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Context-based User Stereotype Model for Mobile User Interfaces in Health Care Applications

Reem Alnanih a, b, Olga Ormandjieva a, T. Radhakrishnan a

a Department of Computer Science & Software Engineering, Concordia University, 1455 De Maisonneuve Blvd. W., Montreal, QC H3G 1M8, Canada

b Department of Computer Science, King Abdulaziz University, Jeddah, Saudi Arabia

Abstract

Mobile technology has been piloted in a range of health-related areas, allowing doctors to receive critically important patient information in an automated way. It is vital that the technology be adaptable, so that the right information is available to the right doctors. We investigate the use of smartphones and various user stereotypes functioning in a hospital environment, as these stereotypes can play an important role in designing and adapting the mobile user interface (MUI) for health care applications. This paper discusses how a user stereotype can be modeled and used for adapting MUI for health care applications in a hospital setting. An empirical study using questionnaires and interviews among 30 doctors is conducted in order to extract the characteristics of each user stereotype, in terms of age group, domain experience, and mobile technology use. The study confirms that there are three groups of doctors in hospitals: junior, intermediate, and experienced, corresponding to the hierarchical structure in place in the hospital setting. A set of context descriptor sentences is extracted from each group during the interview, in order to consider the context of use of smartphones in adapting the MUI for these applications.

Keywords: Mobile User Interface; User Stereotype; Context Descriptor; Health Care Applications.

1. Introduction

In recent years, the rate of adoption of smartphones by health care professionals, as well as by the general public, has increased dramatically [1]. According to research conducted by Manhattan Research in 2012, more than 81% of physicians in the U.S. own or use a smartphone professionally [2]. The smartphone is a new technology that combines mobile communication and computation in a handheld
device, facilitating mobile computing at the point of care. It supports several means of communication, including voice calling, video calling, text messaging, email messaging, multimedia (text, image, and video) messaging, and conferencing through a mobile phone service provider. Unlike most typical software users, doctors work in a very demanding environment, under extreme pressure to help patients, and even to save lives [3]. Today, health care professionals require access to health care applications such as electronic medical records, drug databases and clinical applications. The access is mainly provided through stationary computers, which do not fully support the mobile nature of health care delivery [1].

The characterization of user needs is a key issue in the development of mobile user interfaces (MUI) in the context of health care applications, and new methodologies may be required to improve our understanding of those needs [4]. It is also important to acknowledge the difference in experience between a junior doctor and a senior doctor; the former will likely have more experience with mobile technology and less experience in the medical domain, while the latter will have more experience in the medical domain, but probably less experience with mobile technology.

In this research, the main stakeholders in health care delivery are the health care providers (doctors), who are directly involved in the process of caring for patients. The goal of this paper is to propose knowledge-based MUI adapted to the needs of the various categories of doctors, based on age group, domain experience and smartphone experience, specifically using the iPhone. Adaptation should consider both the context of use and the user stereotype, unlike traditional approaches, which derive static UI considering only general user characteristics.

The novelty in this paper is that we define a user stereotype model for health care applications considering two general characteristics: domain experience and experience using the iPhone technology. Doctors from different hospitals in Saudi Arabia participated in the empirical study conducted in this research. Note that all the participants share the same background and belong to the same Arabic culture. However, some of them have experience working in Canadian hospitals. It is important to point out that this proposed user model for health care applications builds on our previously proposed context model [5], and works in tandem with it.

The paper is organized as follows. Section 2 summarizes related work on user modeling techniques and justifies our choice of the user stereotype in this work. In section 3, we present our model, which provides a clear understanding of the user stereotype in our application for the health care domain. Note that we do not address the important health care-related issues of security, privacy, and reliability in this section. In section 4, the term context descriptor is introduced, in relation to extracting the characteristics of the user based on the interviews conducted. Section 5 concludes our paper and outlines the directions of our ongoing research.

2. Modeling Users: Related Work

Several techniques have been proposed by the Human-Computer Interaction (HCI) community to help researchers understand users and model their needs. These techniques each have their own strengths and weaknesses, and include concepts such as persona [6, 7], archetype [8], and user profile [9]. This paper focuses on a stereotype-based user model.

