USER INTERFACE DESIGN FOR THE ASIA ELDERLY: A SYSTEMATIC LITERATURE REVIEW

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Abstract: According to statistics from the United Nations Department of Economic and Social Affairs, Asian communities are ageing faster and faster, enabling the elderly to use new technology user interfaces to solve their problems, easing the pressure on the elderly social security system. Although new media technology helps people's lives become more convenient, it is difficult for the elderly to learn and use. This article mainly reviews relevant literature on interface design for the elderly in Asia. The goal is to discover current methods and trends in designing interfaces for Asian seniors. The review found that relevant research mainly helps the elderly strengthen their ability to live alone, improve their physical health, and provide social information for the elderly. The method is mostly user-centric interface design. We hope to lay a foundation for continuing research on this topic and suggest the current lack of research and future development.

Keywords: User interface, media art, technology

1. Introduction

The UN's 2019 World Population report (ONU, 2019) pointed out that the world population continues to be ageing, and the population over 65 years old has become the fastest-growing age group. From 2019 to 2050, it is expected that the proportion of people over 65 years old in the total population will double: North Africa and West Asia. Central Asia and South Asia, East Asia and Southeast Asia. The Asia Pacific Risk Center, headquartered in Singapore, released a research report that pointed out that by 2030, there will be about 200 million people in Asia over the age of 65. The annual expenditure on caring for the elderly is expected to reach 2.5 billion US dollars (about 33.7 Billion Singapore dollars), four times higher than in 2015. The ageing population will put heavy pressure on the health care systems of Asia-Pacific countries, and the burden of the elderly for ordinary families will increase.

Different from Europe, Asian older people will show conservative ideas in most behaviours due to cultural reasons. In China, South Korea, India, and Japan, there are low levels of happiness among older people of different severity (Hidehiko RIETI Xiaoyan Lei et al., 2017). But at the same time, some older people are blocked from the Internet because they cannot access the Internet or use smartphones. Not only can they not enjoy the convenience of intelligent services, but they also cause specific problems (Bitterman & Shalev, 2004). How to help the elderly bridge the "digital divide" so that they can fully enjoy the convenience of information technology like most people is a real issue facing the government, enterprises, and society (Olphert & Damodaran, 2013).

User interface design requires a full understanding of user needs. It mainly focuses on the needs of the platform and its user expectations (Pangalos, 1993). However, the general user interface for popular software is not designed to fully consider the needs of elderly users, resulting in the elderly users being unable to smoothly use software applications or resisting new technologies (Punchoojit & Hongwarittorrn, 2017). Therefore, understanding the needs of the elderly in Asia to use new technologies is aimed at the region. It is even an essential part of interface design for elderly users.

This article aims to summarise the relevant research literature on user interface design for the elderly in Asia. Through a systematic literature review, we tried to determine the current research hotspots in this field, and understand the current interface design methods and data analysis methods. We were finding the shortcomings of the recent research in reading the searched literature and further,

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suggesting improvements. The organization of this article is as follows. The second part introduces the method and process of literature review. The third part reports the results of this literature review. The fourth part discusses the results of this research.

2. Methods

2.1 Plan review

At this stage, first based on the needs of this literature review, we first reviewed the latest literature in the field of interface design for the elderly, resulting in two research questions in this review:

RQ1: What needs of the elderly have been solved by the user interface designed for the elderly in Asia?

RQ2: Which design method and evaluation method did the researchers use in the research?

After that, a preliminary exploratory search was conducted in Google Scholar to determine the human-computer interaction field related to this research. The identified domains are mobile user interface, website user interface, conceptual user interface and user input devices. These areas are dedicated to assisting the elderly through technology and are therefore included in the search.

2.2 Perform search

This search was carried out on December 20, 2020. First, we determined the search keywords, search for the user (elderly OR older OR adult) AND (interface OR interfaces OR mobile) in the title and abstract, and search for this review. Based on different database search methods, four databases create filters based on research selection criteria to filter out relevant documents for analysis and reporting. To review high-quality literature, only those that met the following criteria were included: (1) peer-reviewed articles; (2) completed research or surveys; (3) research published after 2010; (4) the elderly with certain diseases from this study.

After the initial search, we performed a reverse search based on the research references to obtain other related articles. During the review process, relevant documents related to medical rehabilitation were found, which were not included in this review's scope due to the medical expertise involved. A total of 321 papers were searched for this review.

