

SapoFitness: A Mobile Health Application for Dietary Evaluation

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Abstract— Health problems related to diet, including obesity and cancer, are important concerns in the current society. The main treatment for obesity includes dieting and frequent physical activity. Diet programs keep and cause weight loss over short, medium, or long term. However, to maintain balanced body energy, a frequent physical exercise is required. This paper presents SapoFitness, a mobile health application for a dietary evaluation and the implementation of challenges, alerts, and constantly motivates the user to use the system and keep the diet plan. SapoFitness is customized to its user keeping a daily record of his/her food intake and daily exercise. The main goal of this application is to offer a motivation tool for weight reduction and increase physical activity. SapoFitness includes the ability to share personal achievements with social networks, a very intuitive human-device interaction and control weight, applying not only to control obesity but also to malnutrition problems. The application offers a continuous alert system activity, sending alerts/messages concerning the user diet program taking into account also his/her physical activity. SapoFitness is a challenged mobile application that delivers the action to the user, motivating for a healthier life style.

Index Terms— Mobile health; mHealth; Application; Dietary evaluation; Obesity

I. INTRODUCTION

A major problem in healthcare is the lack of availability from patient/physician for frequently health monitoring. Health telematics comes to offer less expensive solutions reducing the patient-physician physical relation and provides monitoring solutions for patient/nursing homes and even in hospitals [1, 2]. Patients that live in remote rural areas, travel constantly, in case of accident scenes, among other scenarios, are often physically inaccessible to receive any kind of health monitoring or treatment. The introduction of information and communication technologies (ICTs) brings a new hopefulness for such patients with more accessible and affordable healthcare solutions [3]. Wireless and mobile networks offer an adequate and powerful solution to overcome such barriers [4]. Mobile Internet and the use of Web for telemedicine have a strong impact on health-care models that are based on the concept of anytime and anywhere connections [5]. These mobile technologies offer an improved data accuracy, facilitating remote diagnosis and monitoring, medical data and patient records information transfer. Wireless telemedicine, also known as mobile health (m-Health), proposes to deliver

health-care anywhere and anytime, surpassing geographical, temporal and even organizational barriers [4, 6]. The advent of mobile communications supported on smart mobile devices like smart phones and personal digital assistants (PDAs) offer a unique opportunity to develop efficient and ubiquitous solutions for mobile telemedicine applications. To provide ubiquitous availability of multimedia services and applications, mobile devices feature several technologies such as Wi-Fi, 3g/GSM, GPS receiver, and processing and storage capabilities that turn it feasible [6]. M-health systems, and its inherent mobility functionalities, have a strong impact on typical remote monitoring systems, healthcare alerting systems, clinical and administrative data collection, patient records maintenance, healthcare delivery programs, medical information awareness, detection and prevention systems, drug-counterfeiting, and theft [7].

Any e-Health system is sustained on its electronic health record (EHR) [7]. An EHR-System is basically a repository of information regarding the health records of patient/consumer in a computer form [8]. A mobile EHR-System (mEHR-System) complements a typical EHR-System enabling access to health information regardless of the patient time and place. Nowadays, mobile phones, Smartphones, and PDAs are suitable devices for clinical practice and studies. Several areas have already developed and experimented numerous research projects and applications [9-12] that are based in an m-Health service framework, as illustrated in Figure 1.

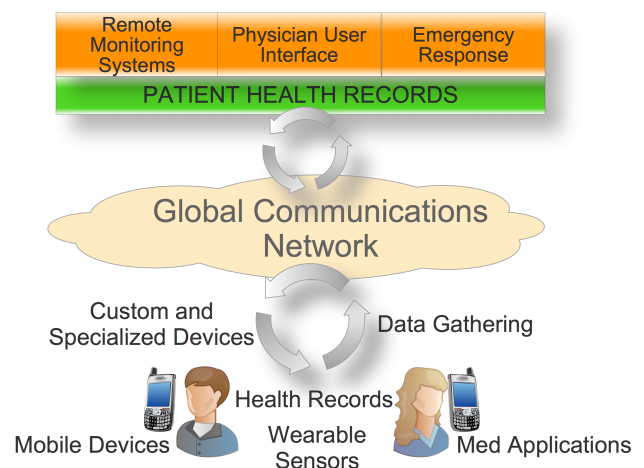


Figure 1. M-Health services framework.