Stereotypes and stereotyping are appear frequently in user representations [10]. As a concept, the use of the stereotype can be understood as a cognitive, social, or narrative approach. From the cognitive perspective, creating stereotypes is an inherent activity of the human being, and we use it internally (mentally) to generate knowledge [11]. For example, when we meet new people, we stereotype them immediately in terms of how similar they are to us, and how different they are from us or others we know. Stereotyping is a natural mechanism of categorization [7]. In a detailed review, Hamilton and Sherman [12] concluded that a stereotype is a cognitive structure containing our knowledge and beliefs about, in this instance, a social group, and our expectations of it.
The goal of this research is to adapt the MUI to individual users, while at the same time assigning each user to one of a number of groups. The user stereotype helps us achieve this goal the most successfully. For this research, we needed to consider two aspects of stereotyping: categorization, and accentuation. Through categorization, the differences between people are simplified, and the individuals are assigned to membership groups. Through accentuation, the differences between groups are exaggerated, and the differences between individual members of the same group are minimized [13]. The symbiosis between categorization and accentuation is an important characteristic of our proposed model. Another is that it is based on the acquisition and use of long-term models of individual users.

Designing a user stereotype model for the healthcare domain is more neutral than the word ‘stereotype’ connotes, since this is not an anthropological study of group hierarchies, politics, or dynamics, but more a method of developing accurate categories in order to make the MUI strategically adaptable according to the ‘type’ of user.

In the section below, our derived model of user stereotypes for health care applications is explained.

3. Proposed User Stereotype Model in Health Care Applications

In this section, we are interested in investigating the idea of creating a user stereotype model through an empirical study based on a questionnaire circulated among doctors and interviews conducted with them, with a view to implementing an adaptable MUI from the perspective of the designer.

Empirical research has been conducted to better understand the nature of the stereotypes involved in health care, with a view to developing a practical MUI for these users. Fifty Saudi doctors were recruited from various departments in Saudi Arabian hospitals, some of whom are currently working at the Montreal Children’s Hospital in Montreal, Canada.

In order to understand the nature of the role that smartphone technology can play in a health care environment, and the relationship among the various user stereotype models proposed, a questionnaire was sent to these doctors, who perform different medical functions. The reason why we decided on a questionnaire at this stage was because of its value as a research tool to help us gather both general and statistical information about our users. The questionnaire was designed with variables in order to collect
- user characteristics, such as age group and gender;
- user experience in a domain or career;
- user behaviors in an environment or with respect to an application, such as mobile technology adoption and use at work; and
- user preferences (likes and dislikes).

The interview was designed based on our context variables that would enable us to derive context descriptors (see section 4), related to the various physical environments in which the users and the mobile technology will be operating.

To generate the user model, we expressed the responses collected as percentages combining the individual responses given and the individual feedback provided by the doctors. In order to maintain a complete dataset for the users in the various age groups, 30 interviews were selected from the 50 conducted: 10 interviews per stereotype and 5 male respondents and 5 female respondents per stereotype were considered. We are not looking at a collective sum, but rather at individual percentages related to each user group created among the 30 doctors selected. Table 1 illustrates how drilling down through the percentages yielded the three doctor stereotypes.
Table 1. Experimental Data

<table>
<thead>
<tr>
<th>User Characteristics</th>
<th>Value</th>
<th>User Stereotype 1</th>
<th>User Stereotype 2</th>
<th>User Stereotype 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stereotype Name</td>
<td></td>
<td>Junior</td>
<td>Intermediate</td>
<td>Experienced</td>
</tr>
<tr>
<td>Age group</td>
<td>25-34</td>
<td>35-44</td>
<td>45+</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Domain experience *</td>
<td>Novice</td>
<td>100%</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>-</td>
<td>90%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>-</td>
<td>-</td>
<td>60%</td>
</tr>
<tr>
<td>Mobile experience **</td>
<td>Basic</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>-</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Mobile use at work</td>
<td>Yes</td>
<td>100%</td>
<td>100%</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>60%</td>
</tr>
<tr>
<td>Mobile use for daily tasks</td>
<td>Strongly agree</td>
<td>100%</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>-</td>
<td>-</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>-</td>
<td>20%</td>
<td>70%</td>
</tr>
<tr>
<td>Mobile use for search location [maps, people, etc.]</td>
<td>Strongly agree</td>
<td>20%</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>70%</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>10%</td>
<td>10%</td>
<td>80%</td>
</tr>
<tr>
<td>Mobile use for social networking tools to communicate with others</td>
<td>Strongly agree</td>
<td>60%</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>40%</td>
<td>70%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>-</td>
<td>-</td>
<td>90%</td>
</tr>
<tr>
<td>Common daily mobile applications: medical, Facebook &amp; Twitter, SMS &amp; MMS, Email, WhatsApp ***</td>
<td>Expert</td>
<td>80%</td>
<td>30%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>20%</td>
<td>60%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Novice</td>
<td>-</td>
<td>10%</td>
<td>70%</td>
</tr>
</tbody>
</table>

