Research on the Design of Elderly Care Robot Based on KANO-AHP

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Abstract. In order to cope with the increasingly serious aging problem in China, the application of KANO-AHP method in the design of elderly care robot is studied and explored, so as to deeply explore the needs of elderly users and promote product innovation. Firstly, the KANO model is used to identify and classify the core needs of elderly users and clarify the design direction. Then, the AHP method is introduced to construct the hierarchical model. The weight and ranking of each demand are calculated by the judgment matrix, and the demand priority is analyzed to provide scientific decision-making guidance for the design. The results show that vital signs detection has the highest weight in essential attributes, followed by fall alarm and emergency call. The remote call ranked top in the charm attribute; the expectation attribute is the highest priority for middle-aged and elderly community services. The sorting effectively guides the design practice of the elderly care robot. Through the integrated application of KANO model and AHP method, we can accurately grasp the needs of elderly users, so as to provide a solution to the problem of aging.

Keywords: KANO model; analytic hierarchy process; home care; escort robot; product design

1 Introduction

With the development of society and the aggravation of population aging, China 's pension model still follows the pattern of ' 9073 ', that is, 90 % of the elderly rely on their children to provide for the aged at home[1]. However, the home-based care model has the problem of ignoring the emotional needs of the elderly, especially with the miniaturization of the family structure, the elderly often face the dilemma of emotional isolation[2]. In order to solve this problem, the development of accompanying robots came into being. By integrating health monitoring and emotional response functions, the quality of life of the elderly can be improved to make up for the shortcomings of traditional home care services, so as to enhance the psychological well-being of the elderly[3].

Foreign research has made significant progress in this field. For example, the ApriAttenda robot [4] launched by Toshiba can assist the elderly to complete house-

A. K. Draman Mud et al. (eds.), *Proceedings of the 2024 5th International Conference on Big Data and Social Sciences (ICBDSS 2024)*, Advances in Computer Science Research 116,
https://doi.org/10.2991/978-94-6463-562-1_34

work, the Chapit robot [5] developed by RayTron can provide daily help for the elderly, and the humanoid service robot [6] designed by JJ Choi et al.can predict the user 's emotions and respond accordingly by capturing the user 's facial expressions, tone and body posture. However, the design and popularization of domestic accompanying robots are not high. The main reason is that the product has a large body feeling and a mechanical ice-cold appearance, which is easy to cause emotional fluctuations of the elderly. Therefore, based on the physiological and psychological needs of the elderly, this paper deeply explores the needs of elderly users through questionnaire survey, KANO model and AHP method, aiming to design a companion robot that can meet the needs of daily life care and emotional companionship of the elderly. Firstly, this paper deeply understands the actual needs of elderly users through questionnaire interview, then uses KANO model to analyze the importance and satisfaction of needs, and then determines the design scheme according to AHP method. This method is helpful to scientifically weigh and make decisions in the design process, so as to improve the feasibility and effectiveness of the design scheme. The purpose of this study is to improve the acceptance of the elderly to the accompanying robot and make up for the lack of emotional needs, so as to provide a new direction for the development of home care products[7].

2 Model Construction Based on KANO-AHP

The KANO model was proposed by Dr. Kano in the 1970 s to analyze the relationship between user needs and satisfaction. The model divides user needs into five categories : basic needs, expected needs, attractive needs, indifference needs and reverse needs, and provides a system framework for identifying and prioritizing these needs, as shown in Figure 1. [8] Collect preliminary user needs through literature research, market research and user interviews, design KANO questionnaires containing positive and negative questions, and reveal the importance and priority of needs by calculating the Better-Worse coefficient and drawing a quartile map. The empirical research of KANO model helps to identify the priority of product functions and its relationship with user satisfaction, provides profound insights for product design and development, and enhances the competitiveness of the product market.

Fig. 1. KANO model

Analytic Hierarchy Process (AHP), proposed by Professor Thomas L. Saaty in 1971, is a multi-criteria decision-making method for dealing with complex decision-making problems. The AHP method decomposes the decision-making problem into a hierarchical structure, establishes a judgment matrix, conducts quantitative analysis, and finally provides support for decision-making[9].

