

Research on Interactive Design of Touch Screen Interface of Old-Age Robot in Artificial Intelligence Era

Tianshuang Zhang*, Fengnan Xu

* Corresponding author: zhangtianshuang@sjzu.edu.cn*, Email: 849220086@qq.com

School of Design and Art, Shenyang Jianzhu University, Shenyang, China

Abstract—This is an era where the rapid development of science and technology is accompanied by an aging population. The advancement of computer technology has brought new technologies to the elderly care industry, and related fields of elderly care robots have emerged as the times require. However, the operation of elderly care robots has always been a problem for older users. In view of such problems, this paper attempts to cut into the UI design of the touch screen interface of the elderly care robot. According to the characteristics of older users, aiming at their operational difficulties, and through research, new ideas and optimizations are put forward for the UI design of the existing elderly care service robot touch screen interface. So as to realize the further adaptation of product functions and older users.

Keywords—the elderly, UI design, elderly service robots, Aging-design.

1 Introduction

1.1 Research background

At present, the whole world is entering an aging era. By the end of 2020, there are 722 million people aged 65 and above, accounting for 9.32% of the global population.[1] Internationally, it is generally believed that in a country or region, 10% of the total population is aged over 60, or 7% of the total population is aged over 65, which means that the country or region has entered an aging society. [2] The results of the seventh national census in China show that the elderly over 60 years old account for 18.7% of the total population in China. Facing the aging problem in China, the pension industry has entered a stage of rapid development in China.

It is estimated that by 2030, the total demand for aged care workers in China will increase from 5.771 million to 16.2468 million. Because of the heavy workload and low wages in the industry, it will be extremely difficult to find nannies and nursing staff in the future. [3] However, the use of aged care robot instead of manual service for the elderly can effectively reduce the burden of the elderly on their families and society, and alleviate the pressure of serious shortage of nursing staff. In recent years, with the rapid development of science and technology, the design of robot for the aged is becoming more and more perfect.

In recent years, with the development of science and technology and the innovation of various high-tech equipment, UI design has attracted more and more public attention. UI Design, also known as interface design, refers to the softwarehuman-computer interaction, operation logic

and beautiful interface. A good UI design not only makes the interface have personality and taste, but also makes the operation comfortable, simple and free, and even highlights the positioning and characteristics of products. [4]UI design has gradually started to pay attention to artistic beauty and user experience from a single satisfying function. The birth and development of the old-age robot has also led to the development of UI design and old-age related fields.

1.2 The research purpose of this paper

At present, the debugging, setting and operation of the old-age robots are all carried out by professionals of robot manufacturers, old-age nursing staff or the younger generation in the family who have some knowledge of information network. We should realize that the object that interacts with the aged care robot the most and uses it for the longest time should be the elderly. Therefore, the interactive system of the aged care robot at this stage deviates from the original design intention to some extent. The purpose of this paper is to identify the difficulties and obstacles faced by the elderly in robot operation, aiming at their actual needs for the touch-screen interface of robots, and put forward a reasonable optimization scheme for UI design of the existing touch-screen interface of elderly service robots.

2 Characteristics of user groups and user needs

2.1 General characteristics of physical function of the elderly

On the definition of the elderly group, some western developed countries take the age of 65 as the demarcation point. The World Health Organization defines the elderly as people over 60 years old. [5] With the increase of age, the physiology and psychology of the elderly will change obviously.

2.1.1 Body

As an individual grows older, the absorption capacity of protein and calcium will decrease, and the decomposition rate of bone cells in the human body is faster than the growth rate of bone cells, and the bone quality of the elderly begins to decline. At the same time, the body parts of the elderly, such as ligaments and tendons, will become slower with the aging of the body, resulting in stiffness and poor coordination of the body.[6] The outstanding performance is that when the elderly use touch-screen devices, the sense of touch drops due to the decline of hand muscles' proprioception, and they can't perform fine operations on the devices, such as touching other controls by mistake and triggering the target controls accurately.