2.3 Conduct review

At this stage, we preliminarily judged whether the literature was related to the questions raised in this review through the title and abstract. If one retrieved a high-quality paper, (s)/he could also refer to its abstract information to improve the keywords used for retrieval. Besides, one could also select the references of the article to read. It should be noted that papers in the field of new media are updated very quickly, so if one wants to know the latest research results, (s)/he needs to pay attention to the literature's publication date.

We started to read the abstracts of 321 documents one by one and determined whether the papers were suitable for detailed research based on this review's questions: (1) the purpose of the study must be to solve the needs of the elderly; (2) there must be a method of prototyping in the literature; and (3) the test population of the study must be the elderly in Asia. We used this as a standard to screen out the documents included in this review.

2.4 Study selection and report results

After deleting documents that did not meet the above review criteria and duplicate records, a total of 30 papers containing the above restrictions were finally determined (Table 1).

Table 1: Summary of Search Result

Electronic Database	Search Results	Relevant Papers
ACM	73	3
IEEE	44	6
Springer	106	10
Scopus	98	11
Total	321	30

We then read the content of the identified research questions, briefly explained the research purpose, test group, design method and evaluation method in the table, and answered these research questions to make a report (Table 2).

Table 2: Summary of review results

Authors	Objective	Design & development methodology	Sample size & demographics	Evaluation method & data capture
Ali et al. (2012)	Developed a digital nutrition education software package (WE Sihat) for the elderly to increase their nutrition knowledge.	User-centred design	31 Malay subjects aged 60-76 years old.	Questionnaire. Perceived ease of use and feelings of independence
Cai & Chen (2020)	Designed the rice cooker interface to promote effective interaction between the elderly and the product interface	User research (Interview, observation, persona	10 elderly people	Usability testing, interviews
Chen & Liu (2017)	Designed a microwave interface for elderly users or patients with Alzheimer's disease.	User research (Interview, observation, persona	20 participants	Usability testing, interviews
Chang et al. (2019)	Provided a reference for the design of the elderly social media mobile application interface	User-centred design	They recruited 20 older people over 55 who use smartphones.	questionnaire
Chang et al. (2018)	Designed car dashboards for older drivers to save energy and burden.	User-centred design	Recruited a group of Chinese elderly	Interview, questionnaire
Chang et al. (2015)	Designed a mobile dictionary for the elderly to help them learn English	User-centred design	(24 females and 26 males) aged between 60~70	Usability testing, focus group
Chen et al. (2018)	For promoting the successful ageing of elderly residents of Chang Gung Silver Village in Taiwan, five interactive exergames were developed to promote the well-being of the elderly.	User-centred design	39 elderly residents (15 male, 24 female; mean age 79.5 ± 17.5 years) of Chang Gung Silver Village.	Usability testing, questionnaire
Chen & Tseng (2011)	This research aimed to find out the interface design guidelines of web maps from the viewpoint of older people's acceptance.	User-centred design	Six elderly participants	Observation and Interview
Gao et al. (2015)	Designed mobile social applications for the elderly in Chinese cities to enhance their social skills and reduce loneliness.	Interviews and Designs available for elderly users in the literature.	100 senior citizens living in Beijing	Demonstrating the prototype to and Interview
Jiang et al. (2020)	Improved the ability of the elderly to use the camera function of mobile phones.	Online survey	People over 50.	User interview for target people's behaviour.