* Domain experience is defined in terms of Novice (less than 10 years), Intermediate (more than 10 years and less than 15 years), and Expert (more than 15 years).

** Mobile experience is defined in terms of Basic (less than 1 year), Intermediate (more than 1 year and less than 2 years), and Advanced (more than 2 years).

*** Common daily mobile application is defined in terms of Expert (uses all the listed applications), Intermediate (uses all the listed applications, except medical), and Novice (sends messages and makes calls only).

The advanced experience using the mobile phone was set at only two years because we are interested in designing an MUI that is adaptable to the iPhone 4™, which was released on June 27, 2010.

Our findings show that all the doctors in all the age groups have been using a smartphone for more than 2 years. While this fact does not help us categorize them in a stereotype, it does allow us to assume that they have all been exposed to the basic smartphone platform. Our findings also show that most of the doctors use their smartphone during working hours. Drilling down into the age group data, we found that young and middle-aged doctors are more likely to use their smartphone in their work than older doctors.

Specifically, we found that most junior and intermediate doctors strongly favor using their smartphone in their daily work, as opposed to not doing so. They also favor using it as a means to connect with others in their daily activities, e.g. social networking. Most of the expert doctors in the experienced category don’t use their smartphone for such daily activities. We believe this is due to a lack of awareness of applications that could be helpful to them.

During working hours, young and middle-aged doctors are those who most frequently consult medical websites, such as Medscape; drug dosage and medical calculation applications; and networking applications, like Facebook and Twitter, WhatsApp, Email, SMS, and MMS, while experts in the experienced category use their smartphones mostly for sending messages and making calls.
Table 1 demonstrates that the pattern of domain expertise emerging from this study is the following: 100% of the junior doctors are novices in their domain, 90% of the intermediate doctors are intermediates in their domain, and 60% of the experienced doctors are experts in their domain. However, in terms of iPhone™ application experience, this study reveals the following: 80% of the junior doctors are experts, 60% of the intermediate doctors are intermediates, and 70% of the experienced doctors are novices. Based on the age group characteristic in Table 1, and following the two categorization rules, which are domain experience, and smartphone experience with different applications, our findings support three significant groups out of nine, taking into account their relative expertise based on the categorization rules. These are: Junior (novice: expert); Intermediate (intermediate: intermediate); and Experienced (expert: novice), as illustrated in Table 2.

Table 2. User Stereotype Model for Health Care Application

<table>
<thead>
<tr>
<th>User Stereotype</th>
<th>Junior</th>
<th>Intermediate</th>
<th>Experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td>25-34</td>
<td>34-44</td>
<td>45+</td>
</tr>
<tr>
<td>Domain experience</td>
<td>Novice 100%</td>
<td>Intermediate 90%</td>
<td>Expert 60%</td>
</tr>
<tr>
<td>Smartphone application experience</td>
<td>Expert 80%</td>
<td>Intermediate 60%</td>
<td>Novice 70%</td>
</tr>
</tbody>
</table>

3.1. User stereotype 1: junior doctors

Junior doctors (medical students and residents) belong to the 25- to 34-year-old age group. These users have the best understanding of the smartphone platform. They spend more time playing with their phones, trying out new applications, Web browsing, and using social media applications than their older counterparts. They have very high tolerance towards using new applications, especially if they can help them with their daily work tasks. We note that the users in this group are usually the younger doctors with limited experience in their domain.

