Profile-based System for Nutritional Information Management

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***Abstract*— Nowadays health concerns are effectively becoming ubiquitous. Most people have the need to effectively control their nutritional consumptions, mostly due to health issues. Personal computational devices may assist this control with a solution that allows an efficient management of each individual nutritional profile.**

In this work we propose a mobile service architecture that allows users to manage their nutritional information, using a profile-based system and build shopping lists based on the user's profiles. This application may contribute to the improvement of the lifestyle of the population through the recommendation of food and drinks that fit their profile of restrictions and/or nutritional options (for instance, due to hypertension or obesity, among others). The person's profile can be accessed and configured on a mobile device. A set of predefined templates provides the initial rules that may be customized to represent specific individual nutrition rules. The rules defined in the profile can later be used to filter the food presented to each user.

The paper includes preliminary usability results from experiments using real data to validate the approach. These results suggest it could be used in real scenarios, although it may require more than simply filtering results.

Keywords—mobile; health; shopping assistant.

I. INTRODUCTION

In modern societies, the population lifestyle in more developed countries is increasingly conditioned by several factors such as a stressful work life, lack of time to exercise and an inadequate diet. One of the consequences of such issues is reflected mainly in the population's food quality that, coupled with the proliferation of fast food restaurants and shopping centers, ultimately contributes negatively to an incorrect diet at many levels.

This work aims to take advantage of the mobile technologies and present an automated way to assist users to control food intake, which in a final analysis allows them to achieve a better quality of life. This profile approach is suitable not only for people with dietary restrictions, but whoever wants to make a more controlled and healthy diet (suggesting, for example, *Light* or rich in fiber foods, according to the person preferences). This solution allows each person to be able to set their individual nutritional profile that may be based on models already defined with certain dietary restrictions (for instance, the amount of salt intake in hypertensive, or the amount of sugar consumed by people suffering from diabetes). By modeling the specific nutritional profile of the person, it is intended that each person is provided with food suggestions adjusted to her or his individual need by demanding, limiting or even avoid the presence of certain substances in food, such as salt, sugar, fats, etc.

The potential benefit of this solution of suggestion/recommendation of products to buy is its preventive nature, since it advises and reminds people in the moment they want to buy their products, allowing them to verify the purchase against the profile constraints. Another important feature of this profile mechanism is its flexibility and applicability to different scenarios other than nutritional recommendations, since it can be used for product recommendation based on any sort of characteristics, such as the price, color, or products origin.

The nutritional profiles mechanism also allows, by analyzing the person's food intake historic, to conclude on which foods should have been avoided (taking into account the rules defined in the profile) in order to make corrections on the person's consumption habits.

The rest of the paper is structured as follows. Next section will present relevant related work on nutritional control and shopping assistants. In Section III we detail the proposed solution of a profile-based system for nutritional information management and in Section IV we show the obtained results. Finally, the paper closes with the main conclusions and some insights on future work.

II. STATE OF THE ART

A. Nutritional Control

Different studies approach nutritional control with different facets [6] [7] [8]. Another possible approach to control food intake is to keep a daily record of the foods consumed and the respective quantities. By keeping track of which foods were ingested, this information can be used to conclude on which ones could have been avoided. Hsiao & Chang state that through a suitable diet and nutritional counseling, chronic diseases can be more easily controlled [1]. The authors suggest a mobile solution which recommends restaurants and meals that fit in the person's nutritional requirements, based on a multi-objective optimization process which considers several variables, such as the person's location, the nutritional profile constraints as well as the person's consumption habits and

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feedback. The authors consider their solution a useful tool for physicians and nutritionists to establish a nutritional plan, which takes into account the patient individual needs, thus maximizing its effectiveness. Although the proposed solution allows to recommend effective nutritional meals, it has the drawback that it only suggests meals that can be found in nearby restaurants meaning that, in practice, as most of the people do not have lunch regularly at restaurants, its use may be restricted to a sporadic use.

