I-Refrigerator

Fayza Mahmoud, Passant El-zayati, Sherif Moustafa, Remon Medhat
Supervised By: Ahmed Fares and Teaching Assistant: Silvia Soliman

January, 2016

1 Introduction

1.1 Purpose of this Document

The purpose of the document is to gather and construe all assorted ideas that have come up to define the system, its requirements with respect to consumers. Also, we shall foresee and sort out how we hope this product will be used in order to gain a better understanding of the project, outline concepts that may be developed later, and document ideas that are being considered but may be discarded as the product develops.In short, the purpose of this Software Requirement Specification (SRS) document is to provide a detailed overview of our software product's parameters and goals. This document describes the project's target audience and its user interface, hardware and software requirements. It defines how our client, team, and audience see the product and its functionality.

1.2 Scope of this document

The i-refrigerator project detailed in this SRS is designed to identify the objects from the image taken with a raspberry pi camera, as well as record its weight which will be displayed on an LCD touchscreen. In addition, i-refrigerator will suggest recipes based on the stored items in the refrigerator and when an item is about to run out and/or expire the user will receive notifications through the mobile application. Our system Identify entering objects with high accuracy and reducing time.

1.3 Overview

For the system to be able to identify objects, there will be multiple of steps that should be done as follow:

I-Noise removal:
To eliminate any noise like brightness and light variation in the image using filters like the averaging filter and a median filter, both methods set the value

of the output pixel to the average of the pixels that surrounds it.

II-Segmentation:
The watershed transform finds the connecting surface between the two objects in an image by treating it as a surface where light pixels are high and dark pixels are low using these steps:

- Read the image and convert it to gray-scale.
- Use gradient magnitude.
- Mark the foreground objects.
- Mark the background objects.
- Compute the watershed transform of the segmentation function.
- Visualize result.

III-Feature Extraction:
Feature extraction like the SIFT key-points, extracting the item from its surroundings in the image, it gets the points that are on the outer outline of the object.

IV-Classification:
Using Convolutional neural network(CNN), the neurons are organized into three layers; input, hidden and output layers. The input layer is where the desired data analyzed, the hidden layer which compares things and passes it to the next hidden layer till they finish then pass it to the output layer.

V-Training/Testing:
For training, capture images applying the feature extraction then after classifying it is stored it in the database. For testing, the captured image applying object identification system(Noise removal/segmentation/Feature extraction/Classification). And the system will be able to suggest recipes from the stored items using decision tree.

1.4 Business Context

An affordable device which is capable of converting any refrigerator into a smart one without the need of buying luxurious smart refrigerators for example Samsung Family Hub Refrigerator which costs around $4,000 (74922.40 LE).

2 General Description

2.1 Product Functions

The upshot function is to have a standalone device which will be outside the refrigerator or can be built inside while industrializing.The device will be able to recognize items going into the refrigerator, record food expiration date, weight(quantity) and suggest recipes from the stored ingredients. When a product expired or reached the minimum level that entered by the user, the system should send notifications to the user through the mobile application. Also, when a product is about to run out it will be added automatically to a shopping list on the mobile application. Accordingly, I-Refrigerator will result in easier lifestyle to the users saving time and money.

2.2 Similar System Information

As [2] exhibits that a smart Fridge application that is incorporated with smart fridges, the application has a database that record information about each individual user including weight, age and height also, it stores nourishment facts and dietary habits. The smart fridge is capable of scanning entering items through the door sensor as a result, it can record the items' type, quantity, and expiry date. The application notifies the users with the expiry date of the stored items. In addition, it will display information on an LCD screen mounted on the fridge door like healthy recipes and suggest a shopping list when an item is about to run out.

2.3 User Characteristics

Our proposed system could be used by a diversity of user types. Such as adults and teenagers that could capture and weight items. Also, the system will suggest recipes from the stored items. In addition, identified item's name and quantity will be displayed on the LCD screen. Furthermore, our proposed system include mobile application to notify the user when a certain item is expired and/or will run out and automatically suggest a shopping list to the user when the quantity of a certain item is below the minimum level which will be determined according to the user's consumption rate.

2.4 User Problem Statement

Fundamentally, applying image processing techniques such as object identification (Training and testing, segmentation, feature extraction, and classification) to identify objects with higher accuracy and reduce the time to identify it. As well as, using decision trees and text processing to enhance the accuracy of the desired recipes.

