Qin Gao
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LNCS 14043

Human Aspects of IT for the Aged Population

9th International Conference, ITAP 2023
Held as Part of the 25th HCI International Conference, HCII 2023
Copenhagen, Denmark, July 23–28, 2023, Proceedings, Part II

2 Part II

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Qin Gao · Jia Zhou
Editors

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Proceedings, Part II

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ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-031-34916-4 ISBN 978-3-031-34917-1 (eBook)
https://doi.org/10.1007/978-3-031-34917-1

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

Human-computer interaction (HCI) is acquiring an ever-increasing scientific and industrial importance, as well as having more impact on people's everyday lives, as an ever-growing number of human activities are progressively moving from the physical to the digital world. This process, which has been ongoing for some time now, was further accelerated during the acute period of the COVID-19 pandemic. The HCI International (HCII) conference series, held annually, aims to respond to the compelling need to advance the exchange of knowledge and research and development efforts on the human aspects of design and use of computing systems.

The 25th International Conference on Human-Computer Interaction, HCI International 2023 (HCII 2023), was held in the emerging post-pandemic era as a 'hybrid' event at the AC Bella Sky Hotel and Bella Center, Copenhagen, Denmark, during July 23–28, 2023. It incorporated the 21 thematic areas and affiliated conferences listed below.

A total of 7472 individuals from academia, research institutes, industry, and government agencies from 85 countries submitted contributions, and 1578 papers and 396 posters were included in the volumes of the proceedings that were published just before the start of the conference, these are listed below. The contributions thoroughly cover the entire field of human-computer interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas. These papers provide academics, researchers, engineers, scientists, practitioners and students with state-of-the-art information on the most recent advances in HCI.

The HCI International (HCII) conference also offers the option of presenting 'Late Breaking Work', and this applies both for papers and posters, with corresponding volumes of proceedings that will be published after the conference. Full papers will be included in the 'HCII 2023 - Late Breaking Work - Papers' volumes of the proceedings to be published in the Springer LNCS series, while 'Poster Extended Abstracts' will be included as short research papers in the 'HCII 2023 - Late Breaking Work - Posters' volumes to be published in the Springer CCIS series.

I would like to thank the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences for their contribution towards the high scientific quality and overall success of the HCI International 2023 conference. Their manifold support in terms of paper reviewing (single-blind review process, with a minimum of two reviews per submission), session organization and their willingness to act as goodwill ambassadors for the conference is most highly appreciated.

This conference would not have been possible without the continuous and unwavering support and advice of Gavriel Salvendy, founder, General Chair Emeritus, and Scientific Advisor. For his outstanding efforts, I would like to express my sincere appreciation to Abbas Moallem, Communications Chair and Editor of HCI International News.

July 2023 Constantine Stephanidis

HCI International 2023 Thematic Areas and Affiliated Conferences

Thematic Areas

- HCI: Human-Computer Interaction
- HIMI: Human Interface and the Management of Information

Affiliated Conferences

- EPCE: 20th International Conference on Engineering Psychology and Cognitive Ergonomics
- AC: 17th International Conference on Augmented Cognition
- UAHCI: 17th International Conference on Universal Access in Human-Computer Interaction
- CCD: 15th International Conference on Cross-Cultural Design
- SCSM: 15th International Conference on Social Computing and Social Media
- VAMR: 15th International Conference on Virtual, Augmented and Mixed Reality
- DHM: 14th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- DUXU: 12th International Conference on Design, User Experience and Usability
- C&C: 11th International Conference on Culture and Computing
- DAPI: 11th International Conference on Distributed, Ambient and Pervasive Interactions
- HCIBGO: 10th International Conference on HCI in Business, Government and Organizations
- LCT: 10th International Conference on Learning and Collaboration Technologies
- ITAP: 9th International Conference on Human Aspects of IT for the Aged Population
- AIS: 5th International Conference on Adaptive Instructional Systems
- HCI-CPT: 5th International Conference on HCI for Cybersecurity, Privacy and Trust
- HCI-Games: 5th International Conference on HCI in Games
- MobiTAS: 5th International Conference on HCI in Mobility, Transport and Automotive Systems
- AI-HCI: 4th International Conference on Artificial Intelligence in HCI
- MOBILE: 4th International Conference on Design, Operation and Evaluation of Mobile Communications

