Article

Design and implementation of virtual coaches for healthy nutrition habits monitoring and encouragement.

Antonio Javier Benítez Guijarro1, Ángel Ruiz-Zafra2, Zoraida Callejas Carrión3, Nuria Medina Medina4, Kawtar Benghazi Akhlaki5 and Manuel Noguera García6

1 University of Granada; mrsasuu@gmail.com

2 University of Granada; [angelrzafra@gmail.com](mailto:e-mail@e-mail.com)

3 Department of Languages and Computer Systems, University of Granada; zoraida@ugr.es

4 Department of Languages and Computer Systems, University of Granada; nmedina@ugr.es

5 Department of Languages and Computer Systems, University of Granada; benghazi@ugr.es

6 Department of Languages and Computer Systems, University of Granada; mnoguera@ugr.es

**\*** Correspondence: mrsasuu@gmail.com; Tel.: +34-648-899-446

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**Abstract:** Agood health is the result of a healthy lifestyle, where nutrition is a key concern. However, in today’s society, nutritional disorders affect children, adults and elderly people, mainly due to a scarce nutrition knowledge and the lack of a healthy lifestyle. A commonly adopted solution to these nutritional imbalances is to record food intake over the course of the day, usually, creating custom meal plans to count the amount of macronutrients and micronutrients acquired in each meal. Nowadays, there exist many nutritional tracking applications (NTA) that record energy intakes as well as users’ physiological parameters. However, most of these NTA are unsupervised applications. That is, they have not been designed to provide gradual meal plans that are tailored to the users and that help them to adopt healthy nutrition habits, or are not supervised by health professionals. In this manuscript, we present a system architecture intended to serve as a reference architecture for building NTA that include plans to adopt a healthy habit gradually in association with professional supervision guidelines. In order to show the applicability of the architecture presented, it is also introduced Food4Living, an app based on the proposed reference architecture and which consists of a cloud-based mobile wellness platform to support the monitoring of daily nutrition habits and improve them through the interaction between users and professional advisors (nutritionist and dieticians). The main benefit of Food4Living is the improvement of autonomy and independence of users through real-time feedback during the process of compliance with adapted diets, adopting new eating habits under rigorous expert control. Food4Living is especially targeted to older people, whose specific needs are not conveniently addressed in the state-of-the-art systems.

**Keywords:** nutrition; telemonitoring; cloud computing; healthy habits; elderly people; smartphones; nutritional assessment; virtual coach;

1. Introduction

Healthy aging involves the interaction between genes, the environment, and lifestyle factors, particularly good eating habits and regular physical activity. Worldwide, the increase in life span has led to an increase in morbidity and mortality as the result of chronic, lifestyle-influenced diseases such as type 2 diabetes, cardiovascular disease and cancer, among others. Nutrient deficiency diseases are giving way to energy imbalances, so links between diet and chronic disease are becoming clearer [1]. Lack of healthy habits such as eating disorders and sedentary lifestyle are the main causes of health issues, according to the World Health Organization [2].

The food we eat is composed of two main groups of nutrients: (1) macronutrients (carbohydrates, proteins and fats), which contribute most of the metabolic energy to the organism; and (2) micronutrients (vitamins and minerals), which are necessary in small proportions and do not provide energy. To be healthy, it is essential to maintain a correct balance of macronutrients and micronutrients, and not exceed the amount that our body needs. A lack of control over nutritional requirements is the main cause of cardio-vascular diseases. This fact highlights the importance of accomplishing food plans that balance all body needs [3]. Adults may engage successfully in changing their eating habits with the aid of a professional nutritionist who performs a strict and continuous monitoring of the user through the design of specific and targeted meal plans and habits [4,5]. However, the elderly may experience difficulties for carrying out traditional food monitoring through regular visits to the nutritionist because of mobility issues and the difficulties to understand and carry out traditional monitoring methods [6,7].

Mobile devices constitute a useful tool to address these challenges. They have become a commonplace in healthcare settings, leading to rapid growth in the development of medical software applications for mobile platforms.

Nonetheless, besides the provision of a particular functionality, this kind of technical solutions requires an underlying system architecture that, first, supports developers in their construction, and ultimately end-users (nutrition practitioners and supervised users) in the consumption of coordinated value-added services related to the acquisition of healthy nutrition habits.

In this paper we present a modular architecture that serves as a basis on which to build telemonitoring and e-coaching nutrition platforms.

As a part of the contribution, and to validate the proposed architecture, we have developed the Food4Living platform and as further validations we have implemented the Food4Living application (Food4LivingAPP) to show how it can be used to easily develop nutrition coaching applications. System architecture and Food4Living applications have been produced in the context of an interdisciplinary research project called Avisame providing the desired flexibility to be easily combined with other fitness and wellness coaching platforms within the project.

This document is divided into four distinct sections. This first section has presented the motivation of the proposal, introducing the work described in this document as well as the objectives pursued in our project. The second section presents the development process, specifying the analysis, design and implementation of the architecture and the different applications. The third section shows the general discussion behind development. Finally, section fourth presents the conclusions and future work.

2. Related Work

Currently, there are numerous studies for healthy weight loss that expose the effectiveness of new platforms for the nutritional telemonitoring of users [8,9]. These studies set out guidelines and insights to achieve a careful nutritional process [10]through the development of platforms and software applications that satisfy the main branches in this process. These main branches are 1) the realization of nutritional evaluations, 2) nutritional diagnoses, 3) nutritional monitoring and evaluation, and 4) nutritional intervention. Based on these guidelines, we have designed a platform that implements functionalities for each of these categories offering a scheme to build applications that perform complete food records, remote monitoring of user progress, goal systems and nutritional education for users.

