Research on Smart Wearable Device Design Based on Semiotic Approach to Product Architecture Design

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Abstract. It aims to improve the wearable device interaction design for old people who are easy to get lost. Typical rehabilitation behavior and related objects of the users are recorded by non-participant observation and interview. Based on the SAPAD frame, the relationship between behavior-object-signification is analyzed. It has provided some solutions to optimize the APP interaction design.

Keywords: SAPAD · Interface design · Interface evaluation

1 Introduction

Great concerns have arisen about the lives of older people due to the increasing number of aging populations. And the lost elderly becomes the biggest concern because of their memory loss. In order to decrease the probability of this dangerous event, people use smart wearable devices to located old people. However, this kind of product pays more attention on old people and pay little attention on mobile users who ultimately makes the buying decisions. Furthermore, this kind of smart wearable devices can greatly help users to deal the anxiety of old people safety. In this case, the smart wearable device interaction demands more suitable framework to improve itself in different situation.

There have been a great number of studies in framework for HMI improving. Zheng Liu proposed the classic software framework of Model-View-Controller (MVC) can be used in the civil aircraft cockpit. The aim of this software framework is decoupling the logic dependency and system model [7]. Wanyu Zhang and Xun Yuan tried to improve APP interface design localization in difference aspect [2], Xun Yuan studied how to improve WeChat interface design with the local style. Wanyu zhang combining "Mobile Internet" and "Productive Protection of Qiang people's silver jewelry" into the APP interface design [1] from the perspective of user experience and cognitive psychology. Hairong Long designed the APP interface and verified it's feasibility by the framework including user factors, environmental factors and emotional factors. Both of these two researches improved the APP interface design with user's mental model [3]. As for evaluation of HMI before improving, there are many researches about evaluation of HMI in different situations. Kuowei su investigated interactive virtual reality navigation system by testing 15 people with Delphi method

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and Heuristic Evaluation. All of these researches have not taken the semantic of user's behavior into account to provide a perspective of interpret users behavior.

The framework used in this research is SAPAD framework which was proposed by Fei Hu and Keiichi Sato in 2011. It was used in product design, service design and interaction design. It aims to reconstruct the functional service modules of community and build the service system for the elderly rehabilitation to realize the design innovation [8]. Researchers mapped relationship between the three dimensions which are behavior, object and signification. From this frame, the relationship between behavior-object-signification is analyzed. It could provide new approach and proposal for some problem in different aspects. However, there is no conclusive research to talk about smart wearable device interface design, especially about the interaction design in specific scenario.

The rest of the paper is organized as follow: Sect. 2 introduces the SAPAD frame . Sect. 3 describes the process of building user model by observing user's behavior. Section 4 analyzes the relationship between behavior-object-signification when people use the APP based on SAPAD frame. Section 5 give solutions for improving this interaction design. Section 6 discusses the gaps and challenges of SAPAD frame for interface design. Finally, in Sect. 7, the conclusion is summarized.

2 SAPAD Frame

SAPAD (Semiotic Approach to Product Architecture Design) is the Product construction under the full name of Semiotic Approach, which was developed by professor Hu Fei in cooperation with professor Keiichi Sato of the Design school of Illinois institute of technology in the United States during his study visit to the United States in 2011. This method forms three dimensions of behavior-meaning-product between products and users by introducing the interpretation of user behavior meaning in semiotics, and each dimension is divided into several levels accordingly. By analyzing the corresponding relationship between user's behavior and object and behavior and meaning when using the product, the mapping relationship between object and meaning can be obtained, and the design opportunity can be explored to improve the product (Fig. 1).

3 Building User Model

It is designed to better monitor elderly people whose memories are fading, mainly by their children, volunteers and CARE worker. For SAPAD, non-participatory observation is adopted to analyze the user's task flow by recording the user's operation steps.