Kuo et al. (2012)	This study proposed an example of a supporting interface design system (SIDS) for the elderly. Reduced the mental workload caused by Internet shopping.	User research	A total of 12 subjects older than 50 years participated.	Behaviour observation and analysis
Lee et al. (2018)	Developed an age-friendly location-based game prototype - Life Chasing, the goal was promoting the health of the elderly.	The interface design of the game follows the Universal Design and the design-for-elderly guidelines.	Not mentioned	Usability testing, questionnaire
Lee et al. (2018)	An opportunity-matching APP for Japanese elders called GBER (Gathering Brisk Elderly in the Region) was created and deployed in a large Japanese city.	User-centred design	Six Japanese elders (3 women and 3 men) aged 62 to 73 (mean age = 67) who were residents of Kashiwa city participated in the study.	Interviews, design sessions, focus groups, usability testing, and feedback rounds.
Li et al. (2011)	Designed a remote-controlled interface of a cross-platform system, called Tech-care, for enhancing the communication and interaction.	User research (Interview, observation, persona)	6 Chinese families with elderly people.	Usability testing, questionnaire
Lin et al. (2015)	This study recruited elderly users to evaluate a mobile newspaper reading APP. Content-oriented and operations-oriented tasks were assigned to understand their performance and preferences of mobile newspaper reading.	Case study	12 elder users	Usability testing and feedback rounds.
Lin et al. (2014)	This study aimed to explore elderly users' reading behaviour with online newspaper.	User-centred design	The average age of twelve elderly users was 68.67 years old.	Usability testing and feedback rounds.
Malik & Azuddin (2013)	This paper reported on qualitative findings that have been obtained from a study about mobile phone usage by Malaysian older people.	Two types of focus groups: 1) Focus group. 2) Focus Groups with Personas.	40 participants (10 females and 30 males). Participants are between 60 and 78 years old	Qualitative evaluation. Usability and user engagement
Restyandito et al. (2019)	Encouraging elder people making use of technology can be done by designing a user-friendly interface.	Based on design principles, design, and usability	A total of 60 elderlies (17 males, 43 females) participated in this study. They were 60-85 years of age (Average = 68.08, STD = 6.24), mostly are retired (96%).	Demonstrating the prototype to and Interview
Sebastian et al. (2014)	WOBOT is simple, a non-humanoid robot that emphasizes 'fun' rather than 'functions', hoping to aid our elders in communication, leisure, and companionship.	Not mentioned	16 older adults aged 52 to 80 interacted with a facilitator through WOBOT	Demonstrating the prototype to and Interview

Siu et al. (2011)	The study was aimed at exploring whether older people might encounter difficulties or fail to participate in concept design visualization.	User-centred design	Thirty-one Hong Kong Chinese people (sixteen males and fifteen females aged between 60 and 89) from four elderly community centres voluntarily participated in this study.	Qualitative, all the collected data were analyzed using SPSS software.
Srisuphab et al. (2016)	REDLE features push notifications for fall alerts and maps for tracking and providing locations and phone numbers of nearby hospitals. It is implemented on Android.	Based on design principles, design, and usability suggestion from other studies and collaboration with a physician	Not mentioned	Usability testing
Sulaiman & Sohaimi (2010)	Designed a simple and effective mobile phone interface for the elderly to help elderly users use smartphones.	Case studies.	Divided into 3 stages, a total of 25 older people over 50 years old	Questionnaire and Interview.
Tsai & Lee (2009)	Designed smartphone icons based on the cognitive abilities of the elderly to reduce the recognition time of elderly users.	Cognition Test, user-centred design	45 volunteers ranging from the age of 55 to 73 years old participated in this study. Among them, 28 were female and 17 were males. The mean age was 67.6 years old.	User testing, usage feedback
Vasudavan et al. (2015)	This research proposed user interface requirement guidelines when designing a tour website for older people. which will enable the identification of the more senior website usability problems and cater to the appropriate measurement	User research (Interview, observation, persona)	A group of older people over 65	The qualitative data gathering techniques involved are interviews and observation
Wang (2018)	Established a hierarchy of eBook design criteria for elderly users by reviewing the relevant literature and screen requirements.	Conduct mini-group interviews to obtain the opinions of elderly users.		Develop a Fuzzy Delphi questionnaire and Analytic Hierarchy Process questionnaire for the expert and elderly user groups.
Wang (2008)	The study aimed to determine user interface design methods for older adults using mobile phones.	User survey	Sixty older people (age 65-75 years) from different cities in China solved these investigations and tests.	User testing, Interview
Yang & Huang (2015)	This paper focused on the interaction design of smartphones for the elderly, based on how to improve the experience of interacting with older smartphones.	Based on the relevant literature to define the user experience, interaction design, older smartphone concept	Three groups of Chinese elderly mobile phone users over 60	User interviews and questionnaires