To design Food4Living we have studied different alternatives from existing telemonitoring platforms to devise a reference architecture of components and services, and in the same way, analyzed the deficiencies of those platforms [11-13]**.** These platforms expose architectures structured in different subsystems for the functionalities of the monitored users and the operational elements that analyze the data obtained by the previous subsystem. Although there does not exist a standard architecture for health telemonitoring systems, there exist a series of common elements. For example, several studies [14] presents a detailed comparison on the most representative European research projects in health telemonitoring and show that they converge into a common architecture with the following main components:

* The monitorized user’s subsystem. It includes elements that act as gateways, either specific technology embedded in a domotic ambience (e.g. a medical box) or a smartphone. It facilitates data collection and user monitoring, in some cases integrating sensors.
* The caregivers or professional’s subsystem, which usually encompasses user monitoring.
* remote server connected to the gateway that deals with:
  + User authentication.
  + Data management.
  + Data processing.
  + User profile and health record management.

The authors also distinguish several key features: mobility, security in data storage and transmission, user adaptation and interoperability. Their architecture is usually based on different layers and modules, which are responsible for isolating the graphical user interfaces of the applications, with sub-modules that synchronize and operate the data in a central server. Our proposal works in a similar way as the previously studied platforms, but adding other subsystems targeted to professionals (nutritionists) that elaborate new information for the monitored users and also handling the information representation in standard formats for interoperability purposes. Likewise, information representation aims at making the expected behavior of the system explicit, such as information regarding action to take below or above certain thresholds, so as to change the behaviour of the systems without having to recode it by just changing data artefacts regarding diets and plans, for example.

Telemonitoring platforms collect information about the behavior of supervised users and, from an analysis process, professionals draw conclusions about those supervised users. Our proposal changes the order of these interactions and defines an interaction cycle. Thus, the telemonitoring system collects information from the users monitored that a subsystem (application) of the platform uses. This subsystem synchronizes user's data and the professional nutritionist who supervises the user performs an analysis (food plan) on the basis of user's data. This analysis or food plan is then synchronized and offered back to the monitored user in order to start the cycle again under new guidelines. As a last difference, the proposed platform architecture together with the software applications based on it, configure systems consisting of three main subsystems: mobile apps, nutritionist’s administration panels and cloud services. Core platform services define an API that allows access to useful data for the system modules and provides access to third parties to use data in their own statistics.

From the reference architecture that we propose, it is easy to build new applications that satisfy needs that are not yet fully met in the applications available today. For this reason, we have carried out the development of an application that serves as a way to validating this architecture. To elaborate our proposal, we have studied the most popular telemonitoring tools and applications available today for smartphones. Among these, we can identify *MyFitnessPal* [15], *Lifesum* [16], *Diary**of Nutrition* [17], *Freeletics* *Nutrition* [18] and *8fit* [19]. All of them are applications for weight maintenance, weight loss or gain muscle mass and, include, a food library with food’s nutrients (macronutrients and micronutrients), to make food records during the day. To support the aims pursued by the users, these applications are designed to set daily caloric plans, create caloric limits depending on the user's objective weight and offer weekly progress statistics until reaching the goal. Once the objective of ideal weight is established, the user chooses a deadline, and on the basis of the current weight, height and level of activity of each user, the application calculates the number of calories to ingest daily. As it is shown in Table 1, *MyFitnessPal, Lifesum, Diary of Nutrition, Freeletics Nutrition* and *8fit*fit with this description, since they do not have functionalities of adapted diet plans, and are only based on nutritional caloric limitation. Although *8fit* does have monthly diet plans for users, they are predefined and general dietary templates (same generic diets for all users). Therefore, it does not create nutritional plans adapted to each user.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Food4LivingAPP** | **MyFitnessPal** | **Lifesum** | **Diary of Nutrition** | **Freeletics Nutrition** | **8fit** |
| Food records | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Custom foods | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Progress statics | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Diet plans | ✓ | x | x | x | x | ✓ |
| Personal coaching | ✓ | x | x | x | x | x |
| Adapted dietary plans | ✓ | x | x | x | x | x |

