A Case Study of the Design and Evaluation of a Persuasive Healthy Lifestyle Assistance Technology: Challenges and Design Guidelines

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Abstract. Technology can be used as an intervention of unhealthy lifestyles, but designing such a technology is challenging – usability as well as the ability of changing the user's behavior needs to be considered. The design and evaluation process of a future generation persuasive healthy lifestyle assistance technology which involves physiology, environment monitoring, and automation was studied in this paper.Several challenges were identified and design guidelines were developed for designing such a technology which is used as an intervention of the user's unhealthy lifestyle.

Keywords: persuasive technology, case study, lifestyle.

1 Introduction

1.1 Persuasive Technology and Lifestyle

Since an unhealthy lifestyle (such as an unhealthy diet and physical inactivity) might lead to many diseases and health risks and is becoming a threat to the general population [1], intervention is needed. Well-designed technology can be a good intervention, because appropriate user interface and information design have shown to be able to cause behavior changes [2]. Literature review also indicated that healthy living persuasive technologies showed that it can change a user's attitude and behavior [3].

According to Chatterjee and Price's [4] categorization of persuasive technologies in healthy living, current generation technologies have the following characteristics: wearable sensors to collect information from the user; awareness the user's current status; persuasive technique and real time information exchange within the system. The future generation technologies should introduce an automation component in the system to make human intervention minimal.

In this case study, the design team developed a future generation persuasive healthy lifestyle assistance technology called HealthyEdge. This technology is able to monitor a user's physiological status (through physiology monitoring accessories worn by the user), the environment, and devices which are closely related to lifestyle

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(e.g. physical exercise facilities and television), and helps the user plan his/her healthy lifestyle by offering health related information as well as a set of automatic planning tools.

1.2 Apersuasive Healthy Lifestyle Assistance Technology

The aim of the project "HealthyEdge" was to develop a persuasive healthy lifestyle assistance technology that is able to support important aspects of user's healthy lifestyle, including diet and physical exercise, while being embedded into the user's daily life.

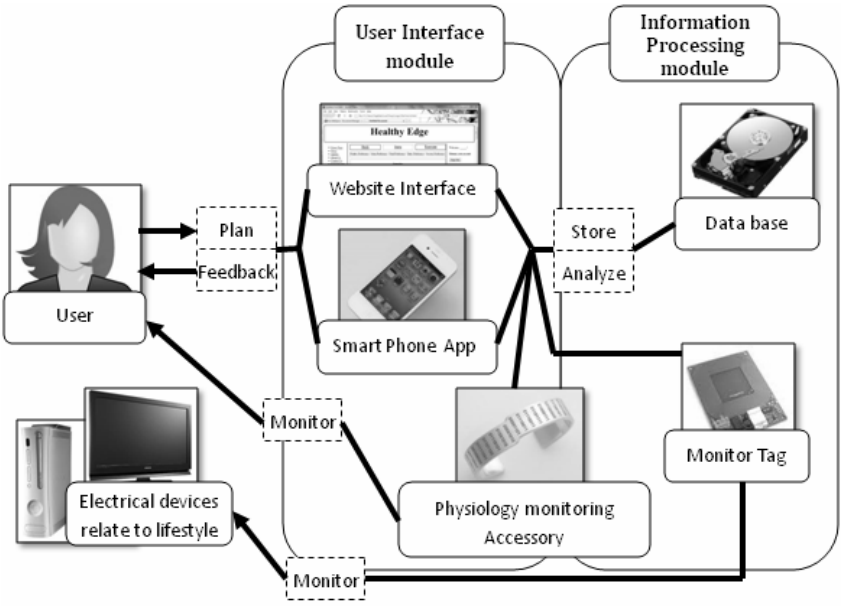

Fig. 1. The structure of the persuasive healthy lifestyle assistance system – HealthyEdge

The final outcome of this project was the HealthyEdge system. The system includes two main modules (see Fig. 1 for visualization of the structure of the system): the information processing module and the user interface module. The information processing module included a data base of user's health information, monitor tags and a physiology monitoring accessory. The monitor tags are used for monitoring how long the user has been watching TV, playing video games, or being inactive with other electrical devices. The tags can be attached to electrical devices. The information gathered by the tag will be transferred to the data base for further analysis. The physiology monitoring accessory is a wearable device which is used for gathering physiological information about the user. It gathers information related to health, such as heart rate and blood pressure. The information stored in it will further be transferred to the data base.

The system's website, which connects the user to the data base, has two main functions: to plan the diet and exercise schedule and to offer feedback from the

information provided by the physiology monitoring accessory and the monitor tags. The fully functional website is able to create a healthy meal, generate a grocery list, make a physical exercise schedule, and to keep track and update health goals (e.g. weight control, body building) for the user. The website can automate lifestyle planning for the users; however, users who are not satisfied with the automatic planning can customize the plan under the instruction of the system as well. Also, various healthy lifestyles related information will be provided. The smart phone application will have similar functionality as the website.