Although the KANO model can effectively classify user needs, there are deficiencies in the judgment of the relative importance of needs. Traditional weight calculation methods such as Better-Worse satisfaction index analysis and Delphi method are limited due to their strong subjectivity and lack of quantitative support. The AHP method can calculate the demand weight more accurately by combining qualitative analysis with quantitative analysis. Therefore, the combination of KANO model and AHP method can not only make up for the shortcomings of traditional weight calculation, but also obtain the needs of elderly care robots through accurate sorting, and provide a reliable basis for the selection of final functions. In the design and research of the elderly care robot, the process architecture using the KANO-AHP method is established, as shown in Figure 2.

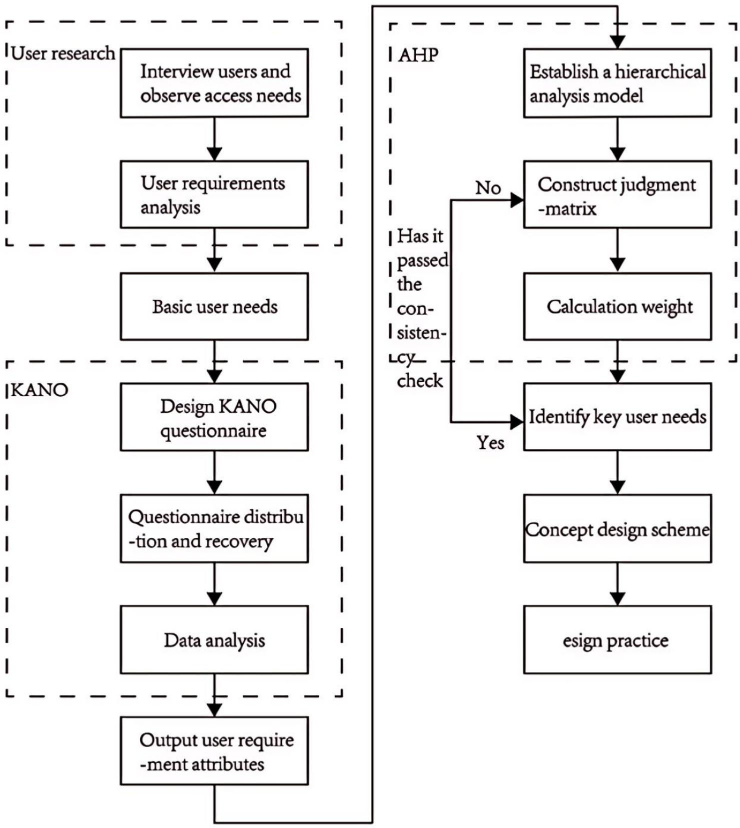

Fig. 2. Research process based on KANO-AHP method

3 User Demand Classification Based on KANO Model

3.1 Acquisition of Preliminary User Requirements for Elderly Care Robots

In order to improve the generalization and wide applicability of the research results, a variety of measures have been taken to expand the sample size and enhance the diversity of the samples. The research object is extended to the elderly with different economic levels and cultural backgrounds in Jiangsu Province, covering densely populated communities and nursing homes in urban areas. To ensure that data is collected from a wider user base, the study combines traditional one-on-one interviews with online surveys and focus groups, increasing data diversity and coverage.

Through in-depth interviews with 45 elderly people with different economic and cultural backgrounds in densely populated communities and nursing homes in urban areas of Jiangsu Province, it is found that in the process of home care, the elderly who lack their children are often accompanied by feelings of loss, loneliness and anxiety. At the same time, with the increase of the age of the elderly, physiological functions such as behavioral ability, muscle flexibility, memory and response speed are degraded, which increases the safety risk of home care[10]. In addition, the research on e-commerce platforms such as Taobao and Jingdong 's elderly care robots such as AIBI intelligent robots and Alpha egg intelligent robots shows that the appearance design of these products fails to fully meet the aesthetic needs of elderly users, and needs to be improved in terms of interactive friendliness, functional practicality, operational portability and compatibility with elderly life.