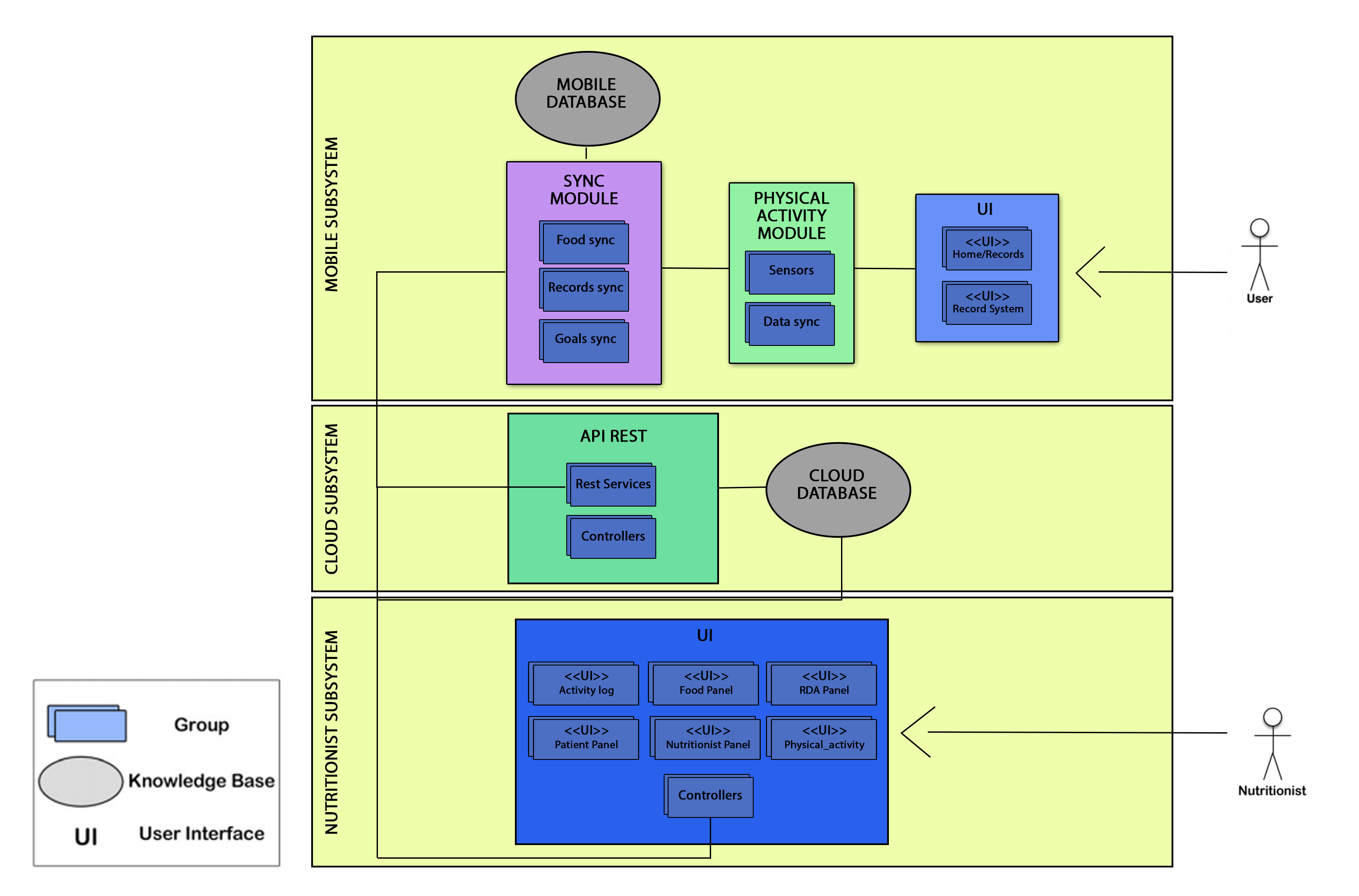
**Table 1**. Comparison of telemonitoring applications and tools.

Despite state-of-the-art systems, the Food4Living platform allows applications that are not restricted to establishing caloric limits to reach a target weight. Instead, it is aimed at enabling to establish diets adapted to each user made from their and support and promote healthy eating habits devised by nutrition professionals. In addition, most of the applications described are not adapted to seniors or users unfamiliar with mobile devices.

**3. A Reference Architecture for building telemonitoring and e-coaching nutrition platforms**

The reference architecture proposed for the construction of telemonitoring and nutrition e-coaching systems is divided into several modules and basic elements for a correct interoperability. These modules are grouped into three well-defined subsystems as we can see in the Figure 1. The *nutritionist* *subsystem* formed by a graphical user interface (*Nutritionist GUI*) from which to access to different supervision functionalities as a main tool for nutritionists, the *mobile* *subsystem* formed by (*Sync module*, *mobile storage* and a *GUI*) for the users that will be monitored, and the *cloud subsystem* (*Cloud storage* and *API RESTful*) that connects all the parts.

The knowledge base includes the nutritional databases necessary for the operation of the platform, which includes information about foods such as nutritional information, and other information as for example, the information of the users of the platform. They also store information to produce the statistics for nutritionists, as the tables of recommended daily amounts.



