C.H.I.P. Fridge

Course: Ambient Intelligence, Campus: Alameda, Group number: 02

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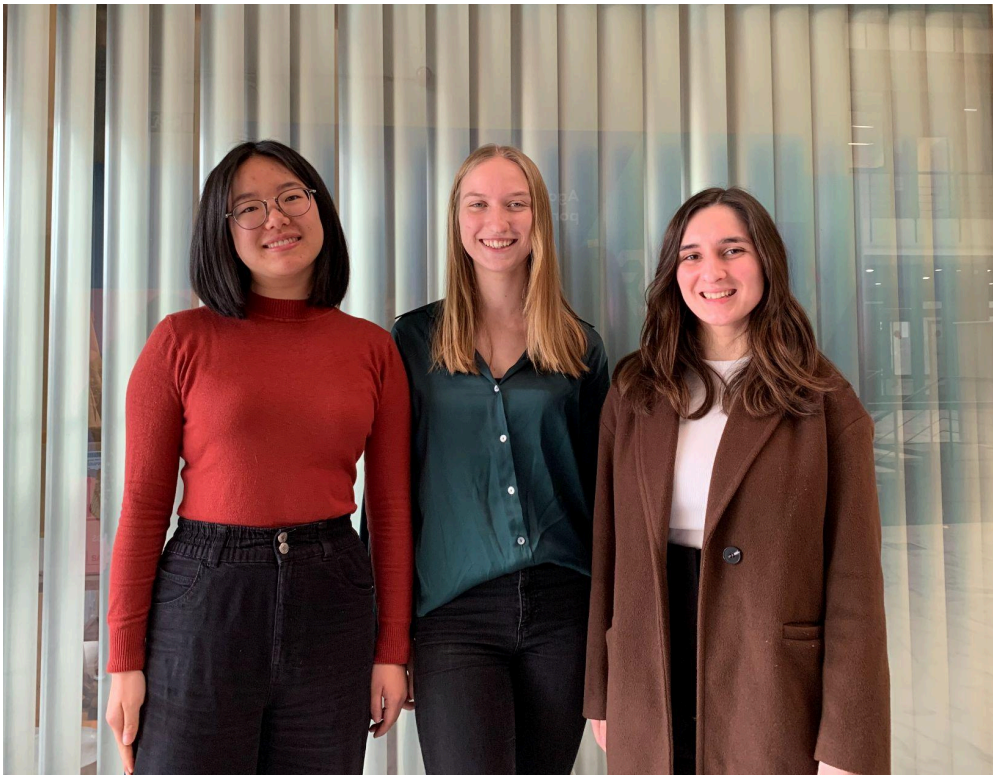


1. Introduction

The Internet of Things brought new features and facilities to human life, changing also the way we interact with our devices. Furthermore, eating and drinking is one of the basic needs of any human being and, therefore, something we also spend a lot of time on. With access to new technologies, improving this time and making it more enjoyable is possible.

C.H.I.P. (Cool Home Intelligent Partner) is a smart fridge with tons of functionalities. This appliance revolutionizes how we interact with our kitchen environment, integrating advanced technology to enhance efficiency, convenience, and culinary creativity.

At the heart of the Smart Fridge is its intelligent Recipe Suggestions feature. It generates recipe recommendations with step-by-step instructions by analyzing the ingredients and quantities available inside.

With a Shopping List Integration, CHIP automatically updates your shopping list as items are used or running low, syncing with smartphones.

CHIP tracks items stored inside, recognizing the items inserted via a camera inside the fridge. A more advanced and expensive version may offer an entertainment functionality which means you can have fun in the kitchen.

Stay ahead of expiration dates and restock efficiently with timely alerts and reminders. The smart fridge ensures that you are notified when items are running low or nearing expiration.