Through user interviews, some important significant behavioral variables are selected to form a number of variable axes, and then the relative position of the interviewees on the variable axis is divided. Generally speaking, the mutual location relationship between users in a certain range is more important than the exact location, which plays a role in subdividing the user group. In this paper, object and behavior

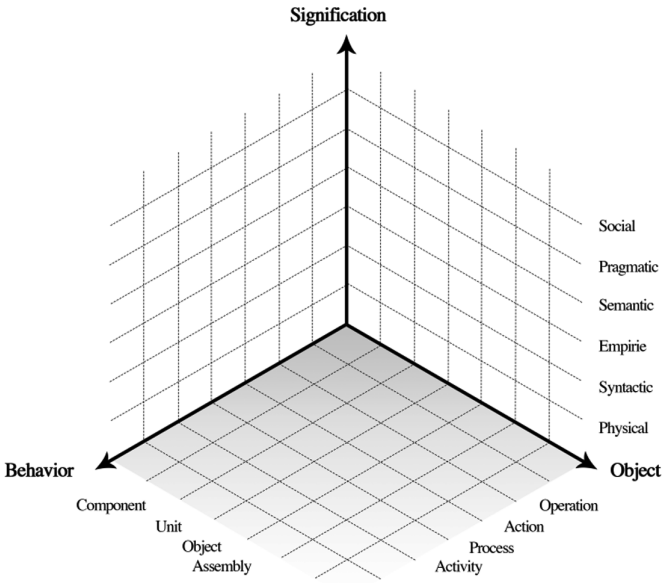

Fig. 1. Semiotic approach to product architecture design

variables are corresponded through in-depth interviews with 5 users. Each user was interviewed separately in a relaxed environment, and the usage of several users was recorded by means of chat and pre-prepared interview scripts. It is possible to observe the similarities between the user's needs for the elderly information management, positioning mode and behavioral operation. If the user has certain commonality in listening, sharing and operation, it indicates that they have similar group behavior pattern.

Record the operation activities related to APP for 5 users with non-participatory observation. They are then interviewed in depth to get a full picture of how users behave when using the APP. The main behaviors include clicking the APP, linking the devices, reading the health information, getting the location information.

4 Analyzes the Relationship Between Behavior-Object-Signification

Based on SAPAD (Semiotic Approach of Product Architecture Design) framework, the user-centered Product Design strategy was established by analyzing the mapping relationship between behavior, meaning and Product (Fig. 1).

5 Analysis of User Behavior and Key Items

After recording the operation behaviors of users in three usage scenarios, the corresponding behaviors and objects in each scenario are studied. The object can be any element related to user operation in APP interface, such as chart, text, virtual button or whole page. Users may use multiple interface elements in each step of operation, which are all related to behaviors. Among them, key elements are directly related to operations and essential interface elements (Table 1).

Table 1. Analysis of key components

Active	Process	Operation	Correlate	Key item
Binding	Master account binding	Open the Bluetooth	APP icon, Bluetooth	Bluetooth
		Find the device	Search devices, choose the device	Choose the device
		Scan the code	Camera, code, Scan the code	Code, scan the code
		Input the information	Registry	Registry
	Vice account binding	Send request	Send	Send
		Master account agrees	Receive the request, agree	Agree
Find the elder	Locate	Locate	Location	Location
	Follow the location	Open Navigation	Navigation, map, voice guide	Map
		Guide over	Navigation, voice guide	Navigation
Know the number of steps	Open the step panel	Open the step panel	Step panel, Statistics Panel	Statistics Panel
Know the heart rate	Open the heart rate panel	Open the heart rate panel	Heart rate panel, Statistics Panel	Statistics Panel
Know the sleep quality	Open the sleep panel	Open the sleep panel	Sleep quality panel, Statistics Panel	Statistics Panel
Schedule reminder	Choose the event	Edit the events	Keyboard, project bar	Project bar
		Choose the event	Project bar, Y	Project bar
	Setup time	Setup time	Time bar, clock	Time bar
		Choose the way of remind	Event list, time list, selection bar	Selection bar

This part completes the analysis of behavior-object, and finds out the interface elements in APP corresponding to user behavior through observation. The relationship

between user behavior and key objects in each scene has been clarified. And then, it is necessary to further explain the meaning of user behavior from the perspective of human.

5.1 Significance Analysis Based on User Behavior Observation

This section is a behavior-signification analysis, focusing on explaining the meaning of the user's behavior. Firstly, the signification of user behavior is qualitatively analyzed from the physical level, the semantic level, the syntactic level, the empirical level, the pragmatic level and the social level through video. In order to avoid the difference between the content of qualitative analysis and the actual thoughts of participants, the user was interviewed again after the qualitative analysis, and the content of qualitative analysis was checked and revised with the participants. Finally, the analysis of signification is completed (Table 2).

