A User-based Heuristic Evaluation of an Intelligent Healthcare System

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Abstract—The current study aimed to evaluate an intelligent health care and promotion system. The developed system, named as CareTogether Pro, was designed for elderly people who are at risk for or suffering from metabolic syndrome that would enable them to manage their health by themselves and improve their satisfaction towards distributed health care. In this study, a heuristic evaluation was employed to identify usability problems in the newly developed system among those users living in an elderly community. The results showed anticipation of both the value of the system as well as potential issues.

Index Terms—Usability, healthcare system

I. INTRODUCTION

A. Health System

With the rapid development of medical technology, most medical issues have changed from chronic disease and frailty to acute disease [1, 2]. 2008 statistics report on cause of death show that metabolic syndrome and its related diseases have become the main cause of death among adults over age 65 [3]. Therefore, not only has metabolic syndrome become one of the most important health issues in recent years, but its subsequent health monitoring products and systems are also receiving more and more attention. Such health systems are intended to promote the effective prevention of diseases associated with the elderly by providing medical care programs [4]. Youn et al. [5] integrated blood pressure, blood sugar, weight, body fat, and other physiological parameters of metabolic syndrome into a self-health system, which combines a lifestyle questionnaire and data analysis to make relevant suggestions and improve the provision of healthcare. Lo et al. [6] applied tiny sensors to measure users’ physiological data, including heart rate, heartbeat, blood glucose, blood pressure, respiratory rate, and etc. This information, combined with RFID technology, is entered into the ubiquitous context-aware healthcare service system (UCHS), which provides medical advice and assistance; the information is also used in an emergency urgent care system so that ambulances can quickly provide relief. In addition, Chen [7] has also embedded a pulse-monitoring system via a network interface to provide an immediate diagnosis of an elderly person’s health status; when there is an emergency situation, the system can notify emergency services. Also, in everyday use, it can assist an elderly person in self-health management in order to enhance his or her quality of life. In this study, we evaluate a health system, CareTogether Pro, to help users manage their blood pressure.

B. Human Factor

However, the human factor has not always been taken into account in the development of new technologies. Many health-measurement instruments and systems are not suitable for user-operation; in addition to their lack of a suitable user interface, their operation is too complicated for the average person, thus causing people to inadvertently ignore their own health [8, 9]. Inappropriate user interface design usually leads to usability problems. For instance, Oztekin et al. studied an e-learning system intended to assist students in a biology course. The system did not provide a warning message to advise users to save their files before they logged out. Therefore, users often accidently lost their files [10]. Saitwl et al. point out that a poorly-designed system interface will confuse users when they attempt to operate the system. The study showed that a health-record system with unclear information can not only lead users enter the wrong data in the system but can also will cost users more time in learning how to operate the system.

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C. Usability – Heuristic Evaluation

A usability evaluation can reveal a system’s usability problems and provide suggestions to refine the system. Heuristic evaluation is one of the most popular methods for evaluating usability. Nielsen [11] designed a heuristic evaluation method for usability experts to examine a given system’s usability through ten heuristics by rating the usability problems on a scale of 0–4 [11, 12]. The following scale descriptions explain the meaning of each scale.

0 = I don’t agree that this is a usability problem at all.
1 = Cosmetic problem: need not be fixed unless extra time is available for the project
2 = Minor usability problem: fixing this should be given low priority
3 = Major usability problem: important to fix, so should be given high priority
4 = Usability catastrophe: it is imperative to fix this before product can be released

Heuristic evaluation has been applied in many different kinds of systems. Chen and Macredie applied heuristic evaluation to study the usability of four supermarkets’ electronic shopping systems, comparing four different electronic shopping sites with the heuristics to discover each site’s user interface’s strengths and weaknesses [13].

Jiajie et al. studied patient safety in using infusion pumps. The study used usability heuristics to evaluate two 1-channel volumetric infusion pumps from two different vendors. These were labeled Pump 1 and Pump 2. The result showed that Pump 1 not only has more usability problems but also has more severe heuristic violations [14].