As a case study of the design and evaluation process of HealthyEdge, the objective of this paper is to identify the challenges and develop guidelines for designing a persuasive healthy lifestyle assistance technology which is used as an intervention of the user's unhealthy lifestyle.

2 The Design Process

This case study followed six user-centered design and evaluation stages towards designing the technology (shown in Fig. 2). In the first stage - Contextual Inquiry [5], each member of the design team observed one participant interacting with technologies to explore opportunities for possible design. During this stage, each member in the design group did their own observation with the participant. The tasks for the participants were stemmed from the group members' own product concepts. Different participants' performing various tasks on the internet or some other interfaces was observed. This was very important because the user may interact with the interface of the system at anytime, so that good interfaces that could be fitted into different contexts are critical.

Fig. 2. The design process of the technology

In the second stage – storyboarding [6], each member created and evaluated cartoon scenarios which displayed users performing different tasks. Then the storyboards were shown within the group to get feedback of the ideas. Participants

were also recruited to make comments on the storyboards. Through storyboarding, a more adaptable healthy lifestyle assistance system was created conceptually.

In the third stage - concept generation, the design team came to a consensus of the final system by brainstorming and combining ideas and concepts from previous design stages. The design team finally landed on apersuasive healthy lifestyle assistance system.

In the fourth stage - paper prototyping [7], the design team created a rough prototype and conducted an user testing with it to facilitate the interface design. According to Snyder [7], paper prototyping is good for testing the terminology, navigation, content, page layout and functionality; and is helpful for finding problems in the early design stage of the interface to allow for rapid changes. A low fidelity model of HealthyEdge website using paper and markers was developed by the design team. User testing of the prototype provided front-end results based on usability and difficulty of use of the system. The participant engaged in the think aloud method while interacting with the system, was observed, and participated in an interview. Think aloud method eliminated the time consuming activity of designer-user communication and proved to be effective [8]. According to the feedback from the user, an efficient website was developed with only a few errors and confusing points in the tasks assigned during the user testing process. This was very important for a healthy lifestyle assistance system of which the stakeholders will have various ages, educational and income backgrounds to have a universally designed website interface.

In the fifth stage - video prototyping, a video prototype was created to simulate how the system will be used in the real-world. Video prototyping can help the designer include contextual elements in the design [9]. The video created by the design team simulated what life would be like using a finished HealthyEdge system. The video mainly focused on the interaction between the user, environment, physiology monitoring accessory and monitor tags. In the process of making the prototype, the design team got a better idea of how the system is able to monitor the activities of the user without disrupting his/her daily life and how to help the user build up a healthier way of living through common devices such as a computer and a cell phone.

In the sixth stage - user testing, an interactive prototype was developed for a multi-stage user testing. The user testing consisted of two components: (1) using of the website, (2) simulating a day using HealthyEdge combined with daily life. In addition to observations, interviews were administered to collect feedback on learnability, efficiency, memorability, errors, satisfactions, and further suggestions for the design.

3 Challenges and Guidelines

3.1 User's Acceptance and Actual Use of Technology

In the early stages of the design process, the biggest challenge was designing the user interface and integrating technologies to increase user's acceptance and technology usage, which was one of the overall goals of the system as well. One important aspect of this problem is that the technology might not be well integrated into the user's normal daily life so additional work (setting up the program, looking for internet

access while updating the information is needed, etc.) will be needed for the user to interact with the technology. Under this situation, the user won't work with the technology in the way as the designer expected [10]. The design team also tested how the system could be embedded in the users' daily life through video prototyping. A challenge was addressed: how to change the user's behavior without interfering with the user's normal life. One possible solution could be designing a smart interface to facilitate the communication between the system and the user. The guidelines for designing a compatible system are also applicable here.

Guideline 1: Compatible with other technologies. In HealthyEdge, the communication between the user and the system needs various channels, for example, email or cell phone text messages .For example, if the system is sending message through cell phone texts, in order to avoid disturbing the user, the message should be sent when the user is available. Therefore the system will work with a calendar program to check the availability of the user. Another issue is that the smart phone application should have different version that works with different operating systems. The monitor tags also need to be compatible with the electrical devices. In the design of a system that is to be embedded into user's daily life, it is necessary that the system beingcompatible with the devices or programs which are currently used by the user (for example, television or online calendar) so that the user does not need to exert extra efforts to start using the new system.