In the nutritional control area, Silva et al. also suggest the *SapoFitness* mobile solution, designed for weight control and obesity prevention/sub nutrition by monitoring the person's food habits as well as the physical exercise [2]. Based on this information – recorded by the person's daily input – *SapoFitness* analyses the nutritional behavior and the calorie intake in order to identify the daily energetic needs. As additional functionalities, it is possible to configure a list of known alergies allowing certain foods to be excluded from the search results. The solution is also integrated with several social networks allowing the person to share the results achieved and keep motivation. One of the disadvantages of *SapoFitness* is the fact that the user hasn't the possibility to add new foods on the existing database, therefore making him dependent on the foods contained there.

Besides the scientific papers that address the area of nutritional control, several applications can be found on Google Play Store, Apple Store, and Windows Phone Store. One of those applications is *MyFitnessPAL*[1], which allows to control the calories ingested daily, as well as the physical exercise practiced. The concept associated to this application is a diary where the person searches and registers the foods ingested during the day. The person setups a goal (for example, lose weight or gain weight) to achieve on a period of time and considering the amount of exercise practiced. At the same time, graphical statistics are generated to control several parameters through time, such as weight, arms width, ingested substances, etc. Another popular application that can be found in application online stores is *Calorie Counter*[2] – very similar to *MyFitnessPAL* – that stands out by allowing to search foods served in restaurants (in example, popular fast-food chains). Both *MyFitnessPAL* and *Calorie Counter* applications have similar functionalities and follow the same diary concept where the person registers the foods ingested during the day. However, these applications are limited to food register and do not provide any kind of food suggestions or recommendations to help the people to achieve their goals, only taking into account the number of calories present in the foods ingested.

B. Shopping Assistants

Instead of the nutritional control based on a permanent record of the food consumed – approach which is already well explored – it is possible to develop other approaches that allow to achieve similar goals. An alternative approach involves the nutritional control by identifying the person's profile, and uses this information to advise and recommend foods that fit that profile [10] [11] [12]. When applied in the context of a shopping assistant, this approach has the additional advantage of avoiding people from considering the consumption of less healthy and potentially harmful foods (due to allergies, food intolerances, in example), even before these are purchased.

In the context of shopping assistants [9], based on information technologies, Davis et al. present a solution, whose goal is to help people in one of the most common day-to-day tasks: make their purchases [3]. This solution allows the person to manage his shopping lists, and search and add products from various supermarkets or stores, offering up to date prices for reference and comparison. The person can create a list of products to buy, and make a search to see in what stores each specific product must be purchased taking into account the price, thus minimizing costs as much as possible. Since the application is integrated with the databases of the stores, there is also the opportunity to see the exact physical location of each product inside the store. While this solution is provided with interesting features, the context of its use is limited only to the economic/commercial area, and the nutritional counseling area is not explored. The only functionality that could fit in the nutritional context is the suggestion of recipes based on the on the shopping list items, although these suggestions are general and not just exclusively healthy meals, for example.

Taking advantage of the existing barcode available on all products (or in alternative by using RFID tags), Adelmann describes a solution to help allergic people to determine which products can be consumed, or not, according to the person's specific allergy. Although the nutritional information of the product may be available, which is extremely important for people with allergies, it may not be present at the time it is more important for the consumer: the moment the person is at the supermarket and picks the product from the shelf [4][5]. Therefore, the author proposes a mobile solution allowing the identification of the products through their barcodes, instantly indicating (via integration with a system containing the nutritional information for all products) whether if it fits on the person's allergy restrictions and can be consumed. The approach proposed by the author is interesting, although it has some disadvantages such as its *ad-hoc* usage: the person grabs a particular product and uses the application to obtain more information about it. This approach prevents the creation of a shopping list containing healthy products before the user (or someone else) points the smartphone to a certain product first and checks if that product may be acquired and consumed. Moreover, by requiring communication with an external service to get the nutritional values of the product, if it isn't possible to contact that service at the time that the application is necessary, it will be useless.