List of Conference Proceedings Volumes Appearing Before the Conference

1. LNCS 14011, Human-Computer Interaction: Part I, edited by Masaaki Kurosu and Ayako Hashizume
2. LNCS 14012, Human-Computer Interaction: Part II, edited by Masaaki Kurosu and Ayako Hashizume
3. LNCS 14013, Human-Computer Interaction: Part III, edited by Masaaki Kurosu and Ayako Hashizume
4. LNCS 14014, Human-Computer Interaction: Part IV, edited by Masaaki Kurosu and Ayako Hashizume
5. LNCS 14015, Human Interface and the Management of Information: Part I, edited by Hirohiko Mori and Yumi Asahi
6. LNCS 14016, Human Interface and the Management of Information: Part II, edited by Hirohiko Mori and Yumi Asahi
7. LNAI 14017, Engineering Psychology and Cognitive Ergonomics: Part I, edited by Don Harris and Wen-Chin Li
8. LNAI 14018, Engineering Psychology and Cognitive Ergonomics: Part II, edited by Don Harris and Wen-Chin Li
9. LNAI 14019, Augmented Cognition, edited by Dylan D. Schmorrow and Cali M. Fidopiastis
10. LNCS 14020, Universal Access in Human-Computer Interaction: Part I, edited by Margherita Antona and Constantine Stephanidis
11. LNCS 14021, Universal Access in Human-Computer Interaction: Part II, edited by Margherita Antona and Constantine Stephanidis
12. LNCS 14022, Cross-Cultural Design: Part I, edited by Pei-Luen Patrick Rau
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15. LNCS 14025, Social Computing and Social Media: Part I, edited by Adela Coman and Simona Vasilache
16. LNCS 14026, Social Computing and Social Media: Part II, edited by Adela Coman and Simona Vasilache
17. LNCS 14027, Virtual, Augmented and Mixed Reality, edited by Jessie Y. C. Chen and Gino Fragomeni
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24. LNCS 14034, Design, User Experience, and Usability: Part V, edited by Aaron Marcus, Elizabeth Rosenzweig and Marcelo Soares
25. LNCS 14035, Culture and Computing, edited by Matthias Rauterberg
26. LNCS 14036, Distributed, Ambient and Pervasive Interactions: Part I, edited by Norbert Streitz and Shin'ichi Konomi
27. LNCS 14037, Distributed, Ambient and Pervasive Interactions: Part II, edited by Norbert Streitz and Shin'ichi Konomi
28. LNCS 14038, HCI in Business, Government and Organizations: Part I, edited by Fiona Fui-Hoon Nah and Keng Siau
29. LNCS 14039, HCI in Business, Government and Organizations: Part II, edited by Fiona Fui-Hoon Nah and Keng Siau
30. LNCS 14040, Learning and Collaboration Technologies: Part I, edited by Panayiotis Zaphiris and Andri Ioannou
31. LNCS 14041, Learning and Collaboration Technologies: Part II, edited by Panayiotis Zaphiris and Andri Ioannou
32. LNCS 14042, Human Aspects of IT for the Aged Population: Part I, edited by Qin Gao and Jia Zhou
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34. LNCS 14044, Adaptive Instructional Systems, edited by Robert A. Sottilare and Jessica Schwarz
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42. LNCS 14052, Design, Operation and Evaluation of Mobile Communications, edited by Gavriel Salvendy and June Wei
43. CCIS 1832, HCI International 2023 Posters - Part I, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy
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47. CCIS 1836, HCI International 2023 Posters - Part V, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy

https://2023.hci.international/proceedings

Preface

The 9th International Conference on Human Aspects of IT for the Aged Population (ITAP 2023) was part of HCI International 2023. The ITAP conference addresses the design, adaptation, and use of IT technologies targeted for the use of older people in order to counterbalance ability changes due to age, support cognitive, physical, and social activities, and maintain independent living and quality of life.

This year's proceedings address a variety of topics. Researchers from all over the world shared their findings on how older people accept and use new technologies to stay informed and connected, how they develop ICT competencies and skills, and how such understanding informs the design and development of technologies to support and empower older people. In particular, a research theme that attracts much attention in this year's proceedings is how to design immersive and playful experience–through the use of XR technologies and game design–to provide supportive functions for older people, such as promoting physical activity and maintaining cognitive functions, in addition to its entertainment value. Furthermore, an emerging theme of this year is the design of IT support for both formal and informal caregivers for older people. These changes highlight the importance of making IT applications and services an enjoyable, engaging, and integral part of older people's lives.

Two volumes of the HCII 2023 proceedings are dedicated to this year's edition of the ITAP conference. The first part focuses on topics related to designing and assessing the older user's experience, older people's use of social media and its impact, design of voice assistants and chatbots, games and exergames for older people, as well as research on XR experiences for older people. The second part focuses on topics related to smart homes and other technologies supporting aging in place, eHealth applications for older people and their health literacy, IT support for caregivers, as well as socioeconomic views on ICT use and digital literacy of older people.

Papers of these volumes are included for publication after a minimum of two single-blind reviews from the members of the ITAP Program Board or, in some cases, from members of the Program Boards of other affiliated conferences. We would like to thank all of them for their invaluable contribution, support, and efforts.