Health problems related to diet, including obesity and cancer, are important concerns in the current society. In 1997, the World Health Organization (WHO) formally recognized obesity as a global epidemic [13]. The centers for disease control and prevention (CDC) considered the American society to be characterized by environments that promote the increased non-health food intake and physical inactivity [14]. The main treatment for obesity includes dieting and frequent physical activity. Diet programs keeps and cause weight loss over short, medium or long term. However, to maintain balanced body energy it is required frequent physical exercise [13]. This paper presents *SapoFitness* a mobile health application for dietary evaluation. It challenges, alerts, and constantly motivates the user to keep a healthy diet plan and also to maintain frequent physical activities. *SapoFitness* is a challenged mobile application that delivers the action to its user, motivating him to a healthier life style.

The rest of the paper is organized as follows. Section II presents the related work focusing on available mobile health applications concerning obesity. Section III addresses the application development including its requirements, system architecture, and used technologies. The application demonstration, including its user interface and main functionalities, strong aspects, and experimental evaluation and validation is addressed on Section IV. Finally, Section V concludes the paper and pinpoints possible future works.

II. RELATED WORK

This section elaborates on related work about mobile applications focused on dietary intake and physical activity. These proposals have an important contribution in the development of *SapoFitness* system architecture.

F. Zhu *et al.* propose a prototype system that uses a mobile device with a built-in camera, network connectivity, and an integrated image analysis that will provide an accurate account of daily food and nutrient intake [15]. Its goal is to use visualization tools with a nutrient database, allowing user to record his eaten food. Acquired images are used to estimate the amount of food and nutrients consumed. The image analysis includes the segmentation of food items and food identification. Furthermore, it presents a method for automatic portion of intake food estimation.

A mobile application/game *Time to eat* for *Iphone* is present in [16]. *Time to eat* is a mobile-phone-based health game created to promote and motivate children to practice healthy eating habits. This game gives to children the control of a pet that reacts to photos showing the food they consume. The pet interacts with the user by sending healthy-eating reminders via email. This messages change depending on the day of the week. Each player must take a photo of his or her meal and submit it. The user will then receive a score given by the pet, based on the healthiness of the food and the amount of food eaten.

A Mobile phone application for real time monitoring caloric balance, called *Patient-Centered Assessment and Counseling Mobile Energy Balance* (PmEB), is presented in [17]. This application allows users to self-monitor caloric balance in real time. The *PmeB* is a mobile client application and uses a Web

interface that allows users to register and personalize the mobile client. The client application allows the user interaction with the *PmEB* system. The server application sends updated caloric reminders to the client, stores food, and activity information, keeping data updated about the users daily calorie consumed.

A. Khalil *et al.* presents the *StepUp* application, a step counter application [18]. This application uses sensor-enabled mobile phones to automatically count the number of steps the user walked. Its primary goal is to return to the user the measured quantity of his/her daily activities and create a healthy competition which serves has a source of positive feedback. The *StepUp* application also aims to increase the users awareness and understanding the importance of physical activities and facilitate the integration of regular exercise into their daily life.

A *Mobile Personal Trainer* (MOPET) system is proposed in [19]. *MOPET* is a wearable system that supervises physical activity alternating jogging and fitness exercises in outdoor environments. This system uses real-time data collection from sensors, information provided by a sport physiologist and a professional trainer, and a user model that is built and updated through a guided auto-test. The main goal of *MOPET* system is to motivate the user as well as provides safety and health advices, adapted to the user and his/her context. The interaction *MOPET*-user includes a 3D embodied agent that speaks and demonstrates how to correctly perform exercises with interactive 3D animations.