2. Literature Review

Ms. Priti C. Sane et al. in Smart Refrigerator and Vegetable Identification System Using Image Processing and IoT [1], propose a smart refrigerator, focusing on vegetables, but is extensible to other products. The main goal is to reduce food waste and improve human lifestyles. This refrigerator uses a camera that continuously captures images of the vegetables from the refrigerator, and, with the help of machine learning, the vegetables are classified. It also includes sensors to measure the weight of the products, and other sensors to detect the temperature and humidity of the refrigerator.

The paper also mentions the problem of the expiration date of the food but does not specify how to handle it.

Focusing now on hardware, it suggests a refrigerator that has an Arduino UNO connected to Wi-Fi for data transmission, and interacts with humans via an application that can suggest some recipes and allows the user to check the vegetables available in the fridge.

The user will have to enter some relevant information such as the minimum amount of content in order to receive an alert to buy more if there is not enough.

The refrigerator has a push button to distinguish “storage” from “taking out for use”, but its use is not very detailed.

The author also warns of potential security flaws.

In IoT Based Interactive Smart Refrigerator [2], authored by Shalini K. J., Poornavi S. R., Sahana D. K., Sheik Thamanna, Spoorthi Y. D., the objective is to design a refrigerator prototype that reduces waste and improves shopping efficiency by allowing the users to track food items.

In this project, an Android app shows how much food is in the fridge using sensors. Eggs, milk, and bread are tracked with IR (solid item quantity), load (weight measurement), and ultrasonic sensors. The controller compares sensor readings to set limits and sends data to an online platform. The app then updates with this info, letting users order food easily. It also suggests recipes based on available ingredients by a machine learning algorithm, using a camera to identify vegetables. The camera sends images to the app, using K-means clustering to recognize vegetables by their color and number of edges, and then it suggests recipes based on the recognized vegetable.

Inside the application is possible to get real-time updates on the fridge and place orders from an online vendor. From the author's point of view, this smart refrigerator is cost-effective and user-friendly.

A feature highlighted by the author that could be left for future work is the expiration date scan, to alert the user when any product in the fridge expires.

3. Problem

As referenced before, eating and drinking is one of our basic needs. To ensure a good quality of life, we spend a good part of our time preparing (cooking) and choosing (shopping) our food. Furthermore, there is a lot of food waste because we don't know exactly what we have in the fridge. Therefore, we intend to make people's lives easier with CHIP, a smart refrigerator that will allow the user to make the most of their time shopping and cooking, and also reduce the problem of food waste.

Stakeholders will be young people, adults, and elderly people who cook and do their food shopping; and current fridge producers who may want to incorporate this technology into their products.

3.1. Solution Requirements

CHIP The fridge will…

R1 - … recognize the food it currently has;

R2 - … weight the food;

R3 - … monitor the temperature;

R4 - … suggest recipes taking into account existing food and quantities;

R5 - … allow the user to create new recipes;

R6 - … create a shopping list taking into account the user's recent history;

R7 - … estimate the expiration date of the food, allowing the user to avoid food waste and also adjust the shopping list accordingly;

R8 - … alert the user when the food is about to expire / already expired

R9 - … provide an application (easy to use) so that the user can obtain information from a short and long distance;

R10 - … present a high level of security to protect customer's privacy, not being able to collect images out of the perimeter of the fridge and protecting the data that is collected (existing food history, recipes, …).