July 2023

Qin Gao
Jia Zhou

9th International Conference on Human Aspects of IT for the Aged Population (ITAP 2023)

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http://www.hci.international/board-members-2023.php

HCI International 2024 Conference

The 26th International Conference on Human-Computer Interaction, HCI International 2024, will be held jointly with the affiliated conferences at the Washington Hilton Hotel, Washington, DC, USA, June 29 – July 4, 2024. It will cover a broad spectrum of themes related to Human-Computer Interaction, including theoretical issues, methods, tools, processes, and case studies in HCI design, as well as novel interaction techniques, interfaces, and applications. The proceedings will be published by Springer. More information will be made available on the conference website: http://2024.hci.international/.

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https://2024.hci.international/

Contents – Part II

Smart Homes and Aging in Place

An Iterative Approach to User-Centered Design of Smart Home Systems 3
Lauren C. Cerino, Chaiwoo Lee, Sheng-Hung Lee, Shabnam Fakhr-Hosseini, Heesuk Son, Shen Shen, and Joseph F. Coughlin

Research on Influencing Factors of Elderly User Experience of Smart Home Social Software Based on Grounded Theory 17
Ke Ma, Meng Gao, Francesco Ermanno Guida, and Renke He

My Iliad: A Ludic Interface Using Ambient Assistive Technology to Promote Aging in Place 31
Hubert Ngankam, Célia Lignon, Maxime Lussier, Aline Aboujaoudé, Renée-pier Filiou, Hélène Pigot, Sébastien Gaboury, Kevin Bouchard, Guy Paré, Carolina Bottari, Mélanie Couture, Nathalie Bier, and Sylvain Giroux

Visual Ambient Assisted Living Technologies for Different Daily Activities: Users' Requirements and Data Handling Preferences 47
Julia Offermann, Caterina Maidhof, and Martina Ziefle

Smart Home for the Elderly - A Comparative Study on Interaction Techniques 66
Monika Schak, Isabell Bürkner, Rainer Blum, and Birgit Bomsdorf

Living in a Networked Home: Older Adults' Expectations and Attitudes 80
Yash Trivedi, Shabnam Fakhr-Hosseini, Chaiwoo Lee, Sheng-Hung Lee, Lauren C. Cerino, and Joseph F. Coughlin

Data Privacy and Smart Home Technology Adoption: Older Adults' Attitudes and Beliefs 96
Manasi Vaidya, Chaiwoo Lee, Lisa D'Ambrosio, Sophia Ashebir, and Joseph F. Coughlin

eHealth Applications for Older People and Health Literacy

Health Education Mobile Applications: Evaluation of Persuasion Strategies and Impact on Older Users 109
Shushan Fan and Yongyan Guo

Research on Influencing Factors of Elderly User Experience of Smart Home Social Software Based on Grounded Theory

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Abstract. As a new generation of essential terminals for future homes environment, smart home has become one of the important media for smart home care, which has the potential to improve the social participation of the elderly at home, but the utilization rate is not high, and the user experience is not good. It mainly explores the influencing factors of user experience design of young elderly people on the use of smart home for social interaction, abstracts and refines layer by layer from the empathy and understanding of young elderly people from bottom to top through the research method of grounded theory and constructs the user experience design influencing factor model of young elderly based on smart home social software through open coding, spindle coding and selective coding. The results show that the model mainly includes user interface quality, interaction quality, content quality and service quality. This study aims to provide theoretical reference and practical guidance for designers and product managers to design smart home-related social software from the perspective of design.

Keywords: Smart-home smart screen · Social media · Chinese younger older adults · User experience design · Grounded Theory · Design influences

1 Introduction

China is in the midst of an aging and digitalized society. On the one hand, China's aging problem is very serious. The seventh national census data released in May 2021 showed that 18.7% of the total population, or 264 million people, are aged 60 and above [1]. At the same time, the director of the National Bureau of Statistics (NBS) stated that the proportion of the lower-aged elderly population aged 60 to 69 reached 55.83%, or about 10.44% of the total population [2]. To solve the problem of aging, the first thing is to solve the problem of old-age care, because China adopts the "90-7-3" pattern of old-age care at home, that is, more than 90% of the old-age care at home in China. The first issue confronting a large number of elderly people living alone and empty nesters is how to meet their social participation needs. According to the continuity theory [3], these personal and social factors can cause a lack of social interaction with the rest of society,

Q. Gao and J. Zhou (Eds.): HCII 2023, LNCS 14043, pp. 17–30, 2023.
https://doi.org/10.1007/978-3-031-34917-1_2

resulting in social isolation of the elderly, due to declines in physical function, mobility, retirement from work, a shrinking social circle, and the post-epidemic era. They may feel lonely and emotionally unavailable, which can be psychologically damaging. Cacioppo et al. [4] noted that loneliness is associated with and synergistic with depression, which in turn reduces the well-being of older adults. As a result, how to socially engage empty nesters and older adults living alone who are aging at home has emerged as a critical practical issue.