The results of in-depth interviews and competitive analysis show that the optimization opportunities of the elderly care robot are mainly focused on three aspects : First, according to the physiological characteristics of the elderly, the functional requirements (N1) suitable for the elderly are selected. Secondly, the emotional needs (N2) that can meet the psychological factors of the elderly are extracted from the relevant literature. Finally, by analyzing the purchasers and sales of best-selling products for the elderly in the market, the appearance needs (N3) [11] that meet the aesthetic characteristics of the elderly are clearly defined. The functional, emotional and appearance requirements are summarized to obtain a preliminary user demand table for the elderly care robot, as shown in Table 1.

Table 1. Preliminary user needs of elderly care robot

Requirement type	Subdivided requirements	Key technology
Functional-requirement N1	Vital sign detection n1	Intelligent Algorithms
	Medication data monitoring n2	Visual tracking, face recognition
	Fall down and alarm n3	Professional knowledge base
	Emergency call n4	Speech recognition
	Medication reminder n5	Image recognition
	Sleep monitoring and analysis n6	Smart Bracelet, Software APP
	Healthy Life Guidance n7	Multi-sensor information fusion
	Face recognition tracking n8	

	Family patrol, automatic follow-up n9	
	Video surveillance n10	
	Intelligent lighting n11	
	Moderate motion detection and analysis n12	
	Remote call n13	
	One-click call n14	
	Chatting and Q & A n15	
	Opera on demand n16	
Emotional needs N2	News broadcasts n17	Software Speech recognition, face-recognition
	Touch feedback n18	
	Community service for the elderly n19	
	Listen to books n20	
	Bright color n21	
	Round appearance n22	
Appearance-requirements N3	Simple n23	CMF
	Covering a small area n24	
	Strong and wear-resistant n25	
	Environmentally sustainable n26	

3.2 Demand Analysis of KANO for Elderly Care Robot

The study designed a five-stage scale questionnaire based on the KANO model for the elderly aged 60 to 85 years old with certain self-care ability and economic ability in the city, aiming to evaluate the satisfaction of the elderly in residential communities and old-age care communities with the above 26 initial user needs. Each of the needs in the questionnaire is set up with positive and negative questions to comprehensively assess the impact of each need on the respondents, as shown in Table 2. Considering the physical condition of the interviewees, the questionnaire was distributed face-to-face and orally assisted. A total of 274 questionnaires were distributed and 274 valid questionnaires were recovered, with a recovery rate of 100 %. The questionnaire data were analyzed by comparing the classification table of the evaluation results of the KANO model, in which the attributes were expressed according to the English code: M (essential attribute), O (expected attribute), A (charm attribute), I (indifference attribute), R (reverse attribute), Q (suspicious attribute) [9]. By counting the frequency of each attribute and calculating its percentage in the total answer, the final attribute category of each requirement is determined. KANO evaluation results classification comparison table, as shown in Table 3.

Table 2. KANO Questionnaire

Number	Question	Satisfaction	It should be so	Be indifferent	Reluctantly accepted	Dissatisfaction
n1 Vital sign detection	If the robot can monitor your vital signs (such as heart rate, blood pressure, etc.), what do you think ? If the robot can not monitor your vital signs (such as heart rate, blood pressure, etc.), what do you think ?					
n2 Medication data monitoring	If the robot can monitor and record your medication data, what do you think ? If the robot cannot monitor and record your medication data, what do you think ?					
……						

Table 3. KANO evaluation results classification comparison table

User requirements		**The accompanying robot does not have this function**				
		Satisfaction	**It should be so**	**Be indifferent**	**Reluctantly accepted**	**Dissatisfaction**
The accompanying robot has this function	**Satisfaction**	Q	A	A	A	O
	It should be so	R	I	I	I	M
	be indifferent	R	I	I	I	M
	Reluctantly accepted	R	I	I	I	M
	Dissatisfaction	R	R	R	R	Q

Based on the detailed survey data of each user 's demand, the effect of the scheme is evaluated by calculating the Better coefficient and Worse coefficient of the demand. Typically, the Better coefficient is positive and the Worse coefficient is negative. The relevant calculation formulas are formula (1) and formula (2).