2.1.2 Hearing

As the elasticity of the eardrum of the elderly begins to harden gradually, the vibration frequency of the eardrum of the elderly will also be affected by sound waves. Moreover, sound waves need to pass through the ossicles of the middle ear, and the ossicles of the middle ear will calcify with age, which further narrows the range of sound frequencies accepted by the brain of the elderly. Therefore, the elderly will gradually lose the ability to properly process sound information.[7]

2.1.3 Vision

The lens of the eye will gradually harden with the increase of people's age, and the elasticity of ciliary muscle will gradually decrease, which results in the decline of the visual ability of the elderly.[8] For color, the sensitivity to color is reduced, so it is difficult to distinguish approximate colors. In addition, due to the decline of the height of the elderly, the visual gaze point of the elderly tends to shift downward compared with that of the young and middle-aged people, which leads to the narrowing of the field of vision of the elderly, and the decline of their ability to perceive things around them, such as the perception of distance and three-dimensional sense.[9]

2.1.4 Thinking

The aging of the human body will make the brain nerve cells decrease continuously, which will inevitably lead to the decline of people's memory. Medical research shows that the cerebral cortex surface and cerebral blood content of the elderly will continue to decline, and the nerve part of the cerebral cortex lacks flexibility, making it difficult to quickly adjust the mental state. After receiving external information, the brain reaction is relatively slow, and the old people will suffer from memory loss and deterioration of thinking ability.[10]

Compared with young and middle-aged people, there is a big gap in physiology and psychology of the elderly. Only by fully grasping the old people's own conditions, can the product function be further adapted to the demand of users, and the products suitable for the old people can be designed.

2.2 Demand analysis of UI touch screen interface of pension service robot

2.2.1 Survey questionnaire and analysis results

2.2.1.1 Questionnaire setting

Due to the numerous functions and low popularity of intelligent old-age robots in China, the equipment in the questionnaire survey is expanded to smart phones, tablet computers, small smart speakers and other smart devices with touch screens, so as to find common operating characteristics among these different smart devices and make the questionnaire more valuable for reference.

The questionnaire is divided into two parts, which are designed in the form of single-choice questions and multiple-choice questions. The first part is the personal information of older users, mainly including age, gender, occupation and education level. The second part is about the functions commonly used by older users when using smart devices and the troubles in the process of using them.

2.2.1.2 Research process

This questionnaire survey focuses on the elderly activity centers, community squares and some elderly people's homes. The questionnaire should be distributed in a gender balanced manner to ensure the objectivity of the survey results. The sample was collected from September 10th to 14th, 2022.

2.2.1.3 Research results

In this questionnaire survey, a total of 130 questionnaires were prepared, and 107 valid questionnaires were collected.

At the time of data collection in this survey, 69% of people aged 60 to 69 are the age group with the largest number in this survey questionnaire. See figure 1. Among them, there are 56 males and 51 females. Out of a total of 107 people, only 20 people live with their children. Housing data indirectly reflect that most of the elderly people who appear in the city cannot be accompanied and cared for by young people.

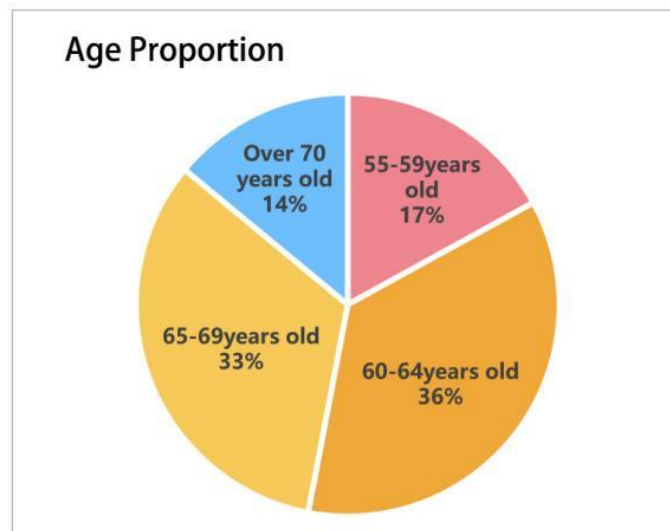


Figure 1. Age proportion of respondents

Image: Self-painted by the author

According to the data survey of equipment usage time, among 107 respondents, 43 people have been in contact with equipment for 4 years or more. 27 people used the equipment for 3-4 years; 22 people have used mobile phones for 2-3 years; Only 15 elderly people have used smartphones for less than 2 years. The data shows that in recent years, the number of elderly people who have used smart devices for more than 3 years on average has reached about 85%. See figure 2.