There are also several popular shopping assistant applications in Google Play, Apple Store and Windows Phone Store, whose concept is to manage one or more shopping lists to which are added products to acquire. The application *Out of Milk Shopping List*[3] is the most popular of these applications and contains much useful functionality, such as the management of several shopping lists, product identification from barcode scanning and voice interaction. The person can

1 https://play.google.com/store/apps/details?id=com.myfitnesspal.android
2 https://play.google.com/store/apps/details?id=com.fatsecret.android
3 https://play.google.com/store/apps/details?id=com.capigami.outofmilk

search the products on an existing database, or add his own products and categories to the application. It can also be found other similar applications like *Shopping Assistant* [4] or *MobileShopper2*[5]. It is important to note that all of these applications have in common the fact that they are simple shopping lists managers, whose main goal is to avoid the use of the traditional pen and paper to annotate the missing products. Although containing various features that make them more interesting and useful, none of these applications include a product recommendation system, or advanced search and filtering based on the products' characteristics, therefore approaching the nutritional control context.

It already can be found several scientific papers and applications addressing the area of nutritional control by information technologies. Regarding the applications available in online stores, the approach generally taken essentially provides the user with a tool record the foods he eats throughout the day. Similarly, another common aspect in these applications is that they are targeted for weight control (weight loss, weight gain, etc.), focusing mainly on controlling the amount of calories ingested and not towards the transmission of appropriate nutritional recommendations. Other disadvantage of these applications is the difficulty people have in using them regularly.

Regarding shopping assistants it can also be found several scientific papers and available applications. However, the area of nutritional advice and counseling has not been properly explored yet, and there isn't any shopping assistants directed to that context. This fact justifies the development of a solution that combines both areas – nutritional control and shopping assistance – to allow people, on the moment they elaborate their shopping lists, to receive food recommendations that fall within their nutritional profile, helping that way to follow a healthier lifestyle, without the need to be constantly keeping track of the foods ingested through the day.

III. PROPOSED SOLUTION

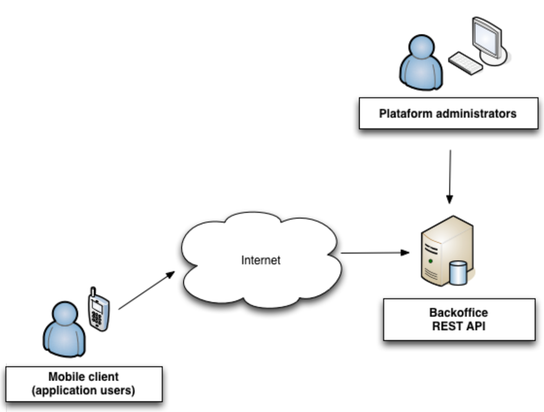


Figure 1 - Platform high-level overview

We propose a platform based on two main components: a mobile application client and a central server that provides the content to the client. The mobile client is the interface used by people to manage their shopping lists and their nutritional profiles. **Figure 1** shows the high-level overview of the proposed solution.

The server component, used to create contents and make them available to operate the mobile client, is divided into two modules: a web back office, allowing the platform administrators to perform all the management tasks on the available content (products, characteristics of the products, nutritional profiles, etc.) and an API, intended to be consumed by client mobile solution. This API is note available to the general public, but only through the mobile client. **Figure 2** shows the server component architecture:

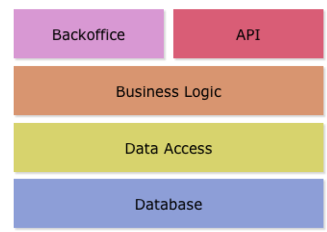


Figure 2 – Server component architecture

In the platform data model it is proposed the concept of an item. An item is a product stored in the database and can be contained in one or more categories. In turn, it is possible to organize the categories in order to create an hierarchical structure by specifying the parent category of a category. In this work, an item will represent a specific food product (" Cheese brand X 50 grams" or "Soya Milk brand Y 1L"). Each item has a set of properties, which identify the product and distinguish it from others. There is freedom for a property to represent any characteristic associated with a product. Examples of properties include, among others, the price of the product, the percentage of DRI (Dietary Reference Intake) of proteins or salt. One property has also an associated unit, which means that, given the previous example, it can be created the unity "Euro" for the product price and the unit "Percentage" to represent the DRI of proteins and salt contained in the product. The data model also allows the specification of nutritional profiles. A nutritional profile consists essentially in a set of properties and their respective values that characterize that profile. The values of each property can be exact values or ranges of values, representing a rule mapped in the profile. The data model is used similarly in both the mobile client and the central server.