**Figure 1.** Architecture scheme of the system.

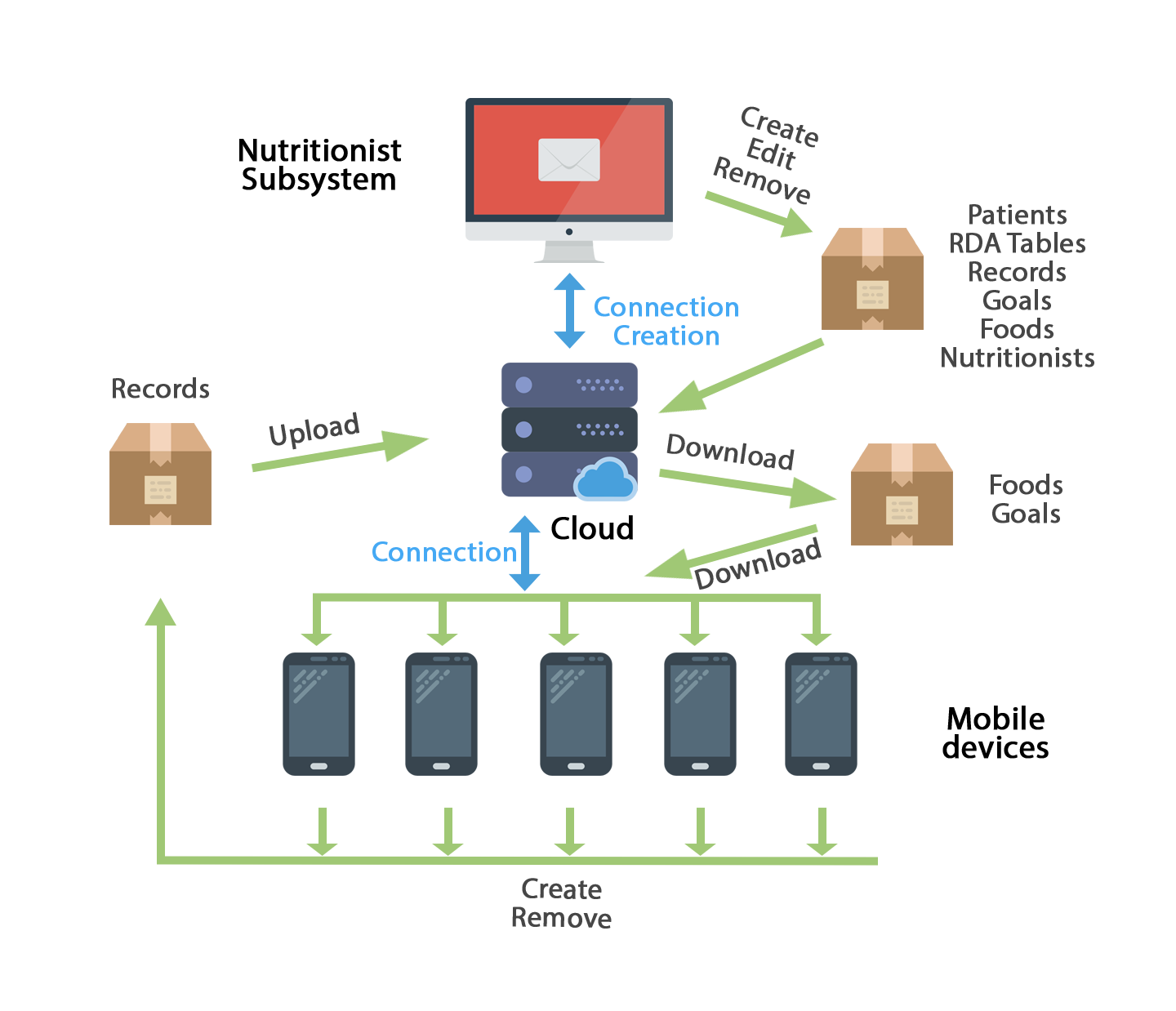
These three parts (mobile subsystem, nutritionist subsystem and cloud subsystem with the API RESTfull) compose the architecture:

* The cloud and the API RESTful (*API RESTful*) components connect all the subsystems of the architecture and synchronize the records about each user, downloading and uploading the data from the mobile applications of the monitored users (*Sync module*). These data are automatically following a system of verification of the record creation dates, keeping the newer versions on the cloud server (*Cloud database through the API RESTful*). The mobile applications register offline in a database data about user intakes, and periodically synchronize the new nutritional records with the cloud server through secure requests (*Sync module*), updating the new records on the server, being accessible by the nutritionist through the administration panel (*Nutritionist GUI*).
* The mobile subsystem is composed by the synchronization module (*Sync module*), the physical activity module (*physical activity module*) and the graphical user interface. The synchronization module (*Sync module*), acts as a bridge between the database of the mobile application and the cloud server, synchronizing the different data of the application (food registers, food and goals). Additionally, during this synchronization, the new nutritional goals established by the nutritionists will be downloaded for a specific date. The physical activity module (*physical activity module*) collects information by measuring the physical activity of the monitored users and then synchronizes it in the cloud server to adjust the nutritional plans.
* The nutritionist subsystem consists of several graphic user interfaces (*GUI*) are responsible for displaying the data to users and nutritionists, isolating the transformation and adaptation of the data. The UIs of the user’s mobile application and all the screens of the nutritionist’s panel are included in this component. This makes Food4Living highly customizable as it allows to interoperate with third-party user and expert applications with different UIs.

This is achieved thanks to the modular architecture proposed. The *RESTful API* module is responsible for providing the services and resources of the cloud storage for external requests, authenticating such requests with security tokens, while the controllers of the modules are responsible for adapting the information extracted from the databases or requests to execute the responses to the requests or to fill in the views of the user interfaces (*GUI*).

The communication scheme is summarized in Figure 2. The mobile subsystem updates (download) the available foods, the food registration bases and the food goals whenever there is a new version of this information on the cloud server. In the same way, the data of the food registers about the users will be uploaded or updated in the cloud server whenever new records are introduced through the mobile subsystem.

The nutritionist subsystem will make use of all the data of the system and will manage the food data (e.g., Goals, Users, RDA Tables, etc.) introducing new information through the chosen administration panel. It will also consult the server for said information and establish food goals for each user, updating the appropriate data of the cloud server.



**Figure 2.** Communication scheme of the system.

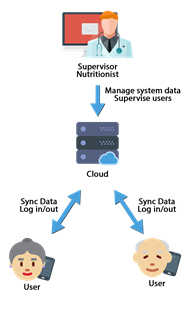
Thus, our proposal is compliant with the key elements of the health telemonitoring architectures described in Section 2, as it integrates a remote server with user authentication, data management, data processing, user profile and health record management, with subsystems for the monitored users and nutritionists.

4. Food4Living: Cloud-based mobile platform to monitor dietary habits

Food4Living is a platform aimed at encouraging healthy habits and maintaining a diet supervised by nutrition professionals through a telemonitoring system. It is the core technology for nutritional coaching within the Avisame Spanish Research Plan and a European COST action, and it is integrated within a more complex system that includes virtual advisors based on graphic avatars and other aspects of healthy life, such as locomotion, postural ergonomics and physical exercise.

