I-Refrigerator

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October 18, 2016

Abstract

The main idea of the project is to have a standalone device which will be outside the refrigerator or can be built inside while manufacturing.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.

1 Introduction

1.1 Background

IoT has been used in every aspect of daily life to provide interconnection among many devices, vehicles (also known as connected devices or smart devices) buildings, and other items embedded with electronics, software, sensors, and actuators. And the proposed system will connect raspberry pi with a camera, weight sensor, LCD screen and a mobile device.

1.2 Motivation

First of all, the academic motivation is to identify entering objects with high accuracy and reducing the time taken to identify it. In addition, enhancing the accuracy of desired recipes by applying text processing techniques and decision trees. Secondly, according to a survey published on October 5th by the team members, it is found that people are in need to be reminded of the food expiration date in their refrigerators and they would like a mobile application to provide them with suggested shopping list. Besides, they would eat healthier and cook by themselves if they have suggested recipes from their stored ingredients everyday.

1.3 Problem Definition

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 Project Description

The system will take a photo of the item using a raspberry camera, then the item will have a default expiration date and the user could choose whether to change it or not. The item will be scaled on a weight balance so the system is to store the food weight(quantity). Then the raspberry pi(RP) will send the object captured image to the cloud applying image processing techniques to identify the objects in the image, returning back the item data to the raspberry pi which will be stored in the database. The identified items' name and quantity will be displayed on the LCD screen. A mobile application to notify the user when a certain item is expired and/or will run out and automatically suggest a shopping list when the quantity of a certain item is below the minimum level which will be determined according to the users' consumption rate. Also, the system will suggest recipes from the stored items.

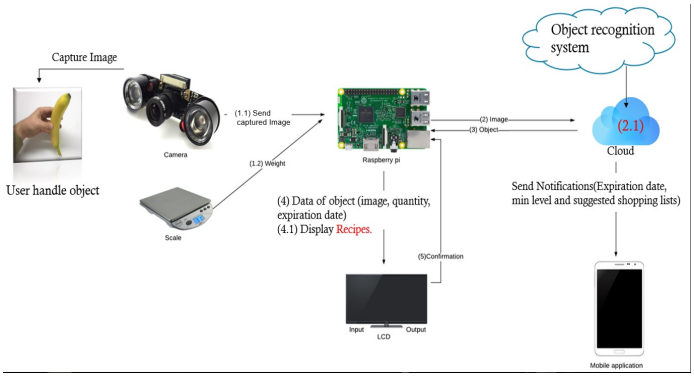

Figure 1: System Description

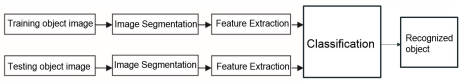

Figure 2: Object Identification System

2.1 Objective

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.

2.2 Scope

The project scope is to identify the objects from the image taken with a raspberry pi camera, record its weight which will be displayed on an LCD touchscreen. Furthermore, it 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.

2.3 Project 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:

A)Read the image and convert it to gray scale.
B)Use gradient magnitude.
CMark the foreground objects.
D)Mark the background objects.
E)Compute the watershed transform of the segmentation function.
F)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.

3 Similar System Information

Suhuai Luo, Hongfeng Xia, Yuan Gao, Jesse S. Jin, and Rukshan Athauda[9] introduced a novel application for a smart fridge with an intelligent multimedia capability which is designed to manage the stored items, provide users with nutrition facts and advising its users with cooking methods depending on what kind of food is stored. Although, we are going to develop a similar system but it will be capable of identifying and categorizing objects before storing even if they are not known by the system.

The increase of smart appliances such as LEDs and/or LCDs with remote controllers have caused inconvenience for users which arises the need of unified, visual and easy operation controller as mentioned by Ou Yang-Xin, Shuai Chun-Yan, Jiang Hong, and Lv Yang in[13] that presents the ESHG(Embedded Smart Home Gateway). A simple, easy and remotely control PDA like controller, that is the manager of the household network and all appliances, which is responsible for receiving the registration and cancellation of home appliances, receives master's command and sends the order to the appliance according to the IA-WRAPPER protocol formats and then send back the results of the order to the user.

The novel easy-to-use technologies has increased the interest in ubiquitous computing even for home appliances like Mert as Bal, Weiming Shen, Qi Hao, and Henry Xue presented in [2] the system uses number of motion sensors operating on Zigbee wireless protocol to analyze and collect data based on actions. Alerting family members through auditory and visual prompts about any failure of home appliances.

Wilson Feipeng Abaya, Jimmy Basa, and Michael Sy [1] presented a system having a raspberry pi connected with an ordinary webcam that is capable of detecting objects' motion using background subtraction algorithm to avoid potential fires by notifying the users through their e-mails. Besides, it sends captured image to notify the user of the upcoming events.

Charalampos Doukas proposed the Collaborative Open Market to Place Objects at your Service(COMPOSE) system [6] which provides an open-source infrastructure and a set of tools and methods for building smart applications that can communicate with smart objects like smart-phones, sensors...etc. These interactions require the utilization of IoT technologies to be communicated by external services.

Kevin Bouchard, Dany Fortin-Simard, Jeremy Lapalu, Sebastien Gaboury, Abdenour Bouzouane, and Bruno Bouchard[4] presented a data mining algorithm adapted for the recognition of Activities of Daily Living (ADLS) inside a smart home in real time to ensure higher quality of life.

