A Mobile Adviser of Healthy Eating by Reading Ingredient Labels

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A Mobile Adviser of Healthy Eating by Reading Ingredient Labels

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Abstract. Understanding ingredients or additives in food is essential for a healthy life. The general public should be encouraged to learn more about the effect of food they consume, especially for people with allergy or other health problems. However, reading the ingredient label of every packaged food is tedious and no one will spend time on this. This paper proposed a mobile app to leverage the troublesome and at the same time provide health advices of packaged food. To facilitate acquisition of the ingredient list, apart from barcode scanning, we recognize text on the ingredient labels directly. Thus, our application will provide proper alert on allergen found in food. Also it suggests users to avoid food that is harmful to health in long term, like high fat or calories food. A preliminary user study reveals that the adviser app is useful and welcomed by many users who care about their dietary.

Key words: Healthy dietary; Food ingredient; Text recognition; Health suggestion; Mobile health

1 Introduction

As a metropolitan nowadays, we are busy at every moment for our work or study. We get used to choose food based on their flavor or common sense, but we seldom think about if its ingredients are good to our health or not. While there is a huge number of new food products to the market every day, it is somehow risky to simply choosing them based on previous knowledge. However, reading the information from food packages can be tedious and require specific knowledge in judging whether certain food had positive or negative effects to our health. Hence, probably no one is willing to spend time on reading them.

Our health is directly affected by what we consumed in both short or long term. For instance, people with food allergy can have fatal reactions to certain food after food intake shortly or instantly. According to a recent study, there are about 5% of children and 4% of adults allergic to one or more kinds of food. 90% of their allergic responses are caused by common foods such as cow's milk, peanuts, and eggs. For long term health, high fat or calories food can accumulate in the body and cause artery diseases, diabetes and other illnesses. Some studies also believe that food additives and preservatives can increase hyperactive behavior in young children. Thus, it is important to be aware of the food in-taken in a daily manner.

Our project comes into the place to help people who suffer from food allergies to select their food safely, as well as the general public in understanding more on their daily dietary. We developed a mobile application to relieve the difficulties in learning food ingredients in packaged food and provide alerts or suggestions for a healthy dietary. Our system provides ways in identifying the ingredients of food products from barcode scanning to direct recognizing the ingredient label. By associating with an ingredient database, suggestions can be provided automatically. As a result, when a user is going to buy a packaged food, he/she can scan the barcode or the text printed on the package to understand the ingredients as in Figure 1(a).

There are two main technical challenges in this project: text recognition in ingredient label and automatic health suggestion. Although text recognition or optical character recognition (OCR) had reported many successful results from the literature, existing mobile OCR engines may not perform well especially when the recognition is done under poor lighting conditions. Thus, we employed several image processing techniques to reduce effect caused by poor lighting, and incorporating approximate matching to our ingredient database in order to improve the recognition outcome. Moreover, providing health related suggestions purely based on the elements listed on the ingredient list is insufficient. It is because some ingredients are correlated and contains similar effects after consumption. Naïvely providing suggestions may generate tons of duplicated messages and easily overwhelm users. So, we proposed a method to consolidate and better organize the suggestions.

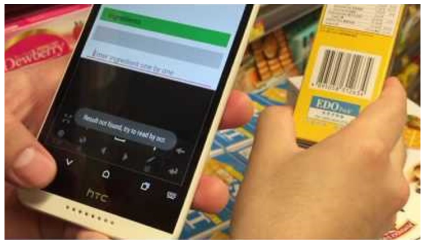
A number of users are invited for testing our app. Most of them are satisfactory to the functionality provided and think the health suggestion are helpful for choosing food products. With our system, the ingredient label becomes more meaningful to everyone. The public can understand more about what they eat and eat wisely. We believe that this application will promote the awareness of healthy eating habits as well as to help people with food allergy to regain certain pleasures of eating in their life.

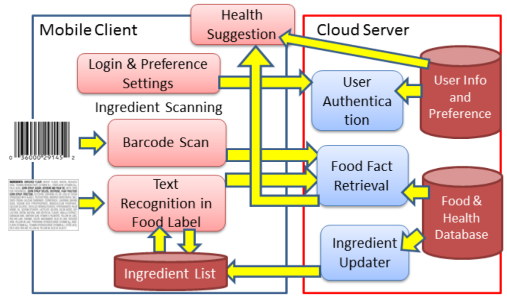
2 Related Works

In recent years, many systems for mobile health (mHealth) have been developed and widely accepted by the public. Most of them are common in exploiting the ubiquitous nature of mobile applications in order to provide monitoring or tracking of physiological status [8, 7, 12, 10].

