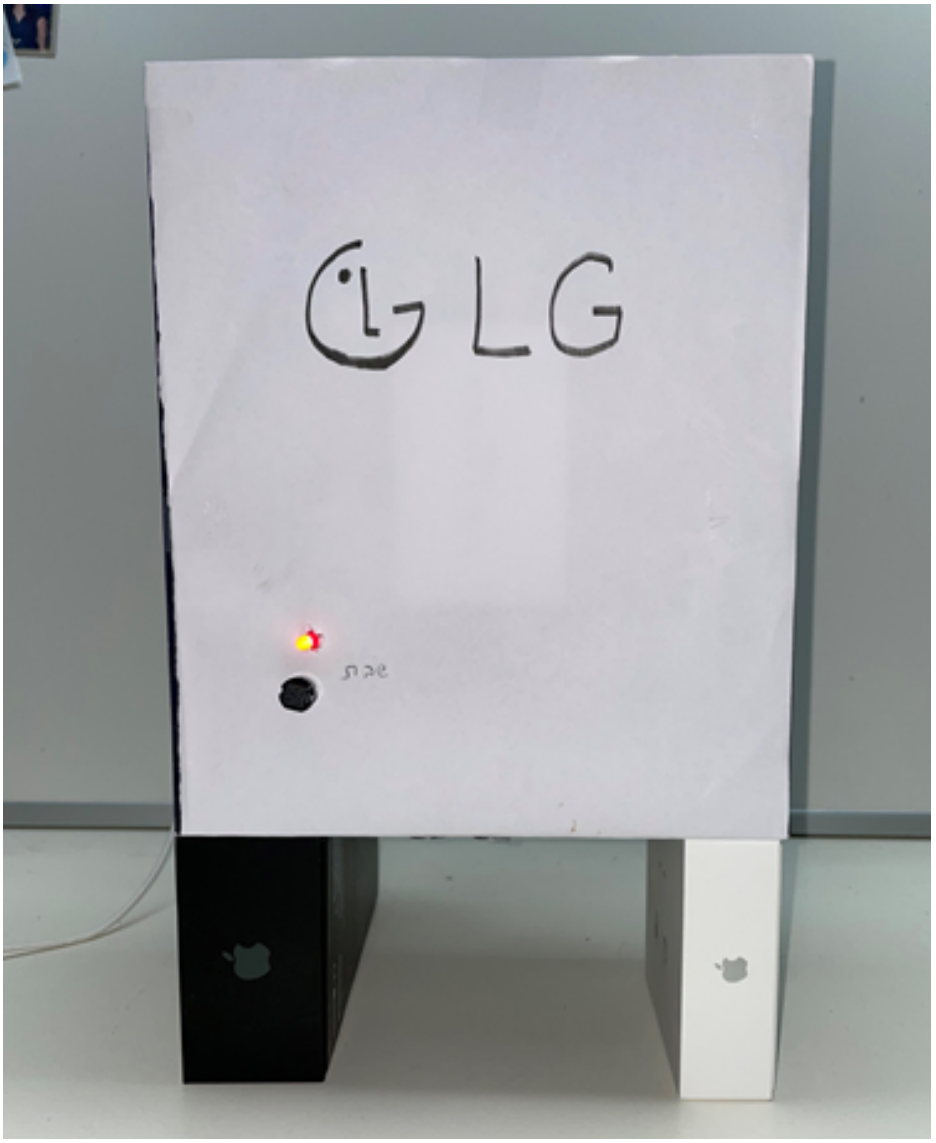
Final Report - IoT 097247

Smart Refrigerator



Evan Azoulay 931161715
Raphael Bellaiche 342457421
Harry Bitboul 342436953

1. Our Project

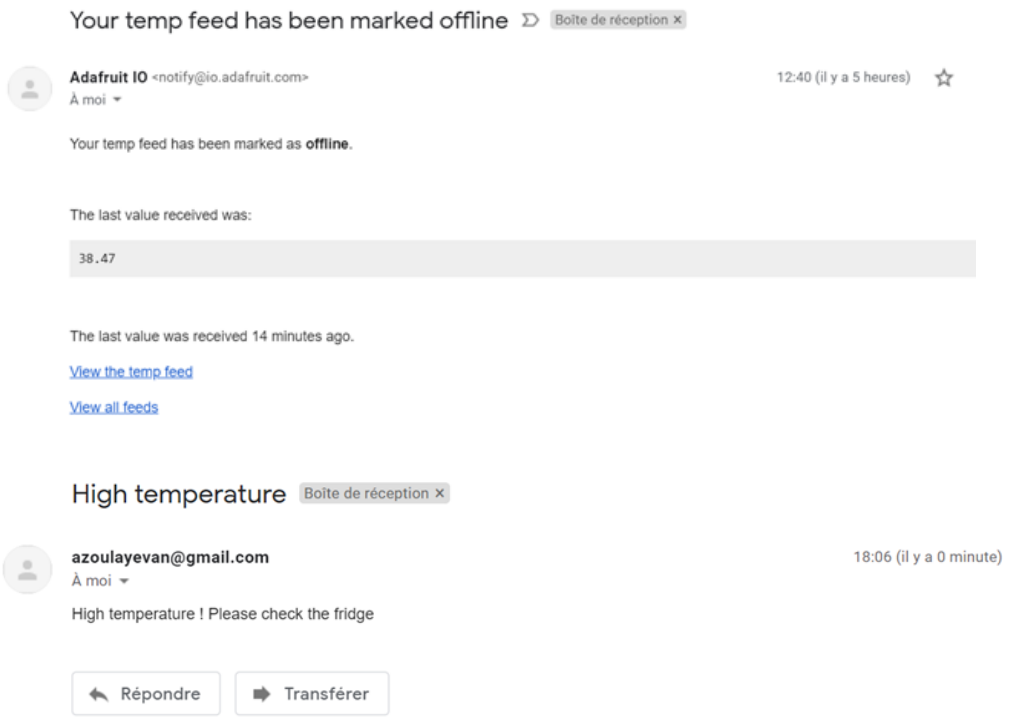
The Project we've decided to develop is a smart refrigerator. It has different features, some basics and some advanced. First of all, like it was required, the system in the fridge is able to connect to a database and in real time share information and present it on a dashboard:

- Basic Features :

  The System we designed is able to detect and report the inside and outside temperature of the fridge and to share this information in live with the database we created on Adafruit.

  Furthermore, we made it possible to know from the dashboard we created if the door of the fridge is opened or closed and how many times it was opened on the same day.

  The system is conceived to send a notification for 3 different cases :
