Research on User Interface Design of Home Appliances Based on Behavioural Logic

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Abstract. It is to solve the usability problem of user interface of home appliances under the development trend of home appliance automation, informatization and multi-function through the design of home appliance user interface dominated by user behavioral logic. It uses the methods of comparative analysis and empirical analysis, and it's distilled and compared the **main** difference between behavioral logic-based user interface and the functional logic-based user interface of home appliances, and then it summarizes and analyzes the main characteristics and advantages of behavioural logic-based user interface. The design ideas of behavioral logic-based user interface based on design psychology and other theories are provided, including that the behavioural logic-based user interface design of home appliances should be based on the user's mental model, and the user's cognitive experience of the task scene and its elements of decision-making process should be extracted, and the user interface should be organized according to the information of common operation scenes and the operation paths, and so on.

1 Introduction

With the rapid development of modern technology, the degree of automation and intelligence of home electrical appliances has been continuously enhanced. At present, there are many home appliances with a high degree of automation such as microwave ovens, washing machines, cameras, etc. existing problems on interface comprehensibility and ease of use. Consumers experienced strong operational frustration and appeared low acceptance of new functions. The existence of operational obstacles in the user interface of home appliances undoubtedly hinders the industry expansion of high-tech home appliances and the further functional innovation of products. The design logic, design methods and principles of user interface on home appliances need to be optimized to promote the healthy development of the home appliance industry.

From the perspective of design logic, the current interface design of home appliances is too biased towards functional interfaces, and the information architecture of user interfaces is mainly based on the functions of the products and the physical attributes of the information. This kind of interface seems simple, and generally it categorizes functions and information in a logical and clear manner, but its operation process does not conform to the

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user's thinking habits and behaviour habits. Many users (especially elderly users) can only uses some common functions, such as most microwave ovens users use only 5% of its functions [1]. Nowadays, users are increasingly concerned about the simplicity and priority in the complexity of interactive experience content, touch mode and multi-modal interaction [2].

Aiming at the problem of user barriers under the development trend of intelligent and high-end home electrical appliances, to improve the quality of the home appliance interface and to change the stagnation of innovation and ease of use improvement, it explores the design of behavioural logic-based user interface.

2 Basic concepts of behavioural logic-based user interface

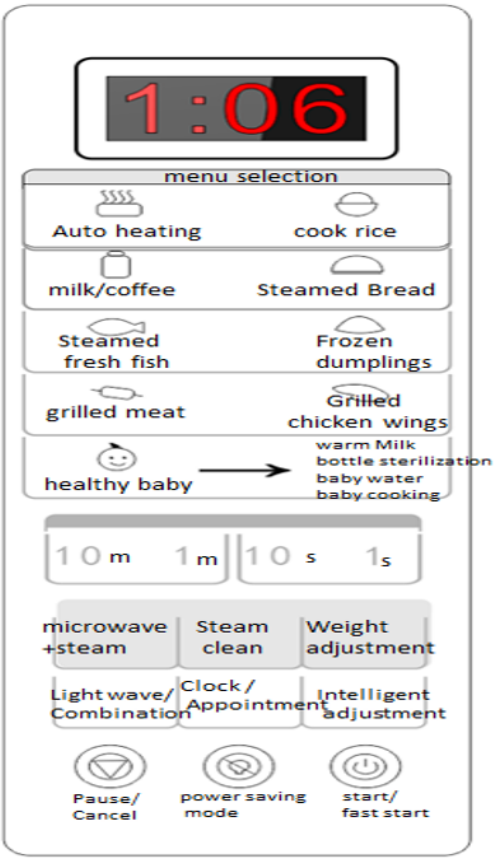

Fig. 1. User Interfaces biased towards functional user interface

In fact, there are not absolute functional logic-based and behavioural logic-based interface of home appliances in daily life. But to a certain extent, home appliances include the physical logic and behavioural logic-based logic information architecture of the user interface [4]. Most of the product interfaces of electrical products on the market focus on the design method of functional logic-based user interface, and it may causes the phenomena of using frustration caused by various use obstacles. A few well-known brands of home appliances are designed with behavioural logic-based user interfaces, by extracting information behavioural logic-based logic that is easy for users to understand to design interface information structures. It effectively is solving the problem of poor interface

usability and giving users a good experience. We analyse the main and specific differences between the "behavioural logic-based" and "functional logic-based" user interfaces of home appliances, through several groups of typical home appliance product interface designs.