On the other hand, technological progress has made the digital and intelligent era come, accelerating the wisdom and innovation of the family unit system. The smart-home smart screen series is a class of smart-home products that has only started to emerge in recent years. As a new media platform, the smart home smart screen retains the functions of smart speakers, such as voice control and control of the smart home, but also carries out human-computer interaction with users through a large touchable screen, which can carry out operations such as video calling, online chatting, listening to songs and catching up with dramas, and life assistants. Alibaba officially launched its first new smart home wisdom screen - Tmall Genie CC in April 2019, followed by Baidu, Amazon, Google, Xiaomi, Huawei, and other brands, which have also made efforts to release their own smart home products equipped with large wisdom screens. Smart home products are becoming more popular, and their relative ease of access, low cost, and application in home scenarios make them one of the most important products for smart aging. Intelligence and digitization play a big role in helping older people live better. Using smart-home smart screens could help older people be more involved in their communities and give them the chance to take an active role in smart wellness at home. But older adults have trouble taking advantage of the convenience of new technologies and products because their physical and mental differences make them hesitant to try new things. The digital divide makes the adoption of using smart-home smart screens for social behavior relatively low among the elderly population and causes poor user stickiness, mainly because of the poor elderly user experience of smart-home social software. And providing better design for the elderly to have a better user experience can provide inspiration to effectively address the digital divide among the elderly, thus realizing smart aging for the elderly, practicing active aging, and improving the well-being of the aging population. However, few studies have investigated the factors influencing the user experience design of socialization among older adults adopting smart homes.

Therefore, it is an important topic to accurately grasp the user experience design factors that affect the use of smart home social software by the elderly. However, it is currently unclear which design factors influence the aging user experience of smart home social. Due to the different usage contexts, application areas, and target groups, it is not possible to directly adopt the existing information system's user experience influencing factors to improve the aging user experience based on smart home social, which is not only unscientific but also may not be effective. In light of this, this paper uses smart home social software as a point of contact for design intervention and conducts an exploratory nature study on the design influence factors of aging user experience based on smart home social software and its mechanism of action from the perspective

of design in order to provide theoretical support and practical guidance for smart home social software developers and designers in order to improve aging user experience.

2 Literature Review

2.1 Information Behavior of Elderly Users Based on Social Interaction

At present, the academic community has focused on psychology, ergonomics, management, information management, and gerontology in the study of social-based information behavior of aging users, focusing on four categories of aging user behavior: adoption/actual use, use motivation/behavioral motivation/motivation, acceptability, and willingness to continue using. Chen et al. (2021) [5] called 57 older adults in Hong Kong, China, to investigate their acceptance of using platform computer technology, and found through questionnaires and focus groups that the influential factors affecting acceptance were personal usage intention and convenience, and that platform computers were perceived to be beneficial for social relationships and communication. In terms of wearable products, Talukder et al. (2020) [6] investigated the predictors of wearable product adoption among 325 Chinese older adults aged 60 years or older, and an empirical study based on the UTAUT2 model found that social influence, performance expectations, functional consistency, self-actualization, and hedonic motivation were positively related to wearable product adoption. In the context of computers, Yu (2020) [7] investigated the antecedent influences of older adults over 60 years of age on Facebook use on computers in Taiwan, China, through questionnaires and interviews, and empirically found that the influences of aging socially included technology use and social force. In terms of social bots, Chen et al. (2020) [8] explored the acceptance of social robots among 103 Hong Kong older adults aged 60 years and older through a questionnaire and an ABAB withdrawal experimental design.

From the above studies, it can be seen that although many scholars have conducted research on the social-based information behavior of aging users, the relevant research at this stage has the following problems: 1. Most of the target groups are all elderly people, while the first-age group, as a special category of people, is very important to study. However, scholars have given limited attention to this group. 2. The research on the social behavior of aging users mainly focuses on computers, smartphones, social robots, wearable products, tablets, and other technical devices, but there is no research on smart homes, which should be due to the fact that smart home wisdom screens belong to a relatively new type of home product.