Desurvire et al. used heuristics to evaluate games. The study focused on heuristic evaluation for playability. It discovered several playability issues, especially in the game story and game usability categories. The results showed that heuristic evaluation for playability is very useful in creating highly usable and playable game designs [15].

Although Heuristic evaluation has been successfully applied to various kind of systems, Liljegren points out that this method has its pros and cons. Heuristic evaluation by usability experts can quickly and efficiently evaluate systems; however, usually, usability experts are not the system’s end users. Therefore, heuristic evaluation tends to ignore the users’ point of view on the system. Liljegren also pointed out that heuristic evaluation is an expert-based evaluation method [16].

D. Aim

Therefore, this study will focus on how to apply the heuristic evaluation method for end users. The aim of this study is to evaluate CareTogether Pro’s usability through heuristic evaluation by non-expert users.

II. METHOD

In this study, a new intelligent health promotion care system, CareTogether Pro, was deployed in a community-care environment for the elderly. In order to examine whether the system user interface is suitable for actual user scenarios, this study conducts a user-based heuristic evaluation with system end users (the elderly).

A. User-Based Heuristic Evaluation

The original Heuristic evaluation is an expert-based evaluation method. Usability experts identify usability problems by their professional knowledge background and rate the usability problems by their severity. In order to investigate users’ usability and point of view when using the system, this study uses heuristic evaluation to assess user satisfaction during system operation. Therefore, we applied Nielsen’s ten heuristics to evaluate users’ satisfaction on a five-level Likert scale from 1 to 5. The following scale descriptions explain the meaning of each scale.

1 = I am strongly dissatisfied with the usability of this system
2 = I am dissatisfied with the usability of this system
3 = I neither satisfied nor dissatisfied with the usability of this system
4 = I am satisfied with the usability of this system
5 = I very satisfied with the usability of this system

B. Subjects

This study recruited 67 subjects from the Chang Gung Health and Culture Village aged from 60 to 95 years old. The average mean age was 81.9±7.45. The recruited subjects consisted of 16 males and 51 females, a male/female ratio of 23.9% to 76.1%. Subjects with a history of psychological problems, mental or motor dysfunction, or cognitive deficits were excluded from this study. We obtained ethics approval for our study from the institutional review board (IRB) of the Chang Gung Medical Foundation. Before the evaluation, researchers explained the purposes of the study to the subjects. All 67 subjects signed informed consent forms before participating. In addition, the subjects in this study have given written, informed approval for their photographs to be published.

C. Materials

CareTogether Pro was designed to facilitate the usability of elderly health records and was installed in the Chang Gung Health and Culture Village as shown in Figure 1. The Chang Gung Health and Culture Village is a silver village designed for elderly communities. The system, CareTogether Pro, contains five main modules. These are: the communication transmission module (CTM), membership management module (MMM), information integration module (IIM), information management module, and disease data management module (DDMM). The system uses general intelligent physiological measurement instruments for the collection of personal physiological data.
It is used by nurses or health management divisions for individual cases in order to ensure that their systems are more in line with personal health management so that the elderly can receive appropriate medical care from medical staff. Also, the system provides corresponding determination and health education so that the elderly can aid their own health promotion and care through technology.

FIG. 1. The CareTogether Pro system

D. Procedure

The Heuristic evaluation experiment was conducted in three stages: “information stage,” “task stage,” and “assessment stage.”

During the information stage, subjects were first made aware of the purpose of the study, introduced to the platform, and guided through its usage. Before the evaluation experiments started, all the subjects were approved by the institutional review board.

During the task stage, subjects were asked to perform a blood pressure measure task with the CareTogether system. The blood measure task is conducted in three steps. First, the subject attaches the measure sensor to his or her arm. Second, the subject presses the “start measuring” button to measure blood pressure. Third, the subject reads the measurement results.

