the IR sensor. Yasmin wrote the progress report while Maha did the gnatt chart for this week. Yasmin also wrote the proposed budget plan for the semester. Maha and Yasmin both prepared the prezi midterm presentation. Each team member is doing the assigned tasks when being assigned to the task.

V. Challenges Faced

The challenges faced so far was with the pixy cam and trying to understand how to train it to identify different fruit and vegetables.

VI. Conclusions

The overall status of the project is good, we are progressing at a normal pace we have also started on preparing the final presentation by just putting the names, name of the project so that we when do eventually get to doing the presentation having done something in the beginning related to the presentation it will help us to have a basis to work with, the status of the project is well we started purchasing the components and testing them as well as doing more reading and more research for the best techniques possible.

Design Methodology & Project Management
Instructor: Dr. Samir El-Nakla

Spring 2021

<u>Progress report #3</u>

Smart Refrigerator System (with a supported phone app)

Team:

Maha Hammad #201701149
Yasmin Alnassar #201600065

Date submitted: April 5, 2021

Advisor: Dr. Saifullah Shafiq
Co-Advisor: Dr. Sadiq Alhuwaidi

I. Project Summary

The project is proceeding gradually as we are in the beginning, we have decided on our three subsystems so far which are: 1) fridge sensors integration, 2) Pixy cam 2, 3) the phone application. So far in terms of the whole project for this semester 30% has been completed as we have started on working the first two subsystems and completed some the parts of the subsystems. The number of tasks that are remaining is complete the subsystems 1&2 sensors on as an independent task that full functions and to assembly all the small systems to complete the subsystems 1& 2 as a whole subsystem. So far, the problems that we have faced is making each subsystem parts work on their own and its assembly for the refrigerator functionalities and finding the exact way of how to implement them, with more reading, testing, and troubleshooting these challenges will be overcome.

II. Project Status

a. Details of Tasks Completed:

The number of tasks that we have completed we have continued our progress on subsystems 1& 2. Subsystem 1 which is the food detection and quantity count we have completed the part relating to the juice and milk (detection & quantity count). We have been able to successfully implement and writing the code for detecting the juice, milk bottles in the fridge we have been able to do that by using 2 IR sensors, 2 LED lights that is from a component wise perspective, as for the software wise point of view we have used the AND condition in our code (as the code is seen in the preliminary results section below). Another task that we have completed is ordering more components such as the HX711 weight sensor but another module as it is seen in figure 1. Another component that we have order is the TFT Color Display ST7735 (figures 2 & 3), IR sensor modules (figure 4). We have decided on using the TFT ST7735 color display because it has more flexibility in showing words and a wider screen. Other tasks that have been completed is we have done testing on the weight sensors but still working on it more to find more satisfactory results that fit with our project.

Figure 1: HX711 module (4 wires)

Figure 2: TFT color display

Figure 3: Displaying words demo

Figure 4: IR sensor module

b. Preliminary Results:

The main results that we have gotten is we got the subsystem 1 parts of it working such as the IR sensors part as it is seen in figure 5 and the code below.

This part will be used for the detection of juice & milk food items in the fridge, other results is we were able to do the codes for the MQ4 gas sensor and detect the voltage range for the methane excretion in some of the fruits/vegetables (subsystem 2).

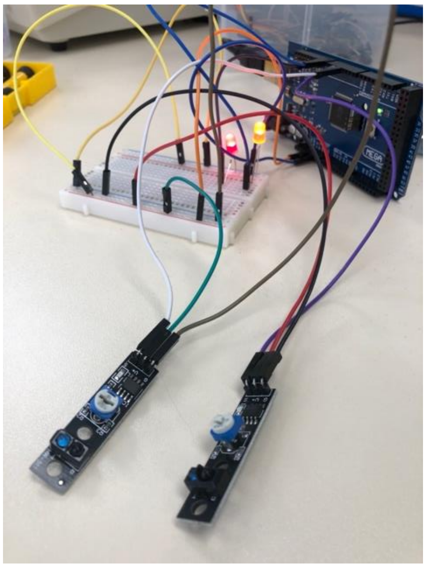


Figure 5: IR sensors

```
#define IR_J 5 /// juice
#define IR_M 4 /// milk
#define LEDM 8
#define LEDJ 9
void setup()
{
 pinMode(IR_J, INPUT);
  pinMode(IR_M, INPUT);
 pinMode(LEDJ, OUTPUT);
pinMode(LEDM, OUTPUT);
 Serial.begin(9600);
}

void loop()
{
int value_J = digitalRead(IR_J);
int value_M = digitalRead(IR_M);

if (value_J == 1 && value_M == 1 )
{
digitalWrite(LEDJ, HIGH);
digitalWrite(LEDM, HIGH);
Serial.println("No Milk, No Juice ");
}

if (value_M == 1 && value_J == 0 )
```

```
{
digitalWrite(LEDJ, LOW);
digitalWrite(LEDM, HIGH);
Serial.println("No milk, Yes Juice");
}

else if (value_J == 1 && value_M == 0)
{
  digitalWrite(LEDJ, HIGH);
  digitalWrite(LEDM, LOW);
  Serial.println("Yes Milk, No Juice ");
}

else if (value_M == 0 &&  value_J == 0)
{
  digitalWrite(LEDM, LOW);
  digitalWrite(LEDJ, LOW);
  Serial.println("Yes milk, Yes juice ");
  }
  delay(200); }
```

c. **List of Tasks Remaining:**

The tasks that remain to be completed is for subsystem 1, we need to complete the Pixycam and weight sensors technique for the fruits and vegetables food items, the second thing that need to be completed in subsystem 1 is the eggs food items we will be using IR sensors and we will be using a for loop in the Arduino code to be able to go through a cycle of detecting the number of eggs in the egg compartment in the fridge.

As for subsystem 2, we need to continue working on improving the accuracy of the methane gas sensor fruit and vegetable detection.

We have also dabbled in the third subsystem a bit (which we will be focusing on more in assessment 3) which is the application, I have downloaded the Blynk app and tried to discover and explore a bit and try to know the future things that we need to consider when creating the application next semester or in the summer vacation.

Table 1 is a summary of the techniques that will be used in the detection and quantity count of subsystem 1.

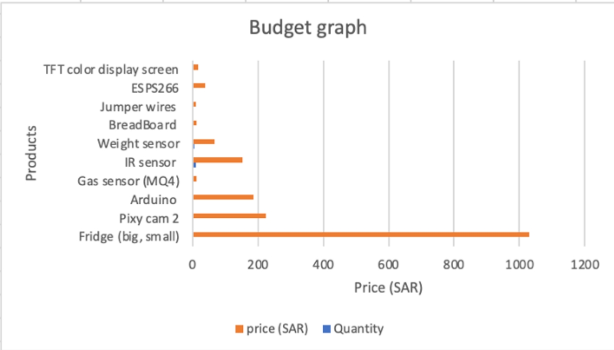
Table 19: Sensors subsystem 1 (detection & quantity count).

Fruits and vegetables	Weight sensors + Pixy cam 2
Juice, milk bottles	IR sensors
Eggs	IR sensors

The tasks that are remaining is seeking to find other techniques for the fruits and vegetables detection and reading more about the pixy cam (subsystem_2) and learning about how to implement it.

d. **Budget status:**

products	Quantity	price (SAR)
Fridge (big, small)	1	1029
Pixy cam 2	1	224.65
Arduino	1	186
Gas sensor (MQ4)	1	13
IR sensor	9	153
Weight sensor	4	68
BreadBoard	1	11
Jumper wires	1 pack	9
ESPS266	1	39
TFT color display screen	1	17
	Total = 1749.65 SAR	



So far, we bought the IR sensor, MQ4 sensor, breadboard, jumper wires, Pixycam, TFT screen, ESP8266, and the Arduino.