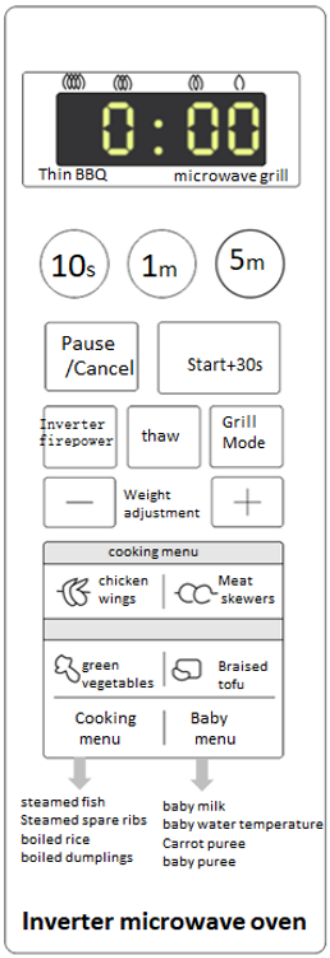

Fig. 2. User Interfaces biased towards behavioural logic

2.1 The difference of information structure of the product interface and the design layout of the main function buttons

First, the user interface in the figure1 is biased towards a functional logic-based user interface, while the user interface in the figure2 is mainly biased towards a behavioural logic-based user interface. Its information architecture of the user interface in the figure1 is mainly based on physical logic, that is, the physical attributes of the product functional system is according to organize structural relationships. From top to bottom of the interface, there is the buttons of menu, the time, the mode, the start and the pause. Although various types of functions are available, but they do not meet the requirements of sequence of operations of commonly used functions. The interface information architecture the user interface in the figure2 is mainly based on user behaviour logic, and it emphasizes the

priority of interface interaction [5]. It conforms to the commonly used operation sequence that the main functions or commonly used functions are placed in the upper middle part of the interface, and the rarely used functions such as menu are placed in the lower part.

Secondly, in the figure 1 the position of the main function buttons do not meet the frequency of use, and there is no instruction on how to operate, while in the figure 2 the position of the main function buttons meet the requirements of the frequency of use, and you can know how to operate at a glance. In the interface design in figure1, the main function buttons, such as start and pause buttons, are most frequently used, but they are small in size, but they are not prominent and at the lowest end of the interface. At the same time, the operation meaning of the function buttons does not indicate the operation actions, such as the buttons of weight adjustment, clock reservation, intelligent adjustment, etc. It is not easy to understand how to operate them. In the interface design in figure2, the common operation buttons on the interface, such as microwave heating operation tasks, are arranged in the prominent position on the upper layer, which meets the needs of the frequency of use. Some function buttons, such as start +30 seconds, adding and subtracting weight adjustment, have clear operation meanings and indicate how to operate. It conforms to the commonly used habits of users.

2.2 The difference of typical operational task paths

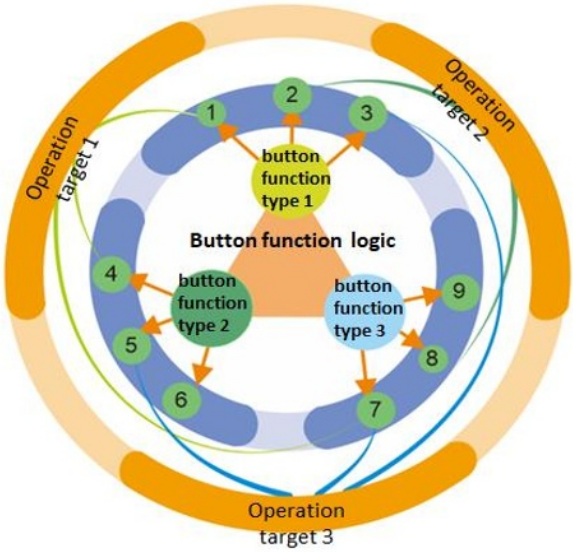

Fig. 3. Designers' mental models of operation of home appliances

Fig. 4. Users' mental models

From the operation process of these two products, the paths of the operation tasks are very different. The common task paths in the figure1 have to be interspersed in various functional areas, while the common task paths in the figure2 are mainly in the main control area, and users don't have to switch to other areas as often.