2.5 User Objectives

The project main objective is to make everyday lifestyle easier for people as it will help them to know the expiration date of the items they purchase which can be spoiled if it is expired resulting in the waste of food and money. Also, keep track of items in the refrigerator and suggest recipes based on stored items. These features appears through a friendly easy GUI.

2.6 General Constraints

The constraint that faces our proposed system is that processing on the cloud will need a lot of time:

- Considerable database of images.
- Intricacy of recognition process.

To handle this constraint processing on the Cloud will reducing time due to the following factors:

- The CPU and RAM of the cloud match bigger.
- No images will be downloaded.

3 Functional Requirements

Code	FR1
name	take a picture
criticallity	high
input	
output	image sent to make object identification on it
description	the user takes an image of the object he is entering in the refrigerator with the default options of the resolution and brightness ,etc...
expected risks	problem taking the image ,user hand shake and object out of focus
pre-condition	the system is correctly running
post-condition	picture taken
dependencies	image extension

Code	FR2
name	object identification
criticallity	high
input	image
output	identified image
description	the image is taken then feature extraction and classification is applied to identifiy the image
expected risks	wrong image identification and object indentification takes too long
pre-condition	not recognized image
post-condition	recognized image
dependencies	image extension

Code	FR3
name	Generating recepies
criticallity	Medium
input	stored food in the refrigerator
output	food recepies
description	generating recepies based on the food that is stored in the refrigerator
expected risks	wrong recepies
pre-condition	
post-condition	generated reciepes
dependencies	

Code	FR4
name	Sending notification
criticallity	high
input	quantity of items in the refrigerator
output	whether or not to send a notification
description	sending a notification to the user when a certain item is below a certain level and send a shopping list if a user demanded it
expected risks	failed to send a notification
pre-condition	
post-condition	successfully sending a notification
dependencies	mobile operating system

Code	FR5
name	Sign up
criticallity	high
input	user name, email and password
output	register the user
description	Sign up form that allow users to signup using their email and password.
expected risks	sql injection and wrong data entered
pre-condition	not registered user
post-condition	registered user
dependencies	

Code	FR6
name	Sign in
criticallity	high
input	email and password
output	successfully log-in
description	the user type his email and password and he log in
expected risks	sql injection and wrong data entered
pre-condition	user not logged in
post-condition	logged in user
dependencies	

4 Interface Requirements

An easy-to-use interface for users to be able to easily deal with the system.

4.1 User Interfaces

Our proposed system designed with a simple friendly User Interface(UI) to be easily used by the users. Firstly, the LCD which will be mounted on the refrigerator's door has containing an application that let the users whether to add new or existing items through capturing images for the entering items. Secondly, users can get recipes from the stored ingredients as well as checking the inventory.

4.1.1 GUI

The friendly interface let the user manage the entering items by capturing images to add it to the inventory as shown in the figures down.

4.1.2 API

OpenCV: A library used for Image Processing. **Google Cloud:** A hosting and computing, cloud storage, data storage. **Keras:** is an open source neural

network library written in Python. It is capable of running on top of either Tensorflow or Theano.

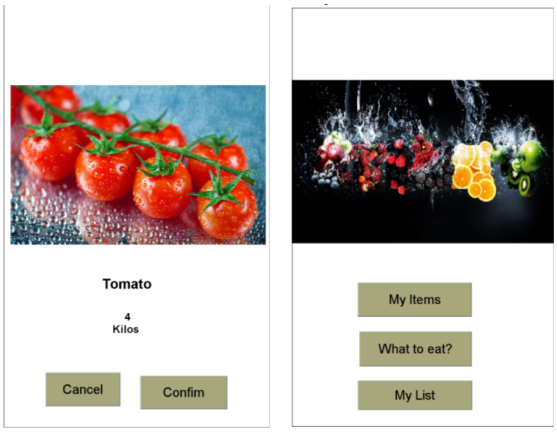

Figure 1: User Confirmation for an entering item

4.1.3 Diagnostics or ROM

- Raspberry Pi(RP)
- Raspberry Camera
- LCD screen

4.2 Hardware Interfaces

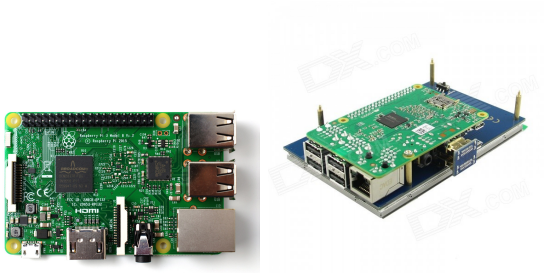

Figure 2: Raspberry Pi 3.