III. Project Plan

I would rate our progress so far as according to schedule however I would like to learn find more solutions, and find better, more efficient solutions and their implementations in our project. in terms of work schedule, we are on plan however in terms of assembly and implementation the project is progressing as we progress and put more effort in it (as the project does not progress without effort). I would still say we are on schedule, but we have an average amount of testing, trial and assembling that we need to do. Our plan is progressing and being developed more in terms of a better smart fridge, in terms of the budget pricing and the type of components that we are going to buy we know what to buy and bought it. The outlook for the remain tasks seem feasible, but more testing should be done, and the assembling of the components should be started as soon as possible to be able to have a full-on working subsystem as a whole.

IV. Contribution of Team Members

Team member contribution so far: Yasmin bought the breadboard and the MQ4 sensor, weight sensor. Maha bought the Arduino and the IR sensor, weight sensor (other type of module). Maha wrote the progress report while Yasmin did the gnatt chart for this week. Yasmin also wrote the proposed budget plan for the semester. Maha and Yasmin both prepared the Prezi presentation. Each team member is doing the assigned tasks when being assigned to the task.

V. Challenges Faced

The challenges faced are many, but with each challenge there is an opportunity for growth, and it means that we are at least accomplishing something and/or finding something that we can develop or find a solution to.

The challenges that we have faced regarding subsystem 1 is firstly the weight sensors, when we tested the weight sensors, we have tried multiple codes 3-4 codes but none of them worked, we have downloaded almost 3 Arduino libraries for the HX711 weight sensor the results were as if we faced a dead end, we reached out to Mr. Abu-Alhussian, then also Dr. Saifullah to resolve this issue, we have also asked for Tony's help. We have faced many obstacles regarding the weight sensors and we have received their feedback now and we are currently working with the suggested solutions they have provided us with, and we have ordered another specific module of the HX711 weight sensor (which has 4 wires instead of the 3 wires) the fourth wire has a built in resistance the HX711 weight sensor that we have purchased we need to manually connect two 1kΩ resistors and the other module of the HX711 sensor that we have does not register the function HX711 scale(,) in the Arduino IDE program,

therefore that is why have determined to using the same module HX711 sensor with the four wires.
Another challenge that we have faced is the pixy cam interfacing between the Arduino software and the pixycam itself, however after doing some more research we have been able to understand how to connect and send the information of the pixycam to the arduino by using the getblocks() function and much more.
Another challenge that I have personally faced is staying focused for the project in coming up with efficient solutions, however as long as we are working on the project, doing the assigned tasks and working towards the full working system of the refridgrator system this will help in keeping me focused for the project.

VI. Conclusions

The overall status of the project is good, we are progressing at a well pace we have also started on preparing the final presentation by adding pictures in the implementation part of the presentation in each day of its implementation day (therefore day by day work for the final presentation), the status of the project is well we are very close to finishing ordering all the components. We are testing the subsystem parts then combining them as well. With more working, reading, thinking, and seeking out the best way to implement our project we will be able to do so.

Design Methodology & Project Management
Instructor: Dr. Samir El-Nakla

Spring 2021

Progress report #4

Smart Refrigerator System (with a supported phone app)

Team:

Maha Hammad #201701149
Yasmin Alnassar #201600065

Date submitted: April 21, 2021

Advisor: Dr. Saifullah Shafiq
Co-Advisor: Dr. Sadiq Alhuwaidi

I. **Project Summary**

II. The project has come a long way since as we are at the end of semester. So far in terms of the whole project for this semester 45% has been completed as we have completed subsystem 1 and are in the middle of subsystem 2 . The problems that we have faced is finding the techniques that we will be using for the weight sensor as we are still testing and troubleshooting and trying to get the most accurate readings

III. **Project Status**

a. **Details of Tasks Completed:**

The number of tasks that we have completed we have continued our progress on subsystems 1& 2. Subsystem 1 which is the food detection and quantity count we have completed the part relating to the juice and milk (detection & quantity count). We have been able to successfully implement and writing the code for detecting the juice, milk bottles in the fridge we have been able to do that by using 2 IR sensors, 2 LED lights that is from a component wise perspective, as for the software wise point of view we have used the AND condition in our code (as the code is seen in the preliminary results section below). Another task that we worked on is writing the code for the IR senor for the eggs. We also ordered extra components such as weight sensors 1kg/5kg/ the with the plate, TFT screen, and 9 IR sensor modules. We also had our first semi-successful attempt for the weight sensor using 2 weight sensors but we still have to troubleshoot it to get more accurate readings. For our next lab session , we continued to try with the weight sensors but this time we tried with 4 to see if that would make it more accurate but we ran into trouble again is it was not giving us any readings. We also had our final presentation this week.

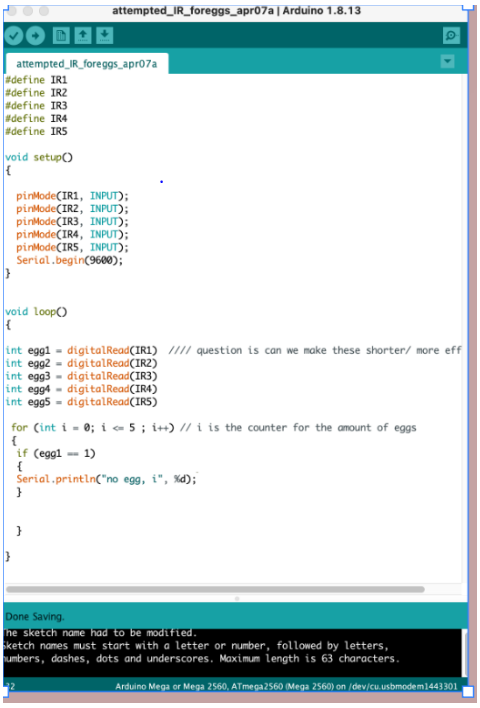


Image 1: Writing the code for eggs IR sensor

b. **Preliminary Results:**

The main result that we have gotten this week is inaccurate readings from the weight sensors.

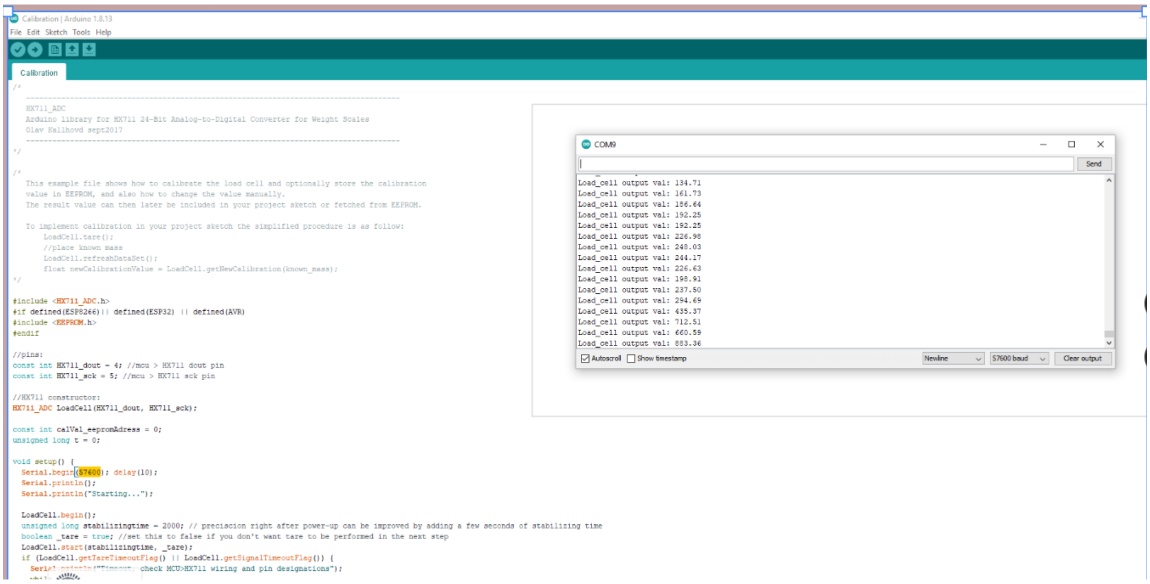


Image 2: inaccurate results from weight sensor

Initial Code used for IR egg sensor :