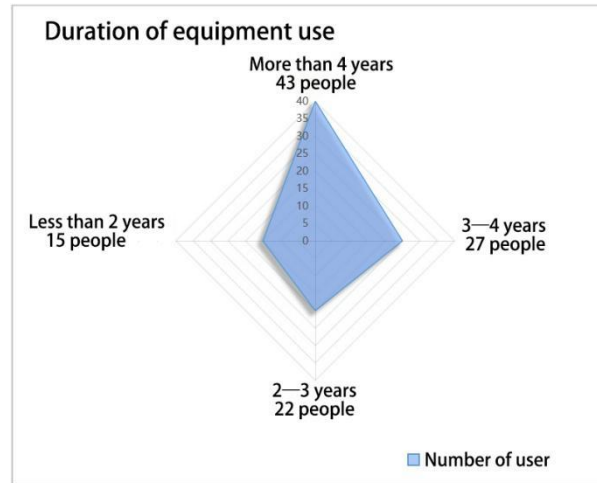


Figure 2. Age proportion of respondents

Image: Self-painted by the author

According to the survey on the commonly used functions of the equipment and the difficulties in the use of the equipment, most of the elderly people choose "different operation logic", "inconvenient operation", "complicated operation steps" and "error-prone operation". These options can clearly understand that it is still very difficult for the elderly to use smart devices. As a result, older users will only choose simple and commonly used equipment functions for them, and it also causes the old people to have resistance to learning new equipment functions and additional functions. See figure 3.

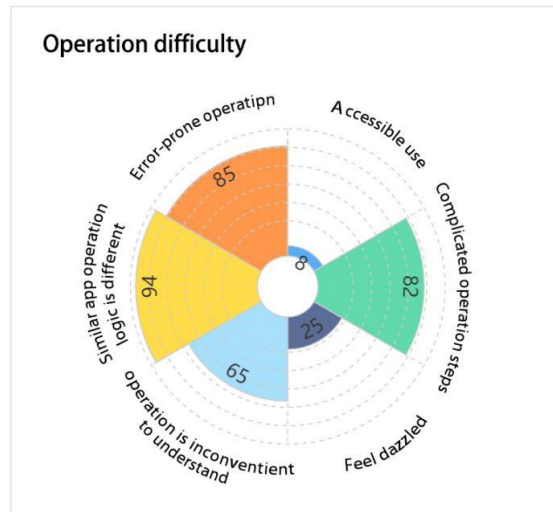


Figure 3. Difficulties in operating equipment of the investigated object (multiple choices)

Image: Self-painted by the author

The survey results show that although the use and acceptance of smart devices will be affected by a few personal factors such as age, education and occupation, it can't shake the fact that the operation of the devices is still unfriendly to most older users. Therefore, we need to understand and analyze the UI design requirements of older users for the aging of touch screens on smart devices, so as to summarize a set of reasonable design rules.

2.2.2 Aging requirements of UI touch screen interface of aged care robot.

By integrating the results of research data, we have made it clear that the elderly have difficulty and intention in operating the touch screen of the aged care robot. Therefore, according to the commonness of the operation difficulty of intelligent devices, the following summary is made on the UI design of touch screen of aged care robot:

2.2.2.1 Simplicity

The old people's thinking ability is in the process of gradual decline. When faced with new things, their thirst for knowledge is relatively low for the old people. At the same time, when faced with complicated things, the old people are prone to frustration when they can't solve or understand them. In view of this situation, the UI design of the interface should be inclined to the simple and clear layout of the interface, and the structure design should reduce the logical level, so that it is easy for older users to understand and operate, reduce their learning costs, and thus improve their operating efficiency.

