Revolutionizing Mobile Healthcare Monitoring Technology: Analysis of Features through Task Model

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Abstract. Proliferation of health information and patient communication had allowed patients to have deeper understanding of their ailments leading to positive effects on personal health management (PHM). There are many PHM systems developed in the form of web and mobile applications to cultivate personal responsibility for one's own health. Thus, this paper aims to explore the alternatives and avenues available in the form of mobile PHM applications utilized by patients, caregivers and medical professionals that can provide value-adding initiatives to improve the process of personal medical care. A Task model for the development of a mobile PHM will be discussed based on six factors, namely (1) subject; (2) objective; (3) control; (4) tool; (5) context; and (6) communication.

Keywords: Friends and family groups, healthcare communities, task model.

1 Introduction

According to WHO statistics [1] government spending on healthcare is escalating more rapidly than the growth in gross national domestic product (GDP). For example it is expected that change in public health expenditure in USA for 2011-2030 is expected to be 5.1% as a percentage of GDP. This indicates that people spend a greater proportion of their wealth on health to be healthy. Present day people are taking a proactive attitude towards their own health as well as that of their family [2]. With the proliferation of health information and patient communication, patients have gained deeper understanding of their ailments leading to positive effects on self-efficacy [3]. However, the prevailing scenario of unequal growth of demand and supply of medical service, may lead to an eventual decline of quality and service provided to the patients [4].

With the rapid technological advancements in smart phones and other mobile technologies, management of one's personal health is no longer an onerous task and could be carried out while on the go [5]. Moreover, ever increasing availability of smart phone users provides us an opportunity to diffuse mobile personal health management (mPHM) among these users [6]. The void of inadequate communication highlighted by both the patients and the doctors during our preliminary study could be filled by

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the integration of technology and especially mobile applications in their daily lives. There seems to be a strong demand for professional and personal healthcare services on mobile applications. Factors enriching the mobile environment, like convenience, increased motivation, and capability of controlling and reminding patients can be considered as value addition to PHM mobile applications.

We will be using the Task model proposed by Sharples and Taylor [7] as the theoretical framework. Even though this model had been proposed for mobile learning environments, the framework could be adopted in mPHM environment as well. The mPHM platform named "SerpentPole" will be proposed to cater to all the requirements of the task model. Our study develops a mobile application for both patients and physicians based on the OSGi framework [8] and web client technologies.

The rest of this paper will deal with a description of the task model for patients followed by a more detailed description of application of the task model in PHM application named SerpentPole mobile app development. Finally, the discussion and conclusion will be presented highlighting the limitations and future directions of this study.

2 Theoretical Framework

Task Model from Sharples and Taylor [7, 9] is an interconnected framework of six factors used to design and analyze projects on a detailed level and Meta level of projects. This model is commonly used in mobile learning environment [10] to understand the design functions of projects and later on to analyze them. We believe that a similar model could be applied in the context of mobile health for capturing of its functions better when designing the architecture of the system and to compare with other available systems to differentiate the application from others. This is mainly composed of three standard factors namely, subject, objective and tool. The subject in a learning process is a learner or the student. Then the objective is moving the learner from novice stage to a trained stage or an advanced knowledgeable stage. Tools can be distinguished as any device, instrument, medium, material or content used to educate students in learning process. In this study, patient is considered as the subject, health management goals are objectives and tools used to mediate objectives to the patient (e.g. doctor, monitoring device, a text) are considered under tools. Then the model is extended by three other influencing factors, namely the context, control and communication. Control can be defined as setting the right aims and meaningful process for leaning. This could be varying from full teacher control to full learner control. In a learning process, this is the responsibility of the teacher or the l earner. Context is defined as the relationship between the context of learning and environment of the learner. This could be independent, formalized or socializing. Communication describes the interaction and communication with other persons of the learning group. For mobile health, we could see that these functions are important. Subsequent sections will deal with each function based on mobile health.

This model appears as two layers as it is considered on dialectic [9]. They are technological and semiotic. The technological layer considers learning as an engagement with technology. Thus, in mobile health, it represents health management as an

engagement with technology, where mobile phone functions as an interactive agent. The semiotic layer considers learning as a semiotic system in which learner's objective actions are mediated by tools. Thus, technology is an enabler for semiotic layer.

Sharples and Taylor's Task model is used to analyze the context, subjects and objectives, tools, control and communication of mobile health applications [10]. Though there are many mPHM applications (e.g. health buddy, iDAT, healthDiary, medscape, iTriage), they have not considered a model like Task model giving a pragmatic and comprehensive view in designing and developing the applications. Moreover, this will provide a common ground to compare with other applications i.e. can look into similarities, differences and contradictions based on this model.

3 Usage of Task Model in PHM Application

First we develop 3 instantiations of the Task model, namely (1) patient who is undergoing medication for a certain condition; (2) caregiver who is looking after the patient and (3) physician who he is diagnosing and prescribing. The semiotic components could be found in Table 1.