$$Better = \frac{(A+O)}{(A+O+M+I)} \tag{1}$$

$$Worse = \frac{(-1)\times(O+M)}{(A+O+M+I)} \quad (2)$$

The Better-Worse coefficient is used to describe the classification proportion of user requirements in the KANO model. When the Better coefficient is close to 1, it indicates that the demand significantly improves user satisfaction; on the contrary, when the Worse coefficient is close to − 1, it indicates that not meeting this demand helps to prevent a decline in user satisfaction or improve satisfaction. The classification results of KANO questionnaire user needs are shown in Table 4. In order to further explain the priority of the demand, a quartile diagram with the Better coefficient as the vertical axis and the absolute value of the Worse coefficient as the horizontal axis is drawn, as shown in Figure 3. It can be seen from Figure 3 that we should first ensure that we meet the basic needs (n3, n4, n5, n2, n11, n22, n7, n15, n6), then give priority to the expected needs (n1, n21, n19, n23, n20), and finally meet the charm needs (n8, n17, n9, n16, n12, n10, n14). This analysis provides a clear direction for the design of the elderly care robot.

Table 4. KANO questionnaire user demand analysis

Demand classification	A	O	M	I	R	Q	Attribute	Worse-coefficient	Better-coefficient
N1	29	30	34	24	6	5	M	-54.70%	50.43%
N2	22	25	50	22	4	5	M	-63.03%	39.50%
N3	27	16	50	27	4	4	M	-55.00%	35.83%
N4	18	24	52	24	7	3	M	-64.41%	35.59%
N5	13	32	48	28	5	2	M	-66.12%	37.19%
N6	30	28	43	18	7	2	M	-59.66%	48.74%
N7	32	22	52	15	2	5	M	-61.16%	44.63%
N8	29	31	20	35	10	3	I	-44.35%	52.17%
N9	43	24	26	26	6	3	A	-42.02%	56.30%
N10	46	23	14	35	10	0	A	-31.36%	58.48%
N11	22	27	41	28	7	3	M	-57.63%	41.53%
N12	37	32	14	35	6	4	A	-38.98%	58.48%
N13	35	25	25	37	4	2	I	-40.98%	49.18%
N14	40	34	16	29	7	2	A	-42.02%	62.19%
N15	32	26	45	20	3	2	M	-57.72%	47.15%
N16	37	34	24	27	6	0	A	-47.54%	58.20%
N17	43	26	20	38	1	0	A	-36.22%	54.33%
N18	31	26	32	33	3	3	I	-47.54%	46.72%
N19	30	36	33	19	7	3	O	-58.48%	55.93%

N20	28	44	21	28	7	0	O	-53.72%	59.50%
N21	31	38	31	25	1	2	O	-55.20%	55.20%
N22	21	30	48	23	4	2	M	-63.93%	41.80%
N23	30	42	29	22	3	2	O	-57.72%	58.54%

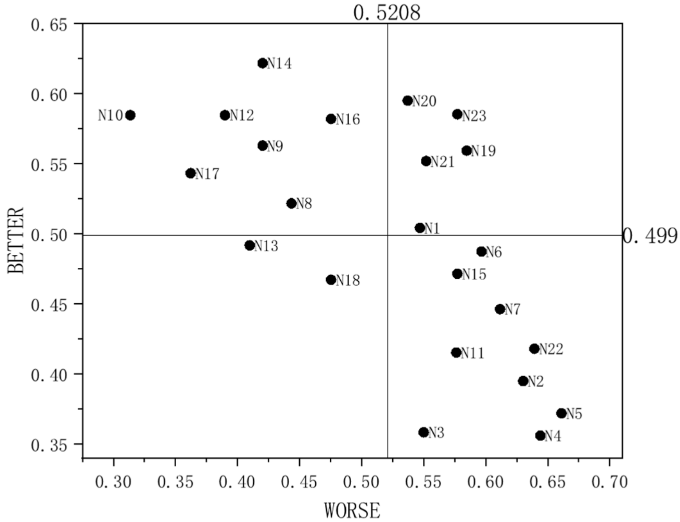

Fig. 3. Quartile of Better-Worse coefficient

4 User Demand Ranking Based on AHP Analytic Hierarchy Process

In the demand analysis of the elderly care robot, three types of requirements are selected based on the KANO model, namely, the necessary demand (M), the expected demand (O) and the charm demand (A). In order to further evaluate the relative importance of these requirements, the expert group and postgraduate tutors in the field of product design applied the AHP method to compare each demand category in pairs, and constructed the judgment matrix to calculate the weight value of each demand index. The weight calculation results are shown in Table 5. This method ensures the systematic and scientific nature of the needs assessment, and helps to accurately measure the impact of different needs categories on the design of elderly care robots.