In the microwave oven interface design case, the functional user interface in figure 1 is divided into several functional areas according to physical logic, and the time, weight, firepower, etc. are distributed into different functional areas. The task scenes are not clear, and different task paths have to be interspersed in various functional areas; Users often need to operate continuously in different functional modules and information levels.

In the main control area of the user interface in Figure2, the common tasks and scenes of heating, defrosting, and grilling in microwave ovens are arranged. The the common operations are clear at a glance and the common operation task paths are basically kept in the main control area. Those basic operations can be performed only in the main area and do not jump basically between more function modules.

2.3. Differences from mental models

The differences between the above two typical product interface designs are mainly due to the different mental models. The functional logic-based user interface of home appliances is mainly designed according to the designer's mental model (Figure 3), and the design of the behavioural logic-based user interface is mainly based on the user's mental model(the Figure 4).

Because the designer has a fully rational understanding of the function setting and operation of the product, the designer's mental model takes the product function button type

and classification as the core of the design idea (Figure 3). When users use it, they can achieve the operation goal by combining a series of function type operations, so they may have to select operation buttons across several functional areas. The designer's mental model belongs to the expert model, but the beginners and even the multi-year operators generally do not have such mental models, so the task paths are difficult for the beginners to understand and it is not easy for them to memorize the information structure and operation steps.

The design of behavioural logic-based user interface is mainly designed according to the user's mental model (the Figure 4). The user's understanding and operating experience of home appliances in daily life mainly exist in the form of a series of targeted operating scene memories. Therefore, the user's mental model (the Figure 4)is centered on its own operation goal and the operation scenes, while not on function button type and classification. Users understand and memorize the operation goal as several operation scenes. An operation scene such as heating food includes a series of step-by-step functional operations. Under the control of the task operation scene, the meaning and steps of the function operation are relatively clear and natural, easy to understand and memorize.

3 Design points of behavioural logic-based user interface for home appliances

In order to improve the usability of the home appliance application interface, it should design the behavioural logic-based user interface, under the premise of fully considering the difference between the designer's mental model and the user's mental model. Designers should break away from the limitations of the designer's mental model and more consider the characteristics of the user's mental model. The specific and important points in the design process are summarized as follows.

3.1 Survey and extract the user's mental model of home appliance operation

In the process of learning to use home appliances, users do not fully understand the interface information structure and function buttons layout at the beginning. At first, users explore various functions of the user interface on the basis of their experience of the operating scenes, and then gradually formed an overall understanding. The higher the degree of agreement between the electrical operation interface and the operating scene information grasped by the users, the more natural and comfortable the users experience will be. [6]

Although the current home appliance interface has the characteristics of personalization and diversification, due to the similar functions of most products, the ordinary users' mental model has the characteristics of generality and universality. So the specific user mental model can be obtained through a large number of target users investigation and analysis

Therefore, at the beginning of the design, we should focus on a full investigation and analysis of the user's product psychology, clarifying the operating goals that users have when operating, and what operating scenes and operating action methods they have grasped in their daily experience, so as to establish an extraction about the operation mental model. The methods of investigating and analysing the user's mental model of home appliance operation include observation method, interview method, psychometric method, KJ analysis method, mind mapping method, metaphor extraction technology, etc. model [7].

3.2 Establish an operational information architecture that conforms to behavioural logic-based logic of users

From the user's mental model we learn users' cognitive experience and behavioural logic-based habits about the operation type and operation process, we should extract the information in the user's cognition of the task scene. It should decompose the operation process in the task scene first, and then obtain the elements of the decision-making information, and then establish the interface information structure gradually.

About the elements of the decision-making information, for example, the typical operation scenario of a microwave oven—heating and the information decision elements are the adjustment of time, firepower, weight, etc. The typical operation scene of an air conditioner—refrigeration, and the information decision elements are the adjustment of temperature, wind power and wind direction, etc. The typical operation scene of a washing machine—standard Washing, including the course of osoaking, washing, rinsing and spinning, etc. ,and the information decision elements are the adjustment of time, intensity, as well as water level, fabric type, etc.