From the feedback we collected in the interviews, it was clear that users belonging to this stereotype like the idea of using a smartphone at work. For example, they said they would like to see their smartphone include information about all their patients and their current medications, along with the expiry dates, so they can alert their patients when needed. They also discussed current uses of smartphones in health care environments; for example, they can be sitting in one room, watching a live operation taking place in another room, and be able to ask questions and learn, all at the same time. Their only concern is the potential risk associated with smartphones being used near patients and the wireless communication perhaps interfering with medical devices. In the opinion of many of the junior doctors, mobile technologies can provide information on the newest evidence-based medical practices. Also, applications could be developed that track treatment outcomes, to help doctors understand where the results of treatment plans diverge from predicted outcomes and why, so that professionals can work to repair them in the future.

3.2. User stereotype 2: intermediate doctors

Intermediate doctors (fellows and newly hired staff) are in the 35- to 45-year-old age group. These users have an understanding of the smartphone platform. They don’t spend a lot of time with their smartphones, and so have not had as much exposure to smartphones as the junior doctors. However, they show average to little resistance to using new applications on their smartphones. They are usually experienced doctors who have worked in their field for at least 10 years.

From the feedback collected in the interviews, we note that these users have as many likes as dislikes about using smartphones in their work. They do not seem interested in using a smartphone to record
information about their patients, for example. Some said that the procedure they currently use gives them all the efficiency they need. They, like the junior doctors, are worried about using smartphones near patients. This issue probably requires more research. With respect to using new applications on their smartphones, they seem to have little tolerance for making the effort. They don’t even seem to have carefully weighed the benefits and disadvantages of doing so.

3.3. User stereotype 3: experienced doctors

Experienced doctors belong to the 45-year-old and over age group. These users have little or no understanding of the smartphone platform. The doctors who spend little or no time with their smartphones and show marked resistance to using them in their work are usually the older ones, who have been in the field for at least 15 years.

From the feedback collected in the interviews, we note that users belonging to this stereotype have more dislikes than likes when using smartphones in their work. This is understandable, given that they are older and in the habit of using more traditional methods. They have almost zero tolerance for being introduced to anything new. They prefer holding papers in their hand when visiting a patient, exchanging information one-on-one with other doctors, instead of using a smartphone or iPad™. They discourage the use of smartphones in the workplace, as they believe that it distracts young doctors from paying attention to their work.

As explained in the section below, context descriptors contain the information that we extracted from the interviews with the members of the three defined categories.

4. Context Descriptors of User Stereotypes for Health Care Applications

Our design goal is to develop an MUI for health care applications that is adaptable to the User Stereotype and to their work context (Fig. 1.). Based on the characterization of health care application contexts performed in [5] and the model of user stereotypes that we develop here, we have conducted a thorough requirement analysis and drawn up a set of context descriptors through interviews with 30 doctors.

A context descriptor (CD) is a sentence or sentence fragment that forms the basis for MUI adaptation [5]. From our interviews with 10 doctors for each of the 3 user stereotypes, we collected 7 different CDs for each stereotype. For the sake of brevity, we provide a sample of the CDs collected from each user stereotype in Table 3.
1. Introduction to Mobile User Interfaces

2. Preliminary Study

3. MUI Context Model

4. Our MUI Adaptation Approach

5. Conclusion and Future Work
increasingly technological world, these organizations are finding that they need better, more efficient, and more effective methods of internal communication and information sharing. The findings from the questionnaire and interviews have prepared the way for designing and implementing an MUI with features and functions to satisfy every user’s taste. We are now in a position to create friendly, responsive, and scalable MUIs for any smartphone application intended for the health care environment.

Among the challenges we encountered in this research was the reluctance of experienced doctors to use smartphones, and their tendency to prefer desktop solutions instead. There are many possible reasons for this resistance, for example: (a) age; (b) fear of the unknown; and (c) physical constraints, such as compromised vision, slower reactions, unsteady fingers, less time available for learning new things, etc. This challenge reflects the general resistance we found among the senior doctors to trying new things – not only smartphones – which supports our stereotyping method. As revealed in some of the interviews, older doctors may prefer their traditional methods over smartphone use. However, some admitted that presentations explaining the benefits of this technology could help them overcome their resistance, and that they would very likely change their minds if it were for the ultimate benefit of patients and the health care organization overall. Two other challenges we faced were the following: the time constraints of busy doctors; and appropriate questionnaire design, in terms of length and content.

Our current research involves the use of the model we developed here in the design, development, and testing of a mobile user interface for health care applications.

References