Mobile Personalized Fitness Advisor Application Using Context-Aware Recommendation Technique

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Abstract. The sensor technology and the emerging mobile computing paradigm offer an opportunity for us to create various pervasive applications. These converged mobile computing technologies make it possible to support the user who wants to be provided with cost-effective health care services. In this paper, we try to novel approach for efficient and useful mobile health care services. For this, we not only use the smart phone sensor technology but also use context-awareness and recommendation technology. Also, we develop a mobile personalized fitness advisor application in which the technique converged with context awareness and recommendations is used.

Keywords: Context awareness, Recommendation, Smart phone sensors, Mobile personalized services.

1 Introduction

With the advance of sensor technology in the mobile devices such as smartphones, there is good chance to develop various kinds of pervasive mobile applications. In practice, the emerging mobile computing paradigm offers a unique and real opportunity for us to create pervasive applications and to support the user who wants to be provided with cost-effective health care services. With the increasing needs of mobile health care services, there are many various mobile health care applications.

However, unlike such existing mobile health care services, we try to novel approach which not only uses the smartphone sensor technology but also uses context-awareness and recommendation technology.

The rest of the paper is organized as follows. Section 2 reviews backgrounds of our study and related works. Section 3 describes our technological solution by means of context awareness recommendation-based mobile health care service. Section 4 presents the prototype issues and section 5 concludes this paper and represents future works.

2 Background and Related Works

A trend that we may be seeing with smartphones and similar devices is that they work with various sensors. The tremendous growth of sensor technology in smartphones increases day by day. Table 1 presents kinds of sensors currently embedded in smartphones [1].

Table 1. Smartphone sensors

Smartphone sensors	Features
Ambient Light(ALS)	An ambient light sensor extends battery life and enables easy-to-view displays that are optimized to the environment.
Proximity Sensor	A proximity sensor detects how close the screen of the phone is to your body. This allows the phone to sense when you have brought the phone to your ear. At that point, the display turns off in order to save battery.
Global Positioning System(GPS)	A GPS takes signal from GPS satellites and use triangulation to calculate the user's exact location
Accelerometer	An accelerometer allows the devices of smartphones to detect the orientation of the device and adapts the content to suit the new orientation. The accelerometer in smart devices measures the acceleration of the device relative to free-fall.
Compass	A compass measures the strength of the magnetic field in three dimensions. The compass in the smartphone can be used to determine the angle by which the device is rotated relative to the Earth's magnetic north pole.
Gyros	A gyroscope is a device for measuring or maintaining orientation, based on the principles of angular momentum. Gyroscopic sensors used in navigation systems and gesture recognition systems in Smartphones and tablet PCs.
Back-illuminated Sensor	A back-illuminated sensor, also known as backside illumination (BSI or BI) sensor, is a type of digital image sensor that uses a novel arrangement of the imaging elements to increase the amount of light captured and thereby improves low-light performance.
Microphone Sensor	A microphone sensor converts sound into an electrical signal. A microphone in the smart phones can detect whether the user is near a sound source.

And aside from theses current embed sensors, smartphone sensors are more and more various because of remarkable development of smartphone technology. Figure 1 shows much various smartphone sensors which allow smartphones to provide the life of human with useful personalized services.

Regarding the fields of mobile health care services with smartphone sensor technologies, this is well treated in the scientific literature [2]-[5]. However, the use of various types of sensors for health care services is not common in smartphone applications. Nevertheless, there are just a few researches using data from various types of smartphone sensors for mobile services. Ganti et al. presented architecture for lifestyle monitoring, but it just collects data from sensors in the smartphone and subsequently, these data are sent to a server for only data analysis [6].

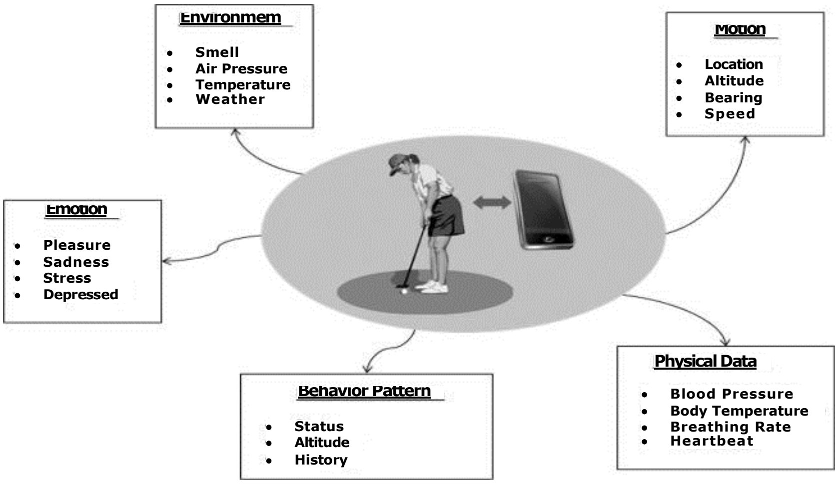


Fig. 1. Various functions of smartphone sensors

In this work, we focus on useful possibilities of smartphone sensors. To develop the intelligently personalized application, we try novel approach which converges context data captured from various smartphone sensors with the recommendation technique.

3 Our Approach

In our case, these are very important to refine data captured from smartphone sensors into useful information and to provide valuable services which are truly proper to user's latent needs for the certain information or services. This makes it possible to understand current user context through which we can know what situation the user encounters. To understand user's currently latent needs, we consider context-aware recommendation techniques for mobile personalized healthcare services.