Food4Living has two main groups of users (besides the technical system administrator): 1) monitored *users,* who employ a mobile application, and 2) monitoring *professionals* (nutritionists and dieticians) that analyze the relevant data of the monitored users, comparing them with objective references (Figure 3).

The monitored user (hereinafter *user*) uses the mobile application to track food records, reflecting their eating habits. This application synchronizes, automatically, the user's data and receive the indications and meal plans of the nutritionists, who supervise the user. In addition, the monitored user receives notifications and reminders to carry out a complete meal plan. On the other hand, the supervisor nutritionist (hereinafter *supervisor)*, uses a panel to collect relevant pieces of data, in order to creates food plans and nutritional goals adapted to their particular needs and eating habits of the user. Everything is synchronized through a cloud computing approach, which will be described in the next section.



**Figure 3**. Platform overview.

To build and app in Food4Living, the developers must develop and implement only the views (GUI) and consume the services provided by the RESTful API [20,21] to obtain the data. As it has been mentioned, for the realization of the *nutritionist subsystem*, we have made a design according to the Model-view-controller pattern [22], making a controller for each important block of requests, such as food management, users, nutritionists, and

Recommended daily allowance tables. These controllers make use of the REST API to request the necessary data from the database, performing an authentication from a token according to Jason Web Token (JWT) [23]. Depending on the type of privileges of the user, some or other data will be displayed. This *API* works as a wrapper between the system information (storage) and third-party applications, offering different types of data according to the routes that are executed in the different services it manages.

The API is divided into services, which will be the controllers responsible for offering the data processed abroad, differentiating and restricting which requests are available without authentication and which require a valid token. While supervised users will have access to their plans and the possibility to update their tracking, nutritionists will be able to:

* Register in the system the new users who will be supervised.
* Create and manage the available foods throughout the system and their nutritional information.
* Manage their own tables of recommended daily allowance.
* Consult and edit the food registries of users under their supervision.
* Establish and update goals and nutritional plans based on the statistics obtained with their eating habits.

Two of the most important services are of the API are the *Objective Service* and the *FoodRegister Service* that are in charge of synchronizing the food records of each user with the mobile application and the administration panel of the nutritionist subsystem following a mechanism that will be explained later. The rest of the services of the API are in charge of serving the information to the rest of the modules of the system and to external calls. Also statistics of food intake can be generated in real time and it is possible to generate comparisons, reports and calendars. With respect to data management, the main system data is sent and received through requests to the API, receiving and responding information represented in JSON [24]. To secure sensitive system data, responses have been encrypted using JWT tokens, giving access to certain parts of the API only if the request is made with a valid access token. All other routes and requests without sensitive data are available through HTTP requests to the API, and receive responses in JSON format.

4.1. Key platform features

The proposed architecture takes advantage of several key features from which the presented platform benefits. We would like to highlight:

* Dynamic data and system adaptability, allowing the incorporation of new foods with non-limited nutritional information. These foods are formed by different attributes equivalent to the nutrients that form them, having only the fields associated with these data and not replicating in empty fields information that they don't have. From which different nutritional statistics can be made depending on the nutritional formats of the food in the patients' food records. Representing the food data of each food from XML to interpret the different fields of each food.
* System based on nutritional goals. These goals are the main communication mechanism between nutritionists and supervised users. With the goals the nutritionists establish guidelines and diets adapted to each user. The goals are displayed directly on the mobile platform and are automatically updated at the time the food established by the nutritionist is ingested, being completed when the amount indicated by the professional is reached.
* System data synchronization, in the case of the mobile platform, it will synchronize the food from the cloud when the date of modification of any of the foods is newer than the one stored in its internal database. In the case of the goals, it will download the information of these when it has something new, that is to say, when a new goal has been introduced in the system and hasn't synchronized yet. Finally, in the case of food records, those records that do not exist in the local database will be downloaded when a record with a modification date / creation with a more recent date appears in the cloud, and in the same way, if the application mobile detects that the cloud has an earlier version than its database will upload all new records.
* Multi-user, representing different profiles for administrators, nutritionists, patients and their caregivers. Each profile has permissions and privileges with which to perform one role or another in the system.
* Accessible for different user profiles. Specially designed to reduce the number of interactions during the use of the mobile application.
* Interoperable system, communicating in real time the information between the three different subsystems of the platform, 1) the user’s mobile subsystem ,2) the nutritionist subsystem and 3) the RESTful API (cloud).
* Immediate availability, disposal of use in any environment with or without internet connection, registering the data in local databases and making synchronizations possible.

5. Food4Living Applications

One of the benefits of the Food4Living platform is the possibility to deploy new applications implemented by developers/programmers. As explained previously, we provide an API with well-defined interfaces to enable communication between all parts of the system (API REST). During the design of the API, data format and representation issues have also been considered, as well as the use of standard (JSON) technologies to facilitate their extensibility, maintenance and interoperability with third party applications and systems.