2.2.2.2 Mildness

According to the physiological characteristics of the elderly, the UI design of the interface should be mild, avoiding strong visual contrast, rapid scene jumping and logical transformation. For example, the color of the interface should be mild, the switching speed between interfaces should not be too fast, and visual progress bar or time scale should be added when waiting for operation. Thereby giving the older users sufficient time to react and think, and relieving the psychological burden of the older users when using the robot.

2.2.2.3 Spiritual needs

The older users' psychological conflict with the operation output of equipment that is difficult to understand. In order to respond to users' emotions and meet their spiritual needs, the feedback prompt after instruction operation should be appropriately added to the older users' robot operation process, so as to improve the correct rate of operation, reduce errors and dangerous operations, and reduce the frustration of the elderly in complicated operations. Make it maintain sufficient confidence and sober logic in its own operation.

3 Design method of UI interface of pension service robot

3.1 Color matching of aging UI

In a design, color matching is very important for the user's emotion. By changing hue, brightness and saturation or matching color blocks in different areas, the effect of psychological suggestion

or some design intention can be achieved. Therefore, the color matching of UI design is an important part of the aging-friendly interface design.

According to the existing research results, the adjustment ability of the pupil size of the elderly is attenuated, and the lens is yellow. When facing short-wavelength light, it is difficult to distinguish, especially the three color systems of "blue", "indigo" and "purple", whose sensitivity to colors is reduced, so it is difficult to approximate colors respectively. [11] On the color preference of the elderly, the research shows that the preference for orange, red and yellow is stronger than other colors. [12] From the above research results, it can be seen that the elderly generally have a soft spot for warm colors and are less sensitive to cool colors. Therefore, the use of warm colors in UI design color matching style is increased and the use of cool colors such as blue and purple is reduced, thus catering to the psychological needs of older users.

In recent years, the popular interface color matching is mainly fresh and elegant, trying to alleviate the visual fatigue of users, but the small color contrast is not conducive to the older users' recognition of information. Therefore, the concept of "intensity is better than softness" should be followed in color matching of aging interface, and the contrast of each color should be increased while avoiding setting indistinguishable approximate colors. When designing, the key optimization parts include the contrast between the background and the main body, and the key information or functional parts should be expressed in a highly attractive contrast. Keeping the interface information can widen the differences between levels and keep clear boundaries, thus giving strong stimulation to older users and attracting their attention. See figure 4.

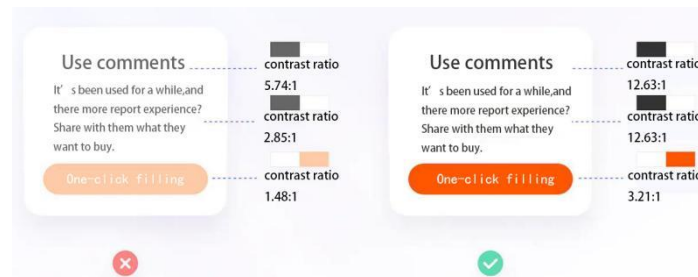


Figure 4. Color contrast optimization

Image: Self-painted by the author

3.2 Aging-design—— UI fonts and typesetting

As an important element to convey information, fonts should be given full attention in UI design. Conventional font design and typesetting are generally too small and too dense to be easily recognized by older users.

According to the investigation and research, when the older users are the users, the sans-serif fonts should be selected as much as possible. See figure 5. The font size should not be less than 18pt (pixels), and the thickness of the font should be determined according to the font size. Only fonts that meet the above requirements are more conducive to the recognition of the elderly. In typesetting, reasonable line spacing should be set aside according to the font, and the left-aligned words that conform to people's reading habits should be used as much as possible. In addition, the article should be reasonably interspersed with explanatory pictures and explanatory texts,

and the combination of pictures and texts can ensure the continuity of older users' reading articles and relieve their reading fatigue.

