Monitoring Weight and Physical Activity using an AmI setting

João Ferreira, Rafaela Rosário, Angelo Costa and Paulo Novais

Abstract We have an increasingly sedentary population without the care to make a healthy diet. Therefore, it becomes necessary to give the population the opportunity, despite living a very busy and tiring life, to have control over important aspects to their health. This work aims to present a model of an ambient intelligence system for monitoring the weight and physical activity in active individuals. To accomplish this objective we have developed a mobile application that allows users to monitor their weight over a period of time, identify the amount of food they consume and the amount of exercise they practice. This mobile application will give information to users about dietary and physical activity guidelines in order to improve their lifestyles. It is expected that students improve their lifestyles.

Key words: Monitoring Weight, Physical Activity, AmI, Mobile, Lifestyle, BMI

1 Introduction

Currently, obesity is increasing across all the population. Besides adults, more than 30% of children are considered as overweight or obese [1]. This increase can be associated with an imbalance between energy intake and energy expenditure. According to the American College of Sports Medicine and the American Heart Association [2], it is recommended that adults, between the ages of 18 and 65, perform exercises of moderated intensity during, at least, 30 minutes per day over 5 days a week, or in alternative exercise of elevated intensity during, at least, 20 minutes per day over 3 days a week. Now, more than ever, it is important to develop and

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implement interventions that aim to improve physical activity in all the population [3].

Besides physical activity, interventions should improve dietary intake [3]. There are no forbidden food, however following a healthy diet rich in fruit and vegetables and poor in low nutrition, energy-dense foods is associated to a reduced risk of obesity [4], cancer [5], asthma [6] and cardiovascular disease [7].

It is known that there is a need to encourage the population to improve physical activity and eating habits, nevertheless best practice is far from complete. In our view, current projects in this area are very generic and do not take in consideration the personal needs of the users and their daily routines. These applications simply suggest a diet for the users to follow and in some cases dont even keep a record of their evolution while using that application.

1.1 Lifestyles impact

Lifestyles are important determinants of chronic diseases. Dietary habits may influence cardiovascular disease (CVD), which continues to be the main cause of death in Europe [8], through an effect on risk factors such as serum cholesterol, blood pressure and body weight. In addition regular physical activity is associated to a reduced risk of CVD [6, 9] and a sedentary behavior to the prevalence of obesity [10]. Therefore, these chronic diseases are preventable.

Although age, gender and genetic susceptibility are non-modifiable risk factors, others such as diet and physical activity play an important role on the prevention of these health problems [3]. There is a need to develop and implement effective programs in order to improve eating habits and physical activity behavior. Evidence suggests that the childhood period is an important opportunity to achieve healthier eating habits [11]. In addition multi-component and adapted to the local context interventions are likely to be successful, as well as those which use social structures of a community such as schools [12, 13, 14]. It is also known that interventions which provide feedback tailored to an individuals needs are more likely to be used [14]. The novelty of this study is the development of an application to be used over time and which gives the opportunity to reinforce information about healthier lifestyles to users and analyze their progress.

1.2 Ambient Intelligence

Ambient Intelligence (AmI) has been used most recently due to an increase in the number of devices that are available to users, like for example, computers, tablets, smartphones, etc.

One of the main purposes of AmI is to reduce the need to be constantly providing information to the system and that he can be able to make decisions without needing great interaction with the users. The decisions, being based in data provided by the sensors from the behavior of the users, may be incorrect, which will lead to the users having to perform slight alterations to the system [15]. In order to design an AmI system, we needed to determine what elements to consider (see Fig. 1).

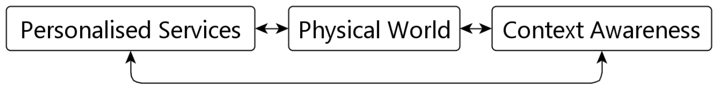

Fig. 1 Required elements in an AmI system

The Figure 1 presents to the following elements:

- Physical World: in this element we consider the environment that surrounds the user, every object and how they communicate between each other. Every chair, desk or plant that surrounds the system is taken in consideration. The users are the most important element of the systems because they are the ones that use the system. Many aspects of the users life are very important for the AmI system such as his daily routine or what type of job he develops. With this information the AmI system can make decisions that will benefit and improve the way that user lives.
- Context awareness: Context Aware Computing is defined to be the ability of computing devices to detect and sense, interpret and respond to aspects of a users local environment and the computing devices [16]. This means that a context-aware system should be attentive to all that surrounds him, with the purpose of adapting to it.
- Personalized services: one very important element of an AmI system is that these systems should adapt themselves to the users habits. A system of this type should learn from all the inputs that the user or the surrounding environment gives it, determine which ones are more relevant. After that, the AmI system should be able to adapt its process and execute all the actions that the user normally would perform, releasing the user from that task.