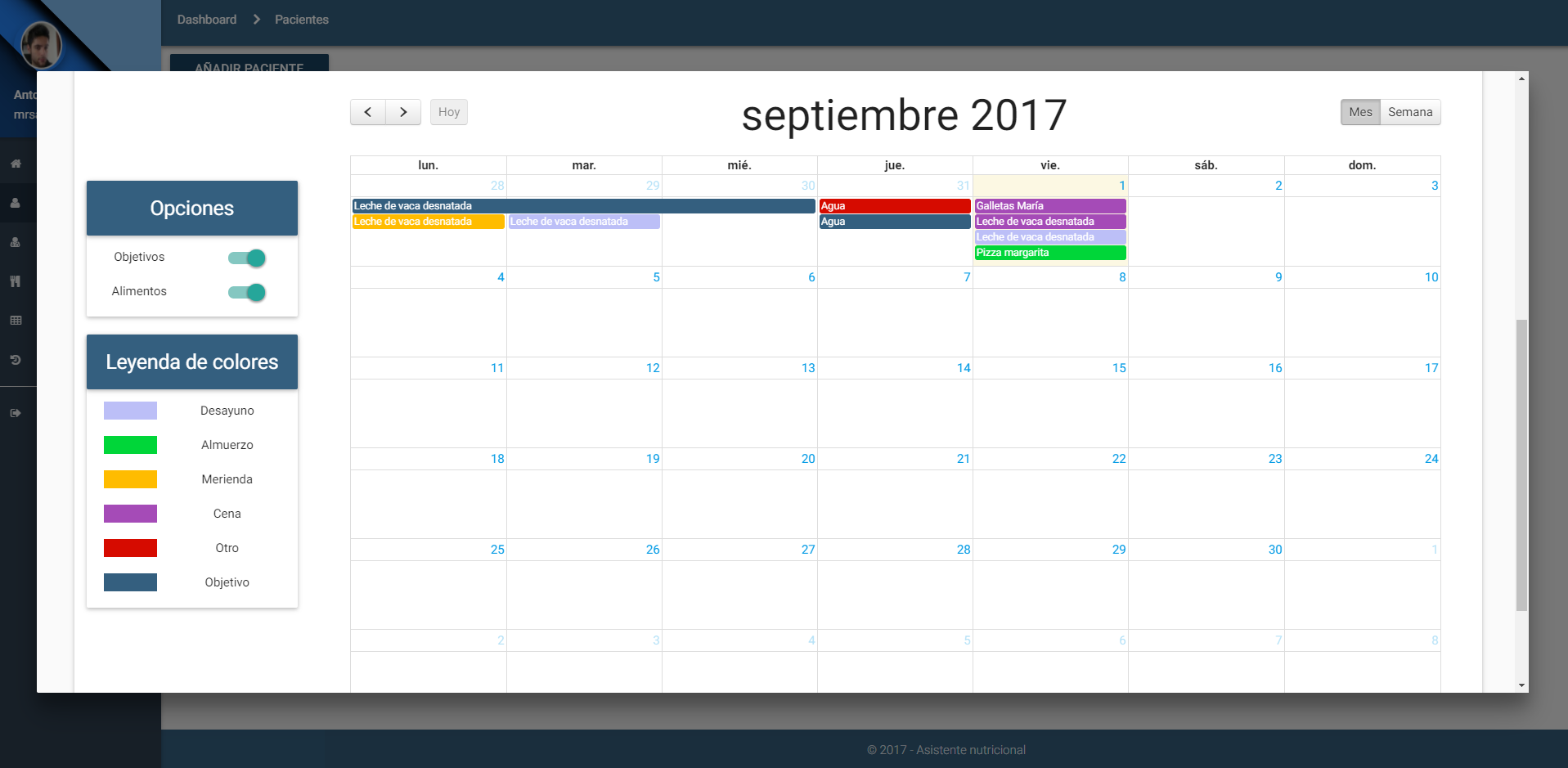
The following applications have been developed, supported by Food4Living Platform:

* A mobile application A mobile application aimed at supervised users, with which to record their nutritional habits.
* An application for the nutritionists to manage and supervise the users in their charge.

**5.1. Nutritionist subsystem**

Through the nutritionist subsystem, nutritionists register, consult, evaluate and establish nutritional guidelines and personalized plans for each user under their supervision. To do this, the system orchestrates its different modules by mean of the architecture proposed and inserts, processes and delivers dynamic data of the users supervised. The system has been designed to interpret different data formats, making it scalable and able to adapt to the new way of representing the data. This way, it is possible to add new parameters in the food, statistics and all parts of the system without affecting its structure. The web interface is based on HTML5 and Materialize CSS, and presents the following functionalities:

* **System of authentication and recognition of different users:** Through the credentials introduced into the system, nutritionists will be able to access the web system through a login form, where the user type is automatically recognized; that is, user administrator, or nutritionist.
* **General administration panel:** Through the general panel will access all the functionalities of the system.
* **User panel:** Panel showing the list of users associated with the nutritionist, showing the main data of the people monitored, and the options to add, display, edit and eliminate such users.
* **User's personal calendar:** Calendar where the supervised users' food records and goals are displayed (Figure 4). The nutritionist will be able to interact with clicks, eliminating or adding new ones to the desired date. This calendar is the main tool of communication with the supervised users, with it the nutritionists can observe the daily progress, breaking down the intakes into the different hours of the day and observing a summary of its nutritional composition. The nutritionist can interact with the calendar by clicking on the different days, establishing new records or goals that will be visible to users from the mobile application. It is also possible to interact with the goals or records already inserted to obtain more details or to remove them from the patient's calendar. Nutritional goals are diet mechanisms where nutritionists associate a target food to eat, a certain amount and a deadline to achieve that goal. The goals are updating their progress according to the food records of the monitored user. It is possible to enter daily goals or goals with a certain duration. With this mechanism, nutritionists can create specific diets by setting a specific time for each food of the goal, for example, establishing a food goal of drinking a glass of milk at breakfast and establishing the specific day for that goal, continuing with another food for lunch, etc.