Among all these examples, food monitoring or logging system is a popular kind of mHealth applications. These food monitoring systems mainly target to analyze the food habit of users and provide suggestions or alert for the diet program of the users. SapoFitness [11] is a mHealth application for dietary assessment. This application provides a list of food for user to input the calories intake. Unlike our system, this kind of application usually cannot help the users in choosing a new product before they make a purchase.

MyFitnessPal. [9] obtains the nutritional values of food by scanning the barcode and suggests users how to keep fit. Image-based food monitoring systems [5, 2] recognize the foods by analyzing food photos. This allows the user to learn the food ingredients or nutrition by simply taking photo. Available works





(a) (b)

Fig. 1. (a) A usage scenario of our mobile app: a user can easily understand more on the ingredients of a food product by simple scanning. (b) An overview of our system.

for people with food allergy [4, 1] allow the user to check the existence of food allergens by barcode scan of package labels. However, these systems all require the products to be registered in the database for their system. In contrast, our system can read the ingredients label and find out food allergens even if the product is not found in the database.

3 System Overview

Our system is mainly divided into 3 major components, they are the ingredient scanning module, health suggestion module and food & health database. Figure 1(b) illustrates the relations between components in the system.

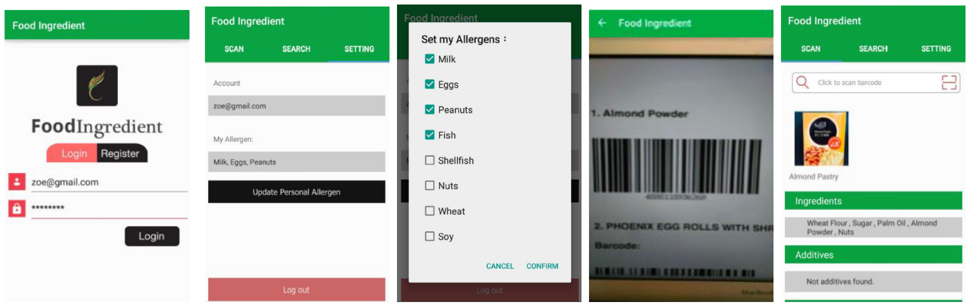
The ingredient scanning module enables the user to identify food product and related ingredient quickly with barcode scanning, as well as text recognition of ingredient label when the food product is not available in the food database. The health suggestion module relies on the food & health database on the server, together with the user's preferences stored with his/her user account which is managed by the user authentication module. The food & health database stores updated information about food products including its product name, ingredient, manufacturer, health suggestion, and etc.

4 Implementation

Following the standard of mobile apps nowadays, the interface is designed to be simple and user friendly enough for daily use. Figure 2 shows a number of screenshots of our mobile app. To enable personalization and support user preferences, user has to login (Figure 2(a)) to our system. The user preferences include selection of allergic ingredients to give alert (Figure 2(b) and (c)).

4.1 Barcode Scanning and Food Database

Almost all packaged food products are printed with barcode labels, but it is designed for sale purposes. It is seldom for the barcode to associate with food ingredient information or even health related suggestions. Thus, many databases



(a) (b) (c) (d) (e)

Fig. 2. The user interface of our mobile application, including a) user login page, b) account settings, c) allergen selection, d) scanning of barcode, and e) result of barcode scanning.

are developed to include barcode-ingredient relation. However, most of these databases are proprietary, except the open food facts [14], or they do not fully cover enough food product entries.

Taking open food facts as an example, it contains 50,000 entries of food products from 134 countries, but most of them are from Europe. The database stores many useful product related data, including the generic name, category, list of ingredients, nutrition facts and etc. Thus, we directly make use of these existing entries for a preliminary retrieval of ingredients. While, we also have our own database which is built to tailor for local food products. Thus, whenever an entry does not exist in the open database, we will rely on our own. Figure 2(e) shows the food ingredient retrieval result by scanning the barcode.

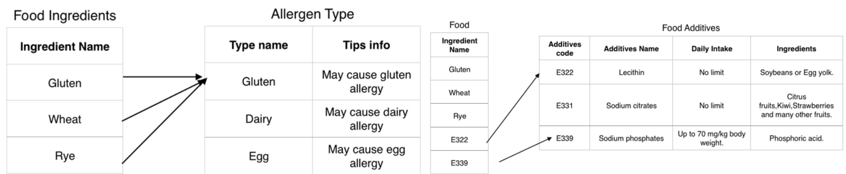
However, most of the food database contains only manufacturing and nutrition information of the food product. No health related information is included. Our food & health database therefore serves this purpose by associating health recommendations to ingredients. The major effective component in the ingredients are factored out so as to produce useful and tidy suggestions in time. For example, many food ingredients like gluten, wheat, and rye, they may cause the same gluten allergy, because all of them contains gluten which is the actual source of allergy. Thus, the recommendations are associated with the actual source gluten only but not the ingredient as in Figure 3(a).

smart

Similarly, some additives are made of other ingredients which further causes other health problems. Like Figure 3(b), additive E322 is made from soybeans and egg yolk. Thus, additive E322 should produce similar health suggestions to soybeans and egg yolk. This decomposition of ingredient to effective components can avoid repeated suggestions which overwhelm the user.