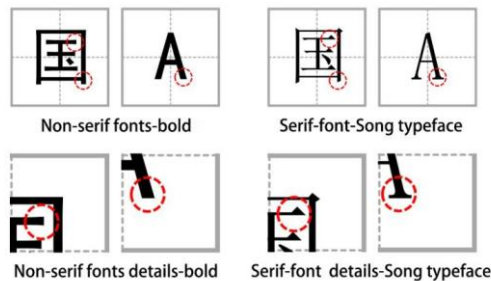


Figure 5. Comparison of sans-serif and serif fonts

Image: Self-painted by the author

3.3 Aging-design——Icon design of UI control

The minimalist style is widely used in the design of control icons of various contemporary applications, and the minimalist style makes the device interface fresh, clean, delicate and full of futuristic feeling. However, compare with that elderly people whose thinking and understand abilities have deteriorated, the minimalist and abstract icon styles have hinder their recognition and understanding. For older users, the "easy to understand" icon style is the most important.

Therefore, in addition to enlarging the control icon to facilitate the touch of the elderly, the image design of the control icon should also grasp the key element information, and make the control icon design easy to identify. In the choice of quasi-materialization, it should be related to similar tools that the elderly are familiar with in their real life, skillfully use their life experience and follow the cognitive law of older users. See figure 6.

On the other hand, the control should be equipped with a name to explain its function, follow the principle of "action is greater than description", and replace descriptive noun phrases with action verbs. See figure 7. For example, the function name "Music" can be changed to "Listen to Music". It is easier to understand than the elderly. Avoid using technical terms, buzzwords and long sentences in names as much as possible.

Older users who meet the above two conditions can better understand the functional meaning according to the control icons.

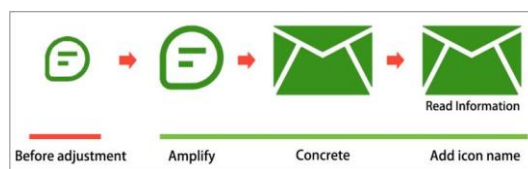


Figure 6. Icon design optimization

Image: Self-painted by the author

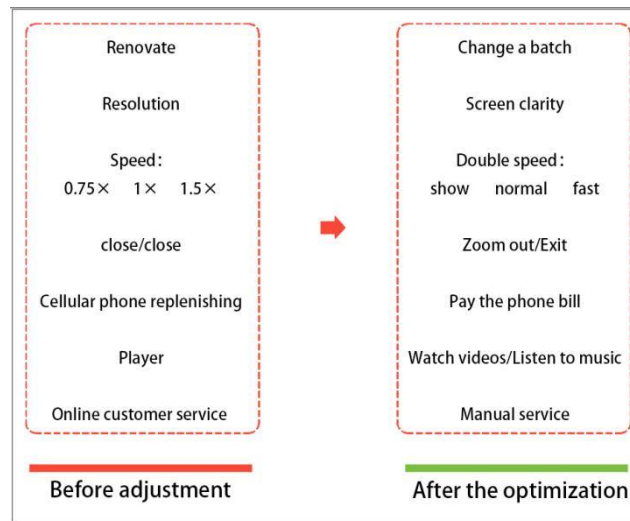


Figure 7. Control button described by "verb phrase"

Image: Self-painted by the author

3.4 Design of UI interactive structure suitable for aging

In the logic of interaction, we should emphasize the idea of simplification and guidance in parallel for older users.

3.4.1 Simplification of interactive structure

The simplification of interaction structure can be divided into two stages. The first stage refers to the hierarchical process design of the program, and the second stage refers to the wireframe layout design of the touch screen interface.