#define IR1

#define IR2

#define IR3

```
#define IR4
#define IR5

void setup()
{

  pinMode(IR1, INPUT);
  pinMode(IR2, INPUT);
  pinMode(IR3, INPUT);
  pinMode(IR4, INPUT);
  pinMode(IR5, INPUT);
  Serial.begin(9600);
}

void loop()
{

int egg1 = digitalRead(IR1)  //// question is can we make these shorter/ more
efficient
int egg2 = digitalRead(IR2)
int egg3 = digitalRead(IR3)
int egg4 = digitalRead(IR4)
int egg5 = digitalRead(IR5)

 for (int i = 0; i <= 5 ; i++) // i is the counter for the amount of eggs
 {
  if (egg1 == 1)
  {
  Serial.println("no egg, i", %d);
  }


  }

}
```

c. **List of Tasks Remaining:**

The tasks that remain to be completed is for subsystem 1, we need to complete the Pixycam and weight sensors technique for the fruits and vegetables food items, the second thing we need to continue working on improving the accuracy of the methane gas sensor fruit and vegetable detection. We are currently waiting for our newly ordered components to arrive so that we can start implementing them into our project. We also need to continue to work on our egg sensors We have also dabbled in the third subsystem a bit (which we will be focusing on more in assessment 3) which is the application, I have downloaded the Blynk app and tried to discover and explore a bit and try to know the future things that we need to consider when creating the application next semester or in the summer vacation.

Table 1 is a summary of the techniques that will be used in the detection and quantity count of subsystem 1.

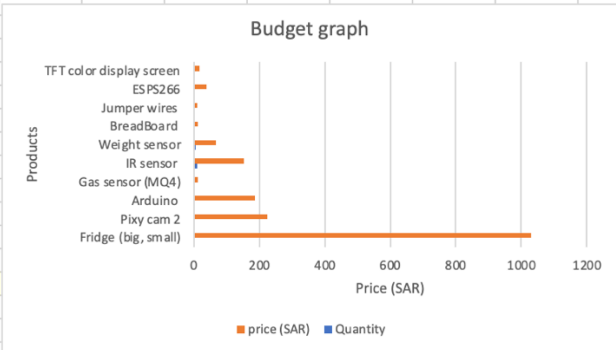
Table 20: Sensors subsystem 1 (detection & quantity count).

Fruits and vegetables	Weight sensors + Pixy cam 2
Juice, milk bottles	IR sensors
Eggs	IR sensors

The tasks that are remaining is seeking to find other techniques for the fruits and vegetables detection and reading more about the pixy cam (subsystem_2) and learning about how to implement it.

d. **Budget status:**

products	Quantity	price (SAR)
Fridge (big, small)	1	1029
Pixy cam 2	1	224.65
Arduino	1	186
Gas sensor (MQ4)	1	13
IR sensor	9	153
Weight sensor	4	68
BreadBoard	1	11
Jumper wires	1 pack	9
ESPS266	1	39
TFT color display screen	1	17
	Total = 1749.65 SAR	



So far, we bought the IR sensor, MQ4 sensor, breadboard, jumper wires, Pixycam, TFT screen, ESP8266, and the Arduino.

IV. Project Plan

I would rate our progress so far as a little bit behind schedule as we are still having trouble with the weight sensor however, we are doing our best to work through this hurtle and trying to troubleshoot it and move on our schedule. Our plan is progressing and being developed more in terms of a better smart fridge, in terms of the budget pricing and the type of components that we are going to buy we know what to buy and bought it. We added more components to our budgets as we have mentioned earlier we are still waiting on those components to arrive. The outlook for the remain tasks seem feasible, but more testing should be done, and the assembling of the components should be started as soon as possible to be able to have a full-on working subsystem as a whole.

V. Contribution of Team Members

Team member contribution so far: Maha bought new weight senors , 9 IR sensors , and a TFT screen. Yasmin wrote the progress report and Maha did the gnatt chart. Both students worked on the final presentation.

VI. Challenges Faced

The challenges faced are many, but with each challenge there is an opportunity for growth, and it means that we are at least accomplishing something and/or finding something that we can develop or find a solution to.

The challenges that we have faced regarding subsystem 1 is firstly the weight sensors, when we tested the weight sensors, we have tried multiple codes 3-4 codes but none of them worked, we have downloaded almost 3 Arduino libraries for the HX711 weight sensor the results were as if we faced a dead end, we reached out to Mr. Abu-Alhussian, then also Dr. Saifullah to resolve this issue, we have also asked for Tony's help. We have faced many obstacles regarding the weight sensors and we have received their feedback now and we are currently working with the suggested solutions they have provided us with, and we have ordered another specific module of the HX711 weight sensor (which has 4 wires instead of the 3 wires) the fourth wire has a built in resistance the HX711 weight sensor that we have purchased we need to manually connect two 1kΩ resistors and the other module of the HX711 sensor that we have does not register the function HX711 scale(,) in the Arduino IDE program, therefore that is why have determined to using the same module HX711 sensor with the four wires.

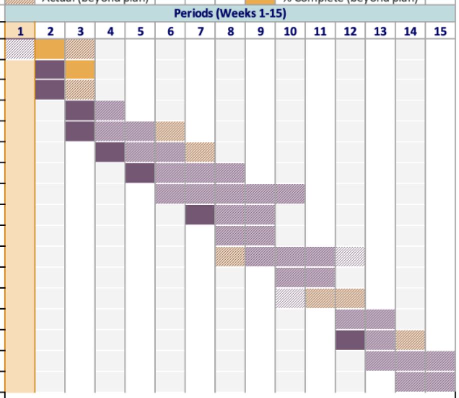
Another challenge that we have faced is the pixy cam interfacing between the Arduino software and the pixycam itself, however after doing some more research we have been able to understand how to connect and send the information of the pixycam to the arduino by using the getblocks() function and much more. Another challenge that I have personally faced is staying focused for the project in as we are reaching the end of the semsester and this is a stressful time for everyone but we are trying our best to produce the best work possible.

VII. Conclusions

The overall status of the project is good, I would rate our status currently 8/10 as we are experiencing delays with the weight senor. The status of the project is well we are very close to finishing ordering all the components. We are testing the subsystem parts then combining them as well. With more working, reading, thinking, and seeking out the best way to implement our project we will be able to do so.

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 1	
		Plan updated (Date): Sep. 15, 2020	
		Instructor: Dr. Sadiq Alhuwaidi	
		Period Highlight: 1	Plan / Actual
		Actual (beyond plan)	% Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	Y	2	2	20%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	40%
Run Code For Weight Sensor	3	2	Y	3	2	20%
Run Code For IR Sensors	3	3	M	3	4	40%
Implement MQ4 Gas Sensor: Fruits	4	3	M	4	4	35%
Run Code For MQ4 Gas Sensor	5	4	M	5	4	30%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	0%
Prepare Midterm Presentation	7	3	ALL	7	3	30%
Prepare Refrigator Hardware	8	2	Y	8	2	0%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	0%
Testing Subsystem 3: Application	10	2	ALL	10	2	0%
Running The Codes	10	1	Y	11	2	0%
Prepapre Final Report	12	2	ALL	12	2	0%
Prepapre Final Presentation	12	2	ALL	12	3	20%
Prepare Project Demo	13	3	ALL	13	3	0%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	0%



Progress Details:	Issues (delay, etc.):
The team members have wrote a project plan and met with the advisor to discuss it.	delay with gas sensor implmentation
We have removed the pixycam out of our design& sticked to the weight sensors for the detection of fruits.	delay with egg counter code
We have bought the fridge, tested the working codes however still not assembled hardware in the fridge yet.	weight sensor base placement
We have started working on the midterm presentation and video (beginning phase).	