  - Interruption of the receiving of the data for 24h
  - Inside temperature reaching 16°C
  - Door was opened for a full minute



- Advanced Features:

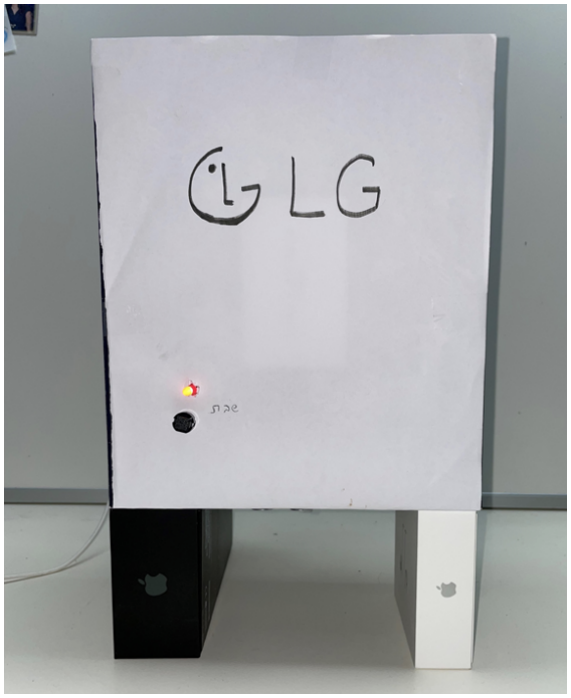
The feature is called Auto-Opening. The fridge we conceived is able to open itself. We placed a sensor under the door that detects if you place your foot in front of it. With this technology, you can open the fridge without using your hands.

The User will be able to turn off all the features of the fridge including the auto-opening or the data sending for example. This feature is called “Shabbat Mode” and makes it possible for someone that respects jewish festivals to open the fridge at any time without touching the light and sending different information to the database. In this mode, the light of the fridge is constantly on. To activate this mode, the user shall push the button (it will also light up the LED).