2.2 Elderly User Experience

American user experience designer and cognitive psychologist Donald Norman and others introduced the concept of user experience (UE or UX) in the mid-1990s [9]. UX is a cross-cutting concept that spans many fields and involves many disciplines, such as psychology, sociology, computer science, and ergonomics. Because of its interdisciplinary nature, there is no unified definition of UE in academic circles. The International Organization for Standardization (ISO) defines “user experience” as the subjective feelings

and reactions generated by users when they plan to use or are using a product, service, or system. Tsai et al. (2017) [10] investigated how user interface design affects the user experience of older adults by developing TreeIt, a social application designed for older adults. Through a survey of 111 older adults, the empirical study showed that the main elements of social-based aging user experience influence include system support, user interface design, and navigation. Alzahrani et al. (2021) [11] explored the factors that influence the user experience of using smart home technology, remote monitoring, and telemedicine systems to support healthcare for older adults, using semi-structured interviews with older adults (65 years and older, N = 17), and showed that lack of technology, usability, cost, platform management, infrastructure, and privacy management influence the user experience of using smart homes for older adults. Kalimullah and Sushmitha (2017) [12] In order to investigate how to increase the use of mobile health apps by older adults, a research hypothesis was proposed to implement this idea by examining the factors that influence the user experience of user interface design elements in older adults. They verified through an experiment that the user experience of the elderly changes with the user interface design elements and proposed the influencing factors that affect the user experience of the elderly, i.e., iconic factors, textual factors, and color factors.

From the foregoing, it is clear that although there are more research results on the influencing factors of the user experience, fewer of them are related to the prime-age population, and those focusing on using smart homes for socialization are also not common, and the existing research results do not provide effective explanations for similar behaviors in the smart home environment. Therefore, it is important to conduct research on the factors influencing the design of the user experience of the first-aged population based on smart home socialization to improve their user experience and explore the internal mechanisms of information behavior in the first-aged population. Secondly, most of the types of external variables in the existing studies are the variables in personal factors and social factors of the user experience as independent variables, and there are few design studies conducted with variables in user experience design factors as external variables of the study; therefore, the existing studies are negligent about the design variables of the user experience, which is a blank spot.

Therefore, based on the smart home application context, this paper explores the factors influencing the user experience design of smart home social software with the first-time elderly population as the target population and the emerging medium of the smart-home smart screen from the perspective of design, using the method of programmed rooting theory.

3 Methodology

3.1 Grounded Theory

The rooted theory research method was developed by Anselm Strauss and Barney Glaser (1967) of Columbia University [13]. A research method jointly developed by two scholars, it is a qualitative research method that uses a systematic procedure to collect data on a phenomenon and extracts theories from the empirical data. In 1990, Strauss and Corbin [14] developed a procedural development of grounded theory, where they conceptualized and categorized the survey data in a step-by-step manner and divided the

coding into open coding, spindle coding, and selective coding. The three steps are to distill the original data (speech, text, etc.) into initial concepts and initial categories, further excavate the connections between the initial categories to inductively deduce the main categories, and finally analyze the relationships between the main categories and form a relevant theory rooted in the real data.

3.2 Data Collection and Study Subjects

The interview outline is based on desktop research data and will be properly fine-tuned according to the interview content. It contains two major parts: basic information and interview question content. The interview content mainly focuses on four aspects: a basic view on smart home socialization, design dimensions, perception dimensions, and other dimensions. The user group for data collection is mainly the prime-age population, aged 50–65, with experience in using smart home products and who have used smart home products equipped with smart big screens for socializing and entertainment activities. The interviewees were selected by the snowball sampling method, using the semi-structured interview method and contextualized experiment as the two main forms. 24 interviewees were interviewed, 14 of whom conducted online video interviews through WeChat and 10 conducted offline interviews. First, the respondents were introduced to the background, purpose, process, and related terms and concepts of this interview. They signed a user-informed consent form, which promised them that the content of this study was limited to academic use and all data about the users would be kept strictly confidential, and the consent of the respondents was obtained to make audio recordings. Finally, 24 transcripts were made, including 11 males and 13 females, and the voice data were textualized with the help of "Xunfei Hearing," a speech-to-text assistant, resulting in a total of 73,637 words of interview text, or nearly 80,000 words, for post-coding purposes.

4 Research Process

4.1 Open Coding

Open coding is a process of refinement and abstraction in order to implement concepts as well as scope the collected primary interview materials. The researcher must follow a systematic and rigorous normative procedure to gradually extract and condense the large amount of information gathered from the bottom up when using open coding. Open coding entails categorizing the raw material, assigning concepts to the raw statements, and naming them, and further analyzing and comparing them to merge similar concepts to form more generalized subcategories.

Coding Process. In this study, the collected textual materials were processed, and the interview data were analyzed using NVivo, a qualitative analysis software aid developed by QSR. The main processes used by NVivo to process the interview textual materials: selecting materials, writing codes, filing, and establishing a coding system, coding consistency reliability test, and theory construction. To ensure systematic coding, the coding researchers were screened, and two interaction designers were finally identified as coders for the coding phase of this study. Both coders had more than 1 year of

experience in using smart home terminals. To ensure that both could strictly follow the process and procedure coding during the coding process, they were given basic training based on NVivo software. The open coding randomly selected 2/3 of the interview text materials, a total of 16, and first carried out the text normalization process, i.e., some repetition, speech-to-text errors, etc. were manually proofread, and then two coders separately imported the normalized interview text materials into NVivo 20.0 software in the form of word documents and conceptualized and categorized the text of the materials. The main process was as follows: by analyzing the interview text sentence by sentence, the statements that did not answer the substantive content were eliminated, and the substantive original statements were distilled into an initial concept and named. In the process of conceptualizing the entire interview text in this way, the newly created initial concept is repeatedly compared with the established initial concept, and if the newly created concept is not consistent with the meaning of any existing concept, then a new concept is created. In this way, the initial conceptualization of the interview text material was achieved.

