Data Mining for the Interactive Requirement of Elderly Chaperone Robot

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Abstract. From the perspective of the user, to summarize the population characteristic of elderly user and acquire interactive requirement model of Elderly Chaperone by former study, and then gather effective sample data and obtain Elderly Chaperone through analysis on the basis, and the key requirement item of 2-level requirement is determined through calculating weight by analytic hierarchy process (AHP). Quantitating identification of user needs to obtain a more objective requirement, and then to draw the outline of frame for the product emotion and functional requirement of Elderly Chaperone with reasonable perception.

Introduction

Along with the anabatic population aging phenomenon, various countries in the world have paid attention to the study of robot in the elderly care, and even service robot aimed at special populations such as the elderly and cognitive disorder has been developed. People wishes the household robot can think with intelligence and emotional awareness and finally achieved integrated service and communication. The traditional Chaperone Robots tend to be decisioned by technology rather than user requirement, leading to a result that user have to adapt to the machine. So in the Smart era, it is more important to guide product design with the user and study on the requirement of the user.

Rajiv Khosla [1] and so on set up the use requirement and satisfaction assessment aimed at Matilda, an Elderly Chaperone. Danyi Li [2] developed innovative functionality of household Chaperone by using the angle of “Human-centered Design” to survey the interactive system of household Chaperone based on the study of classical user’s requirement. Analytic hierarchy process (AHP) is a comprehensive evaluation method by combining qualitative research and quantitative research, it can express in terms of subjectivity on the basis of the user [3]. Combined with literature analysis method and interview method to study the assessment indicators of user requirement in designing elderly Chaperone; to determine the importance and weighted score of satisfaction through questionnaire investigation and independent collocation methods, and excavate user requirement items through data analysis to provide reference basis for the design of interactive system of Elderly Chaperone in the future.

Analysis of User Groups and Hierarchy Model of Requirement

In the user-requirement oriented design process, the study on user group in early period is helpful to turn the user study into actual requirement and eliminate the "boundary” of the product, making the aged users able to cross the threshold caused by product using experience and technical limitation[4]. So before obtaining the requirement model, it is necessary to have a comprehensive understanding to the user and the concept prototype can be determined by former study.

Internationally people over the age of 60 are usually defined as the elderly population. In terms of physiology, the elderly have special living requirement, such as requirement of daily life activity caused by the decrease of independent activity ability, range of activity and flexibility [5]; and the product shall timely provide assistance information to guide the operation directly and help the user to keep daily routine, so memory aids tool and highly intuitive information is required.

In terms of emotion, due to the user’s psychological changes caused by social role transformation, the elderly people are faced with loneliness in life and spirit, so this product aimed at the elderly group shall have more loving care. For instance, the empty-nest elderly need good self-perception, because the communication and interaction energy of the elderly people decrease gradually, so the

smart product for elderly user shall provide more emotional concern and love and ensure the user's communication with the outside world.

Based on the investigate and survey of Elderly Chaperone product and analysis on the elderly user group, to select from and conclude existing product and the elderly requirement solution provided in the study, combined with Maslow's Requirement Theory, the requirement hierarchy model of the elderly is obtained (as shown in Fig.1).