A. *Server funcionalities*

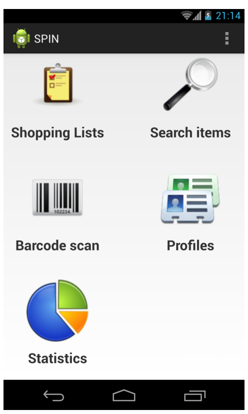
The server component of this solution has as main responsibility the management of content and its availability to the client application. For the content management, a back office is included through which all operations can be performed on the contents (management of nutritional profiles, products, properties, etc.) that are later available through the existing RESTful API to be consumed by the mobile client. A key aspect of the server is that it doesn't keep track of any user personal data, meaning it is free from ay privacy issues.

4 https://play.google.com/store/apps/details?id=com.blogspot.hypersynapse.sa
5 https://play.google.com/store/apps/details?id=com.ideasave.mobileshopper2

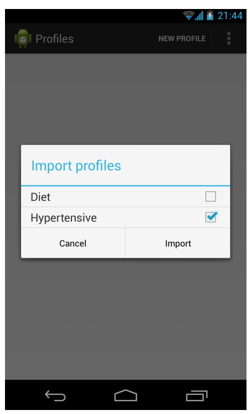
B. Mobile client funcionality

The client component is the end user's front-end and consists of a mobile application, which consumes the data made available by the server API (product related information and default nutritional profiles). The client application allows people to manage their nutritional profile, either by importing a default profile from the server, apply changes to its rules, or even create a nutritional profile completely from scratch. The client application also allows people to manage their shopping lists, search and navigate through the available products, and apply the profile rules in order to filter the available products to fit in the person profile. This is achieved by comparing the food nutritional values with the set of rules defined in the profile. For instance, a product with a DRI of salt of 25% will not be presented to a user with an active profile that limits that value to a maximum of 15%. The purpose of this filtering is to present to the user only the products that fit in the rules defined his profile. Once a user activates a certain profile, its rules are automatically applied when navigating through the available products.

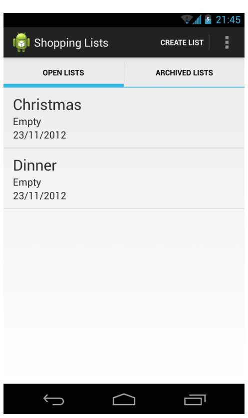
An Android application with the discussed functionalities was implemented and tested. **Figure 3** show some screen captures of the mobile application.



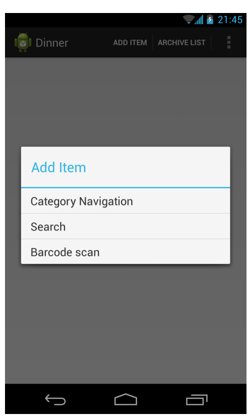
a) Home screen



b) Profile import screen



c) Shopping list screen



d) Add item to shopping list

Figure 3: Application screenshots

IV. TESTS AND EVALUATION

A. Tests Setup

In order to test the proposed solution, the platform was set up with test data simulating a real environment (with real products, properties, units and profiles), and usability tests were conducted with people so that it was possible to determine if the concepts introduced by the application were clear and which parts of the application were considered more confusing. In total, eight people, 5 male and 3 female, aged between 21 and 29 years old tested the application. Since the mobile application is targeted for smartphone users, all the testers selected are smartphone users (either iPhone and Android) and, therefore, familiar with the use of mobile applications and with technology in general. To get users to test the application in a consistent way, a script was created so that testers follow a predefined set of tasks:

1) Import and configure the profile "Light Products" from the server;
2) Create a new shopping list based on a previous shopping list kept in the historic;
3) Add a specific product the shopping list which fits in the "Light Products" profile;
4) Add a product through barcode scanning;
5) Add a specific product not fitting in the "Light Products" profile;
6) Assuming that not all products were available in the supermarket, register that information in the shopping list and archive it in the historic.