Table 5. Demand index weight judgment

Requirement type	Necessary demand	Charming demand	Expected demand	Eigenvector	Weight value (%)
Necessary demand	1	3	2	2.213	47.473
Charming demand	0.333	1	0.5	0.76	16.297
Expected demand	0.5	2	1	1.189	25.506

In order to ensure the consistency of the tester 's evaluation thinking and the compatibility of the judgment matrix, the consistency test analysis of the judgment matrix results is performed. The calculation formula of the consistency index CI (Consistency Index) is:

$$CI = \frac{(\lambda_{\max} - n)}{(n-1)} \tag{3}$$

Here, λ _ max is the largest eigenvalue of the judgment matrix, and n is the order of the matrix. CI is used to measure the consistency of the judgment matrix. The smaller the CI value, the better the consistency. The average random index RI (Random Index) is obtained by referring to the RI table, which is only related to the order of the matrix. After calculating the CI and RI, the consistency ratio CR (Consistency Ratio) can be obtained. When CR < 0.1, it means that the consistency test is passed. For the consistency test of the judgment matrix of the elderly accompanying robot, CR = 0.017 is calculated, indicating that the consistency test is passed.

The research carefully evaluates the secondary user needs of the elderly care robot through the AHP method. The designed questionnaire adopts the scale scoring criteria of ' 1 to 9 ', and invites product design experts and graduate tutors to evaluate. In the process of pairwise comparison, the secondary needs of necessary demand (M), expected demand (O) and attractive demand (A) are evaluated, and the corresponding judgment matrix is constructed. Through this method, the weights of various requirements are successfully calculated, which provides a scientific basis for further product design. All kinds of demand weights are shown in Table 6, Table 7 and Table 8. The consistency test was performed by calculating the CR value, and the results were 0.056,0.024 and 0.01, respectively, all of which passed the consistency test standard. The comprehensive weight value of 22 secondary requirements is calculated, and the comprehensive weight ranking of the user requirements of the elderly care robot is finally obtained, as shown in Table 9.

Table 6. Necessary attribute index weight

	n1	n2	n4	n3	n6	n5	n10	n7	n25	n14	Eigenvector	Weight value (%)
n1	1	4	3	2	5	4	6	7	9	7	4.077	27.113
n2	0.25	1	0.5	0.5	3	2	1	7	7	6	1.6	10.642
n4	0.333	2	1	0.5	4	3	5	6	8	6	2.377	15.807
n3	0.5	2	2	1	6	5	7	8	8	6	3.317	22.058
n6	0.2	0.333	0.25	0.167	1	0.5	2	4	6	3	0.851	5.661
n5	0.25	0.5	0.333	0.2	2	1	3	5	6	4	1.196	7.955
n10	0.167	1	0.2	0.143	0.5	0.333	1	3	4	2	0.673	4.475
n7	0.143	0.143	0.167	0.125	0.25	0.2	0.333	1	2	0.5	0.306	2.032
n25	0.111	0.143	0.125	0.125	0.167	0.167	0.25	0.5	1	0.333	0.222	1.474
n14	0.143	0.167	0.167	0.167	0.333	0.25	0.5	2	3	1	0.419	2.784

Table 7. Charm attribute index weight

	n9	n11	n15	n13	n17	n16	n20	Eigenvector	Weight value (%)
n9	1	0.5	2	0.333	4	3	5	1.534	15.961
n11	2	1	3	0.5	5	4	6	2.318	24.121
n15	0.5	0.333	1	0.25	3	2	4	1	10.404
n13	3	2	4	1	6	5	7	3.38	35.166
n17	0.25	0.2	0.333	0.167	1	0.5	2	0.431	4.488
n16	0.333	0.25	0.5	0.2	2	1	3	0.652	6.782
n20	0.2	0.167	0.25	0.143	0.5	0.333	1	0.296	3.078