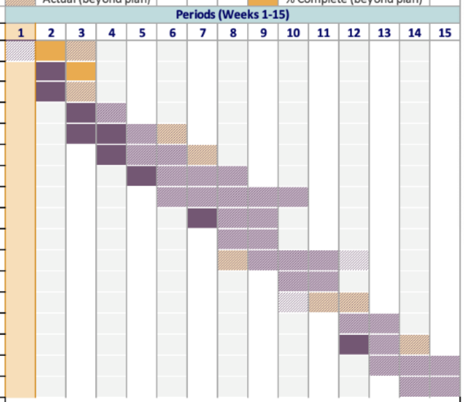
Title: Smart Fridge System | **Advisor: Dr. Sadiq Alhuwaidi** | **Design II (ASSE 3)** | **Fall 2021**

Yasmin AlNassar 201600065 (Y)
Maha Hammad 201701149 (M)

Project PLAN & Progress
ProgRpt No. 2
Plan updated (Date): Sep. 30, 2020
Instructor: Dr. Sadiq Alhuwaidi

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	Y	2	2	20%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	50%
Run Code For Weight Sensor	3	2	M	3	2	40%
Run Code For IR Sensors	3	3	M	3	4	50%
Implement MQ4 Gas Sensor: Fruits	4	3	M	4	4	40%
Run Code For MQ4 Gas Sensor	5	4	M	5	4	30%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	0%
Prepare Midterm Presentation	7	3	ALL	7	3	40%
Prepare Refrigator Hardware	8	2	Y	8	2	0%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	0%
Testing Subsystem 3: Application	10	2	Y	10	2	0%
Running The Codes	10	1	Y	11	2	0%
Prepapre Final Report	12	2	ALL	12	2	0%
Prepapre Final Presentation	12	2	ALL	12	3	35%
Prepare Project Demo	13	3	ALL	13	3	0%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	0%



Progress Details:

Weight sensor base installed (correct installement with code working)
starting to locate placement of sensors inside fridge
working on weight sensor code to give amount of fruits (convert from grams to average amount for tomatoes& bananas
Figuring out ways to make gas sensor more accurate

Issues (delay, etc.):

Delays: Gas sensor (need to test it in a closed enivornment)
Ordered new gas sensor
Reinstallment of the weight sensor base

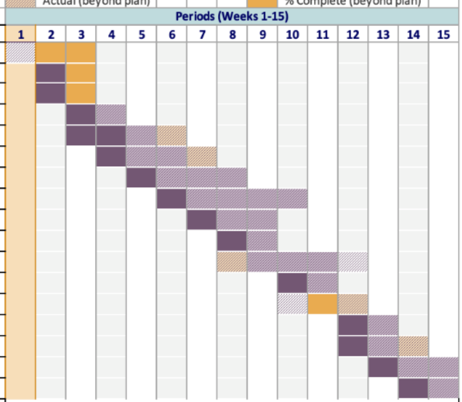
Title: Smart Fridge System | **Advisor: Dr. Sadiq Alhuwaidi** | **Design II (ASSE 3)** | **Fall 2021**

Yasmin AlNassar 201600065 (Y)
Maha Hammad 201701149 (M)

Project PLAN & Progress
ProgRpt No. 3
Plan updated (Date): Oct. 14, 2021
Instructor: Dr. Sadiq Alhuwaidi

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	65%
Run Code For IR Sensors	3	3	M	3	4	50%
Implement MQ4 Gas Sensor: Fruits	4	3	Y	4	4	40%
Run Code For MQ4 Gas Sensor	5	4	ALL	5	4	30%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	30%
Prepare Midterm Presentation	7	3	ALL	7	3	40%
Prepare Refrigator Hardware	8	2	Y	8	2	25%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	0%
Testing Subsystem 3: Application	10	2	Y	10	2	20%
Running The Codes	10	1	ALL	11	2	40%
Prepapre Final Report	12	2	Y	12	2	10%
Prepapre Final Presentation	12	2	ALL	12	3	35%
Prepare Project Demo	13	3	ALL	13	3	20%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	5%



Progress Details:

rked on the weight sensor code to include the approx. amount of fruit, also changed the weight scale readings to grams instead of
Started preparing hardware and deciding where to place sensors in fridge.

Issues (delay, etc.):

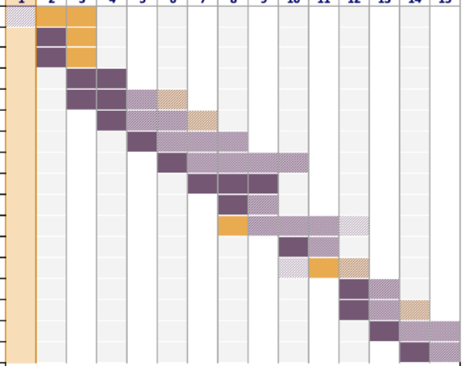
Midterm exams delayed us from working more.
Platforms to build Apps.

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 4	
		Plan updated (Date): Oct. 28, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	50%
Implement MQ4 Gas Sensor: Fruits	4	3	Y	4	4	40%
Run Code For MQ4 Gas Sensor	5	4	ALL	5	4	30%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	30%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	30%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	5%
Testing Subsystem 3: Application	10	2	Y	10	2	20%
Running The Codes	10	1	ALL	11	2	40%
Prepapre Final Report	12	2	Y	12	2	10%
Prepapre Final Presentation	12	2	ALL	12	3	35%
Prepare Project Demo	13	3	ALL	13	3	20%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	5%



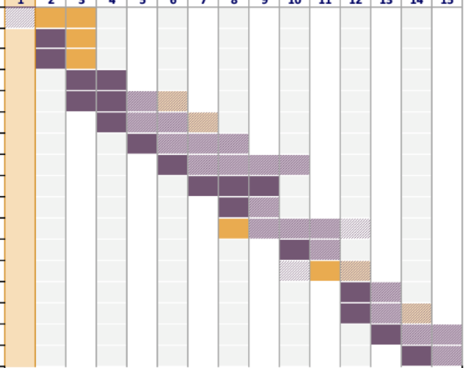
Progress Details:	Issues (delay, etc.):
We finished the midterm presentation.	3D printing service could not provide us with needed items.
Brought the fridge to PMU.	Application buliding.
Went to 3D printing place to get sensor covers.	
	Accessing male campus.

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 5	
		Plan updated (Date): Nov. 11, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	60%
Implement MQ4 Gas Sensor: Fruits	4	3	Y	4	4	45%
Run Code For MQ4 Gas Sensor	5	4	ALL	5	4	35%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	30%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	32%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	10%
Testing Subsystem 3: Application	10	2	Y	10	2	20%
Running The Codes	10	1	ALL	11	2	40%
Prepapre Final Report	12	2	Y	12	2	30%
Prepapre Final Presentation	12	2	ALL	12	3	35%
Prepare Project Demo	13	3	ALL	13	3	25%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	20%



Progress Details:	Issues (delay, etc.):
Bought another MQ2 gas sensor.	Need to buy and make box for gas sensor with a specified place.
ng MQ2 gas sensor in a closed environment for three days with the fruit inside two boxes (one good banana, the other rotten bar	ACCESSING MALE CAMPUS.
Meet with Dr. Saifullah working on gas sensor.	Application delay parts.
	waiting on gas sensor (MQ2) to arrive.

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 6	
		Plan updated (Date): Nov. 24, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	100%
Implement MQ4 Gas Sensor: Fruits	4	3	Y	4	4	45%
Run Code For MQ4 Gas Sensor	5	4	ALL	5	4	35%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	30%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	40%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	30%
Testing Subsystem 3: Application	10	2	Y	10	2	42%
Running The Codes	10	1	ALL	11	2	40%
Prepapre Final Report	12	2	Y	12	2	35%
Prepapre Final Presentation	12	2	ALL	12	3	40%
Prepare Project Demo	13	3	ALL	13	3	30%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	30%

Progress Details:	Issues (delay, etc.):
completed the hardware placement for subsytem 1(Milk and juice / eggs).	need to preheat the gas sensor for 24 hours.
worked on app codes	hardware implmentaion.
preheated the gas sensor.	getting accurate readings from application.