3.1 Context Similarities

We consider the context-awareness recommendation technique as a key in personalized health care application to recommend useful services to the user or to assist the user's certain tasks such as an exercise. To recommend useful services which are proper with user's current context, the storage of user's history which includes user's frequent pattern, user's preference and user's profile such as age, sex and a job is needed. Using the data from the storage of user's history, we compute various types of context similarities. The similarity between objects is widely used factor in the domain of recommendation systems [7]. Based on these calculated context similarities, we can determine which services are most useful to user's current latent needs. In this work, we define three types of context similarities as shown in Table 2. *Preference CS* is used in finding other users who are similar with an active user, which allows us to know the general preference of an active user based on found other user's preferences. Through this similarity, we can provide useful services to an active user considering his preference. *Pattern CS* is for detecting the user's frequent behavior. Based on this similarity, we can expect what the user is doing currently and we can provide services that are frequently experienced by the user when the user encounters same contexts. The use of *Situation CS* helps for deciding what is happening around the user currently, and providing useful services which are statically defined in advance by some other experts.

Table 2. Types of context similaritis

Context Similarity(CS)	Target	Used Context
Preference CS	Preference of an user and preferences of the others	User's profile
Pattern CS	User's current contexts and past contexts	Currently captured sensor data and stored sensor data
Situation CS	User's current contexts and expected contexts	Currently captured sensor data and expected contexts which are defined with expert information in advance

For example, if the user immoderately exercises, by the previously defined expected contexts, the urgent notification service is automatically provided to stop the user exercising excessively.

$$\frac{nE a_i u_i \text{ — I }_{at} \text{ Eui} \quad {}_{i=1} \quad {}_{1,1} \quad {}_{i=i}}{\text{—}_{i=1} \quad {}_{i=1} \, \boldsymbol{a_i})^2 J\text{—}_{i=1} \quad {}_{i=1} /4_i)^2} \quad \textbf{(1)}$$

To compute *CSs*, we use Pearson correlation coefficient to efficiently get the similarity between context data. Equation (1) is for calculating the *CS*. $Sim_{a,u}$ is the context similarity between context data *a* and *u*.

3.2 Personalized Mobile Fitness Advisor

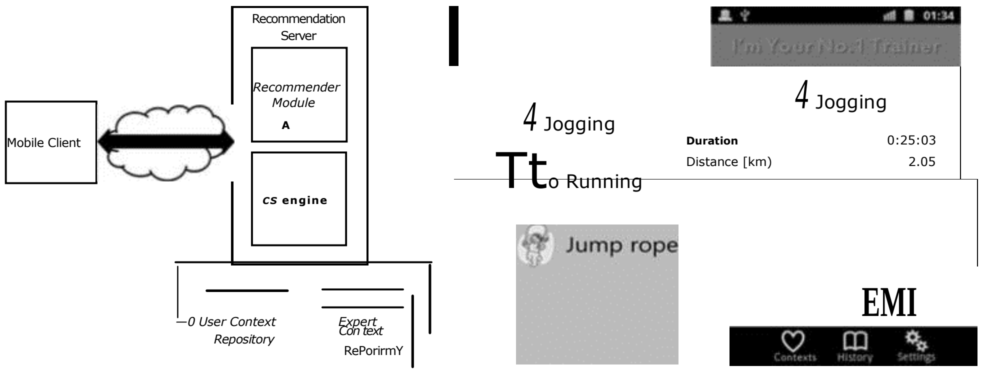
For showing the usability of our approach, we develop mobile application which provides the personalized fitness advisor service. Functions which the developed application has are divided into four parts. The function of *recommendation* recommends certain sports and good tips about the particular sports depending on the user's preference. The function of *monitoring* allows the application to monitor the user's current physical status. For example, the user firstly selects which sport he currently exercises. Then, during monitoring the user's physical status, the application provides useful information such as tips or notifications when the user encounters certain contexts. The function of *history* is for storing the user data which include encountered contexts, experienced exercise. Based on this history, we can compute CSs and recommend useful information to the user. The function of *notification* is for notifying urgent information such as the time of exercising or the user's bad status.

Table 3. Usability of fitness advisor application

Function	Used *CS*
Recommendation	*Preference CS, Pattern CS*
Monitoring	*Situation CS, Pattern CS*
History	*Pattern CS*
Notification	*Situation CS*

3.3 Prototype

With Android SDK 2.2, we develop the prototype in which our proposed approach is applied. Figure 2 (a) presents the overall service architecture of the prototype. The overall architecture of developed prototype consists of a recommendation server and a mobile client. The mobile client sends context data captured from considered sensors to the recommendation server. Then, *CS* engine in the server calculates *CSs* based on data which are stored in a user context repository or an expert context repository. The recommender module recommends assisting information which is proper with user's current contexts through wireless internet.



(a) Service architecture (b) Prototype

Fig. 2. Mobile personalized fitness advisor application

For the sports which the prototype application provides as services, we only consider three common sports, jogging, running and jump rope. The provided service related with each sport is different with other sports. Based on provided services, the considered *CSs* are also different. For example, the service of jogging provides exercising information such as duration, distance and average speed. And it recommends some tips as shown in Figure 2 (b). In the case of jogging, we use *preference CS* for recommending the duration of exercising time, and *situation CS* for dynamically notifying tips. Also we consider *Pattern CS* for recommending user's proper aim with personal history data.

4 Conclusion and Future Works

With the increasing needs of mobile health care services, there are many various mobile healthcare applications. In this paper, we proposed novel approach. The proposed approach not only uses the smartphone sensor technology but also uses context-awareness technology and recommendation technology for efficient and useful mobile health care services. Also, we developed mobile personalized fitness advisor application. Through developed application, we showed that our proposed approach is much possibility to use in various mobile health care services.

While our proposed approach is verified useful through developing the practical prototype, we did not consider any public purpose such as helping patients. In the future, we will develop another mobile health care application for elder persons with disabilities. For this, we will extend our proposed approach for this motivation.

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