



Research on Human-Computer Interaction Design of Intelligent Companion Robots for the Elderly

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Abstract. This study focuses on the functional and emotional needs of the elderly for intelligent companion robots. Through market research, user interviews, and questionnaires, the human-computer interaction interface design of intelligent companion robots for the elderly has been investigated. The research finds that the functional needs of the elderly for companion robots mainly focus on health and entertainment, while emotional needs are reflected in alleviating feelings of loneliness and gaining recognition. Based on this, the paper proposes an interactive mode combining fitness with red envelope rewards, aiming to enhance the elderly's sense of self-worth and recognition. At the same time, the interface design takes into account the usage habits of the elderly, employing large-size icons, high saturation colors, rounded contours, and other designs to improve operational convenience and recognition. Through user testing and evaluation, the interface design has received positive feedback. This research provides a useful reference for the interaction design of intelligent companion robots for the elderly.

Keywords: Elderly, Human-Computer Interaction, Interaction Design.

1 Introduction

With the intensification of population aging, the "4+2+1" family structure in China has led to the gradual integration of the concept of smart elderly care into daily life, bringing attention to elderly companion robots^{[1][2]}. However, the elderly often have psychological resistance to smart products, necessitating interface design for elderly companion robots that considers the special needs of older users^[3]. Presently, there is a lack of research in this area within China^[4]. This paper, based on the physiological and psychological needs of the elderly, employs methods such as market research, interviews, and questionnaires to explore the functional and emotional needs of the elderly for companion robots. It proposes corresponding human-computer interface interaction design solutions aimed at opening up new feasible paths for smart elderly care models.

2 Design Research

Elderly companion robots, as intelligent products designed to assist the elderly in their daily lives, are intended to enhance the quality of elderly care and the happiness of the elderly^{[5][6]}. To this end, the human-computer interface of these robots needs to adapt to the usage habits of the elderly, and their functional design must meet the specific needs of the elderly^{[7][8]}. To gain a deeper understanding of these needs, this study employs a comprehensive approach including market research, interview research, and literature research to conduct a detailed analysis of the characteristics of the user group.

2.1 Market Research

This study conducted online research on elderly service robots available in the domestic market, collecting information from companies such as Wanda Technology, Humanoid Robotics, and Kunbo Robotics Co., Ltd. Based on this, a comparative analysis was conducted on three robots: "Jia Bao," "Xiao Xue," and "Xiao Hui," focusing on three dimensions: interaction methods, basic functions, and unique features. The specific content is detailed in Table 1.

Table 1. Market research on elderly service robots

product	interactive mode	basic function	Special feature
Jia Bao	Voice interaction touch interaction	APP support One touch call Voice calls Video search	Chronic disease management health check
Xiaoxue			Furniture Internet Air purification Human-computer dialogue
Xiaohui			personal space Smart dancing

All three robots utilize voice and touch-based interaction methods and share some basic functions such as APP support, one-key calling, voice calls, and video search. In addition to these common features, each robot has its unique special functions. For example, "Jia Bao" is a home care robot designed by Siasun Robot & Automation Co., Ltd. It monitors the health of the elderly through a smartwatch and can develop personalized chronic disease care plans based on the health data of the elderly. "Xiao Xue" is a household robot designed by Shanghai Kunbo Robotics Co., Ltd. Its smart home interconnectivity feature makes companionship more seamless, and its mobile purifier design also helps improve the respiratory health and mood of the elderly. As for "Xiao Hui," it is a household companion robot designed by Humanoid Robotics, enriching the elderly's entertainment through personal space and intelligent dancing functions, thus providing emotional companionship.

From the above analysis, it can be seen that the main functions of elderly companion robots currently on the market focus on voice calls, one-key calling, and video search. These functions not only improve the safety factor for the elderly living alone at home

but also enhance communication and contact between the elderly and their children and friends, enriching their online life. The control methods mainly involve voice control and touch control, which provide convenience for the elderly to use. The special functions mainly revolve around health and entertainment, aiming to improve the quality of life of the elderly.

2.2 Interview Research

To gain a deeper understanding of the behavior habits and cognitive abilities of the elderly towards smart products, this study selected three places with a high concentration of the elderly: parks, markets, and areas around kindergartens and primary schools. The research combined questionnaire surveys and interview surveys, collecting a total of 48 questionnaires, with all respondents being elderly aged between 65 and 74, and 10 of them were selected for in-depth interviews. The main questions and their answer categories in the interviews are detailed in Table 2.