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 7	
		Plan updated (Date): Dec. 9, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	100%
Implement MQ4 Gas Sensor: Fruits	4	3	Y	4	4	50%
Run Code For MQ4 Gas Sensor	5	4	ALL	5	4	40%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	30%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	60%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	35%
Testing Subsystem 3: Application	10	2	Y	10	2	50%
Running The Codes	10	1	ALL	11	2	45%
Prepapre Final Report	12	2	Y	12	2	40%
Prepapre Final Presentation	12	2	ALL	12	3	45%
Prepare Project Demo	13	3	ALL	13	3	50%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	35%

Progress Details:	Issues (delay, etc.):
completed the hardware placement for subsytem 1+2(Temp and humpidty / gas / weight).	DHT 11 needs 3D printed cover
worked on combined app code	need rotten bannans / tomatos
gas sensor accurate readings	imroving data reading in combined app code

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 3	
		Plan updated (Date): Dec. 21, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	100%
Implement MQ2 Gas Sensor: Fruits	4	3	Y	4	4	98%
Run Code For MQ2 Gas Sensor	5	4	ALL	5	4	97%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	100%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	100%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	100%
Testing Subsystem 3: Application	10	2	Y	10	2	100%
Running The Codes	10	1	ALL	11	2	98%
Prepapre Final Report	12	2	Y	12	2	97%
Prepapre Final Presentation	12	2	ALL	12	3	100%
Prepare Project Demo	13	3	ALL	13	3	100%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	100%

Progress Details:

Issues (delay, etc.):

Title: Smart Fridge System	Advisor: Dr. Sadiq Alhuwaidi	Design II (ASSE 3)	Fall 2021
Yasmin AlNassar 201600065 (Y)		Project PLAN & Progress	
Maha Hammad 201701149 (M)		ProgRpt No. 3	
		Plan updated (Date): Dec. 21, 2021	
		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 | Plan | Actual | Actual (beyond plan) | % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

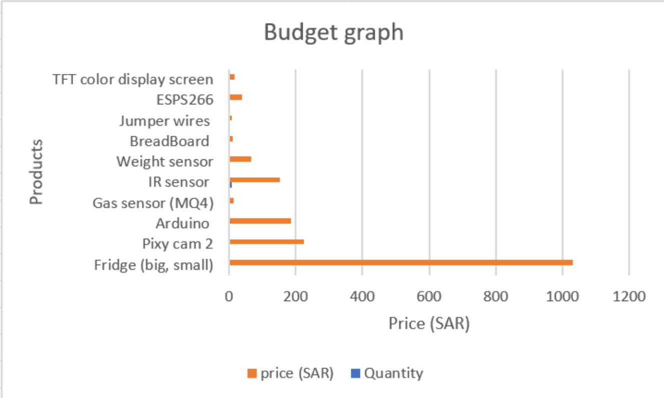
ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Implement Weight Sensor: Fruit Detection& Count	1	1	M	2	2	100%
Implment IR Sensor: Milk And Juice Detection & Count	2	1	M	2	2	100%
Implement IR Sensor: Egg Detection& Count	2	1	M	2	2	100%
Run Code For Weight Sensor	3	2	M	3	2	100%
Run Code For IR Sensors	3	3	M	3	4	100%
Implement MQ2 Gas Sensor: Fruits	4	3	Y	4	4	100%
Run Code For MQ2 Gas Sensor	5	4	ALL	5	4	100%
Prepare Manual Entry Feature Of Rest Of (Juice, Milk, Eggs)	6	5	Y	6	5	100%
Prepare Midterm Presentation	7	3	ALL	7	3	100%
Prepare Refrigator Hardware	8	2	Y	8	2	100%
Test Subsystem 1 +2 in the Fridge	9	4	ALL	8	4	100%
Testing Subsystem 3: Application	10	2	Y	10	2	100%
Running The Codes	10	1	ALL	11	2	100%
Prepare Final Report	12	2	Y	12	2	100%
Prepare Final Presentation	12	2	ALL	12	3	100%
Prepare Project Demo	13	3	ALL	13	3	100%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	ALL	14	2	100%

Progress Details:

Issues (delay, etc.):

Appendix B: Bill of Materials

products	Quantity	price (SAR)
Fridge (big, small)	1	1029
Pixy cam 2	1	224.65
Arduino	1	186
Gas sensor (MQ4)	1	13
IR sensor	9	153
Weight sensor	4	68
BreadBoard	1	11
Jumper wires	1 pack	9
ESPS266	1	39
TFT color display screen	1	17
	Total = 1749.65 SAR	



Appendix C: Datasheets

1) **<u>IR sensor datasheet:</u>**

1. Descriptions

The Multipurpose Infrared Sensor is an add-on for your line follower robot and obstacle avoiding robot that gives your robot the ability to detect lines or nearby objects. The sensor works by detecting reflected light coming from its own infrared LED. By measuring the amount of reflected infrared light, it can detect light or dark (lines) or even objects directly in front of it. An onboard RED LED is used to indicate the presence of an object or detect line. Sensing range is adjustable with inbuilt variable resistor.

The sensor has a 3-pin header which connects to the microcontroller board or Arduino board via female to female or female to male jumper wires. A mounting hole for easily connect one or more sensor to the front or back of your robot chassis.

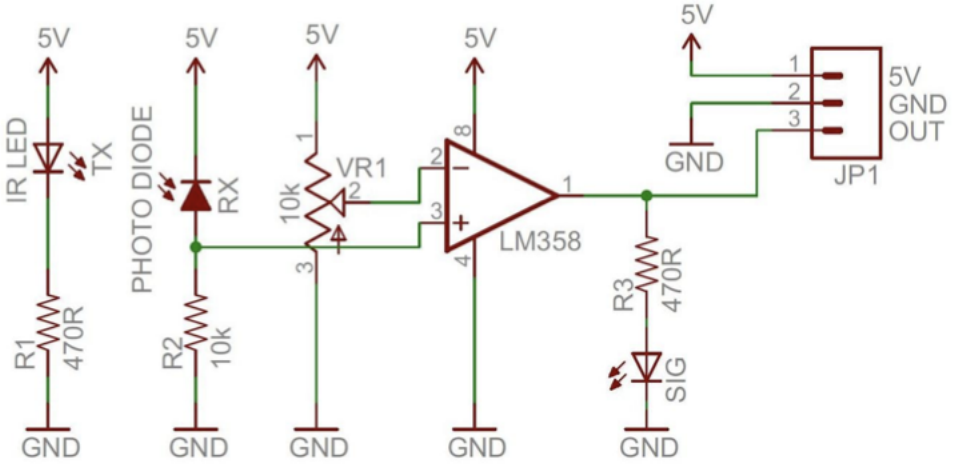
2. Features

- 5VDC operating voltage.
- I/O pins are 5V and 3.3V compliant.
- Range: Up to 20cm.
- Adjustable Sensing range.
- Built-in Ambient Light Sensor.
- 20mA supply current.
- Mounting hole.