SapoFitness gathered contributions from the above-described works and also from *Android market* [20] applications, *CardioTrainer* [21], *MyFitnessPal* [22], and *CalorieCounter* [23]. These applications complement each other with different functionalities. *CardioTrainer* uses the GPS to track the meters walked by the user and measure the calories burned. *MyFitnessPal* and *CalorieCounter* are similar applications, both keep track of the user food intake, and *CalorieCounter* even allows the input of physical activities. However, both applications do not have a suggestion of a diet or exercise plan. *SapoFitness* complements all the above approaches and intents to be a more complete solution for obesity prevention and treatment. The application will be presented, in detail, in next section.

III. APPLICATION CONSTRUCTION

This section discusses the application requirements, the system architecture, and the required technologies to create it. The focus will be on available and emerging architectures that foster its practical deployment.

A. System Requirements

Mobile applications have specific requirements that must be followed in order to provide a good solution and furnish a nice user experience. The user's interface must be intuitive and easy to use, with minimal data input from the user. The limited

D. Strong Aspects

SapoFitness application presents several strong aspects and novelties that are identified here. The ability to share milestones with social networks, a user-machine interaction, easy handling, and a good ratio between fun/motivation and control weight, applied not only to control obesity but also to encourage on problems of malnutrition. The application constantly monitors its user. The application keeps track of all food intakes and sends several customized alerts regarding his/her diet progress. *SapoFitness* also allow adding a list of food allergies.

The sharing mode is a strong aspect that allows sharing milestones with social networking, electronic mail (eMail), short message system (SMS), and all the applications that are installed on the mobile device. All of the *Android* preinstalled communication type applications, and a lot of 3rd party applications have support for communication between each other. Then, it increases the possible ways to share achievements/milestones in weight control. This function is limited to share milestones (share successes), and the system itself also present suggestions to the user. For example, after validate/update the weight off, the system detects that a milestone has been reached and sends a sentence with a picture to Facebook and / or Twitter.

Another strong aspect of this application is the user-machine interaction, offering a simple and powerful user interface to interact and handle the system. Another important aspect is the experience at the first utilization. It is very easy to use and intuitive. Finally, the application includes a certain dose of fun, allowing a user to interact and have fun with the application, but at the same time controlling his/her weight and promoting several physical activities. Summarizing, *SapoFitness* offers an intuitive, stable, fun and helpful application to users.

IV. DEMONSTRATION AND VALIDATION

This section presents an overview of the mobile application from the user perspective and demonstrates its use in a practical deployment. It includes the main application windows and the application validation.

A. *SapoFitness* Demonstration

As above-mentioned, the *SapoFitness* user interface is simple, uses large buttons, and includes appropriated size for fingers use. The application is always running, even in the background when the user is performing other actions with the mobile device. The application monitors the user's diet, even running in background, and alerting the user whenever is necessary to take another meal, all in accordance with the customization specified for the user. Figure 4 shows the login and menu window on the system. The user will enter his/her mail address (login) and the corresponding password. If a user is not already registered, the link "or register" provides access to a register menu to execute the registration, this because there may be more than one user per PDA. After logging in, and if it is the first time using the application, the user must introduce his/her personal data to customize his/her user

profile. Then, it goes to the window presented on Figure 5, in order to fill the personal setup.



Figure 4. The Login and the Main Menu window.

In the *Personal Setup* window, the user enters all the necessary information such as his/her height, weight, age, and sex, for determining the BMI (body mass index) and the maximum daily calories must consume. Thus, the system automatically sets a sort of user profile and the system basically tells the user if he/she is or not on overweight and some more information surrounding, such as weight target, date for the purpose, and calories to consume.