Table 2. Main questions and answers in the interview survey

Question	Answer		Answer		Answer	
Have you ever been exposed to smart products?	used	2	Used smartphone	6	Never used smart products	2
What is the frequency of fitness?	every day	7	2-3 times a week	2	once a week	1
Do you accept merchants' offers?	accept	6	occasionally accepted	2	Not accepted	2
Reasons for acceptance/non-acceptance	feel pity if don't take	3	Use only if it suits your needs	6	Don't believe in quality	1

The main questions in the interviews included: 1. Have you ever used smart products? This question aimed to understand the familiarity of the elderly with smart products, so that when designing the robot's interactive interface, adjustments could be made based on this data to adapt to the elderly's usage habits. 2. How often do you exercise? This question aimed to explore whether the elderly have exercise habits and their level of importance attached to fitness. 3. Do you accept promotional offers from businesses? 4. What are the reasons for accepting or not accepting? These two questions aimed to understand the elderly's attitudes towards promotional offers, in order to better design related functions.

Among the 10 elderly people interviewed, 2 had experience with smart products, 6 had only used smartphones, and 2 had never been in contact with smart products. All respondents maintained a fitness frequency of at least 3 times a week, up to 7 times a week. Regarding the acceptance of promotional offers from businesses, 80% of the elderly said they would accept, while 20% chose not to accept due to doubts about the quality and safety of the activities.

In the interviews, 8 of the elderly mentioned using smart products, but 6 of them said these products were usually bought by their children for communication and entertainment, and they did not use them frequently and felt uncomfortable with them. Due to the unique background of the elderly, promotional methods such as discounts and gift-giving were more attractive to them. During the survey, which coincided with the Chinese New Year, special questions about promotional activities were asked. The results showed that 6 elderly people liked and accepted promotions and gift-giving activities; 2 were interested in such activities and would selectively accept them; and another 2 did not accept these activities, believing that their personal information might be leaked and the quality of the items exchanged could not be guaranteed.

2.3 Questionnaire Survey

Considering the special needs of the elderly for the interactive interface of smart products, this study conducted an in-depth analysis of the elderly population through designed questionnaire questions.

1. Interface-related issues: Among the 48 elderly people surveyed, all suffered from presbyopia, and 5 of them also had myopia. When using 4.7-inch and 5.5-inch mobile phones for APP interface operations, they generally found the interface font too small and difficult to use; whereas when using 9.7-inch tablets for operations, their experience was generally better.

In terms of screen icon arrangement types, the questionnaire included two reference styles: (1) a tablet-style common combination and (2) a computer-style square combination. The survey results showed that 33 participants chose the tablet-style common combination. Upon inquiry, it was found that this was because the elderly were already accustomed to the tablet-style combination and knew how to operate it.

In terms of icon styles, the questionnaire designed three reference styles: (1) Linear icons, as shown in Figure 1a; (2) Realistic icons, as shown in Figure 1b; and (3) Imagery icons, as shown in Figure 1c. The survey results showed that out of the 48 elderly respondents, 45 chose realistic icons, with only 3 choosing imagery icons. The feedback on linear icons was that their symbolic meaning was not obvious and their recognizability was low.



Fig. 1. Figure 1a linear icon, Figure 1b realistic icon, Figure 1c image icon

In terms of icon size, the questionnaire provided three reference sizes: (1) 152 pixels, (2) 214 pixels, and (3) 312 pixels. The survey results showed that out of the 48 elderly respondents, 37 chose the icon size of 214 pixels, and another 11 elderly people chose a size between 214 pixels and 312 pixels.

2. Daily Life-Related Issues: Studies have shown that when elderly people are in a negative emotional state, such as feeling lonely and lacking social support, they may lose confidence and courage, thus accelerating the aging process. The findings of this study also reflect this: 41% of the respondents did not feel lonely, 46% of the elderly sometimes felt lonely, and 13% frequently felt lonely. Further conversation revealed that those who did not consider themselves lonely were usually busy taking care of their grandchildren or engaged in activities they loved, such as dancing, listening to music, and exercising, which helped them maintain a positive mindset and stay socially active, thus reducing feelings of loneliness.

When asked about their daily entertainment activities, the results showed that 48% of the elderly chose "watching TV" and 23% chose "chatting with neighbors" as their main forms of entertainment. However, when asked how they would soothe their mood when feeling lonely or unhappy, 67% of the elderly chose "talking to someone," including chatting with neighbors, children, and spouses, while the proportion choosing "watching TV" dropped to 21%. The remaining 12% chose "doing things they enjoy," such as exercising, square dancing, reading, and other activities to regulate their emotions.