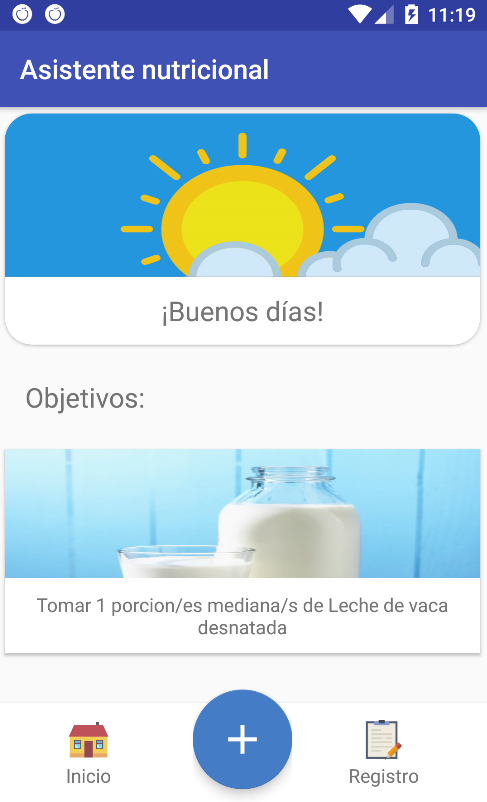
**Figure 4.** User's personal calendar.

* **User statistics:** Section where to generate a statistical report of the supervised user from the records recorded in the selected month, comparing these results with a table of RDA (daily recommended allowance) registered by that nutritionist and previously selected and where to observe a weekly summary disaggregated in timetables for the main macronutrients.
* **Nutritionist’s panel:** This is the management panel for the system administrator to add, edit or remove nutritionist users.
* **Food management:** Panel that allows the creation, modification and elimination of new foods in the system. Such foods will be used by the mobile application and the patient's personal calendar for the incorporation of new food records or goals. It should be noted that this section indicates the elements necessary for food registration; that is, the photographs to be used in the mobile application, their correspondence in portions, and all the nutritional information of the food. The quantity selection system developed is based on choosing quantities from photographs that visually represent the portion size, and transparently each photograph would correspond to a size. For example: If we drink skimmed cow's milk, we can take a small cup, a medium cup or a bowl of large milk, where each container corresponds to a different portion. For example, a small cup a portion of 100g, to the glass a portion of 200g and to the bowl one of 350g translating this to: cup = 1.0, cup = 2.0 and bowl = 3.5; since multiplying these portions by their correspondence would yield the equivalent of 100g, 200g and 350g. That is why one of the indispensable requirements is to correctly choose the equivalent photographs for the portions.
* **Management of daily-recommended allowance (RDA) tables:** Panel for the creation, modification and elimination of tables of information to make the statistical comparisons of the people monitored and to generate the reports already described above.

**5.2. Mobile subsystem**

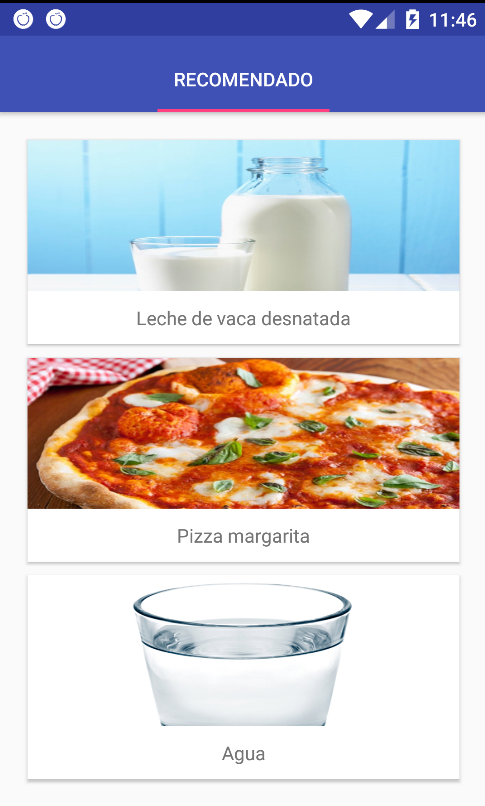
The main tool of monitored users is an Android based mobile application, which monitors their eating habits, noting the food intake throughout the day, introducing a new record in their mobile application, and synchronizing in a transparent way the data, so that almost in real time, the supervisors can keep track of the user. Through a simple interface, users can record the food ingested using a simple form where with three steps they select the schedule of intake, food and quantity taken. For this, we have implemented a quantity selection system of images that show representations of different portions for the same food, for example; annotating a specific beverage, displaying images with different sizes, making the user choose the photograph that most resembles the portion ingested. This system module has the following functionalities:

* **Secure authentication:** Authentication protected by a generated token that only allows the connection to be opened from a point, thus making it unreachable.
* **Welcome screen and display of objectives:** An initial screen that welcomes greeting depending on the schedule. At the same time, it shows more interesting information, such as today's pending goals (diet plan system), indicating that it should be taken and which portion size. This screen also shows the main buttons of the application, the simplification of actions to return to the home panel, add a new record, or view the annotated records. Attending the usability needs of the elderly, the interface has been simplified enough to show only the most essential elements. The "*Objetivos*:" panel shows the user's daily goals that have not been exceeded. (Figure 5).