Table 8. Expected attribute index weight

	n19	n21	n23	n22	n24	Eigenvector	Weight value (%)
n19	1	3	4	5	2	2.605	42.245
n21	0.333	1	1	2	0.5	0.803	13.017
n23	0.25	1	1	2	0.333	0.699	11.332
n22	0.2	0.5	0.5	1	0.25	0.416	6.75
n24	0.5	2	3	4	1	1.644	26.655

Table 9. Comprehensive weight ranking

Demand type	weight	Secondary demand	weight	comprehensive weight	Comprehensive weight ranking
M	0.4747	n1	0.2711	0.1287	1
		n2	0.1064	0.0505	7
		n3	0.2206	0.1047	3
		n4	0.1581	0.0750	4
		n5	0.0796	0.0378	10
		n6	0.0566	0.0269	14
		n7	0.0203	0.0096	23
		n10	0.0448	0.0212	16
		n14	0.0278	0.0132	20
		n25	0.0147	0.0070	25
A	0.163	n9	0.1596	0.0260	15
		n11	0.2412	0.0393	9
		n13	0.3517	0.0573	6
		n15	0.1040	0.0170	19
		n16	0.0678	0.0111	22
		n17	0.0449	0.0073	24
		n20	0.0308	0.0050	26
O	0.2551	n19	0.4225	0.1078	2
		n21	0.1302	0.0332	11
		n22	0.0675	0.0172	18
		n23	0.1133	0.0289	13
		n24	0.2666	0.0680	5

5 Design Practice of Elderly Care Robot

5.1 Design Scheme

In the design of the elderly care robot, the KANO model and AHP method are used to analyze the user 's needs in depth and rank them by weight. Basic needs include fall alarm, emergency call, medication reminder, medication data monitoring, intelligent lighting, etc., and expected needs such as vital signs detection and elderly community services are also given priority. Charming needs such as home patrol automatic follow-up and video surveillance are higher in the weight ranking.

Based on the above analysis, the design scheme covers three aspects: modeling design, functional design and interface design, aiming to fully meet the core needs of elderly users. The modeling design emphasizes strong wear-resisting, bright color and mellow appearance. The functional design gives priority to the realization of basic functions and enhances emotional support and interaction. The interface design focuses on user-friendliness and simplifies the operation interface so that the elderly can easily use it. In addition, additional functions such as drama on demand and news broadcast are also considered. In addition, in order to comprehensively evaluate the application of the elderly care robot in the actual scene, the research will implement comparative tests in nursing homes and home environments to evaluate the differences in performance and efficiency between the design and the existing elderly care robots on the market, and collect user satisfaction feedback through user experience research and data analysis to optimize the design scheme [12].

5.2 Modeling Design

Combining the analysis results of the KANO model and the AHP method to design the shape of the aging escort robot, it can ensure that the design can fully meet the needs of users. First of all, through the user demand analysis of the KANO model, bright colors, round appearance, simple atmosphere, and small footprint are identified as expected attributes, strong wear resistance is an essential attribute, and environmental sustainability is an indifference attribute. Therefore, in the design practice, on the basis of ensuring that the necessary attribute of strong wear resistance is met, the expected demand is given priority. Combined with the weight ranking of the AHP method, the subdivision requirements in the appearance requirements from high to low are small footprint, bright color, simple atmosphere, round appearance, and strong wear resistance. Based on this weight ranking, the focus of the design should meet the expected demand of high weight, followed by the necessary demand.

Firstly, in terms of size design, the small footprint has the highest weight in the AHP ranking, so a compact volume of 160mm × 200mm is selected to adapt to the limitations of the home space of elderly users. Secondly, in terms of color selection, bright color is the expected demand in the KANO model and ranks second in the AHP ranking. Therefore, the pearl white tone is adopted to meet the aesthetic preferences of elderly users and integrate into the home environment. Then in terms of appearance design, the simple atmosphere is the expected demand in the KANO model and ranks third in the AHP ranking. Pursuing a minimalist yet atmospheric style, with leaf reliefs and built-in petal-shaped magnifiers, aims to improve indoor smells and provide a comfortable environment, while automatically adjusting brightness through a warm yellow aperture to enhance emotional interaction. On this basis, the research adopts modular design, allowing users to adjust according to the needs of different cultural backgrounds. For example, adjusting the lighting color of the robot to better integrate into a specific environment, while ensuring that the design meets the necessary functional and aesthetic needs. The shape design of the robot is mellow, which is the expected demand in the KANO model and ranks fourth in the AHP ranking. The mellow appearance design not only reduces sharp edges and increases safety during use, but also makes the robot look more friendly and friendly to enhance the acceptance of elderly users. Finally, in terms of material selection, strong wear resistance is an essential attribute in the KANO model. Although the weight is low in the AHP ranking, it must be met as a basic requirement. Therefore, a strong and wear-resistant PC material is used to ensure the durability and safety of the product, and a transparent PV material is used on the periphery of the product to improve visual transparency and adapt to the visual needs of elderly users. The modeling design of the elderly care robot is shown in Figure 4.