Based on the above research findings, we can draw the following conclusions: 1) The basic functions of the elderly intelligent companion robots currently on the market are similar to those of smartphones, while the unique features mainly focus on the elderly's health and entertainment. 2) In their daily leisure time, the elderly are mainly engaged in fitness activities (including walking, running, dancing), listening to music (singing), and shopping, and they pay more attention to their health. 3) Promotional activities are generally welcomed by the elderly. 4) In terms of interface design, realistic icons with sizes between 214-312 pixels and a tablet-style icon combination are more suitable for the elderly. 5) When feeling lonely, the elderly are more inclined to choose interactive ways of communication to alleviate their emotions.

3 Interaction Framework Design

During the interview process, we observed that some elderly people had rather monotonous daily lives and often exhibited a lack of confidence and enthusiasm during the survey. In contrast, those who frequently participated in fitness activities and had a rich life showed a proactive and willing-to-share attitude. Like children, the elderly have a "playful" personality and also experience strong feelings of loneliness. Research by American psychologist Mann has found that people experience a significant increase in pleasure after exercise, which is known as the "short-term emotional effect of physical exercise." The reason is that exercise promotes the secretion of endorphins, a hormone also known as the "happy hormone" or "youth hormone." Therefore, for the elderly, engaging in fitness activities can alleviate negative emotions and feelings of loneliness.

Based on these research findings, we designed an "assistant fitness mode through fitness for red envelope rewards." This mode not only helps reduce the risk of elderly people developing psychological illnesses but also promotes the generation of positive

emotions. The red envelopes obtained through fitness can be used directly in daily life. In today's society, the basic living needs of the elderly are generally met, and they want more recognition and respect from their families and society. Combining red envelopes with fitness not only adds fun and motivation to the elderly's fitness activities but also enhances their self-confidence and sense of pleasure. Additionally, we designed a "health reminder" feature that reminds the elderly to exercise at appropriate times (e.g., 9:00-10:00) to minimize discomfort caused by external factors such as temperature.

In Chinese traditional culture, red envelopes usually refer to the "lucky money" that elders give to younger generations during the Spring Festival, symbolizing the suppression of evil spirits and the protection of the younger generation's safety, with red symbolizing joy and good fortune. With the development of technology, "virtual red envelopes" have become popular, and red envelopes have gradually evolved into a popular form of entertainment. Nowadays, the elderly, due to their long-standing habit of thriftiness, have become the main supporters of the "red envelope" culture. Therefore, introducing a "red envelope" reward mechanism in the companionship method not only conforms to the living habits of the elderly but also effectively enhances their enthusiasm for participation, thereby achieving emotional companionship.

Regarding the main functional framework of elderly companion robots, reference can be made to Figure 2.

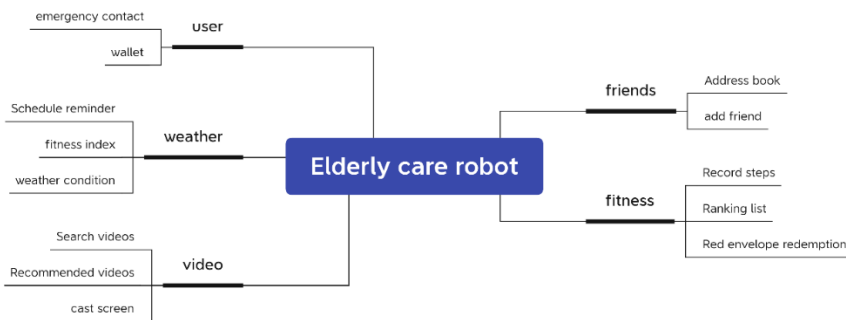


Fig. 2. Functional structure

4 Interface Design and Evaluation

(I) Interface Design: The interface, as the bridge between the user and the product, is a key element in the interaction process. Considering the convenience of use for the elderly, we chose a 9.7-inch tablet screen size and set the icon size to 214 pixels. Color psychology research shows that different colors can evoke different psychological responses, and the elderly have a higher recognition ability for red and yellow tones compared to blue and green tones. Therefore, in designing the main interface, we used warm tones as the primary colors, supplemented with cool tones for embellishment. The icon design adopted a realistic style and incorporated cultural elements that align with the life experiences of the elderly, enhancing their visual memory and reflexive operation abilities. Considering the gradual decline in the mobility and psychological energy of

the elderly, we used high-saturation colors as accents to moderately stimulate their psychological energy. Compared to straight-edged contours, rounded contours are more attention-grabbing and give the elderly a soft, warm feeling. Therefore, the interface design widely used rounded corners, increasing the interaction area to suit the physiological characteristics of the elderly and improve the accuracy of operation. At the same time, high-recognizability symbols were used to reduce the difficulty of recognition for the elderly.