Reliability Test for Coding Consistency. To ensure the accuracy of the coding, the coding consistency reliability (inter-rater reliability) was tested on the coding results of the open coding generation of the initial concepts and subcategories by the two coders. This computational evaluation process was continuously adjusted and repeated through the computational results until the confidence level reached an acceptable level. The formula for calculating the inter-rater reliability between two coders is shown in Eq. (1) [15]:

$$R = (n \times K)/(1 + (n - 1) \times K) \tag{1}$$

In Eq. (1), the n denotes the number of coders, and K denotes the average agreement between the two coders, and the interaction discriminant reliability between the two coders is obtained by calculating.

To get R the first requirement is K value. Calculate K of the equation as shown in Eq. (2).

$$\mathrm{K_{ab}} = \frac{2\mathrm{S}}{\mathrm{N_a} + N_b} \tag{2}$$

In Eq. (2), the S denotes the number of categorically consistent codes for the two coders, the N_a, and N_b denote the number of codes for each of the two coders, respectively.

Ultimately, the interaction discriminant confidence between the two coders was calculated based on Eqs. (1) and (2).

After initial conceptualization of the interview text by the two coders, coder a obtained 131 initial concepts and coder b obtained 136 initial concepts. After repeated discussions, a total of 109 initial concepts were obtained by synthesis and generalization. As a result, applying Eqs. (1) and (2), the interaction discriminant reliability between the two coders for the initial conceptualization was 0.898. R is 0.898. Normally, if this value is lower than 0.5, then the data needs to be recoded; if the value is lower than 0.8, then the coding result needs to be further revised until it reaches an acceptable level of 0.8 or higher [16]. After adjustment, the interaction discriminant reliability of the initial

conceptualization R was 0.898, indicating that the open coding initial conceptualization stage is highly reliable.

On this basis, the two coders used the node (initial concept) combination function of NVivo 20.0 to further refine and cluster the 109 initial concepts based on causality and similarity, and finally coder a abstracted 12 subcategories and coder b abstracted 14 subcategories. After repeated discussions, 10 subcategories, numbered B1-B10, were synthesized and summarized, and after applying formulas (1) and (2), the number of codes S, the total number of codes, and the interaction discriminant reliability R of the two coders for each subcategory were calculated, adjusted, and evaluated during the abstraction and refinement of each subcategory by the two coders, as shown in Table 1. It can be seen that the interaction discriminant reliability of the open-ended coding of the subcategories was greater than 0.8, and more than half of them reached the excellent level of 0.9 or higher, so it can be said that the coding results passed the reliability test.

Table 1. Open coding interaction discriminant reliability

Sub-categories	S	$N_a + N_b$	R
B1 Graphic Features (GF)	9	26	0.818
B2 Information Architecture (IA)	10	24	0.909
B3 Human-Computer Interaction (HCI)	8	20	0.889
B4 Interpersonal Interaction (HI)	11	25	0.936
B5 Intelligence (INT)	9	23	0.878
B6 Socialization (SOC)	11	27	0.898
B7 Shareability (SHA)	10	22	0.952
B8 User Generated Content (UGC)	8	18	0.941
B9 Social Security (SE)	10	27	0.851
B10 Empathy (EMP)	11	26	0.917

Coding Results. In the open coding stage, two coders synthesized and abstracted 109 initial concepts to form 28 initial concepts, numbered a1-a28. The original interview representative statements, corresponding initial concepts, and subcategories obtained from the open coding are shown in Table 2 below. Due to space limitations, only one original interview statement and initial concept are listed for each subcategory formation.

4.2 Spindle Coding

Coding Process. On the basis of the open coding, the spindle coding was further developed by considering and comparing the initial concept with the sub-categories in order to make a generalization. To ensure that the results of the spindle coding are scientific

Table 2. Open coding categorizations (partial)