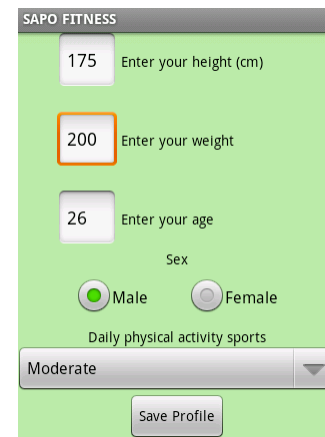


Figure 5. Personal Setup.

After saving the user profile, the application opens the menu window. If the user is already registered on the system, the above-mentioned data that is required to fill the screen shown on Figure 5, it is automatically imported from the local database. Then, it goes directly to the menu window. It considers the following nine button options: *Diary*, *My Profile*, *Food*, *Diet*, *Plan*, *Physical Activities*, *Info*, *History of Sharing*, and *Exit*. Again, *Diary*, *My Profile*, *Food*, and *History of Sharing*. The user *Diary* is the main window of *SapoFitness* (Figure 6). In this window, the user records eating habits and its diet progress. The diary presents the current date and time, how many calories users have eaten until the current time of the day and how many calories he/she should consume on average per day. In background is portrayed a motivation image of the user. Meals eaten and physical activity are

information to be recorded daily. Based on this information, it is possible to calculate the daily calories consumed and also a weekly weight loss that can be validated or corrected by the user. On the left-inside window, the user can enter his/her daily meals. When a user wants to see or search the food he/she intends to eat and identify its benefits or consequences that comes with it, this window may be consulted (Figure 6).

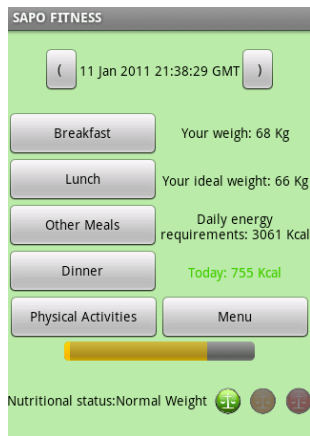


Figure 6. User Diary.

There are also pre-defined warnings in the meal plan for the space between meals. The sentence "You are for three hours without eating, eat a cereal bar" is a warning example. In addition, the system can still generate a warning when the user exceeds the calories that should consume daily. In the button *Physical Activities*, user can add daily activities, so those corresponding calories expended can be "deduced" in the dashboard. The window of physical activity presents three spinners. In the first one, the user can choose different kind of exercises. In the second spinner, the activity intensity can be selected and, in the third, the practice frequency. The activity is saved in the database as historic physical activity allowing multiple activities.

In the window *User Profile*, shown in Figure 7, it is possible to see the user nutritional status. The application calculates the BMI and reports back if the user is overweighted or not. It also indicates his/her ideal weight, and how many calories should be eaten per day. By pressing "Learn more about your nutritional status", user will have access to medical information about dangers of obesity/malnutrition and nutritional status. In this window, the user also has access to food plans suggested according to their nutritional status (2 or 3, at maximum). The user can also modify his/her profile data. For example, if, after three months, he/she lost 3 pounds of weight, the field "weight" should be updated on his/her Plan. This window also includes a motivation picture that changes depending on user status. For example, if the user is leaner, a red icon is presented, if he/she is in a good shape, it shows a green icon, or a red icon appears if he/she is overweight.

In *Food* menu, the user can search on the food database. It is the same mechanism that is used to insert meals. For this, the food must be available in the system database. When a user writes the name of a meal, the application displays all the meals that begin with the characters that will be inserted (allowing a faster choice). The food database is composed by

food that makes up a meal. For instance, a lunch should include baked potato + salad + fish. Therefore, it is useful that user can see all available foods already included in the database. It is also important to put a window to enter quantities (i.e. 100gr), or 2 tablespoons or a medium apple, since the calories for food will depend on the quantities.