Yeh (2020)	Enhanced older people's ability to use touch screens, focusing on medical application interface icons and fonts.	User-centred design	Invited 32 people aged 18–35 years, and 32 people aged over 65 years	User testing, Interview
Yen et al. (2019)	The purpose of this study was to develop a user-friendly VR balance training system for the elderly, christened VirReB system.	User-centred design	A group of elderly	Focus groups, 30 therapists joined the focus group discussion
Zhou et al. (2011)	This paper focused on augmented reality (AR) used in mobile device and analysis advantages of touch-screen devices in facilitating user experience for elderly people.	User-centred design	27 elderly people in which 6 of them were not steady with their hands had been involved in the test.	User testing, Interview

3. Results

3.1 RQ1 Which user interface designed for Asian seniors mainly addresses the needs of Asian seniors?

According to this search results, the user interface designed for the elderly in Asia mainly helps elderly users solve the following four (4) needs.

a) Independent living ability

Asian population is ageing faster than any other region globally (Ito et al., 2013). Unlike European culture, it is more common for Asian older people to live alone (Wong & Verbrugge, 2009; Neighbourhood et al., 2010). Therefore, novel technologies to help the elderly maintain independent living ability is an important research direction. Among the papers included in the review, there are four (4) literature studies to help the elderly develop separate living interfaces. With age, the memory of the elderly will decrease, which means that the elderly will increasingly rely on their limited cognitive abilities to interact with the external environment. In the past 10 years, the continuous iteration of new technologies has caused the cognitive ability of elderly users to be unable to afford the operation interface of new life tools.

In a study by Chen and Liu (2017), they designed the microwave interface for the affordability of the elderly. For example, the button indicates the start and the knob indicates the increase and decrease. In the user test, two different interfaces are provided for the elderly. The test proves that elderly users have shown remarkable ability in the use of simple interfaces. However, the more display interfaces and multi-function interfaces on the market will confuse the elderly user's complete test. Therefore, intuitive interaction and usability are essential to design methods for designing interfaces for an ageing society. In the 2020 International Conference on Human-Computer Interaction which included a rice cooker interface study designed for elderly users, focus group interviews were used to explore the application of affordability in designing product interfaces for elderly users. The research results showed that the reduced cognitive burden of elderly users should be considered when designing interfaces. The interface is designed according to the experience of the elderly to promote efficient interaction between the elderly and the user interface, thereby improving the living ability of the elderly.

In 2018, a study by Chang et al. (2018) on designing dashboards for older drivers indicated that people over 60 years of age who have a driving license in China would account for a larger proportion in the future. This research hopes to design a display screen that meets the vision and touch of the elderly, thereby enhancing the elderly's sense of independence, protecting their driving rights, and improving social traffic safety. The focus group testing found that the best design is black text and white background. Compared with young people, older people prefer simple and eye-catching colour combinations. After a simulated user test, the results showed that the dashboard's colour matching makes the elderly spend more energy, thus increasing driving risk. The best colour combination can reduce their visual burden, thereby improving driving safety.

In a 2012 study by Kuo et al. (2012) on reducing the burden of online shopping for the elderly, it was found that elderly users were confused by dazzling product advertisements and cannot quickly find shopping goals. Simultaneously, in the shopping habits of elderly users, comparing products of the same type is a crucial step in determining purchases. The research integrates the efforts to search for products, check products, and compare products into one step supporting system design. When consumers visited the website, they only needed to enter the required search conditions to obtain similar products. Elderly could compare product information or remember the prices and attributes of many products without replacing pages. This reduced the confusion of the elderly in online shopping and obtained a better shopping experience.

b) Reduce loneliness

Statistics show that Asian elderly people are most likely to feel lonely (23% of people feel lonely). The common denominator of Asian elderly society is that Asian elderly generally have higher prestige and higher courtesy in society, but this also leads to self-closure. The elderly are marginalized by society (Wan Mohd Azam et al., 2013). Increasing the social skills of the elderly is an essential means to reduce their loneliness. In this search result, there are four (4) documents to help the elderly improve social skills and reduce loneliness.

In a 2019 study by Chang et al. (2019) on social software interface design for the elderly, 20 elderly people over 55 years old were recruited. Through testing, it was found that methods such as increasing the area of interface buttons, enhancing colour contrast, and adding text descriptions could solve the problem of decline in the physical ability of elderly users and make it easier for the elderly to identify information. However, the issue of cognitive decline will cause more significant distress for the elderly. Due to cognitive decline, it is difficult for elderly users to complete tasks involving multiple steps (such as sending emails, connecting to WiFi). Therefore, research suggests that older people need more straightforward navigation.