Table 1. Semiotic components for patient, caregiver, provider

Semiotic Components		**Required features**
Object	Patient	• Maintain record of condition, medication and interactions; • Promote healthy diet and behavior by tracking daily food intake, exercise and encouraging to maintain wellness goals • Provide healthcare services like managing appointments, get map of nearest hospital or clinic • Maintain a repository of medical records, prescriptions and other image files (x-ray images) • Demonstrate change in pattern of measurements in condition (e.g. blood pressure) • Recommendation of peers based mutual similarities and location
	Caregiver	• Manage multiple number of patients • Monitor changes in conditions and interactions for medication • Send reminders to perform certain actions (e.g. medication, appointments) • Keep track of location of the patient • Encourage and remind to maintain wellness goals

Table 1. (*continued*)

	Physician	• Monitor changes in conditions and interactions for medication of patients • Determine the current status of the patient • Facilitate patient collaboration and discussion
Subject	Patient	• Patients taking medication for a certain condition
	Caregiver	• Caregiver who is looking after the patient. Caregiver could be a family member or an employed person to look after the patient.
	Physician	• Physician who is diagnosing conditions and prescribing medications to cure or control the condition.
Tool	Patient Caregiver Physician	• Device independent PHM • Real-time update of data collected from measuring instruments to reflect actual changes in symptoms
Control	Patient	• Patient retains the full control of what to share with others and whether to join public groups • Patient has control in deciding the level of participation in group discussions • Patient derives various wellness goals
	Caregiver	• No control over the content unless patient has allowed
	Physician	• Physician maintains control over the content shared in a private group (moderation) • No control over the content unless patient has allowed (e.g. personal medical condition)
Context	Patient Caregiver Physician	• Able to participate in informally structured groups exchange and reflect with users having common interests • Location independent where current place of being has no issue with using the application • Dependent on the context where it has a relationship to current issue of health
Communication	Patient Caregiver Physician	• Enable one-to-one communication between patients, patient-caregiver and patient-doctor to discuss on symptoms, medication etc. • Enable group communication to share experiences and for emotional support • Enable sharing of conditions or certain files in the repository with doctors or other particular user

Based on the instantiations for semiotic components, we built a general list of technological components (Table 2).

Table 2. General list of requirements for technlogical compoenets

Technological Components	Required features
Tools	• Sufficient power and network access to sustain uninterrupted usage
Object	• Personal health management on mobile platform
Communication	• Mobile network access via internet • One-to one messaging • Multi user messaging and collaboration • Posting of updates by users
Context	• Role-based control panels • Geo-location services to allow geo-tagging • Informal discussion space for user created groups
Control	• Hide/show of blocked components

3.1 Application Architecture

SerpentPole system as mPHM platform is architected to provide condition, medication tracking and collaborative features to patients, caregivers and physicians. The architecture of the system is discussed in another paper of the authors [11]. Nevertheless, technologies employed will be discussed briefly (Fig 1). First, SerpentPole mobile application is platform independent. Today mobile applications are highly segregated based on the mobile operating systems as Apple iOS, Google Android, Blackberry OS, and Microsoft Windows Phone. Considering the heterogeneity of these platforms and smart phone brands, it is important to provide the users with similar standard support. Thus, it is important to consider the development of a platform that allows these necessities. Our application is developed using HTML5, CSS5 and JavaScript and PhoneGap is used as the development framework. Furthermore, JqueryMobile is used to develop the responsive mobile client application. Thus, these technologies and frameworks guarantee the cross platform usage.

Location based services are used in this context for several reasons. It assures to keep track of the patients; this is especially useful for the caregivers. Moreover, when recommending fellow patients as friends to other patients, geo-location of the patients will also be taken into consideration. As a social media application, geo-tagging is allowed when interacting with peers, thus, to indicate the access environment to others. To render maps and to get the shortest path to the nearest clinics or hospital or the preferred hospital, our platform is using Google Maps API.

The server side platform is developed using OSGi framework [8] to assure the modularity and extensibility and coded in Java. Each server side component works as plug-in.

This application allows management of multiple profiles. That is multiple user profiles could be maintained in a single user account. This is especially useful for caregivers as they could log in from their personal account and could link with user profiles of the patients. Thus, they can oversee the conditions and other records of the other patient from the same user account, rather than re-logging over and over again from different accounts.