Figure 3: Raspberry Pi camera.

Figure 4: Raspberry Pi and LCD screen HMDI.

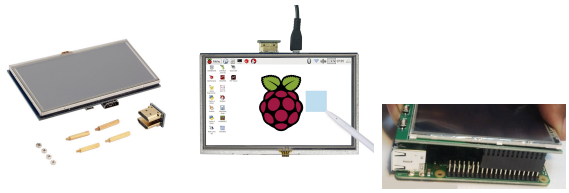

Figure 5: LCD screen 5-inch.

Figure 6: Raspbian OS SD card.

4.3 Communications Interfaces

5 Performance Requirements

Enhances The speed by uploading the code on the Google cloud which helps in reducing processing time. As much as possible, try to make the process storing of the items in the database, which includes capturing the image and processing

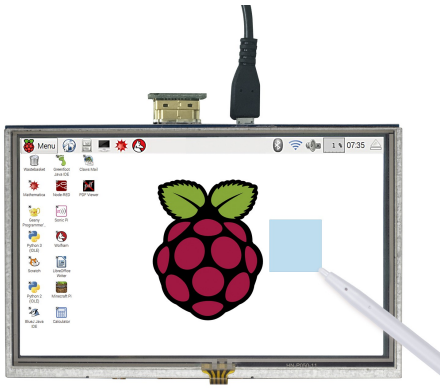

Figure 7: LCD touch screen 5-inch.

on it, less than 5 seconds.

6 Other non-functional attributes

Code	NFR1
name	written code
type	maintainance requirement
description	the source code must be identied and understandable , the methods must have clear names that describes what do the function do, like so the classes must have names that describe what they do.
priority	10/10

Code	NFR2
name	commented code
type	maintainance requirement
description	the source code must be commented to guarentee a better maintainance of the software which translate also into upgradability
priority	10/10

Code	NFR3
name	system security
type	security requirement
description	Checking for unallowed strings entered in the the login form which will stop several mysql injection attacks , also the password of the user will be encrypted in the database.
priority	10/10

Code	NFR4
name	user manual
type	usability requirement
description	there must be a user manual written for the final users using simple and understandable language that elaborates how the system works.
priority	9/10

Code	NFR5
name	memory size used
type	Portability requirement
description	the software must occupy the minimum amount of space on the hard disk
priority	10/10

7 Preliminary Object-Oriented Domain Analysis

7.1 Class Descriptions

7.2 User:

Concrete.

7.2.1 List of Super Classes:

7.2.2 List of Sub Classes:

No sub classes for user.

7.2.3 Purpose:

This class contains all the operations that the user can do it.

7.2.4 Attributes:

Name, Email, Mobile, Password.

7.2.5 Operations:

Login(Email,Password);
SignUp(Name,Email,Mobile,Password);
InsertItem();
UpdateItem();
DeleteItem();
weighItem();
CaptureImage();

7.3 Notifications:

Concrete.

7.3.1 List of Super Classes:

7.3.2 List of Sub Classes:

No sub classes for user.

7.3.3 Purpose:

This class contains functions that respond to the users' actions.

7.3.4 Attributes:

NotificationsContent,TimeStamp.

7.3.5 Operations:

Notifications();
Notifications(String NotificationsContent, int TimeStamp);
set NotificationsContent(String NotificationsContent);
get String NotificationsContent();
set TimeStamp(int TimeStamp);
get TimeStamp();

7.4 Mobile:

Concrete.

7.4.1 List of Super Classes:

7.4.2 List of Sub Classes:

No sub classes for user.

7.4.3 Purpose:

This class for displaying notifications for the users.

7.4.4 Operations:

ReceiveNotifications(Notifications N);
DisplayNotifications(Notifications N);

7.5 Cloud:

7.5.1 List of Super Classes:

7.5.2 List of Sub Classes:

7.5.3 Purpose:

7.5.4 Attributes:

Image, resultedName, resultedWeight.