In terms of style, we avoided designs that specifically targeted the elderly. Due to their psychological characteristics, the elderly may be more sensitive to special services or perceptions, and such special treatment might exacerbate their psychological differences. With the times advancing, the elderly are also pursuing fashion and aesthetics. Therefore, we aimed to minimize differences in design, making it similar to the interaction interfaces of ordinary smart products.

(II) Design Evaluation: To further refine the design, we conducted a design evaluation of the "fitness" function with four elderly individuals, using questionnaire surveys, observation methods, and interviews.

Firstly, we conducted a basic questionnaire survey with the four elderly participants, collecting their names, ages, and information on whether they had used smartphones or companion robots before, and organized the data into a table, shown in Table 3. In the table, "√" indicates previous use of a smartphone or companion robot, while "×" indicates no previous use.

Table 3. Information about personnel participating in the evaluation

Name	Ms. Zhang	Ms. Guo	Ms. Li	Mrs. Guo
Age	67	66	73	60
Have you ever used a smartphone/accompanying robot?	√	×	×	√

Table 4. Test feedback

Name	Ms. Zhang	Ms. Guo	Ms. Li	Mrs. Guo
Task usage time	47s	75s	65s	53s
User experience	5	4	3	5

Next, we provided the elderly participants with a brief introduction to the purpose and functions of the interface design. We printed the main function, "Fitness - Mode Selection," on paper for them to simulate its use and recorded the time it took for them to complete the task. The test results are shown in Table 4, with the shortest task time being 47 seconds and the longest being 1 minute and 15 seconds.

Finally, to better understand their experience, we asked them to rate their experience on a scale of 1 to 5, with 1 indicating a poor experience and 5 indicating a very good experience. Among the four elderly participants, two gave a rating of 5, while the other two gave ratings of 4 and 3, respectively. Through interviews, we learned that Ms. Zhang and Mr. Guo, who had previous experience with smartphones or companion

robots, operated more smoothly. In contrast, Ms. Guo and Ms. Li, lacking such experience, were more hesitant during use.

Overall, the elderly encountered almost no difficulties in understanding the icons or recognizing the text, and the task completion process was relatively smooth.

5 Conclusion

In this rapidly developing society, the elderly are a group that requires our special attention and consideration. Their mental health is particularly important, as only by enhancing their sense of joy and happiness and providing them with psychological companionship can we effectively reduce their risk of physical illnesses. By combining "fitness" with "red envelope rewards," we not only allow the elderly to enhance their sense of self-worth and recognition while exercising but also provide them with the "fitness reminder" function, which helps maximize the benefits of exercise in accordance with their physical rhythms and avoid chronic diseases due to improper exercise. This model of "dual companionship of fitness and emotions" truly embodies the role and value of companion robots for the elderly.

Reference

1. Tabone, W., & de Winter, J. (2023). Using ChatGPT for human-computer interaction research: a primer. *Royal Society Open Science*, 10(9), 231053.
2. MacKenzie, I. S. (2024). Human-computer interaction: An empirical research perspective.
3. Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction*. Morgan Kaufmann.
4. Wobbrock, J. O., & Kientz, J. A. (2016). Research contributions in human-computer interaction. *interactions*, 23(3), 38-44.
5. Chen Chao, Shen Jie. Research on product service design for new and elderly people in cities based on emotional interaction [J]. *Design*, 2018 (02): 32-33.
6. Liu Ying. Inheritance and changes of red envelope folk customs in the presence of technology - Taking the WeChat red envelope practice of Shenyang N campus as a case [D]. Shenyang: Liaoning University, 2017.4.
7. Wu Li, Gao Wa, Hou Jiazhen, et al. Research on smart home client interface design for indoor environmental health [J]. *Furniture*, 2018, 39(05): 79-82.
8. Geng Xiaohan. Research on age-related issues in contemporary visual communication design [D]. Nanjing: China Academy of Arts, 2016.31.

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