5.3 Functional Design

The functional design is determined based on the functional requirements N1, emotional needs N2 and the key requirements obtained by comprehensive weight ranking in the KANO model. The purpose is to provide comprehensive support and services for elderly users. Through the KANO model, the user needs of functional demand N1 and emotional demand N2 are analyzed, and the vital signs detection, fall alarm, emergency call, medication reminder, intelligent lighting, chat question and answer are identified as essential attributes. The remote call is the indifference attribute, and the home patrol, video surveillance, and one-click call are the attractive attributes. According to the weight ranking of AHP method, the demand from high to low is vital sign detection, fall alarm, emergency call, remote call, intelligent lighting, medication reminder, home patrol, video surveillance, chat question and answer, one-click call.

Fig. 4. Modeling design of elderly care robot

First of all, the essential attributes are the primary consideration to ensure that the elderly care robot can provide basic health monitoring and safety functions. Vital signs detection has the highest weight in AHP ranking, which is realized by supporting smart watches, and continuously monitors the heart rate and blood pressure of the elderly, so as to carry out timely health management. The fall alarm function is to use the sensor of the watch to automatically trigger the robot 's alarm system when a fall event is detected to quickly take countermeasures. The emergency call function enables the robot to automatically dial the preset emergency contact phone when it detects an emergency situation for the elderly, and quickly obtain assistance. Intelligent lighting automatically adjusts indoor lighting according to the change of ambient light, especially at night to provide the necessary lighting for the elderly at night to prevent falls. Medication reminders regularly send reminders to the elderly through smart watches to help take medicine on time. The chat and question answering function provides emotional support and companionship through daily dialogue and interaction, adding fun to the lives of the elderly. In addition, the robot also has the function of playing music, drama, audio books and news to alleviate the loneliness of the elderly. Although the remote call function is indifferent in the KANO model, it has a higher weight in the AHP ranking. Therefore, the design should include the audio call function of the robot to meet the emotional communication needs of the elderly. Charming attributes such as home patrol and video surveillance functions are realized by robots regularly patrol the home and monitor the home environment in real time to ensure the safety of the elderly. The one-click call function simplifies the steps of the elderly to make calls. With simple voice commands, the robot will automatically complete the dialing. The integration of these functions reflects the design 's deep understanding and care for the needs of the elderly, aiming to improve their quality of life, enhance their sense of security, and meet their daily and emotional needs through the product.

5.4 Interface Design

Before designing the ' Little Companion ' App, the needs of elderly users were systematically evaluated by KANO and AHP methods, and the key functions of the APP interface were finally determined, including medication data monitoring, sleep monitoring and analysis, and healthy life guidance functions in the essential attribute requirements ; video surveillance, drama on demand, news broadcast function in charismatic attributes ; the elderly community service and listening function in the expected attribute. According to the weight ranking of AHP method, from high to low, it is community service for the elderly, medication data monitoring, sleep monitoring and analysis, video monitoring, drama on demand, healthy life guidance, news broadcast and listening to books.