In the next section is presented part of the model developed, being the mobile application. It is explained its importance and the preliminary development results

2 Platform Architecture and Technologies

Currently, from the complete system, it is being developed the mobile platform. In Fig. 2 can be seen a simple system architecture.

The proposed mobile platform is implemented in Android OS. The Android and mobile device provide access to the accelerometer and GPS, which are vital to the movement mesures.

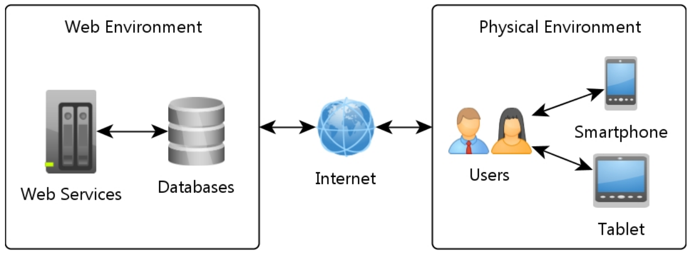

Fig. 2 System architecture

The accelerometer is a sensor that measures the acceleration force that is applied to a device on all three physical axes (x, y and z), including the force of gravity. Or in other words, detects the motions of the devices (shake, tilt, etc.). The GPS keeps track of the user outdoor position. Both these sensors may provide information that determines if the if the user is performing exercise or not. The platform is built to interact with any type of user, being technological savvy or not [17, 18, 19].

All the information that is retrieved from the use of the application is saved in Json files. This format allows us to serialize and transmit structured data over a network connection. Therefore, the information will be sent to a JAVA web service through any Wi-Fi network to which the device is connected. The web service will intermediate between the user and the database as way to keep the data of the users secure. This information will be important to recognize data patterns, so that it will be easier in the future when the application encounters similar situations.

The platform created for this work is divided into three modules: personal data gathering, monitoring system and decision making. The platform easily adapts to different scenarios, by only changing the configuration and database files. This operation translates in a simple exchange of secure files, which retain all the information saved over the platform operation.

2.1 Personal data gathering

The application can correctly adapt to the users personal and work life, by gathering some information essential to its future work. First of all, the application needs to know the users name, so that the contact with the user can be more personal. This way, when in the regular use of the application, the contact between the application and the users is more personal and, therefore, more easily taken in consideration by the user. In order to preserve the identity of the user, when the information is saved in the database, the user is identified by a number and not by his name.

Besides the name, the application needs the information about the height and weight of the user so that we can compute their Body Mass Index (BMI), kg/m2, which will be what the application will take in consideration when analysing the users progress . Moreover, we will have information about regular weight (see Fig. 3).

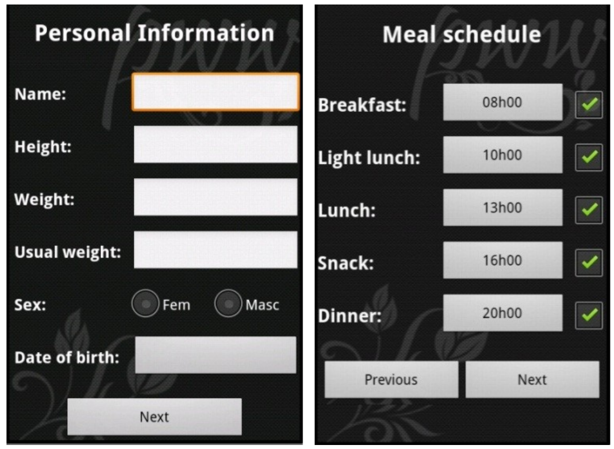

Fig. 3 Personal Info Application Screen

The application requires the information about the time that the users normally take their meals (see Fig. 3). This is used not only to know which are the meals that the user takes and at which time, but also to remember the user to give those information.

Finally, it is asked to the user information about his/her work, as for example the work schedule. This information is important in order to understand great discrepancies in the values that the accelerometer returns. It is also asked how many hours the user is standing up. The reason behind this question is that on this position he/she is expending more energy at the same time.

2.2 Monitoring system

The monitoring system is constituted of two types: online or offline. The online system uses the information that comes from the smartphone sensors (accelerometer and GPS) and using data mining algorithms, finds patterns in the information, thus calculating the exercise done. This way the user will not have to constantly be inserting information in the application.

The offline system makes the user insert all the information about the exercise that he performs. The user can insert the information daily or, if the user performs exercise in a weekly basis, the user can insert one time and the values will be saved for the correspondent week, as shown in Fig. 4a.