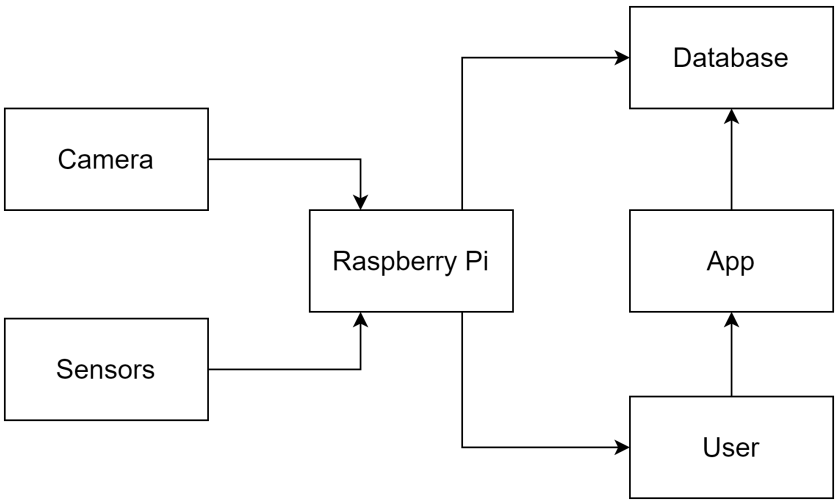
3.2. Assumptions

It is assumed that…
A1 - … the environment where the device is inserted has electricity;
A2 - … there is internet connectivity;
A3 - … the user has a smartphone and can understand a basic application.

4. Proposed Solution

4.1. Overview

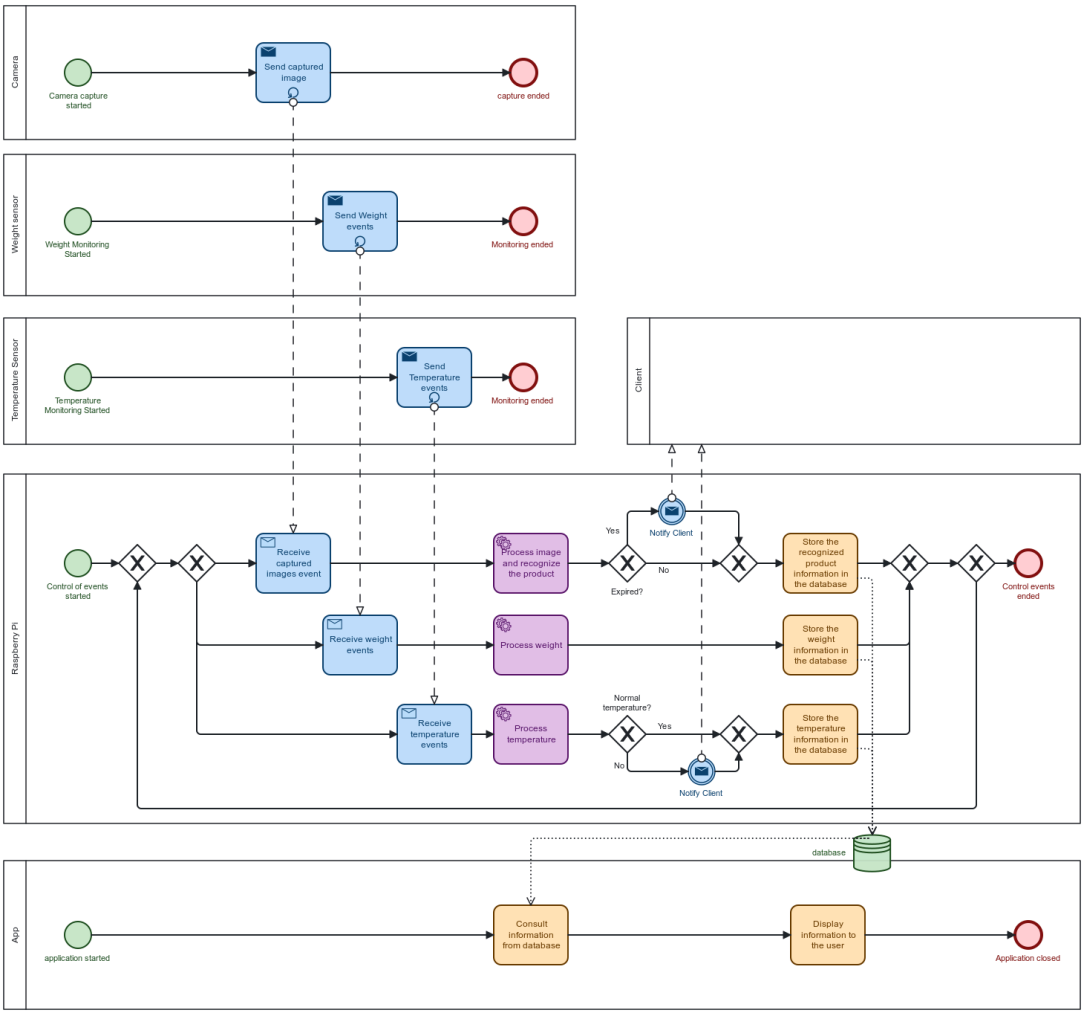
The idea of our project is to create a smart fridge that will help the user reduce food waste and have better management of what they have in the fridge. This way they can save money and time. We want to create a simple application to reach more people. Another goal is to automate the process as much as possible. This means that the user only needs to use the application to obtain information (shopping lists and recipes). It would be possible for the user to insert new information but it is not mandatory, the application should work well only with the data history.