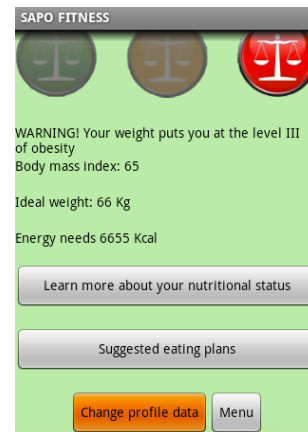


Figure 7. User Profile.

The *History of Sharing* window allows the user to observe previously shared information in social networks. The menu window *Plan* button, presents plans of physically activities/food for each profile. It also includes the ideal and current weight, together with the differential. By this way, the user knows the nutritional status and obtains information not only about diet programs, but also physical activities and the time pre-defined to loose weight. The user may choose a date and weight to be achieved. In the *Diet* window, the user can observe the respective diet program. The *Exit* button will close the application.

B. System Experiments and Evaluation

The performance evaluation and real deployment of *SapoFitness* is presented on this section. The application validation was performed through exhaustive running experiments. In the testing phase, two main validation approaches were considered: general application functionality and user experiments. Real devices were used in all the performed experiments, instead of the bundled Android emulator, as may be seen in Figure 8. *SapoFitness* was deployed in three different mobile devices with three different screen sizes, and the behaviour of the application user interface performed very well. General application functionality tests focused on local application functionalities (like database testing, search engine testing, PDA screen sizes, and stability issues) were performed. These tests enabled various debugging operations.

The second area of validation is the evaluation of the user experience. Several users experimented the application for several weeks and the feedback was extremely good. Several scenarios were experimented and the system performed very well, as expected. These experiments included communication with food database, daily food inserted, behaviour of the users, profile changes, and motivation of the users to use the

application. Users have been testing *SapoFitness* on a daily basis entering their user profile and updating their food intake. There was a pretty good feedback from users. Who use the application has a component of fun, using it without feeling obliged to do so. Thus, a very positive and motivated relationship is created between fun and control weight.

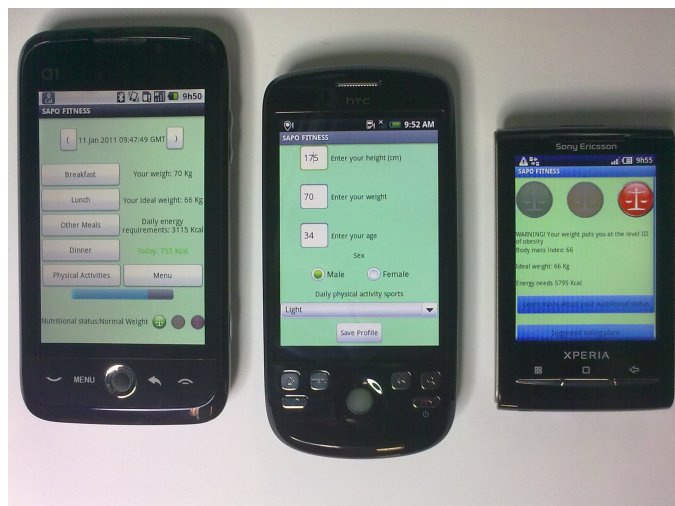


Figure 8. Deployment of *SapoFitness* in real devices with different screen sizes.

V. CONCLUSIONS AND FUTURE WORK

This paper presented *SapoFitness*, a mobile health application for a dietary assessment and evaluation. This application is very intuitive and easy to use. Its main goal is to motivate the user to lose weight, increase physical activity, and have a good and balanced nutritional state. *SapoFitness* continuously monitors its user taking into account his/her food intake and physical activities, sending alerts/messages concerning his/her diet program. *SapoFitness* is a challenged mobile health application that promotes a healthier live style. It was demonstrated and validated, and it is ready for use.

Future improvements include the use of a Web service that will connect to a server database that will support the current local database freeing storage space from the mobile device. This Web service may also have a Web interface with *SapoFitness* user or users stats. Furthermore, collaboration and cooperation among users, socializing and helping each other to reach pre-defined thresholds, belongs to further application improvements.

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