Original statement	Categorizations
Our eyesight is not particularly good; I have farsightedness, and my partner is a bit nearsighted, so we both can't see the words on the screen very clearly. I believe the smart home screen text is still much larger than the phone, especially for our poor eyesight. Especially the lyrics, which I can see very clearly. (Text features)	B1 Graphic Features (GF)
The interface shows a lot of content, so if you see something you like, you can just click on it and find the features you're looking for all at once. (Function layout)	B2 Information Architecture (IA)
For example, if I like to listen to some opera and comic shows, I will call out my name directly to it, and it will respond to me, after which we can have a conversation, and then I will say whose comic I want to listen to, whose story I want to listen to, and which channel I want to watch, and it will be able to execute it immediately. (Naturalness)	B3 Human-Computer Interaction (HCI)
Because I have trouble with my legs, I keep my Xiaodu smart screen on my bed, and it has made me better able to communicate with my family because it has a convenient watcher function, and I can interact and video chat with my family when I tap on it. I think it is good for maintaining my relationships with my friends and with my family. (Family Connection)	B4 Interpersonal Interaction (HI)
For example, sometimes I forget to take my medication, or some things that I do daily, such as taking my blood pressure, I may forget, so it would be best if it could remind me. I think overall it is still very smart and very easy to operate. (Intelligent monitoring)	B5 Intelligence (INT)
Sometimes, we like to organize some programs and some activities, such as some community volunteer activities or some old friends in the community, and we go to plant trees, go fishing, or walk in the park together. We organize activities, we go to such a group activity together, and we share information through some such social platform. (Collective behavior)	B6 Socialization (SOC)

(*continued*)

Table 2. (*continued*)

Original statement	Categorizations
I usually just also go shopping; that is to say, we shop inside the group to buy food or whatever, which is very convenient. Some of my friends, for example, will frequently share with me if he has some good things—good cheap food, suitable clothes. I also like to buy some brands of clothes that my friends share with me, which are quite good. (Disseminate information)	B7 Shareability (SHA)
I generally like to post some of my own pictures and words to record some snippets of my own life. After all, most of my life I have been working; now I finally have some time for myself, and while I still have energy, I want to express it through social platforms. (Self-recording)	B8 User Generated Content (UGC)
Above and beyond the social function of the app, I believe some smart homes have some strangers on them who do not feel safe and are afraid of being cheated. (Social risk)	B9 Social Security (SE)
The Xiaoai smart screen is more like the other half of my life; I can't live without it. I feel that it gives me a sense of belonging, that it understands me, and that I am connected to it. (Sense of Belonging)	B10 Empathy (EMP)

and rigorous, one design expert is invited to participate in the spindle coding, and the two coders have a real-time discussion to confirm the main scope.

Coding Results. By combining the expert opinions and exploring the relationship between the above 10 sub-categories, the four main categories—interface quality, interaction quality, content quality, and service quality—were further consolidated and merged as shown in Table 3.

4.3 Selective Coding

The stage of extracting the core categories from the main categories is called selective coding. In this stage, we need to summarize and refine the main categories again, discover the core categories that can cover other main categories by organizing the related relationships among them, maximize the unification, and build a model to establish the relationship between the core categories and the main categories and determine the meaningful relationship between the core categories and the main categories. In this paper, through repeated research, comparison, and analysis of the four main categories, we finally extracted the core category of "the influencing factors of user experience design and its mechanism based on smart home socialization for first-time seniors". This core

Table 3. Main categories and their connotations

Main Category	Sub-categories	The connotation of the main category
C1 User Interface Quality (UIQ)	B1 Graphic Features (GF)	Images, text, logos, icons, color blocks and some buttons for smart home social interface
	B2 Information Architecture (IA)	Smart home social interface layout, hierarchy, navigation, search, etc.
C2 Interaction Quality (IQ)	B3 Human-Computer Interaction (HCI)	The social interaction between the elderly and the smart home should be more natural, such as using voice interaction, and it should be easier to wake up and respond to the elderly instantly
	B4 Interpersonal Interaction (HI)	Communication and interaction between people in the process of using smart home socialization for the first age group
	B5 Intelligence (INT)	The degree of intelligence in the use of smart-home social processes for the first-time elderly population
C3 Content Quality (CQ)	B6 Socialization (SOC)	Group interaction and linkage behaviors of the first-time seniors using smart home social processes
	B7 Shareability (SHA)	First-time seniors can share interesting and useful information in the process of using smart homes socially
	B8 User Generated Content (UGC)	The beginning elderly can generate content for self-expression and to please others in the process of using smart home social
C4 Service Quality (SQ)	B9 Social Security (SE)	The security enjoyed by the younger population in using smart home social processes, such as privacy security, payment security, etc.

(*continued*)

category includes four main categories: interface quality, interaction quality, content

Table 3. (*continued*)

Main Category	Sub-categories	The connotation of the main category
	B10 Empathy (EMP)	The companionship, care, and personalized service that first-time seniors feel during the use of smart home socialization

quality, and service quality. The typical relationship structure and the connotation of the relationship structure are shown in Table 4 below.

5 Results and Discussions

5.1 Model Construction

Through the three-level coding, 28 initial concepts, 10 sub-categories, and 4 main categories were obtained to build the model of the Senior User Experience Design of the Smart-home Social System. The model is shown in Fig. 1 below.