2. Fridge Components

To achieve our goals we used some basic components :

- Esp32 : Chip controller :
  We used this connected chip to link and control every element. The wifi was important to share all the data with the cloud.
- BME280 : Temperature sensor :
  Temperature, Pressure and humidity sensor that we used to collect the Inside temperature of the fridge.
- TMP36 : Temperature sensor :
  We used this temperature sensor to collect the outside temperature.
- Button : We use the button to activate the Shabbat Mode.
- Led : Shabbat Mode indicator
- Photoresistor : DoorOpen indicator
- HC-SC04 : Ultrasound sensor (movement/distance detector)
  the sensor returns the time the ultrasound takes to return. We convert this time to a distance knowing the speed of sound.
- Servomotor : because we didn't have a servo motor powerful enough, we decided to create a refrigerator prototype with a smaller size, appropriate to our servor.



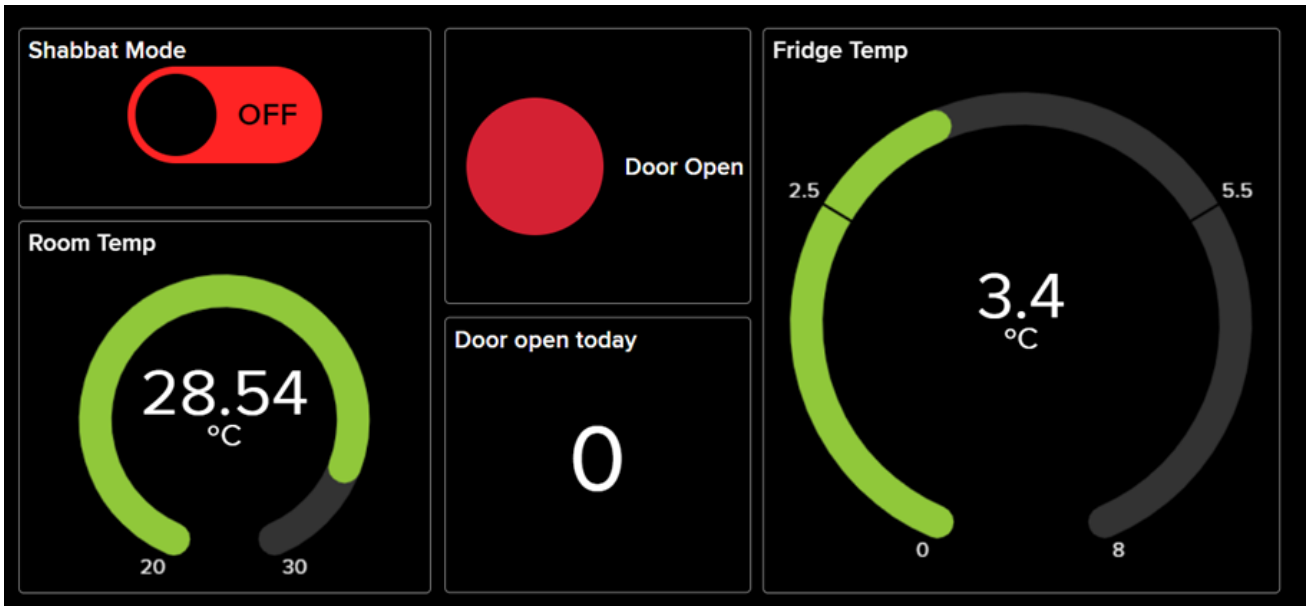
3. Code

Let's analyze a snippet of the code.

Before each loop of 10ms the controller checks if the Shabbat Mode is active i.e. the button was pressed. If yes a variable called chabbatState takes the value 1 and the led lights up.
All the remaining code is included in a condition which is active only if the shabbat mode is on. We can see in the screenshot for example that the ultrasound sensor is getting the signal.
We fixed that if the distance from the foot to the sensor is less than 6cm the servo motors can move and so open the door.
Finally the information like the temperature are sent to the cloud every 5 minutes.

```
void loop() {

  io.run();

    Serial.print("chabbat state ");
    Serial.println(chabbatState);

  //button
  chabbatButton = digitalRead(button);
  Serial.print("button ");
  Serial.println(chabbatButton);
  if (chabbatButton==0 && chabbatState==0){
    chabbatState = 1;
    digitalWrite(4, HIGH);
    SH ->save(chabbatState);
  }
  else if (chabbatButton==0 && chabbatState==1){
    chabbatState = 0;
    digitalWrite(4, LOW);
    SH ->save(chabbatState);
  }

if (chabbatState == 0)
{
  //sonar
  unsigned int distance = sonar.ping_cm();
  Serial.print(distance);
  Serial.println("cm");

  //servo
  if (distance<=6){
    for (pos = 0; pos <= 20; pos += 1) { // goes fro
    // in steps of 1 degree
    myservo.write(pos);              // tell servo t
    delay(10);                       // waits 15ms f
  }
  for (pos = 70; pos >= 10; pos -= 1) { // goes from
    myservo.write(pos);              // tell servo t
    delay(10);                       // waits 15ms f
  }
  }
```