4.2 Text Recognition in Ingredient Labels

One way to identify the food ingredient is to read the ingredient list printed on the package of food. This ingredient list can be easily found on many packaged food products as it is required by the safety regulation of many countries. However, reading all the ingredient lists of every food one-by-one is tedious and



(a) (b)

Fig. 3. Relationship between food ingredients and health suggestions.

sometimes difficult. Some ingredients, like additives, are either not well-known to the general public or written in scientific names. For instance, not many people know that "Mandelona" and "Enchilada sauce" are two ingredients which contain peanuts.

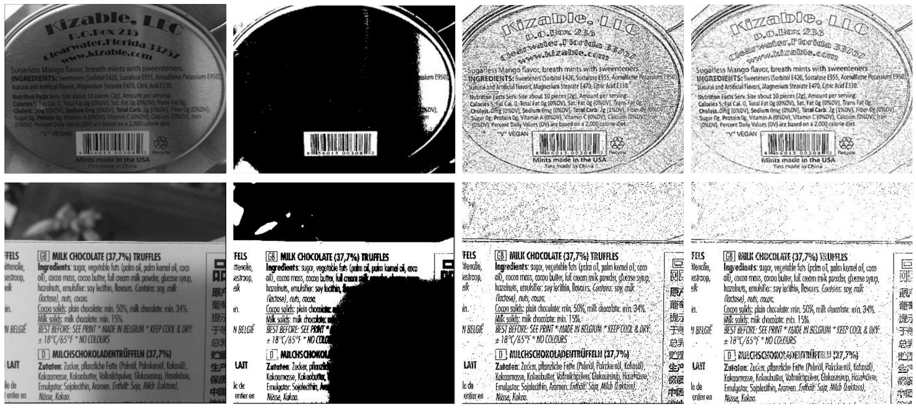
As a result, our mobile app allows users to scan the label, and analyze the ingredients. To accomplish this, we rely on OCR techniques with improvements in speed and accuracy by means of text region extraction, adaptive thresholding, and approximate matching.

Text Region Extraction Before recognition, our method tries to locate text regions in image. Thus, we employ MSER (Maximally Stable Extremal Regions) [3] algorithm for fast region detection as shown in Figure 5. It will extract regions (in red) which have high chance containing text. Hence, later processing like image enhancement and OCR will only involve these extracted regions. This speeds up a lot as irrelevant regions are ignored. Moreover, we can effectively reduce noise generated from OCR as non-text parts are filtered out before the recognition.

Adaptive Thresholding Most of the text recognition engines begin with a gray-scale conversion of image and followed by a thresholding to produce a binary image. In our implementation, we use Tesseract-OCR engine [13] which preforms thresholding with Otsu approach. However, the Otsu method does not work well under extreme lighting conditions, like environment containing regions that are too bright and too dark.

We, therefore, try to improve thresholding with the use of adaptive approaches, including the Adaptive Mean and Adaptive Gaussian Thresholding. Figure 4 shows the results with different methods. Otsu thresholding always fails to handle changes of brightness across text regions. Shadow regions will completely turn into black, seriously ruins the recognition. Both adaptive methods generate more reasonable binary results useful for subsequent recognitions.

Approximate Matching Directly performing recognition with Tesseract-OCR engine does not always provide acceptable results in practice. One reason is that the thresholding result always contains noise. Thus, the recognized text outcome usually looks scrambled or incorrect as shown in Figure 5 or Figure 6(b). It often returns paragraphs of text with extra punctuations or irrelevant digits (Figure 5) and some spelling of words are wrong (underlined in Figure 6(b) in red). More-



Original Ostu Adaptive Mean Adaptive Gaussian

Fig. 4. Comparison of different thresholding methods.