First of all, we need to focus on the necessary attribute requirements. The monitoring of medication data has a higher weight in the AHP ranking, and the data is recorded and automatically synchronized to the smart watch through the small companion App to ensure that the elderly can get regular medication reminders. The sleep monitoring and analysis function collects sleep data of elderly users by wearing a smart watch, such as sleep duration, quality and nighttime frequency, and provides detailed analysis results and improvement suggestions in the App to help users optimize sleep quality. The healthy life guidance function enhances the user 's health management and disease awareness by integrating the advice of medical experts and disease-related information[13]. Secondly, among the expected attributes, the elderly community service has the highest weight, and the design can provide the function of creating or joining the interest circle, such as the ' 60-year-old retirement circle ', which not only promotes the social interaction between the elderly, but also enhances their sense of community belonging. The listening function is provided through the ' Little Companion Channel ', and the loneliness at home is reduced by providing audio books. In terms of charismatic attributes, the video surveillance function provides a real-time home monitoring system to ensure home security, and supports historical playback and voice intercom. The on-demand and news broadcast functions of the opera provide rich entertainment content in the ' Little Companion Channel ', aiming to enrich the spiritual life of the elderly. In addition, the Little Companion App specifically designed the family member sharing function, so that family members, especially children, can participate in the health management of the elderly. This feature allows children to access the health data of the elderly through the companion app, including medication, sleep quality and video surveillance systems. In this way, children can understand their parents ' health status and home situation in real time, so as to provide timely care and support.

In order to cope with cultural differences, interface design includes personalized interface themes, such as traditional festival patterns or local cultural landscapes, and supports multiple languages to provide customized services to optimize the user experience. The study will continue to collect direct feedback from older users in different countries on App operations, and regularly update to correct the inconvenience of interface operations to ensure that all functions can be easily accessed. Through the design of cultural adaptability and ease of use, it aims to improve the satisfaction and acceptance of elderly users in different cultural backgrounds. The small companion APP interface is designed, and the three main interface design effects are shown in Figure 5.

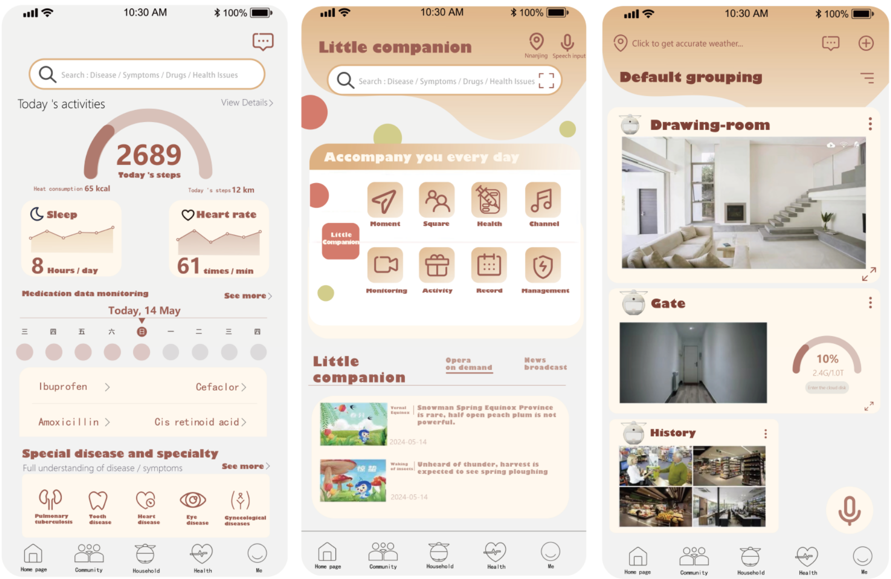

Fig. 5. Small companion APP interface design

6 Conclusion

In the design and research of the elderly care robot, by combining the KANO model and the AHP method, the research effectively solves the problems of fuzzy user needs and unclear importance in terms of function, emotion and appearance, and significantly improves the quality of life and emotional satisfaction of the elderly at home, making the design process more scientific and reasonable. In order to reduce the subjectivity in the design process, the follow-up research will adopt the method of user participatory design and implement multiple rounds of iterative tests at the design stage. Each round of testing will be adjusted according to the actual user feedback to ensure that the design practice is supported by data and user feedback. In addition, an interdisciplinary expert group will be introduced to verify the objectivity and practicability of the design through multi-angle evaluation, so as to further improve the design of the elderly care robot.

Acknowledgement

This work was sponsored by the Major project of Philosophy and Social Science research in colleges and universities of Jiangsu Province (2023SJZD108), Provincial innovation training program for College Students (202311276049Z), Ministry of Education Human Society project of China (22YJC760024), and sponsored by 2023 Qing Lan Project.

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