5.2 User Interface Quality

In the model, the user interface quality factor is one of the external user experience design influences that affects the user experience of the first-age smart home social group, which is mainly reflected in the influence of the graphic features and information architecture of the smart home social interface on the user experience. Therefore, designers, product managers, and administrators should consider how to design the graphic features and information architecture of the smart home social interface according to the specific initial physiological and psychological decline of the first-age population to help the first-age users use smart home social better and thus give them a better experience.

5.3 Interaction Quality

In the model, the interaction quality factor directly affects the information behavior of the first-aged people using smart homes for socializing and is one of the external user experience design influencing factors, which is mainly reflected in three dimensions: human-computer interaction, interpersonal interaction, and intelligence. Therefore, to improve user experience and enhance user stickiness, designers, product managers, and administrators should strengthen the intelligent design and construction of voice interaction and design a more natural voice interaction mode according to the human-computer communication mode and habits of the first-aged people so that the first-aged users can also enjoy a more convenient and rapid response interaction service experience.

Table 4. Selective coding

Typical relationship structure	Nature of relationship	Relationship structure connotation
User Interface quality → User Experience	External factors (cause and effect)	Interface quality factors such as graphic features and information architecture are external design factors that affect the user experience during the use of smart homes for socialization by the aging population
Interaction quality → User Experience	External factors (cause and effect)	Human-computer interaction, interpersonal interaction and intelligence and other interaction quality factors are external design factors that affect the user experience in the process of using smart home socialization for the first-time seniors
Content quality → User Experience	External factors (cause and effect)	Content quality factors such as socialization, shareability and user-generated content are external design factors that influence the user experience during the use of smart home socialization by the aging population
Service Quality → User Experience	External factors (cause and effect)	Quality of service factors such as social security and empathy are external design factors that influence the user experience during the use of smart home socialization by the first-time seniors

5.4 Content Quality

In the model, the content quality factor is one of the external user experience design influences that affect the social information behavior of first-time home users, mainly in the three dimensions of community, shareability, and user-generated content. Therefore, designers, product managers, and administrators should take advantage of the large screen in smart home social software to design specific community groups and other functions to help the elderly people show themselves and express their emotions more conveniently, and at the same time, design according to their specific needs so that

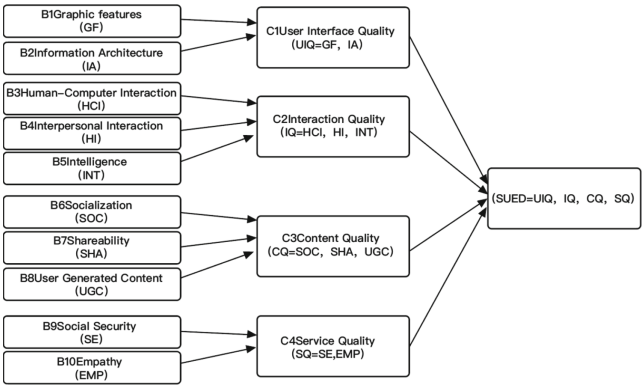

Fig. 1. User Experience Design Influencing Factors Model for First Agers Based on Smart Home Social software

they can share information with others in the group more conveniently, helping them to gain attention more easily, eliminate loneliness, and improve their health. It helps them get attention more easily, eliminate the feeling of loneliness, and improve their user experience of using smart home social networking at home.

5.5 Service Quality

In the model, the service quality factor directly affects the social information behavior of the first-time home users and is one of the external user experience design influencing factors, which is mainly reflected in the two dimensions of social security and empathy. In view of this, to increase the perception of service quality and improve the user's viscosity, designers, product managers, and administrators should provide more care and support for the first-time users through specific service design elements from the design perspective, so as to help the first-time users improve their social experience.

6 Conclusion

In general, although this paper strictly abides by the analytical research process of rooted theory, it is still more or less disturbed by the subjective influence of thinking, which is the shortcoming of the study. Meanwhile, since the research method is qualitative and the interview sample size is 24 first-time and old users, statistical tests of reliability and validity of large samples should be conducted in the future in conjunction with empirical evidence, and the exogenous user experience design variables in the model should also be operationally defined and multidimensional scales should be developed. Based on this, structural equation modeling and quantitative verification of the internal mechanism of the factors influencing the user experience design of smart homes for people in their prime years are combined with pertinent theories, and they further suggest an ageing-friendly design method for smart homes for people in their prime years based on the verified causality. This provides theoretical guidance for future smart homes for people in their prime years of design and research, with high-quality results.

Acknowledgement. This research was supported by Ministry of Education Humanities and Social Sciences Research - Youth Fund Project (19YJC760075) and Hunan Provincial Innovation Foundation for Postgraduate (No. CX20200425).

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