In the first stage, when designing the hierarchical process of a program, we should consider introducing the concept of "simplification" into the interactive logic. "Hierarchical process design" is more like the soul of an interactive system, which represents the interior of a set of systems, and it can subtly influence the difficulty of interaction. Therefore, the hierarchical process design can adopt the "flat hierarchical structure". Compared with the conventional deep-level interactive structure, the flat hierarchical structure aims to reduce or fold the functions that are not commonly used, so as to ensure that the structural relationship level of the application can be kept at one or two levels. Thereby reducing the logical level of the program. See figure 8. To actually reduce the burden of memorizing functional positions and finding functions for the elderly.

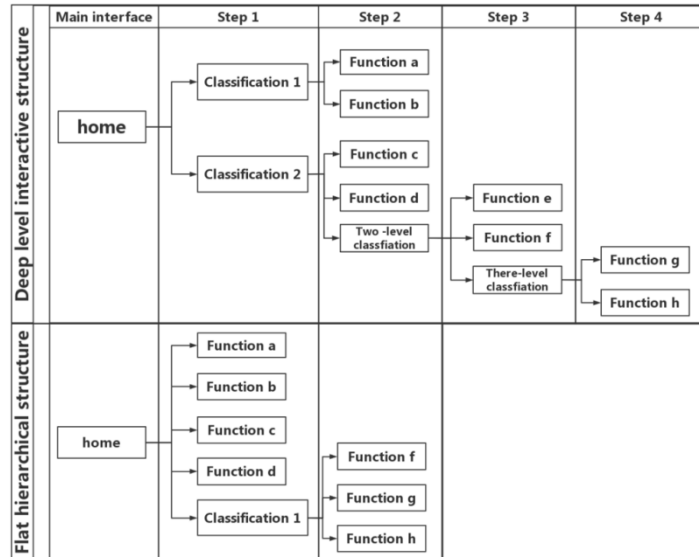


Figure 8. Flat structure

Image: Self-painted by the author

In the second stage, the wireframe layout design of touch screen interface is the concrete externalization of each level of interface in hierarchical process design. The design in this stage mainly controls the specific size of functional areas on the interface, such as BANNER at the top, tab bar and category bar. Let's take a look at a group of survey data about common functions of smart devices for the elderly (mobile phones for example). See figure 9. It is not difficult for us to see from the survey data that the elderly generally like to use the main functions of the equipment. Take mobile phones as an example. They think that mobile phones are mainly used to make telephone communication tools, while listening to radio, music, movies and TV shows are more inclined to radio, newspapers, television and other conventional channels. According to the above-mentioned characteristics of the elderly and the concept of "simplification", the wireframe layout design of the touch screen is optimized for aging as follows: First, for the gradual display mode with core functions as the main plus expanded functions as the supplement, the secondary important functions are hidden; Second, reduce the size and shape changes of elements such as keys and links in the interface; Third, use blank or slight background color to divide elements, and reduce the use of lines or other elements to divide pages. The above three points aim to create a focused visual path for the elderly users, reduce interference elements, and reduce and simplify interactive logic. See figure 10.

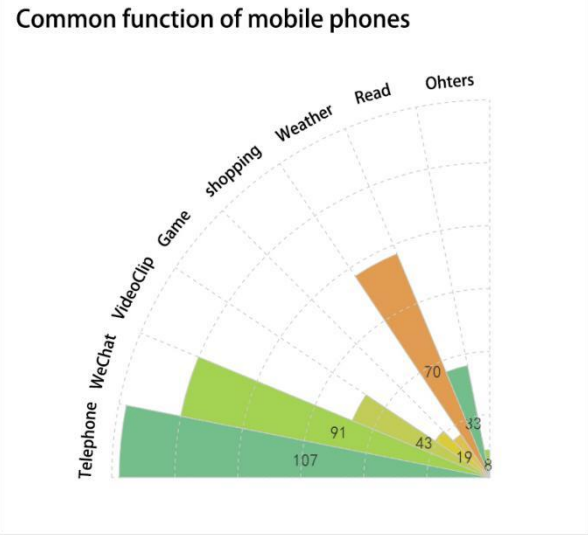


Figure 9. Common functions of smart devices for the elderly (mobile phones for example)