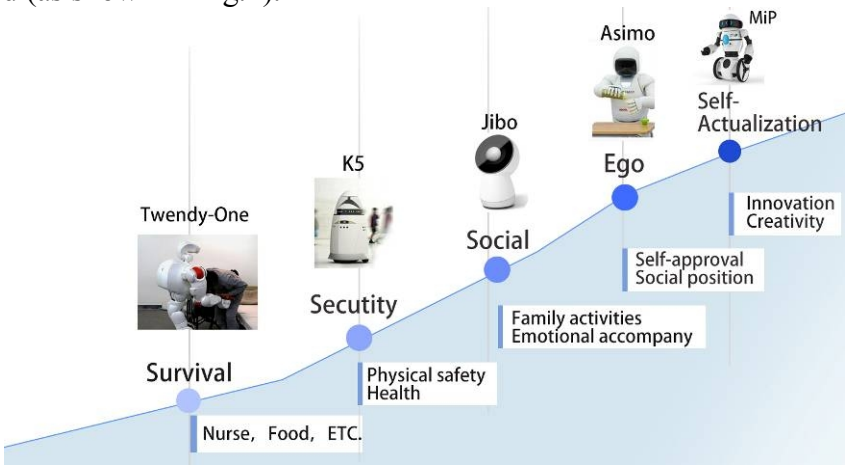

Fig.1 Hierarchy Model of Information Requirement for the Elderly People

User Survey and Requirement Index Acquisition

In order to preliminary understand the real requirement, attitudes and ideas of the user to the product, user interview shall be carried out to obtain the scope of range for the user's goals and motivations. Gathering small sample data through open question or interview outline can reflect the emotion, thinking and behavior of target user group for household robot deeply and accurately. In this user interview, semi-structural interview, participating questions and non-participating observation, individual case statistics shall be used to obtain user perspective and on the basis to set up assumption and theory [4], which divides the user's requirement into 4 primary requirement dimensions and 21 secondary requirement as shown in Fig.2.

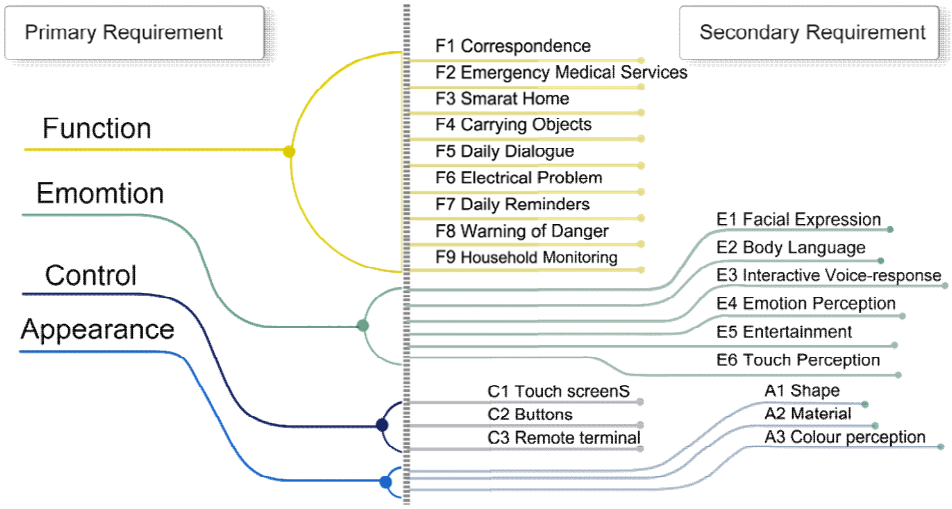

Fig.2 Unwind Table for the Requirement of Household Chaperone

Dependent Requirement and Its Weight Determination

After studied and designed user requirement indicators, it is necessary to determine which requirement indicator is key indicator, i.e. the user requirement item in need of improvement. At first, this paper designs a questionnaire for the importance and satisfaction of Elderly Chaperone user

requirement according to the assessment indicator of user requirement, and it rates 21 secondary indicators with five-spot method. In the study, population between 60~75 was set to be the survey objective; 120 questionnaires were sent out and 113 of which are effective.

The weighted valuation of requirement has direct influence on quality requirement upgrade; referring to the understanding degree of the responder to household robot and in accordance to the original effective data, the study sets total weighted sum as 1.00 and calculates the 0.0088 weight coefficient of each responder with response average amount. The weight coefficient allocation is adjusted according to the actual situation and shown in Table 1:

Table 1 Determination for the Weight Coefficient

Understanding degree	Number	Weight coefficient	Total
1	9	0.005	0.045
2	22	0.007	0.154
3	59	0.009	0.531
4	15	0.011	0.165
5	8	0.013	0.104
Total			1.000

After assigned the weight of result for each respondent, the importance and satisfaction shall be calculated weighting separately, obtaining the score of importance. The total score calculation of importance weighted is as follows: set X_{ij} as the importance score of the i_{th} person to the j_{th} requirement, and R_i is the weight coefficient of the i_{th} person; a_j is total score of importance before weighting, and A_j is the total score weighted, then:

$$a_j = \sum_{i=1}^{n} x_{ij}, A_j = \sum_{i=1}^{n} x_{ij} * r_i \quad , \quad n=113;$$

The result for each requirement item is obtained through calculation, as shown in Table 2:

Table 2 Score Result for Requirement Importance

Project	F1	F2	F3	F4	F5	F6	F7	F8	F9	E1	E2	E3	E4	E5	E6
Weight	3.16	4.15	2.41	3.25	2.79	2.19	4.03	3.58	3.76	2.50	3.52	4.17	3.91	1.22	3.96
a_j（before Weighted）	357	469	272	367	315	248	455	404	425	283	398	471	442	138	447
A_j（after Weighted）	2.53	3.58	2.37	2.78	2.28	1.79	3 .34	2.91	2.87	2.12	3.07	4.10	3.72	1.03	3.46