Table 2. Meaning construction based on observed behavior

Operation	Physical	Empiric	Syntactic	Semantic	Social
Log in	Click the APP	Click the APP	Enter the APP	Want to get elder's information	
Binding	Search and choose the device	Link the mobile phone and device	Synchronize data		
know the number of steps	Open the step panel	Get the information of physical activity	Analyze the fitness data	Care of the elder's health and get security	
Know the heart rate	Open the heart rate panel	Get the information of physiological safety	Analyze the life data	Care of the elder's health and get security	
Know the sleep quality	Open the sleep panel	Get the information of sleep	Analyze the sleep data	Care of the elder's health and get security	
Schedule reminder	Setup time	Remind the check time	Receive the reminders and take the action	Make sure the important things are done	
Locate	Follow the guide	Find the elder	Get the elder's location and follow it	Ensure safety of elder	

5.2 Cluster the Significant of User Behavior

In the SAPAD framework, the behavior-signification relationship is corresponding related objects. Therefore, the association construction of core signification may reassemble the objects, point out the gap of the interaction, and improve the existing design. Since the signification of the physical level and the syntactic level reflects the objective logical relationship between the interactive elements of the APP and the interactive elements, the result of clustering can only reflect the original interaction design of the APP. Therefore, the focus here is to cluster the empirical level related to interactive optimization.

By cluster analyzing, we have gained the core significance cluster, and constructed the core significance relationship (Table 3). The strong or weak relevance of meaning can be divided into 4 levels: 0, 1, 2, and 3. "0" represents no correlation, "1" represents weak correlation, "2" represents strong correlation, and "3" represents core correlation. The meaning cluster can be clearly seen from the operation results.

Table 3. Significant cluster of empirical level

	Click the APP	Link the mobile phone and the device	Get the information of physical activity	Get the information of physiological safety	Get the information of sleep	Remind the check time	Find the elder
Click the APP	3	1	0	0	0	0	0
Link the mobile phone and the device	1	3	0	0	0	0	0
Get the information of physical activity	0	0	3	3	3	2	1
Get the information of physiological safety	0	0	3	3	3	2	0
Get the information of sleep	0	0	3	3	3	2	0
Remind the check time	0	0	2	2	2	3	3
Find the elder	0	0	1	0	0	3	3

The empirical level emphasizes users' skills and life experience, and the clustering analysis results in 2 meaning clusters, which are getting information of elders' health in daily life and ensuring elders will not get lost.

6 Solution

Optimize the information architecture:

The goal of information architecture optimization is to reduce the complexity of information acquisition and shorten the distance between users and information. As for start page, there are two scenarios of using the APP which are daily scenarios and emergency scenarios. Users prefer to get the information on health in old age in daily scenarios but get bored of this kind of information when the elders get lost. It better to move the relevant information from start page to health information page.

Optimize product functions:

The goal of product function optimization is to find out the difficulties or inconveniences when users use the APP and solve them or propose better ways to replace the original functions.

Optimization of visual details of product:

The goal of visual detail optimization is to use the visual method to make the information display more clearly and do the appropriate beautification. Through users' operation and feedback, it can be found that the first part that can be improved is to emphasize some contents and functions that users pay more attention to. For example, the font size of some fonts should be enlarged and optimized within the current visual design style of the whole APP.

7 Gaps of the Research

There are some gaps and disadvantages through the research. Firstly the research of SAPAD method select users randomly when conducting user research, which is not typical, and it is not very helpful for the iterative update of APP products. Secondly, SAPAD does not take into account the user's usage scenarios when analyzing the user behavior, while the APP user usually has multiple usage scenarios. Therefore, it is necessary to distinguish the user's usage scenarios.

8 Conclusion

In this paper, the effects of SAPAD frame were investigated. This framework not only focuses the user needs but also excavates the users' demand from the behavior to signification in order to get the core requirement. The APP of elder wearable device are analyzed with this framework in empirical level. The result of analysis shows that users require more efficient interaction when they locate elders urgently and they call for humanize interaction when they learn the health information about the elder. However, the study ignore users preform differently in different scenarios, although it is discussed in solutions part.

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