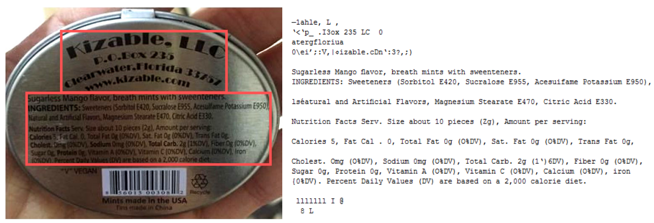
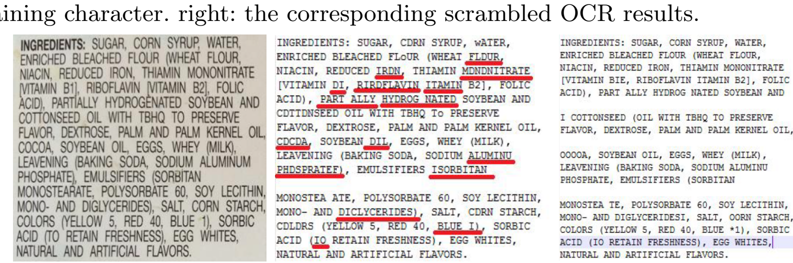


Fig. 5. left: Text region detection. The red colored box indicates the detected regions containing character. right: the corresponding scrambled OCR results.



(a) Original food label (b) Result directly from OCR (c) Result tidied up

Fig. 6. Recognition accuracy improved with use of approximate matching with the ingredient list.

over, we would like to extract only words that are ingredients, and remove those irrelevant like product name, weight or manufacturer name.

To tidy up the results, our idea is to remove or correct them based on our ingredient list. That means only words that are certain or likely to be ingredient will be extracted. Currently, we have implemented a full text search with criteria to approximate match strings that are smaller than half word length of the ingredient name. A simple approximate string distance measure based on the Levenshtein algorithm [6] is employed with a quick pruning when the word length difference is more than double. Figure 6(c) demonstrates an exam-

No.	Question
1	What is degree of satisfaction to you on the reliability of this application?
2	What is degree of satisfaction to you on the security of this application?
3	What is degree of satisfaction to you on the ease of use of this application?
4	What is degree of satisfaction to you with the look and feel of this application?
5	What is degree of satisfaction to you with the account setup experience?
6	Choose the best in the app from (UI/Layout; Ease of use; Barcode scan; OCR)
7	Choose the worst in the app from (UI/Layout; Ease of use; Barcode scan; OCR)
8	Do you think the health suggestion are helpful?
9	What else do you think the health suggestion function should provide?
10	What do you think about the speed of OCR function?
11	Which is more important to you about the OCR function? Speed or Accuracy?
12	Please provide further comments or suggestion to improve the application

Table 1. The 12 questions that are asked in our user study.

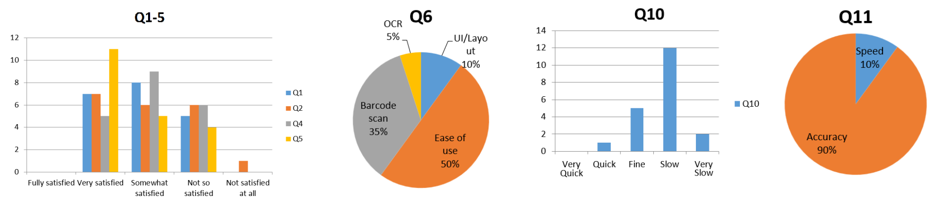


Fig. 7. Responses from our user study.

ple of applying approximate matching after OCR. We can find that many of the wrongly recognized words in Figure 6(b) are now corrected with the use of ingredient list.

5 Preliminary Result

To evaluate the effectiveness of the developed mobile application and obtain useful user opinions for further improvements, a small scale user study is carried out. A total of 20 subjects are asked to make a trial to our app using an Android phone with Qualcomm snapdragon 615 CPU and 2GB RAM, followed by completing 12 questions listed in Table 1.

Some of the responses to the questions are shown in Figure 7. We can find that the satisfactions to different aspects of our application are slightly satisfied in general, with nearly no unsatisfied or totally satisfied. Most of the users think ease of use is one of the best parts in our application, while barcode scan is also another part which they like most. Regarding to the speed of OCR, over half of them think it is slow, this may be caused by the low-end android device and the preprocessing is not optimized yet. It is also the reason why only 5% of them think OCR is the best part in the mobile app. In contrast to speed of OCR, over 90% of the users will prefer to have better accuracy in the text recognition which is the focus of enhancement we made in the current prototype.

Besides the above responses, the interviewees further provide us some useful suggestions. For example, they suggest that the app should support more languages and localization. They also suggest that we can extend to other allergens such as metal, animal skin tissue, dust mites etc. Some of them want the app to include additional information to the users; for instance, the first aid guide about suffered from allergen by mistake.

6 Conclusions

We presented a prototype of a food ingredient analysis mobile app which can scan the barcode or ingredients label on packaged food products to obtain included ingredients and provide proper health suggestions. A preliminary user study reveals that our application is ease to use and potentially helpful to promote healthy dietary to the general public. The prototype should be further improved with the speed of scanning ingredient labels and multiple languages support. This enables users to identify the potential allergens and additive for imported ingredient labels written in a foreign language.

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