4. Dashboard

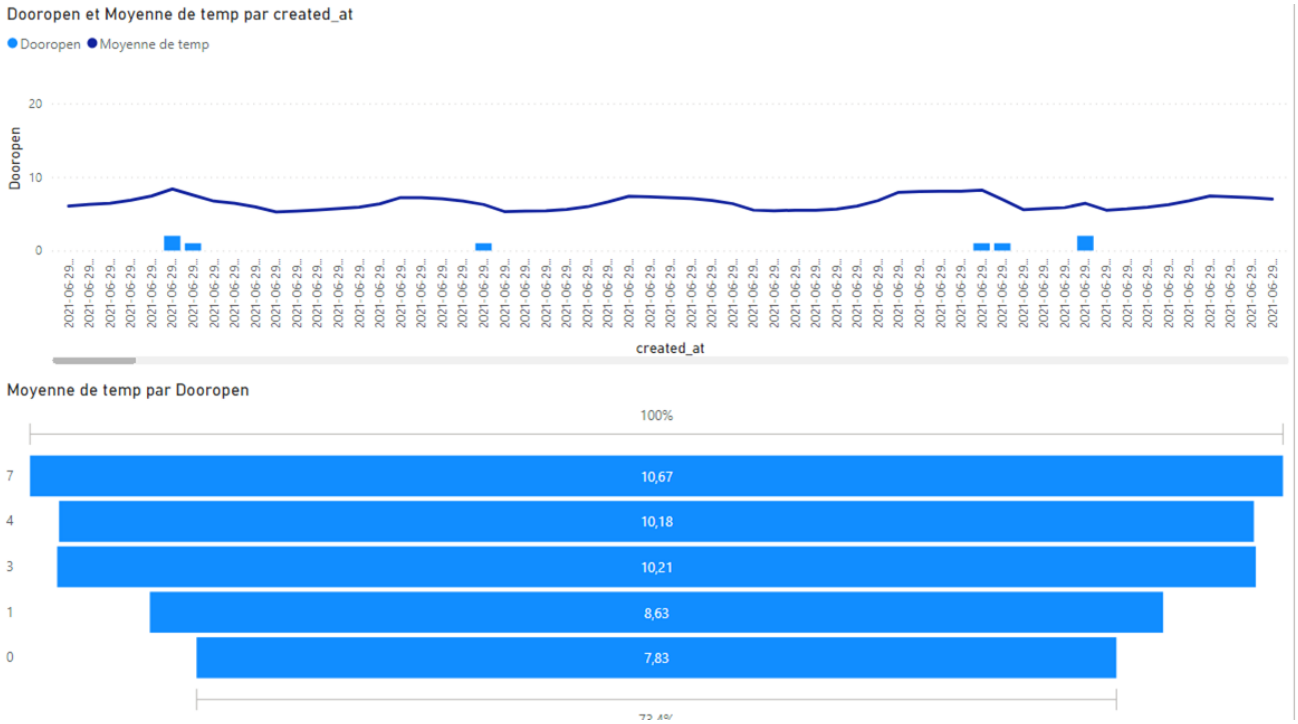


On our Dashboard, we decided to show different values that we considered important:

- The state of Shabbat Mode. If it's colored in green, it's on, and if it's red, it's off.
- Room Temp shows in live the outside temperature of the fridge.
- Door Open shows if the fridge is at the same moment opened or closed. Red means Closed.
- Door open today is a counter that shows the number of times that the fridge was opened on the same day.
- Fridge Temp shows the inside temperature of the fridge. We decided to present this value this way cause it's very visual and the graph color changes from green to red if the temperature is not as it should be (between 2,5°C and 5,5°C)

5. Data

Our data results :