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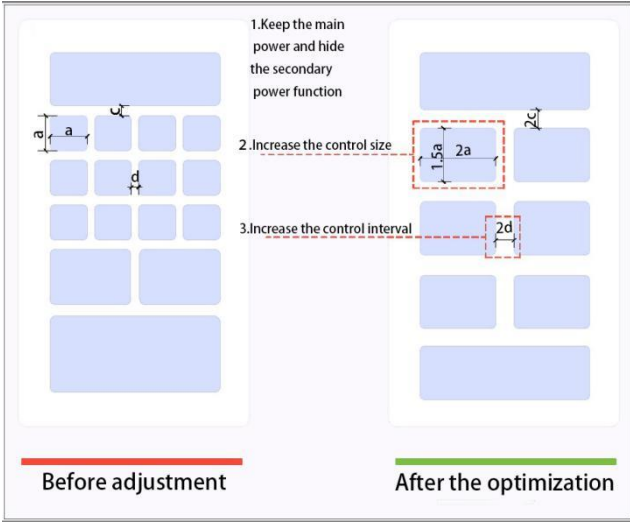


Figure 10. Aging optimization of wireframe layout design

Image: Self-painted by the author

3.4.2 The guiding aspect of interactive structure

Because it is difficult for older users to intuitively feel the results of their own operations, they will question their own operations. Therefore, we should pay attention to "reminding and feedback" in guiding the interactive structure.

The aging-adaptive interactive structure should pay attention to "feedback". It should inform the user whether the current operation is successful or not by means of transitional animation, icon change and prompt sound, and set a visual progress bar or time scale on the corresponding control to indicate the response time of the current operation. Thereby giving the user psychological expectation.

The aging interaction structure also attaches importance to "reminding", giving clear feedback through reminding to confirm the progress of the steps, and then showing how to move forward and backward. By marking the starting point, ending point and each step of the task, older users can easily identify their current position, and know what has been done and what still needs to be done. During this period, destructive and profitable operations should be confirmed and reminded, or instructional videos should be added. So as to reduce the operation errors of users.

4 Conclusions

This research involves information technology, media technology and psychology of the elderly. Understand the development and present situation of the old-age service robot, combine the theory of UI design, according to the physiological and psychological characteristics of the elderly, and put forward a set of reasonable new ideas and optimization schemes for the elderly users to use the touch screen interface of the old-age service robot, that is, optimizing the UI design color matching, text layout, control icons and interactive structure in four aspects, so as to achieve the adaptation between the touch screen interface of the old-age service robot and the operation of the elderly users. See figure 11.

The elderly should not be ignored by this era of rapid development, but should be given special care, understanding and respect. What we need to do is to combine the modern advanced information technology, so that the elderly and our younger generation can enjoy the benefits brought by the development of the network.

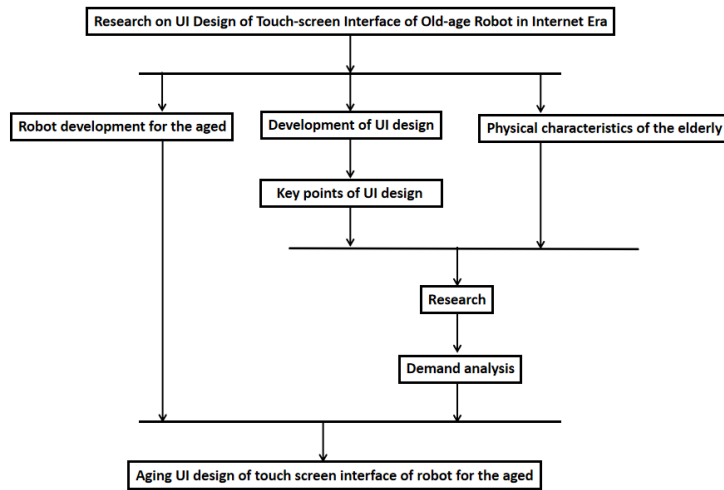


Figure 11. Article framework and research ideas

Image: Self-painted by the author

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