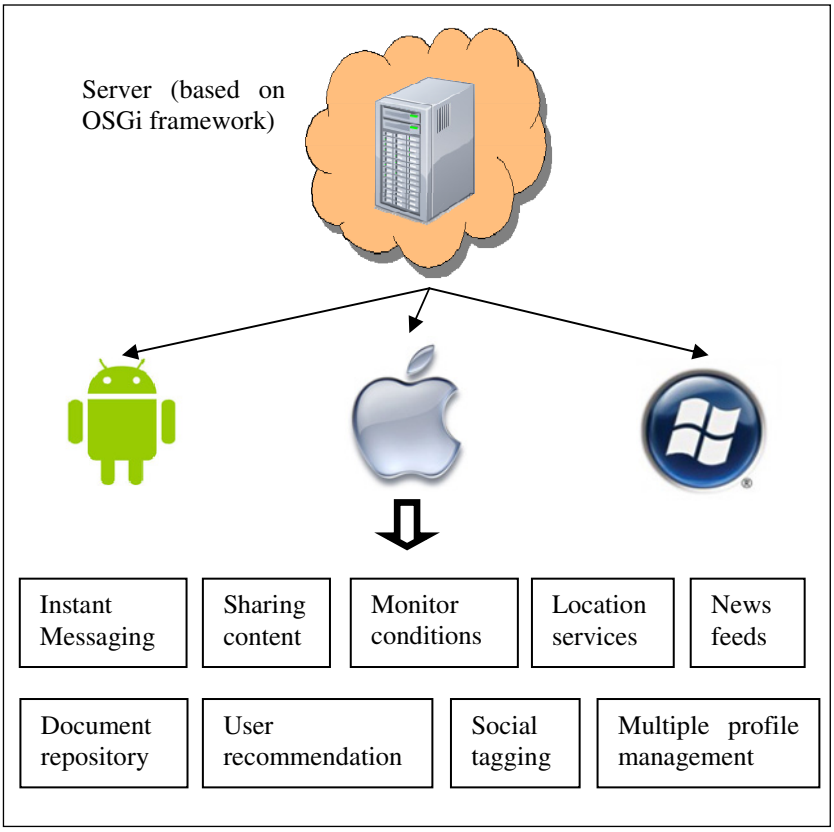

Fig. 1. Overview of SerpentPole platform

Social interaction (Fig 2) is allowed in this application where the user can create and interact as peer-to-peer and with multiple peers. The users can create private and public groups where, first only the invited users can join and contribute while anyone can search for the group and can join the groups later. These groups are segmented based on topics. If a certain comment is useful, then the users can like or unlike those posts and vice versa.

The SerpentPole application will act as a repository of medical documents. The users can upload images of prescriptions, discharge reports, medication labels etc. The documents will be classified based on user tags and users can create folders and store

them for letter reference. This is especially useful when seeing a doctor, where one can show all the necessary documents rather than worrying about any important documents left at home. Moreover, these records can be linked with data entry records. For example, particular condition could be linked with the set of documents.

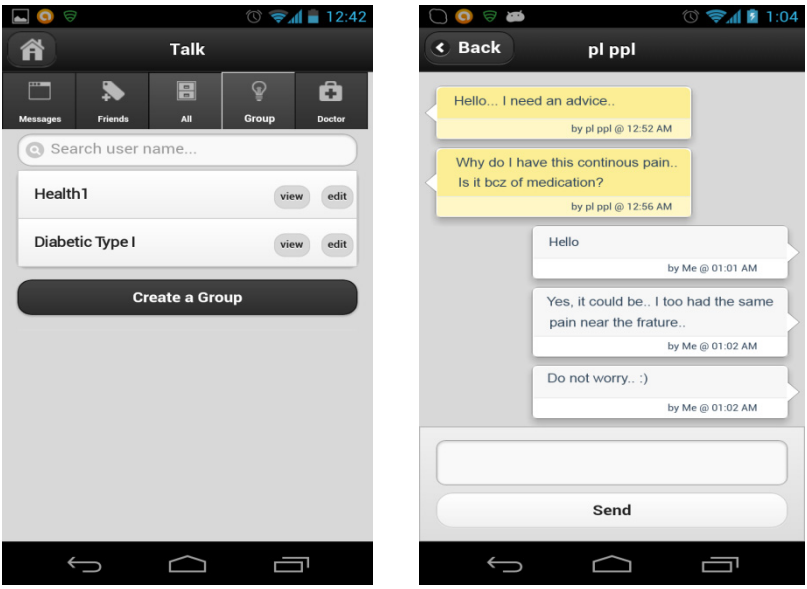

Fig. 2. (a) Group discussion and (b) instant messaging screen shots

4 Discussion

The theoretical implication of this study can be identified as follows. First, this study will be an extension to the theoretical discourse of mPHM as we are adopting an established method in mobile learning into mobile health. Second, based on Sharples and Taylor's Task model, our study could be used to identify broad set of semiotic and technological requirements for mPHM system on pragmatic scenarios.

The practical implication of this study is that, we designed and developed Serpent-Pole mobile application for PHM as a complete platform for formalized health management and structured for ad-hoc social interaction. The system is composed of social media components like instant messaging, social tagging and social networking. The system allows extensibility for different instances of the context. The initial application is developed and anyone interested, could contact the authors for further information.

5 Conclusion

On a meta-level, we can identify necessary requirements we need to consider when developing a mobile application to facilitate PHM. It is important to consider about object, subject, tool, control, context and communication. Based on these categories, users are able to create different instantiations of the Task model to achieve an application to meet different contexts, subjects or other requirements. This paper is the beginning of further research into mPHM. In future we are considering means of interfacing with input devices (hardware) and also with the electronic health records (EMR). Furthermore, we plan to perform user experiments to evaluate the effectiveness of SepentPole application.

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