This first task required the user to go to the configuration settings and import one of the predefined profile templates available from the web service. For the second task the user had to duplicate an existing list. For the following tasks we expected users to add an items to the shopping list from a list of products (task 3) or using the phone camera to recognize the product's barcode (task 4). For task 5, to add a product that does not fit in the defined profile the user has to disable the profile filtering. And finally for task 6 user has to archive the shopping list to register it to the historic.

The tests were conducted on a casual environment. The Android application was installed on a Google Nexus 4 smartphone.

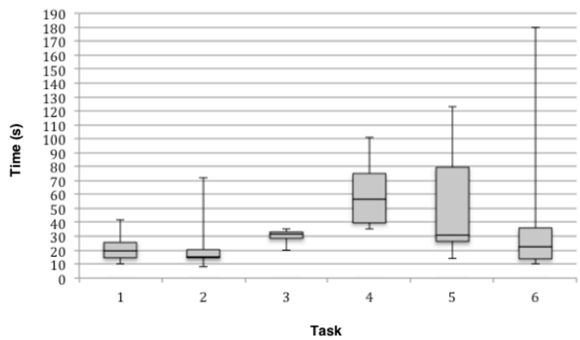
B. Results

In general, all testers felt comfortable and curious to explore the application interface, and in some cases insisted in repeating some of the tasks more than once. Users had no problem to complete the shopping related tasks: creating a shopping list and adding items to the list using different strategies (filtered list, barcode scanning and unfiltered product list). However, users had problems performing administrative tasks such as importing profiles form the server or archiving a shopping list. Tasks *1* and *6* are not common tasks and some users felt confused.

For task 1, most of the testers found that options "*Create profile*" and "*Import Profile*" were confusing.

Regarding task 6, not all testers managed to accomplish the expected steps. Although only one tester failed to mark the list items as bought and archive the list, several testers only completed this task partially. Most users marked items as bought but did not archive the list. Regarding this task, some testers also expected an option *"Mark item as bought"* under the contextual menu instead of single click over the items. Testers completed the remaining tasks with success. They used the different possible approaches to add items to the shopping lists: advanced search and category navigation.

Graphic 1 shows the distribution of the times to execute the tasks. Since many testers explored several approaches to complete the tasks 4 and 5, related to specific product search in the products database, those tasks where the ones that, in average, took more time to complete, as they were in fact "completed" several times.



Graphic 1 – Distribution of the times (in seconds) users took to complete the several tasks

C. Analisys

The time that users were willing to spend adding and browsing products was encouraging. Users were engaged on the task of building a shopping list and using a barcode or a selection list appeared to them as an interesting option. The profiling functionality to filter products was not as appealing as the regular shopping functionality. A possible cause for this may be the type of profile adopted was not appealing to users, as they were not consumers of "light" products.

Although users were confortable with the shopping list features, the combination of shopping list with profile was not obvious to most users. Profiles were seen as an external functionality and not a shopping list assistant. To avoid confusion in profile import/creation, the two existing options were replaced by a unique option "*New profile*" which then presents users a popup with two options more clear: *"Create from scratch"* and *"Create from template"*. A possible approach to avoid expecting users to press *"Archive list"* option manually is to ask them, when leaving a shopping list where some items were already marked as bought, if that list should be archived. Although not all testers complete all the proposed tasks in the testing script with success, all felt comfortable with the application and agree on its usefulness.

V. CONCLUSIONS AND FUTURE WORK

The area of nutritional advice and counseling hasn't been properly explored leaving room for a solution combining both areas of shopping assistants and nutritional control. This paper proposes a technological solution allowing people to elaborate their shopping lists based on food recommendations that fit in their profile of nutritional restrictions by filtering the products available that match the set of rules defined in that profile. Preliminary tests suggest that applying profiles through simple filters may not be appealing to users. During the tests, users were enthusiastic to test regular shopping features and not so much to take advantage from the profiling mechanism. The inadequacy of the defined profile for the user may be the cause for this behavior.

Future work directions may consist of integrating the existing product database with a real retail chain supplier, which would add an increased value to the solution and allow the access to a large and an up to date database of products and characteristics. Regarding the mobile client, it would also be interesting to provide statistics adapted to the specific profile in use (for instance, a diabetic profile would provide consumption statistics related to sugar consumption).

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