We need to classify the elements of the decision-making information mainly according to the user behaviour logic and arrange them in a certain common operating scene. It also need consider them with functional logic.

3.3 Design the layout and task paths of functional areas

The design of behavioural logic-based interface should be able to show operation scenes and typical task paths.

The user's decision-making process when interface operations are the process of matching their own mental models and task requirements with interface information.

In the design of functional logic-based user interface, only functional partitions that conform to physical logic are given, which leads users try to explore the functional architecture logic of the interface, and then think about how to convert the operation goal into using various function buttons step by step.

The behavioural logic-based user interface design is different. On the basis of the user's mental model, the designer comprehensively considers the five interactive behaviour elements of the user's cognitive experience, operation goals, operation scenes, operation buttons, and operation actions to design the system. It organizes the interface according to operation scene information, and arranges the operation paths with common operation steps, so that the user can quickly and directly find the information of task scenes and related buttons that are consistent with the cognitive experience on the interface, then start the operation according to the interface action instructions.

In addition, the user interface of behavioural home appliances is laid out according to the frequency of use of functions and common steps in the design, and its task paths are generally arranged according to the laws of human vision (generally, the interface is from top to bottom, from left to right, and from the middle to both sides. etc.) [8]. It is easy to understand and memorize.

3.4 Pass operation action instructions on the operation buttons

The design of behavioural logic-based user interface focuses on making users understand the meaning of operations and guiding users how to implement operations.

The functional requirements of home appliances should be decomposed into several button function nodes, and accurately defined them as function buttons that are easy for users to understand.

The specific action operation information of the button should be indicated by the verb name or action meaning icon, so that the function button symbol has a clear indication [9], and the users could understand the task of the button that it will perform and what the corresponding result is.

For example, the weight function node of the microwave oven interface in figure2 tells the user how to adjust the firepower according to the weight of the food through the plus and minus buttons. This is designed according to users' cognitive. The directionality of the operation action information allows the user to clearly understand how to use this function button. While that is not in the microwave oven interface in figure1.

3.5 ide feedback information that conforms to the operation scenes

Feedback is an important part of the information in the behaviour logic. The behavioural logic-based user interface of home appliances should provide clear previews, reminders and warnings and other feedback information so that users can reasonably predict and judge their own behaviour before and after each step of operation. It is only timely, accurate and easy-to-perceive feedback can guide users to carry out the next action quickly and effectively.

The interface operation keys and the feedback should conform to the "natural match" in the relationship between position and shape, so that the operation and feedback are well matched, so that the user can have as accurate an expectation of the operation as possible, and have a stable expectation psychology. At the same time, all the feedback in the operation scene should be arranged in an orderly manner, and it should not be chaotic, otherwise the user cannot find the feedback in time [10]. It is not conducive for the user to establish a correct mental model. For example, in the microwave oven interface figure2,the function button of frequency conversion firepower corresponds to the change of the three different flame shape indicators above the display screen. The buttons and indicators conform to the "natural matching" relationship and the feedback position stand out in the operation scene and are easy to identify.

The user's ability to notice is limited, so that various feedback elements on the number, scope, and spatial layout should not be too much at the same time. Therefore, it should not display too much information in an operation scene, and unnecessary information should be hidden.

It should not put different types of data information automatically on the display at the same location without prompting. For example, some washing machine display screen sometimes shows the amount of water, sometimes it shows the time in the same position during operation, but there is no prompt. It could clear up misunderstandings easily if the unit is shown. [11].

4 Summary

The design of behavioural logic-based user interface of home appliances is dominated by the behavioural logic concept.

The core of the behavioural logic design concept and methods is to strengthen the user-oriented design connotation. That is, design start from the user's existing cognitive experience and thinking logic, and to follow the characteristics of the user's mental model.

The behavioural logic-based user interface design of home appliances can make the user interface naturally fit the user's psychological characteristics and behavioural habits, and can help achieve the goal that the product feature rich while operation simple. It would promote the humanized development of home appliances effectively.

The research cases attempting on the design principles and methods of behavioural logic-based user interface here are not comprehensive enough. With the development trend of home appliance intelligence and informatization, and the society's increasing emphasis on user experience, it is believed that the behavioural logic-based user interface design of home appliances will be developed and applied more abundantly and deeply in the vast design practice.

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