The development of projects using hardware such as Raspberry Pi(RP) making the costs of implementing smart home solutions much cheaper as César Cheuque, Felipe Baeza, Gastón Márquez, and Juan Calderón stated [5]They presented a simple system to automate and facilitate access to the people into their home lighting network. It is able to turn on/off LEDs using smart-phone through which Raspberry Pi(RP) IP(Internet Protocol) can be accessed that can be used by a huge user group in the same network.

According to[15] ZHIHENG ZHOU, XIAOWEN ou, and JING XU proposed a combination between Speeded Up Robust Features (SURF) and Mean-shift tracking algorithms that obtained a self-adaptive bandwidth based on SURF feature matching which met the need of real-time tracking and/or recognizing of objects with high accuracy.

J. Cloud Yu, I-Cheng Chang, and Yi-Jun Lin in [14] The increase of mobile usability and the storing of many unstructured data files lead to the growing usage of cloud storage services. The proposed service collects 200 music pieces, whose duration are pre-clipped and the music adding process selects music pieces with the proper emotion and length for the reviewing video. This work proposed a Flexible Harmony Search Algorithm (FHSA), which is modified from Harmony Search Algorithm (HSA). Therefore, it produce the appropriate background music based on the video emotion.

Neslihan Bayramo˜glu, A. Aydın Alatan in[10] proved that integrating the Scale Invariant Feature Transform(SIFT) algorithm with shape index representation in matching surfaces with different scales ,orientation, and occlusion improve the performance and efficiency for matching.

Rodrigo C. Barros, Márcio P. Basgalupp, Alex A. Freitas, and André C. P. L. F. de Carvalho [3] In this paper, they proposed HEAD-DT, a hyper-heuristic algorithm that automatically purposes for top-down decision tree induction algorithms tailored to a certain type of classification data set (or application domain). Following recent penetrations in the automatic design of machine learning algorithms. Also, they assessed the performance of HEAD-DT by two different predictive performance measures, accuracy, and F-measure.

Chethan sharma, Shafeena Basheer, Anish Francis, and Anish Francis in[11] examined the image identification of X-ray radiographs of lungs for diagnostic purposes where the input data for learning is, the radon transform for projection transform of the images. The neural network we used was back propagation neural network trained with Levenberg-Maquardt algorithm.

Shiv Ram Dubai discussed [7] In this paper, texture feature or texture identification presented here using improved sum and difference histogram (ISADH) performance and comparing it to other state of art color and texture features in the fruits and vegetables classification, and proving that ISADH has a better performance and accuracy. Using neighbor pixels and merge them with color pixels, is what makes it has a better performance.

Bai Xingli ,Zhang Yuanping proposed in [12] the fast SVM classification algorithm-FCSVM it has been successfully utilized to pattern recognition problems and considerable classification like text categorization, image recognition and bioinformatic.In addition, the fast SVM classification algorithm was improved and using dichotomy to reproducer the minimum subset met requirements as the main calculation of accuracy from vector set. Also , reducing the complexity of the time of structuring matrix and support vector subset.

Hokuto Kagaya , Kiyoharu Aizawa , Makoto Ogawa In this paper [8],they want to recognize and detect food item although there are lots of food types and it is hard to get. They applied here convolution neural network (CNN) and compared its performance with traditional methods to evaluate the accuracy of the CNN using a dataset of the most types of food that people frequently used.

3.1 Similar System Description

Regarding [9] that presents a smart Fridge application that is integrated with smart fridges, the application has a database that record information about each individual user including weight, age and height also, it stores nutrition 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.

[8] It appeared in this paper after comparing Convolutional neural network(CNN) with Traditional methods to recognize different types of food through images recognition, that CNN has much better performance using handcrafted features, using data set of many types of food people mostly use. They also concluded that color features are very important in food recognition.

3.2 Comparison with Proposed Project

Point of comparison	Data set size	Algorithm	Accuracy	Real time data
[15]	Video in MATLAB	SURF	-	No
[10]	201 images	SIFT with Shape index	75 %	No
[8]	170,000 images	CNN	62.5 %	Yes
Our proposed system	-	Convolutional neural network(CNN)	-	Yes

4 Project Management and Deliverables

4.1 Tasks and Time Plan

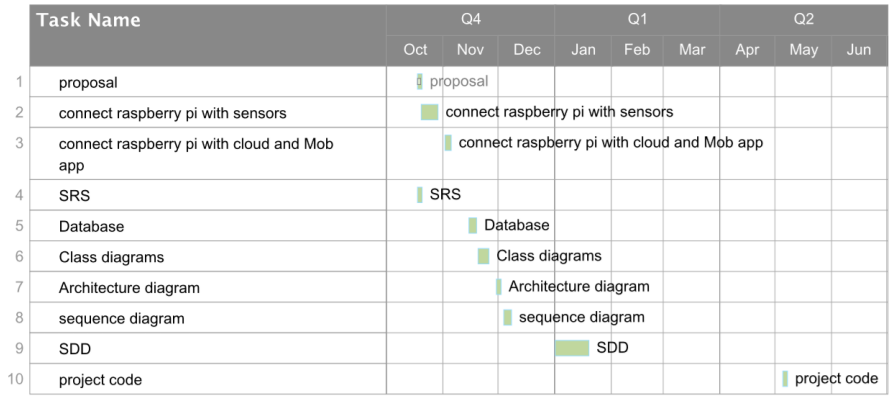

Figure 3: Time Plan for Deliverables

4.2 Budget and Resource Costs

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

4.3 Supportive Documents

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