Guideline 2: Create a "player experience" for the user. The system should have a high level of usability as well as player experience [11] to make sure the user can have fun while interacting with the system, so that technology usage will be increased.A literature review showed that video games are used for changing health related behaviors [12]. "People fun" refers to the emotions created by enjoyment of social interaction [11], and this kind of play experience maybe used by healthy lifestyle persuasive technologies; for example, social support from an online community could have an impact on health related attitude and behavior change [4]. Some kind of multi-user games (for example, games involved in competing or collaborating with other users in losing weight) can be designed for using in the online community to motivate the user. Other than games, "player experience" can also be created in product designs [11]. A goal setting module of health status (for instance, set a weight goal and visualize how the user's weight changed over time and finally reached the goal) could offer the user "serious fun", which is related to the enjoyment of real-world benefits from interacting with the system [11].

3.2 Adapting the System to the User

Through paper prototyping, the design team mainly investigated an efficient way for the user to understand and control a system. In the video prototyping, how to make the system adaptable to a user's need and daily life was considered. The main challenge that the design team encountered was how to make the interface adaptable to a user who is not aware of healthier lifestyles and a user who knows more and would like a customized health planning.

Guideline 3: Design an understandable interface. A survey based research showed that about one third of the respondents did not understand calorie labeling and about half of the respondents would not use the calorie information in restaurants [13]. This implied that information should not be merely presented in the way that the user is "supposed to understand". In the design process, the design team made efforts to group the concepts related to lifestyle in an understandable manner to help the user learn, navigate and explore the system more efficiently. Health information should be presented in an easy way that is understandable to most people while more detailed information is also made available for advanced users. For example, for novice users, nutrition information could be presented using food categories like "grain", "oil", "vegetable", etc.; for more advanced users, the same information could be presented as "calorie", "protein", "fiber", etc.

Guideline 4: Support special needs of the individual user. The needs of individual users may vary. For example, normal daily diet may not work well for the users with diabetes. So the individual information concerning the user's health condition should be gathered by the system. This will be critical if the system is automated. In HealthyEdge, there was an option for automatically doing diet, physical activity monitoring and planning. The information offered by the automated system should not conflict with physician's advice or mislead the user. In most cases, this information could be provided by the user; but in some cases, the system will need to work with other information sources to acquire more detailed and accurate information. One possible way to accomplish this is to work with personal health records [4]. However, more research should be done on this because of the involvement of political and ethical issues. Another option may be to work with the caregiver of the individual user, such as nurses, to acquire information needed.

Guideline 5: Automation made adaptable to "novice users" and "expert users". In the design of HealthyEdge, a prototype with an automatic meal and exercise planning feature was developed to help the novice user get started; meanwhile, different levels of automated life planning and information offering were also provided to the users who have a better idea of health related concepts and knowledge. Offering more information to advanced users can lead to better understanding of the underlying mechanism of the automation and may increase their trust towards the system. This was also served for the purpose of educating the novice users. As the usage by users increased, the system would offer more detailed information for the user (for example, more detailed nutrition intake recommendation for a day). In this way a novice user will eventually become an advanced user.

3.3 Usefulness and User Satisfaction

In the user testing stage, the design team explored factors attributed to perceived usefulness and user satisfaction of the system. Main design challenges included the design of the functionality of the system, physiology monitoring accessory, and the information visualization method.

Guideline 6: Capture the full scope of user's lifestyle. HCI design guidelines were well developed for how to maintain ease of use with rich functionalities [14]. In the design of a healthy lifestyle assistance system, enough functions should be included into the system to capture the full scope of the user's lifestyle. There are four health lifestyle characteristics (HLCs) frequently cited in the literature – nonsmoking, healthy weight, fruit and vegetable consumption, and leisure time physical activity [15]. The basic functions of the system should include smoking cessation, weight control, health diet, and physical activity assistance. Previous research showed that persuasive technologies could be effective in helping the user with those HLCs (for a review please see [4]). A system that could offer assistance in all four aspects would be helpful.

Guideline 7: Well designed and customization of wearable physiology monitoring accessories. The physiology monitoring accessories should be in various shapes and customizable, since it is the device that the user will be wearing. However, there are still other issues. In the user testing stage of this experiment where a user's one day life with HealthyEdge was simulated, the participant chose a metal bracelet when multiple choices regarding material and types of accessories were offered. In the interview after the simulation, when being asked if the bracelet was comfortable to wear, our participant answered "*No. It was too heavy and I always noticed it. I took it off to sleep even though I knew I was supposed to keep it on at all times. I also took it off to shower.*" Therefore, it is necessary to find a material that is comfortable to wear at all times, including sleeping time. More importantly, a return/exchange policy should be adopted for physiology monitoring accessory, since even when offered the choice for different accessories, the user may choose the "wrong one" that they then find it uncomfortable to wear.

4 Conclusion

A future generation persuasive technology like HealthyEdge will soon become possible given the recent advances in internet, mobile computing, and physiology monitoring technologies. This paper studied the design and evaluation process of such a system, discussed some of the challenges, and presented seven design guidelines for overcoming the obstacles. However, there are still many other challenges other than the design of the technology itself. For example, the ethic and policy related problems with monitoring the user's behavior and using the user's health records. These problems should be studied by future research.

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