- Camera: Identify the items present in the fridge
- Weight sensor: Weigh the items in the fridge
- Temperature sensor: Monitor the temperature of the fridge
- Raspberry Pi: Process information received from the sensor and camera
- App: The user can see the data collected and manage his shopping list and recipes, both on the fridge (with a screen) and on the mobile phone.

4.2. Logical design

- The Raspberry Pi, when receiving the images captured by cameras and the items' weight from weight sensors, recognizes the images using machine learning, processes them with the weights, and sends the data to the application, where the information is stored.
- The temperature sensor sends the collected temperatures to the Raspberry Pi, and this last one sends alerts by email to the user if the temperature is not proper.
- The application can find recipes on the Internet and suggest them according to the products present in the fridge.
- Raspberry Pi can estimate the expiration date based on the usual conservation interval, and, in the case of vegetables for example, can recognize an expired product by its appearance.
- With the history of products added to the fridge and consumed, the Raspberry Pi can create a possible shopping list.



4.3. Technology selection

The primary development platforms needed are Android Studio and Visual Studio Code. As for the programming language for implementation, we chose Python.

There's a camera inside the refrigerator that is connected to the Raspberry Pi, sending the images there. The sensors are responsible for the weight of the products and temperature of the fridge and the data is also sent to Raspberry Pi. These pieces of information are then processed and sent to the database via Wi-Fi so that the user can see everything in real-time.

5. Bill-of-materials

5.1. Hardware

- Camera - To identify the food inside the fridge
- Weight sensor - To weight the products
- Temperature sensor - Makes sure the temperature is good
- Raspberry Pi - To create the shopping list and send information to the database

5.2. Software

- PyTorch and Torchvision
- Smtplib library - to send notifications by email to the client
- Amazon Web Services Rekognition

6. Plan

The most important feature that we want to achieve is the recognition of the products, followed by the weight estimation. Then a database is created that stores all the information. With this feature complete we will be able to create the application and the feature that creates the shopping list. Based on the existing products, and a recipes database, we will create the feature that suggests recipes. Finally, we want to implement the feature that estimates the expiration date and the one that monitors the temperature (and sends notifications).

Since none of us had any experience with hardware, we decided to work together instead of dividing tasks.

7. Bibliography

[1] Ms. Priti C. Sane, Prof. Harish K. Barapatre, Prof. Ankit Sanghavi, "Smart Refrigerator and Vegetable Identification System Using Image Processing and IoT", Open Access International Journal of Science and Engineering, vol. 6, Issue 4, April 2021

[2] Shalini K J, Poornavi S R, Sahana D K, Sheik Thamanna, Spoorthi Y D, "IoT Based Interactive Smart Refrigerator", International Journal of Advanced Research in Computer and Communication Engineering, vol. 10, Issue 6, June 2021