7.5.5 Operations:

cloud();
cloud(bufferedimage img, string resultedName, double resultedWeight);
recieveImage();
sendInformation();

7.6 Object Identification:

7.6.1 List of Super Classes:

7.6.2 List of Sub Classes:

.

7.6.3 Purpose:

This class contain all function for the identification of objects.

7.6.4 Operations:

Segmentation();
featureExtraction();
classifyInput();

8 Operational Scenarios

The first thing that will appear in the system on the LCD screen will be a sub-menu that will offer three options (My items - What to eat? - My list), when the user press on My items another sub-menu will appear with options (New - Old) and all the system sub-menus will have a back button, when the user press New the camera will open up and he will capture an image for the item and take it's weight , this item will be send from the raspberry pi to the cloud where image processing will be done to identify the item , then the result will be sent back to the raspberry pi and will display the result in a new sub-menu that will have a the details of of the item entered which is the weight or quantity and

the item name , a 'confirm' button and a 'cancel' button , the user will click the 'confirm' button when the result is the same as the item he had , otherwise the user will click ' cancel'. If the user in the previous step pressed on ' Old ' , the system will compare the item with what the current items in the fridge and will add the quantity which will be taken from the weight sensor to the stock quantity in the fridge. For the second option , when the user press on 'What to eat', a sub-menu will open and with a search bar where he can search for recipes. for the third option , when the user press on ' My list ' , a sub-menu will open with all the items that is currently stored in the fridge and it's quantity. there is also a mobile application that will send a notification to the user when a certain item is below a certain level or that it will expire in the near future and will make an automated shopping list to the user .

9 Preliminary Schedule Adjusted

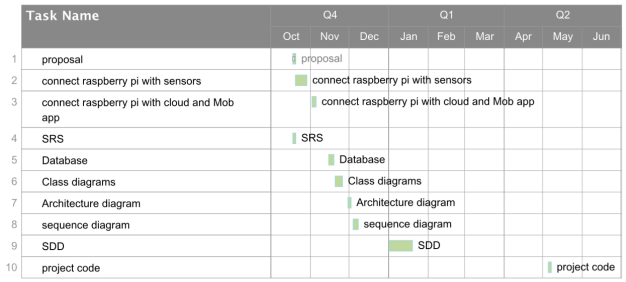

Figure 8: Project Plan.

10 Preliminary Budget Adjusted

Resource	Cost
Raspberry pi 3 Model B	Around 925 LE
5MP Night Vision Camera	550 LE
5-inch LCD Touch Screen Suitable for Raspberry Pi	550 LE
Weight sensor	100 LE
Micro SD card 32 GB class 10	130 LE
Micro SD card 16 GB class 10	90 LE

11 Appendices

11.1 Definitions, Acronyms, Abbreviations

Raspberry Pi(RP): is a series of credit card-sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries.

Image Processing: The analysis and manipulation of a digitized image, especially in order to improve its quality.

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel's research center in Nizhny Novgorod (Russia), it was later supported by Willow Garage and is now maintained by Itseez. The library is cross-platform and free for use under the open-source BSD license.

A convolutional neural network (CNN or ConvNet): is a type of feed-forward artificial neural network in which the connectivity pattern between its neurons is inspired by the organization of the animal visual cortex(plays an important role in processing visual information).

Scale-invariant feature transform (SIFT): an algorithm in computer vision to detect and describe local features in images. The algorithm was patented in the United States(US) by the University of British Columbia and published by David Lowe in 1999.

Raspbian: is a Debian-based computer operating system for Raspberry Pi. It is now officially provided by the Raspberry Pi Foundation, as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012. The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

11.2 Collected material

Hardware components: All purchased from RAM electronics.
Dataset: A ready made dataset from a similar system[1]

12 References

References

[1] Hokuto Kagaya, Kiyoharu Aizawa, and Makoto Ogawa. "Food detection and recognition using convolutional neural network". In: *Proceedings of the 22nd ACM international conference on Multimedia*. ACM. 2014, pp. 1085–1088.

[2] Suhuai Luo et al. "Smart fridges with multimedia capability for better nutrition and health". In: *Ubiquitous Multimedia Computing, 2008. UMC'08. International Symposium on*. IEEE. 2010, pp. 39–44.