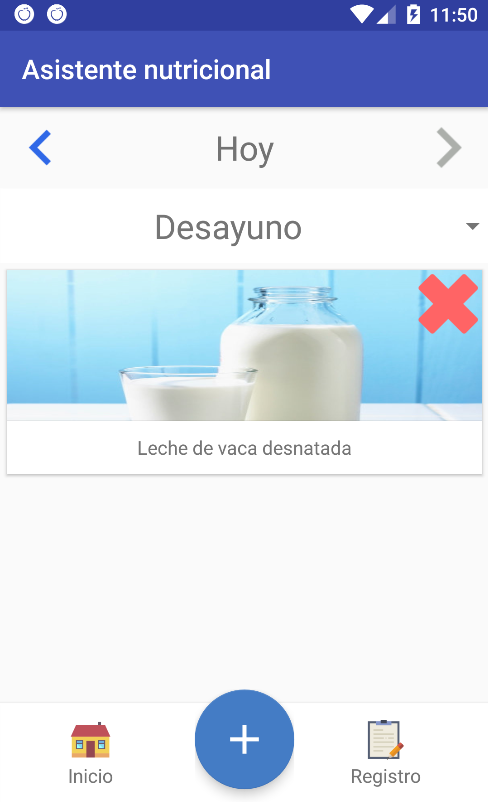
**Figure 5.** Welcome screen and display of outstanding goals.

* **Records system:** Food selection screen that suggests foods obtained from the local database of the application (Figure 6 (b)). Then, a quantity selection screen (Figure 6 (c)) is showed using the method described above (Figure 6 and 7).

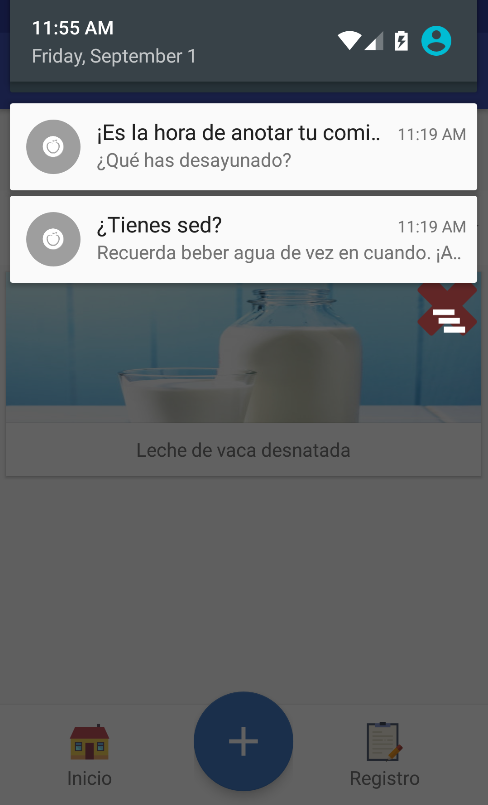
|  |  |  |
| --- | --- | --- |
| (**a**) | (**b**) | (c) |

**Figure 6.** Drop down to register a meal.



**Figure 7.** Record display panel.

* **Notification reminder system:** When aging, people gradually loose the feeling of thirst, so one of the most important functionalities of our solution is to remind users to consume liquids and meals in the necessary periods. Through the notification system of mobile devices, the application launches reminders to drink water on a regular basis, and from preset hours reminds the user if he has to write down a meal in the application (Figure 8). To do this, different services are used that execute inscriptions in the system of alarms of the operating system in the background, executing a service for each schedule of annotations.



**Figure 8.** Notification reminder system.

6. Conclusions and future work

Telemonitoring is a relevant alternative to promote healthy eating habits, especially for elderly. However, the software systems available in the literature lack the adaptability and expert supervision demanded by this population. For this reason, we have proposed Food4Living, a multiplatform scheme with which to develop applications that satisfy the perspectives of users and professional nutritionists. With it, we try to facilitate the development of the necessary basic questions of a nutritional telemonitoring system composed of three interconnected subsystems (Nutritionist subsystem, cloud subsystem and mobile subsystem). These three components aim to solve problems not addressed by the applications and models that currently exist. Developing a platform aimed to 1) users, with which they will offer the data of the system about their behaviors and eating habits, and will collect plans, guidelines, diets and advice from a professional nutritionist; and 2) nutritionists, with whom they will analyze all the data on the users, and where they will establish nutritional action plans adapted to each user.

At the same time, we present Food4LivingAPP, an implementation of the proposed platform as a software application. With this implementation we show how the different subsystems of the proposed model can be integrated, offering as a final result a fully usable application that meets the needs of our initial objective.

Likewise, Food4LivingAPP has been carried out, integrating the work in an open project, the nutritionist subsystem, the mobile and the server in the cloud, satisfying the needs of each party and interoperating among all the platforms to build a system that allows semi-autonomous monitoring It forms the nutritional habits of each user, but at the same time, it shows in real time the progress of each user giving him the opportunity to develop action plans and diets adapted to each individual, promoting in a simple and not abrupt way a progressive change to good and healthy habits.

Currently, we are undergoing the evaluation of the app within the Avisame project with elderly users and professional nutritionists.

For the next phases of our project, pilot studies will be started to test the usability of the platform and its perceived usefulness, new mechanisms of artificial intelligence will be introduced in order to suggest adapted diets according to the most ingested foods of the users. We will apply automatic data mining mechanisms based on user statistics, adapting the project to the results and bringing the final product closer to users and researchers.

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