Seen by the scoring result of Table 3, weighted average score of each requirement variable is mainly among 2.5~3.5; the diversity factor of functional requirement is lower than that of emotional requirement, which proves that in terms of functional requirement, different improvement spaces of user requirement are in different levels. Scatter diagram is made up of weighted importance score and requirement item and it is shown in Fig.3:

Each point in Fig.3 stands for the location of requirement item surveyed, in hash distribution shape. It can be seen that the importance of requirement item beyond range of linearity is higher, and the user has a great expectation to this, especially the scatter item with higher than 3.5 requirement importance weighted is the most importance content in need of improvement. In terms of functional requirement, the items with higher requirement degree are F2 and F7; the elderly people requirement to high-tech smart product is small, and the requirement to aspects of drugs, medical treatment and nursing is huge. Different users have huge differences in the emotional requirement for robot, so in the design of household robot interactive system it is necessary to consider the sensitivity of different users to functional requirement and integrate it in the design.

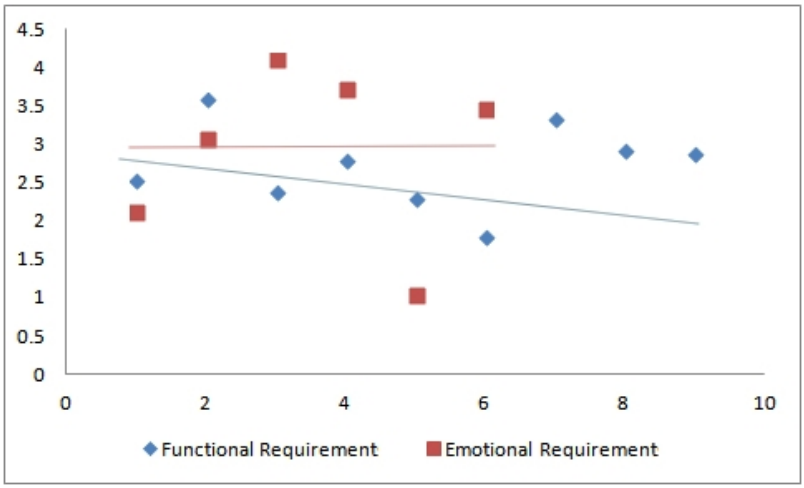

Fig.3 Total Scatter Diagram for weighted Requirement Degree of the Survey Item

User Preference Analysis and Requirement Expansion of Elderly Chaperone

According to the aforementioned user requirement analysis and combined with the understanding of elderly people's feature, Elderly Chaperone shall provide emergency rescue auxiliary services and do trivial affairs, assisting the daily life of the disabled elderly users, communication with the outside world through man-machine interactive system, or even necessary emotional communications with the elderly people. In the perspective of medical caring which the user concerned most, it can gather basic condition and physical parameters of the elderly people by creating personal database for the elderly, and combined with physical health record of the elderly people, the elderly health check expert database system is set to provide health status notification. At the same time, the robot can be the carrier of communication and information exchange for the elderly people, and remote audio and video and physiological state real-time transmission function for the elderly can be used to achieve interactive chat between the elderly people and Chaperone and the wireless audio and video emotional communication among relatives.

In the selection of interactive routine between the elderly user and Chaperone, the elderly users pay attention to the interaction of touch and voice channel, and they hope to order the robot through simple and direct way--feedback interaction; therefore, in the design of interaction channel it shall be ensured that the robot can respond to the user's voice instructions correctly and high efficiency and user experience degree human-computer interaction system also shall be ensured.

Conclusion

Elderly Chaperone is different from general household electrical appliances, and its high smart feature makes huge cognitive differences expressed by different audiences. This audience combines user requirement theory with elderly user characteristics and handles comprehensive discussion on the requirement theory of Elderly Chaperone; it handles analysis and discussion on the user preference and potential requirement through concluding the information requirement model of Elderly Chaperone and creating requirement indicator and satisfaction assessment of user requirement. The user requirement study of Elderly Chaperone Robot is the basis for the "customer-centered" product design idea, and it has important theoretical and practical significance, and it also can provide certain theoretical basis to the elderly product design.

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