3. Specifications

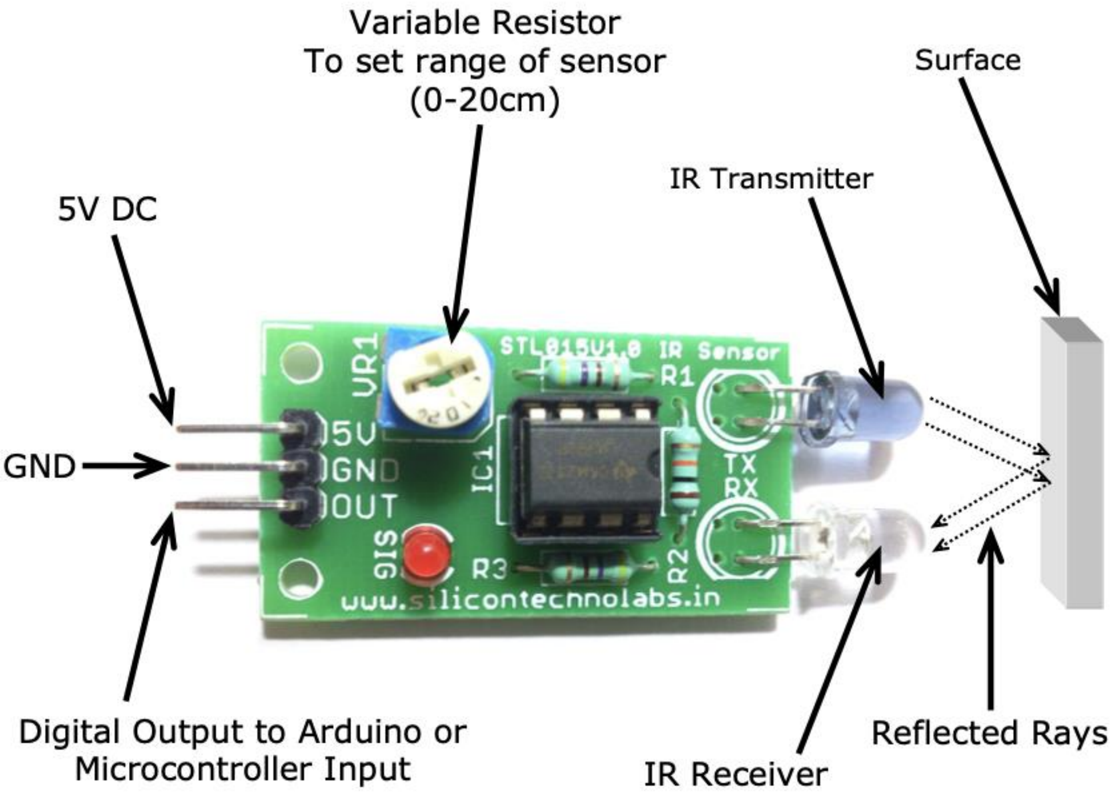
- Size: 50 x 20 x 10 mm (L x B x H)
- Hole size: ϕ2.5mm

4. Schematics



Silicon TechnoLabs **IR Proximity Sensor**

5. Hardware Details



Product Datasheet www.silicontechnolabs.in 3

2) Weight sensor/Load cell (HX711)

TAL201 PARALLEL BEAM LOAD CELL

Features:

◆Capacity： 3~120kg
◆Material: aluminum-alloy
◆Type: Parallel beam type
◆Defend grade: IP65
◆Recommended platform size:250x350mm
◆Application: electronic price computing scale, electronic counting scale, electronic balance and other electronic weighing devices

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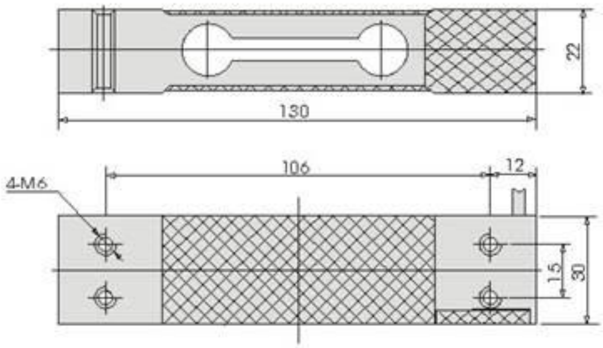
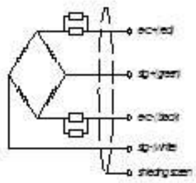
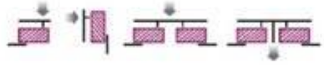
Electrical connection and Dimensions:(dimension unit: mm)



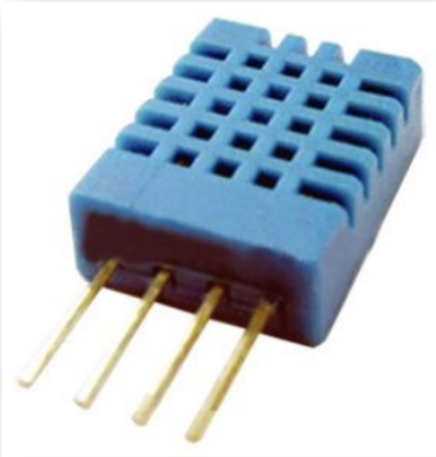




Specifications:		
capacity	kg	3,5,10,15,20,30,40,50,100,120
safe overload	%FS	150
ultimate overload	%FS	300
rated output	mV/V	2.0 ± 0.2
excitation voltage	Vdc	9~ 12
combined error	%FS	± 0.03
zero unbalance	%FS	± 2.0
non-linearity	%FS	± 0.02
hysteresis	%FS	± 0.02
repeatability	%FS	± 0.01
creep	%FS/30min	± 0.02
input resistance	Ω	405 ± 10
output resistance	Ω	350 ± 3
insulation resistance	MΩ	≥ 5000 @ 50 Vdc
operating temperature range	℃	-20 ~ +60
compensated temperature range	℃	-10 ~ +40
temperature coefficient of SPAN	%FS/10℃	± 0.02
temperature coefficient of ZERO	%FS/10℃	± 0.03
Electrical connection	cable	4 core shielded PVC cable, Ø4.5 × 450 mm

※Ordering code: model-capacity- rated output-accuracy-defend grade- the length of cable

3) Temperature and humidity sensor (DHT11)



Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

2. Technical Specifications:

Overview:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

Detailed Specifications:

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

Appendix D: Program Codes

```
#define MQ4pin 0

float sensorValue;  //variable to store sensor value

void setup()
{
  Serial.begin(9600); // sets the serial port to 9600
  Serial.println("Gas sensor warming up!");
  delay(20000); // allow the MQ-4 to warm up
}

void loop()
{
  sensorValue = analogRead(MQ4pin); // read analog input pin 0

  Serial.print("Sensor Value: ");
  Serial.print(sensorValue);

  if(sensorValue > 300)
  {
    Serial.print(" | Smoke detected!");
  }

  Serial.println("");
  delay(2000); // wait 2s for next reading
}

unsigned char IRpins[ ] = {2,3, 4, 5, 6};   // replace with the actual pin numbers
void setup()

{

  for (int i=0;i<5;i++)
  pinMode(IRpins[i], INPUT);
  Serial.begin(9600);

}

void loop()

{

for (int i = 0; i < 5; i++) // i is the counter for the amount of eggs

{

  if (digitalRead(IRpins[i]))

  {
```

```
  Serial.print("no egg : ");

    Serial.println(i+1);

  }

}

}


#include <dht.h>

dht DHT;

#define DHT11_PIN 7

void setup(){
  Serial.begin(9600);
}

void loop(){
  int chk = DHT.read11(DHT11_PIN);
  Serial.print("Temperature = ");
  Serial.println(DHT.temperature);
  Serial.print("Humidity = ");
  Serial.println(DHT.humidity);
  delay(1000);
}


#define IR_J 5 /// juice
#define IR_M 4 /// milk
#define LEDM 8
#define LEDJ 9
void setup()
{
 pinMode(IR_J, INPUT);
  pinMode(IR_M, INPUT);
 pinMode(LEDJ, OUTPUT);
pinMode(LEDM, OUTPUT);
 Serial.begin(9600);
}

void loop()
{
int value_J = digitalRead(IR_J);
int value_M = digitalRead(IR_M);

if (value_J == 1 && value_M == 1 )
{
digitalWrite(LEDJ, HIGH);
digitalWrite(LEDM, HIGH);
```

```
Serial.println("No Milk, No Juice ");
}

if (value_M == 1 && value_J == 0 )
{
digitalWrite(LEDJ, LOW);
digitalWrite(LEDM, HIGH);
Serial.println("No milk, Yes Juice");
}

else if (value_J == 1 && value_M == 0)
{
  digitalWrite(LEDJ, HIGH);
  digitalWrite(LEDM, LOW);
  Serial.println("Yes Milk, No Juice ");
}

else if (value_M == 0 &&  value_J == 0)
{
  digitalWrite(LEDM, LOW);
  digitalWrite(LEDJ, LOW);
  Serial.println("Yes milk, Yes juice ");
  }
  delay(200); }


#include <HX711_ADC.h>
#if defined(ESP8266)|| defined(ESP32) || defined(AVR)
#include <EEPROM.h>
#endif

//pins:
const int HX711_dout = 4; //mcu > HX711 dout pin
const int HX711_sck = 5; //mcu > HX711 sck pin

//HX711 constructor:
HX711_ADC LoadCell(HX711_dout, HX711_sck);

const int calVal_eepromAdress = 0;
unsigned long t = 0;

void setup() {
  Serial.begin(57600); delay(10);
  Serial.println();
  Serial.println("Starting...");

  LoadCell.begin();
  unsigned long stabilizingtime = 2000; // preciscion right after power-up can be improved by
adding a few seconds of stabilizing time
  boolean _tare = true; //set this to false if you don't want tare to be performed in the next
step
  LoadCell.start(stabilizingtime, _tare);
  if (LoadCell.getTareTimeoutFlag() || LoadCell.getSignalTimeoutFlag()) {
    Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
```

```
    while (1);
  }
  else {
    LoadCell.setCalFactor(1.0); // user set calibration value (float), initial value 1.0 may be
used for this sketch
    Serial.println("Startup is complete");
  }
  while (!LoadCell.update());
  calibrate(); //start calibration procedure
}

void loop() {
  static boolean newDataReady = 0;
  const int serialPrintInterval = 0; //increase value to slow down serial print activity

  // check for new data/start next conversion:
  if (LoadCell.update()) newDataReady = true;

  // get smoothed value from the dataset:
  if (newDataReady) {
    if (millis() > t + serialPrintInterval) {
      float i = LoadCell.getData();
      Serial.print("Load_cell output val: ");
      Serial.println(i);
      newDataReady = 0;
      t = millis();
    }
  }

  // receive command from serial terminal
  if (Serial.available() > 0) {
    char inByte = Serial.read();
    if (inByte == 't') LoadCell.tareNoDelay(); //tare
    else if (inByte == 'r') calibrate(); //calibrate
    else if (inByte == 'c') changeSavedCalFactor(); //edit calibration value manually
  }

  // check if last tare operation is complete
  if (LoadCell.getTareStatus() == true) {
    Serial.println("Tare complete");
  }

}

void calibrate() {
  Serial.println("***");
  Serial.println("Start calibration:");
  Serial.println("Place the load cell an a level stable surface.");
  Serial.println("Remove any load applied to the load cell.");
  Serial.println("Send 't' from serial monitor to set the tare offset.");

  boolean _resume = false;
  while (_resume == false) {
    LoadCell.update();
```

```
    if (Serial.available() > 0) {
      if (Serial.available() > 0) {
        char inByte = Serial.read();
        if (inByte == 't') LoadCell.tareNoDelay();
      }
    }
    if (LoadCell.getTareStatus() == true) {
      Serial.println("Tare complete");
      _resume = true;
    }
  }

  Serial.println("Now, place your known mass on the loadcell.");
  Serial.println("Then send the weight of this mass (i.e. 100.0) from serial monitor.");

  float known_mass = 0;
  _resume = false;
  while (_resume == false) {
    LoadCell.update();
    if (Serial.available() > 0) {
      known_mass = Serial.parseFloat();
      if (known_mass != 0) {
        Serial.print("Known mass is: ");
        Serial.println(known_mass);
        _resume = true;
      }
    }
  }

  LoadCell.refreshDataSet(); //refresh the dataset to be sure that the known mass is
measured correct
  float newCalibrationValue = LoadCell.getNewCalibration(known_mass); //get the new
calibration value

  Serial.print("New calibration value has been set to: ");
  Serial.print(newCalibrationValue);
  Serial.println(", use this as calibration value (calFactor) in your project sketch.");
  Serial.print("Save this value to EEPROM adress ");
  Serial.print(calVal_eepromAdress);
  Serial.println("? y/n");

  _resume = false;
  while (_resume == false) {
    if (Serial.available() > 0) {
      char inByte = Serial.read();
      if (inByte == 'y') {
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.begin(512);
#endif
        EEPROM.put(calVal_eepromAdress, newCalibrationValue);
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.commit();
#endif
        EEPROM.get(calVal_eepromAdress, newCalibrationValue);
```

```
        Serial.print("Value ");
        Serial.print(newCalibrationValue);
        Serial.print(" saved to EEPROM address: ");
        Serial.println(calVal_eepromAdress);
        _resume = true;

      }
      else if (inByte == 'n') {
        Serial.println("Value not saved to EEPROM");
        _resume = true;
      }
    }
  }

  Serial.println("End calibration");
  Serial.println("***");
  Serial.println("To re-calibrate, send 'r' from serial monitor.");
  Serial.println("For manual edit of the calibration value, send 'c' from serial monitor.");
  Serial.println("***");
}

void changeSavedCalFactor() {
  float oldCalibrationValue = LoadCell.getCalFactor();
  boolean _resume = false;
  Serial.println("***");
  Serial.print("Current value is: ");
  Serial.println(oldCalibrationValue);
  Serial.println("Now, send the new value from serial monitor, i.e. 696.0");
  float newCalibrationValue;
  while (_resume == false) {
    if (Serial.available() > 0) {
      newCalibrationValue = Serial.parseFloat();
      if (newCalibrationValue != 0) {
        Serial.print("New calibration value is: ");
        Serial.println(newCalibrationValue);
        LoadCell.setCalFactor(newCalibrationValue);
        _resume = true;
      }
    }
  }
  _resume = false;
  Serial.print("Save this value to EEPROM adress ");
  Serial.print(calVal_eepromAdress);
  Serial.println("? y/n");
  while (_resume == false) {
    if (Serial.available() > 0) {
      char inByte = Serial.read();
      if (inByte == 'y') {
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.begin(512);
#endif
        EEPROM.put(calVal_eepromAdress, newCalibrationValue);
#if defined(ESP8266)|| defined(ESP32)
        EEPROM.commit();
```

```
#endif
        EEPROM.get(calVal_eepromAdress, newCalibrationValue);
        Serial.print("Value ");