Shared by both is the need to introduce information about the weight and eating habits of the user. Although the information related with users meals needs to be inserted daily, the information about the user weight should only be inserted at the end of the week because the user weight variations are only noteworthy in long periods of time.

When inserting the information about the meal, the user will have to choose the two most representative elements of his meal between the following: fruit, lettuce, meat/fish/vegetables, rice/pasta or cake. Then the user will be asked to insert the quantity of the eaten food. Moreover, the user also has to insert the type of beverage that he/she had and the quantity. Finally, the user will have to insert whether or not if he/she had a coffee (seen in Fig. 4b).

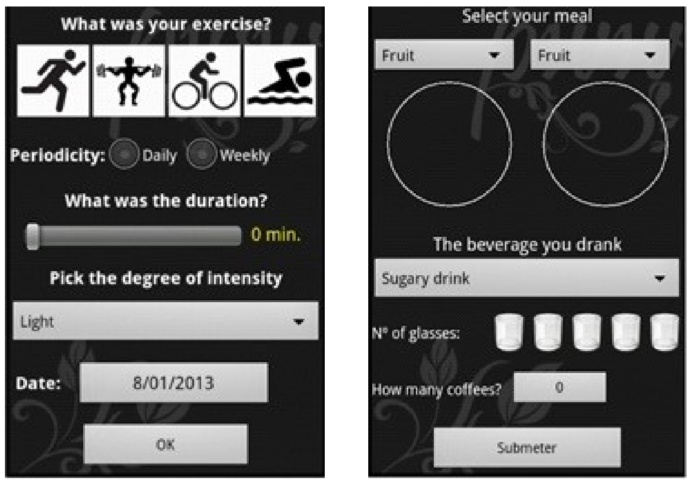

Fig. 4 a) Exercise information b) Meal information

The user can see his BMI evolution in the last 10 weeks as he can also see energy intake by meal in the last 10 days. This gives the user the opportunity to keep track of his/her performance in energy intake since he/she has the application.

2.3 Decision Making

The decision making module will be responsible for giving advice to the user. All the decisions will be based on the information saved in the knowledge base that is stored in the users smartphone memory card. This is a very important module because this is expected to affect the diet of the user when following the tips that the application shows. Therefore, it is expected that the user will start losing weight and having a healthier lifestyles than what he/she used to have.

The application will advise the user about his eating patterns. For example, if the user usually skips breakfast he/she will be advised by the application to change this routine, and will be encouraged to eat the breakfast, as it is considered the most important meal of the day. Another possible advice the application gives refers to the need of the user eat fruit at any meal in the day, especially when the application notices that he/she does not eat this food. Then, the application will recommend that he/she starts eating fruit at least two meals per day, due to the number of nutrients that is available in fruits.

In order to determine the amount of energy intake at every meal, the application sums the values of each element of the meal. These values are calculated differently depending on the element the user chooses. For example, if the user inserts that he/she ate rice/pasta, the application takes the percentage of the plate that the rice occupied. We consider that a portion of rice is 110 gr which represents 140kcal. The user will identify the portion that he/she ate, according to the figure of the plate. At the end we will sum all the eaten foods and compute the final energy of the meal.

$kcalingredient = (\%ofplate/12.5) * kcalperportion$

The formula varies between elements because of the size of the portion. When we are adding all the values so we can determine the total of calories ingested in a meal, all the meal elements have the same importance.

3 Conclusions and Future work

Currently it is being developed and fine-tuned the mobile application. The model architecture sustains the base structure to the further developments. That is, we are developing the webservices to manage the data coming from the mobile application.

While the mobile application is currently in an alpha stage, it is able to collect and do basic operations, demonstrated in the section 2. We expect acceptance from the users by because of two main motives: personal interest and attractive interfaces. Therefore, work is being done towards optimizing calculations and using profiles. To achieve the main goal, that is being used by a user with intention but without being annoying.

Tests are in the development roadmap. University students will be invited and selected, in a first stage, to participate in this study. All of the students must be considered ”active students”, according to our selection criteria. Students with physical disabilities will be excluded from the study.

This first trial will give us information to determine if the system has any faults and to know the opinion of each person about the system and the improvements needed. This is will result in a test of a greater magnitude that will outcome in more information. Therefore, allowing the system perfecting and improving any bugs.

Acknowledgments

This work is partially funded by National Funds through the FCT-Fundação para a Ciencia e a Tecnologia (Portuguese Foundation for Science and Technology) within projects PEst-OE/EEI/UI0752/2011. Project AAL4ALL, co-financed by the European Community Fund FEDER through COMPETE - Programa Operacional Factores de Competitividade (POFC).

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