During the assessment stage, after the task is performed, the subjects evaluate the CareTogether Pro system according to Nielsen’s ten heuristics. The severity of any usability problems is rated on a scale from 1 to 5.

III. Result

After the building of the Smart Care Health Promotion platform was completed, the system was implemented in an elderly community and was used to conduct users’ actual operation and use assessments. Based on Nielsens’s ten heuristics [11] as an assessment rule, we used a rating scale of 1 to 5 to rate user satisfaction. Among the 67 elderly residents who used CareTogether Pro, a user-based heuristic evaluation method was conducted to assess and explore the system’s usability. The results showed that, according to the subjects, the system can fully meet users’ needs as measured by the nine heuristics, which are “user control and freedom,” “recognition rather than recall,” “consistency and standards,” “aesthetic and minimalist design,” “match between system and the real world,” “error prevention,” “help users recognize, diagnose, and recover from errors,” “visibility of system status,” and “flexibility and efficiency of use.” These nine heuristics received a score of 4.88 to 4.97, which means users were between satisfied and very satisfied with these nine usability heuristics of the system. The heuristic “help and documentation” received a score of 3.87, which means that subjects consider usability as measured by this heuristic between “neither satisfied nor dissatisfied” and “satisfied.” Subjects noted that there is no help documentation regarding system operation in CareTogether Pro. If the system can provide some instructional information for reference, it will be easier to use. Therefore, this heuristic evaluation showed that the only usability problem is “help and documentation.” The rest of the heuristics do not appear to have usability problems. In contrast, if subjects think that the system design is simple and easy to use, they are satisfied with the system overall. Also, the measurement results were presented in a graphical way that made the results pleasing to view.

<table>
<thead>
<tr>
<th>Heuristic</th>
<th>Rating score</th>
<th>Total</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>h1. Visibility of system status</td>
<td>0 0 0 4 63</td>
<td>331</td>
<td>4.94</td>
</tr>
<tr>
<td>h2. Match between system and the real world</td>
<td>0 0 1 1 65</td>
<td>332</td>
<td>4.96</td>
</tr>
<tr>
<td>h3. User control and freedom</td>
<td>0 0 1 1 65</td>
<td>332</td>
<td>4.96</td>
</tr>
<tr>
<td>h4. Consistency and standards</td>
<td>0 0 1 0 66</td>
<td>333</td>
<td>4.97</td>
</tr>
<tr>
<td>h5. Error prevention</td>
<td>0 1 1 0 65</td>
<td>330</td>
<td>4.93</td>
</tr>
<tr>
<td>h6. Recognition rather than recall</td>
<td>0 0 0 4 63</td>
<td>331</td>
<td>4.94</td>
</tr>
<tr>
<td>h7. Flexibility and efficiency of use</td>
<td>0 0 1 6 60</td>
<td>327</td>
<td>4.88</td>
</tr>
<tr>
<td>h8. Aesthetic and minimalist design</td>
<td>0 1 0 1 65</td>
<td>331</td>
<td>4.94</td>
</tr>
<tr>
<td>h9. Help users recognize, diagnose, and recover from errors</td>
<td>0 0 0 2 65</td>
<td>333</td>
<td>4.97</td>
</tr>
<tr>
<td>h10. Help and documentation</td>
<td>9 9 3 7 39</td>
<td>259</td>
<td>3.87</td>
</tr>
</tbody>
</table>

IV. Conclusion

This study applied a user-based Heuristic evaluation method to examine the CareTogether Pro health system end
user operation of the system and an investigation into their satisfaction via the system usability heuristic. The results showed that, overall, users are very satisfied. Only the heuristic “help and documentation” received a score of 3.87, but this did not upset the users.

Future studies can apply this method to study or test other kinds of systems. Last but not least, to emphasize user opinion and feedback, future studies should also record users’ viewpoints.

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