        Serial.print(newCalibrationValue);
        Serial.print(" saved to EEPROM address: ");
        Serial.println(calVal_eepromAdress);
        _resume = true;
      }
      else if (inByte == 'n') {
        Serial.println("Value not saved to EEPROM");
        _resume = true;
      }
    }
  }
  Serial.println("End change calibration value");
  Serial.println("***");
}
```

```
////FINAL CODE THAT WAS USED
#define IR_J 12 /// juice used to be 3  >>>>>>>>>>>>>>>>>>>>>>>>>>>>>> damaged one on the right >> used to be 12
#define IR_M 13 /// milk used be 4
#define LEDM 8 ///milk LED will be on when missing to fill the milk
#define LEDJ 9 //juice LED will be on when missing to restock juice in the fridge
#define DHT11_PIN 7
#define DOUT1 2 //1kg
#define CLK1 3 //1kg tomatoes
#define DOUT2 4 //5kg bananas
#define CLK2 5 //5kg
#define BLYNK_PRINT Serial
#define ESP8266_BAUD 9600
#define EspSerial Serial1
unsigned char IRpins[] = {22,23,24,25,26};
#include <BlynkSimpleShieldEsp8266.h>
#include <SoftwareSerial.h>
#include <dht.h>
#include "HX711.h"

dht DHT;
HX711 scale1;
HX711 scale2;

int ir1 = 0;
int ir2 = 0;
int ir3 = 0;
int ir4 = 0;
int ir5 = 0;

int eggcount = 0; // egg count
int methanereading = 0;
```

```
int bananas = 0;
int tomatos = 0;
float tomato = 136; ///average weight of tomato (modifications in
here)>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>>>>>>>>>>>>>>>>
float banana = 210; ///average weight (can modify
here)>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> //118
float calibration_factor1 = -792100.06; //1kg Change this for calibration your load cell was -
100000
float calibration_factor2 = 172322; //5kg Change this for calibration your load cell was -
100000
float scale1Gram = 0;
float scale2Gram = 0;

char auth[] = "64ZJcTBdSoVq9x0f7sT5idibyDslFBOO";//Enter your Auth token
char ssid[] = "Maha ";//Enter your WIFI name
char pass[] = "Maha1234";//Enter your WIFI password

WidgetLCD lcd(V3); // milk
WidgetLCD lcdJ(V4); //juice
WidgetTerminal terminal(V5); // eggs
WidgetTerminal terminal_0(V6); // Weight sensor bananas 5kg
WidgetTerminal terminal_T(V8); // Weight sensor tomatoes 1kg
WidgetLCD lcd_0(V7); // gas sensor

ESP8266 wifi(&EspSerial);


void setup()
{
for (int i=0;i<5;i++)
pinMode(IRpins[i], INPUT); // eggs
pinMode(IR_J, INPUT); // juice
pinMode(IR_M, INPUT); // milk
pinMode(LEDJ, OUTPUT); // milk and juice code
pinMode(LEDM, OUTPUT); // milk and juice code
scale1.begin(DOUT1, CLK1);
scale1.set_scale();
scale1.tare(); //Reset the scale to 0
scale2.begin(DOUT2, CLK2);
scale2.set_scale();
scale2.tare(); //Reset the scale to 0
long zero_factor1 = scale1.read_average(); //Get a baseline reading
long zero_factor2 = scale2.read_average(); //Get a baseline reading
Serial.begin(9600);
EspSerial.begin(ESP8266_BAUD);
Blynk.begin(auth, wifi, ssid, pass);
}
```

```
void loop()
{
  MILK();
  JUICE();
  EGGS();
  WEIGHT();
  TEMP();
  GAS();
  //delay(5000);
eggcount = ir1 + ir2 + ir3 + ir4 + ir5;
int value_J = digitalRead(IR_J);
int value_M = digitalRead(IR_M);
int chk = DHT.read11(DHT11_PIN);
int methanereading = analogRead(A0);
///starting with the eggs (1/5)
/*next milk& juice (2/5)**reduced the delays from 500 to 100
or can remove completly */
//next Weight sensors (3/5)
//next Temp& Humidity (4/5)
//next Gas Sensor (5/5)
Blynk.virtualWrite(V1, DHT.temperature);
Blynk.virtualWrite(V2, DHT.humidity);
Blynk.run();
}


void JUICE()
{
int value_J = digitalRead(IR_J);

if (value_J == 0)
{
lcdJ.print(0,0,"Yes Juice");
 Blynk.run();
}

else if (value_J == 1)
{
lcdJ.print(0,0,"No Juice");
 Blynk.run();
}
  delay(500);
  Blynk.virtualWrite(V4, IR_J);
  Blynk.run();
return;
  }

void MILK()
{
```

```
int value_M = digitalRead(IR_M);

if (value_M == 0)  ///// if zero yes  milk for sure
{
 lcd.print(0,0,"Yes Milk");
  Blynk.run();
}

else if (value_M == 1)
{
 lcd.print(0,0,"No Milk");
  Blynk.run();
 }
 delay(500);
 Blynk.virtualWrite(V3, IR_M);
 Blynk.run();
return;
 }

void EGGS()
{

 if(!digitalRead(IRpins[0]))
 {
   ir1 = 1;
   Blynk.run();
 }
 else{
   ir1 = 0;
 }
 if(!digitalRead(IRpins[1]))
 {
   ir2 = 1;
   Blynk.run(); ///last trial
 }
 else{
   ir2 = 0;
 }
 if(!digitalRead(IRpins[2]))
 {
   ir3 = 1;
   Blynk.run();
 }
 else{
   ir3 = 0;
 }
 if(!digitalRead(IRpins[3]))
 {
   ir4 = 1;
   Blynk.run();
```

```
  }
  else{
    ir4 = 0;
  }
  if(!digitalRead(IRpins[4]))
  {
    ir5 = 1;
    Blynk.run();
  }
  else{
    ir5 = 0;
  }
   if(eggcount == 5)
   {
    Serial.println("The tray is full");
    terminal.println("The tray is full");
    Blynk.run();
   }
   if(eggcount == 0)
   {
    Serial.println("The tray is empty");
    terminal.println("The tray is empty");
    Blynk.run();
   }
   else{
    Serial.print("Eggs present: ");
    Serial.println(eggcount);
    terminal.print("Eggs present: ");
    terminal.println(eggcount);
    Blynk.run();
   }
Blynk.run();
   return;
   }

void WEIGHT()
{
scale1.set_scale(calibration_factor1);
scale2.set_scale(calibration_factor2); //Adjust to this calibration factor
scale1Gram = abs(scale1.get_units())*0.453592, 4;
scale1Gram = scale1Gram*1000;
scale2Gram = abs(scale2.get_units())*0.453592, 4;
scale2Gram = scale2Gram*1000;
bananas = scale2Gram/banana;
tomatos = scale1Gram/tomato;
//tomatoes
Serial.print("Reading 1 kg: ");
terminal_T.print("Reading 1 kg: "); // FOR TERMINAL WIDGET ADD TO EVERY
serial.print
Serial.print(scale1Gram);
```

```
terminal_T.print(scale1Gram);
delay(1000);
Serial.print(" gm");
terminal_T.print(" gm"); // FOR TERMINAL WIDGET ADD TO EVERY serial.print
Serial.print("  ");
Serial.print("  ");
terminal_T.print("  ");
terminal_T.print("  ");
terminal_T.println();
Serial.println("Approx amount of tomatoes"); // removee ln
terminal_T.print("Approx amount of tomatoes  "); // FOR TERMINAL WIDGET ADD TO
EVERY serial.print
Serial.print("  ");
Serial.print("  ");
terminal_T.print("  ");
terminal_T.print("  ");
Serial.print(tomatos);
//Serial.println();
terminal_T.print(tomatos);
terminal_T.println(); ///what does this do? not sure
delay(5000);
//bananas
Serial.print("Reading 5 kg: ");
terminal_0.print("Reading 5 kg: "); // FOR TERMINAL WIDGET ADD TO EVERY
serial.print
Serial.print(scale2Gram);
terminal_0.print(scale2Gram);
delay(1000);
Serial.print("gm");
terminal_0.print(" gm"); // FOR TERMINAL WIDGET ADD TO EVERY serial.print
Serial.print("  ");
Serial.print("  ");
terminal_0.print("  ");
terminal_0.print("  ");
terminal_0.println();
Serial.println("Approx amount of Bananas"); // remove ln
terminal_0.print("Approx amount of Bananas"); // FOR TERMINAL WIDGET ADD TO
EVERY serial.print
Serial.print("  ");
Serial.print("  ");
terminal_0.print("  ");
terminal_0.print("  ");
Serial.print(bananas);
//Serial.println();
terminal_0.print(bananas);
terminal_0.println();
delay(5000); ///Was 3000
Blynk.run();
return;
}
```

```
void TEMP()
{
 Serial.print("Temperature = ");
 Serial.println(DHT.temperature);
 Serial.print("Humidity = ");
 Serial.println(DHT.humidity);
// delay(1000); i removed the delay in here
Blynk.virtualWrite(V1, DHT.temperature);
Blynk.virtualWrite(V2, DHT.humidity);
Blynk.run();
  return; }
void GAS()
  {

     Serial.println(methanereading);
 if (methanereading < 247)
 {
  Serial.println("Good Bananas"); ////should be goood but for video
  lcd_0.print(0,0,"Good Bananas");
  }
 else if (methanereading >= 250)
 {
 Serial.println("non-edible Bananas");
 lcd_0.print(0,0,"Rotten Bananas");
  }
  Blynk.run();
    return;}
```

Appendix E: Operation Manual

1- Plug your fridge and turn it on.
2- Connect your fridge to your phone Hotspot WIFI.
3- Turn on Blynk app.
4- Press PLAY.
5- Wait for 2 minutes (DO NOT PUT ANYTHING ON TOMATOES/BANANAS COMPARTMENT YET).
6- After 2 minutes, you will notice the fridge information is being displayed in the app.
7- You can now place items in designated compartment: Fruits: tomatoes/bananas compartment, Eggs compartment, Milk& Juice Compartment.
8- Be able to get all related information of the fridge: Temperature& Humidity, Availability& count of: Milk& Juice, Selected fruits& vegetables, Eggs, Expiry date all through the App.
9- Enjoy your fridge!