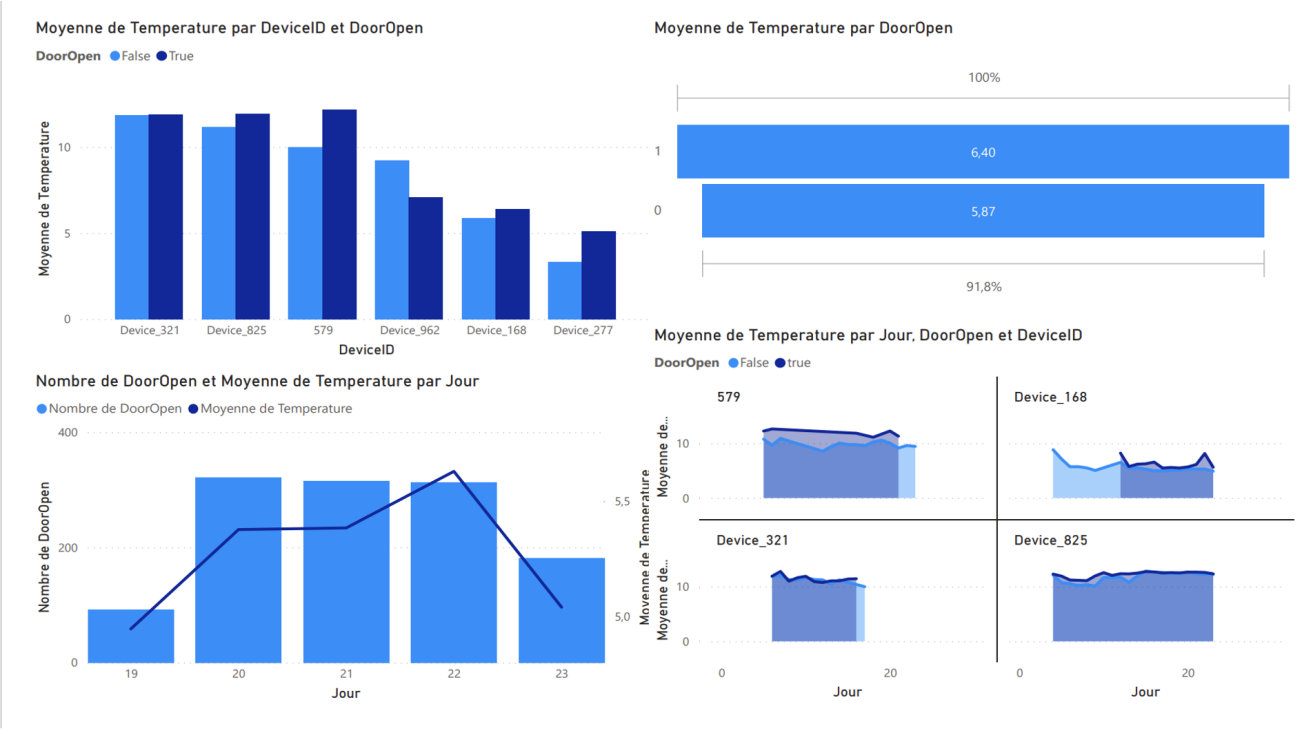


In the first graph, we can observe the fridge's temperature depending on time (the blue line) and below that line, we can observe how many times the fridge has been opened at a specific time. As we could expect, the fridge's temperature increases when the door is opened. The main purpose of the graph is to understand the impact of the action of door opening on the temperature's fridge in real time.

In the second graph, we can observe the temperature's' mean in function of a definite period of time and depending on how many times the door has been opened. For example, the average temperature of the fridge when the door has been opened 3 times in a short time is 10,21 degrees. The main purpose of this graph is to show the impact of the number of times that the door has been opened on the fridge's temperature in a definite short time.

Last year's data results :

First of all, we decided to select the devices where the data was usable to seek conclusions.



In the first graph (up left), we can compare the average fridge's temperature when the door is opened (light blue) and when the door is closed (dark blue), for 6 different devices. We can see that on average between the devices, the temperature is higher when the door is open. Furthermore, we can conclude that the devices Device_962, Device_168 and Device_277 are more efficient because they have a colder temperature than the other devices.

In the second graph (up right), we can observe the temperature's mean if the door was or not opened in the last 5 minutes. For example, the average temperature of the fridge when the door has been opened in a short time is 6,40 degrees. The main purpose of this graph is to show the impact of the opening of the fridge on his inside temperature in a definite short time.

In the third graph (down left), we can see the evolution of the fridge's temperature depending on the number of times that the user has opened the door in a day.
In the last graph (down right), we can see for 4 devices, the mean of the fridge's temperature when the doors have been opened (dark blue) or not (light blue). As expected the light blue curve is generally below the dark blue curve.

To conclude, we've had a great experience and it was a very interesting course for us. This Smart fridge project was very exciting and challenging to design and create. Of course, it was also hard work and lots of investment but we have learned a lot of practical things and we are proud of the project we presented.