In a 2015 study by Gao et al. (2015), a mobile social application for the elderly in Chinese cities was developed through interviews and learning available designs for elderly users in the literature. They were designed to reduce the loneliness of the elderly. The research found that when creating navigation or menus, it was necessary to simplify working memory. It was also difficult for the elderly to remember the current page position. The navigation needed to be clean and clear, reduce the level, and avoid moving and expanding the menu. The study also found that East Asian culture had brought collectivist influence to the elderly. The elderly in East Asia preferred to participate in collective social activities and gained a sense of happiness.

In a study conducted by Lee et al. (2018), an application called GBER was developed for the elderly to promote the elderly to attend parties. The APP is an opportunity matching APP. Six senior citizens aged 62 to 73 participated in the study. The GBER application redesigned a new user interface for smartphones based on user feedback. The research revealed the use of flat UI design. Through user tests, they found that older participants were attracted by colours and focused on brightly coloured texts rather than black and white elements and text when reading. Besides, there was evidence that due to cultural influence, the elderly read from right to left and top to bottom. They usually spent some time searching the upper area of the screen first, even if the task had stated that the button was at the bottom of the screen. Therefore, essential action elements could be considered in the upper area.

In a study by Sebastian et al. (2014), a simple non-human robot called WOBOT was introduced. The primary interaction function was concentrated in the screen on the top of the robot, aiming to help the elderly communicate, relax and accompany. WOBOT adopted the "body and brain" system structure, making it an open platform. New applications could be added by developing APPs on a tablet (brain), and the tablet transmitted commands to the robot platform via Bluetooth to perform the requested action. From a laboratory-based evaluation in which 16 elderly people aged 52 to 80 were involved, the results showed that the interacted with counsellors through WOBOT. The results showed that the elderly had a high degree of acceptance of WOBOT. Based on the heart rhythm, the elderly had low level of anxiety when interacting with WOBOT; also, according to eye movement records, they have a high concentration level when interacting with WOBOT.

c) Healthy living and medical information

In a study in Malaysia by Ai et al. (2012), they developed a digital nutrition education package called WE Sihat, which combined text, audio, video and graphics. According to the design guidelines for the elderly, attention was paid to physical characteristics, information organization and conceptual design to ensure that elderly users could easily read the content, increase usability and encourage interaction. The results showed that it was essential to use appropriate procedures and guidelines for the elderly because they could interact with the system, and the APP could help the elderly eat healthy food.

In addition to diet, proper exercise could also promote the health of the elderly. Hence, many games aimed at the health of the elderly have been designed. In a study by Lee et al. (2018), it was found that, due to the large individual differences among the elderly, the intensity and length of exercise required by each elderly were different. The research aimed to develop an age-appropriate location-based game prototype to promote good health of the elderly. The interface design of the game followed the design guidelines for the elderly. Besides, an experience evaluation module has been developed. Based on the elderly exercise data collected in the game, individual game exercise levels were designated for elderly users after some evaluation.

In a study by Chen et al. (2018), five interactive games were developed to promote good health of elderly people in Taiwan. The games included physical games and cognitive games. Thirty-nine elderly residents in Taiwan tested the game. The results showed that the acceptance of the game by the elderly depended not only on the fun consciousness of using the game but also on the related physical and cognitive abilities.

d) Learning and reading

The review found that learning and reading were also important ways to improve the quality of life of the elderly. Chang et al. (2015) found that most people had mobile phone English dictionaries, but there was no English learning APP interface explicitly designed for the elderly. The research developed an APP interface intended to help the elderly learn English and adopted the topology structure in the dictionary application user interface design practice. Fifty-one elderly people aged 60 to 70 participated in the test. The test results showed that the hybrid topology structure was better than the linear system, and the interaction ratio was positive. It showed that the hybrid structure was suitable for the interface layout of smartphone applications for the elderly.

A study by Lin et al. (2014) developed an online newspaper application to explore the electronic reading behaviour of the elderly. Twelve elderly people participated in the experiment of the project. They were asked to find news in the newspaper on the touch screen and perform the task of zooming in and out. The results showed that placing the instructions in a prominent position could help the elderly read the news and easily used gestures to zoom in and out the page.

3.2 Which design method and evaluation method did the researchers use in the research?

In 30 documents, 3 documents that did not mention specific design methods were removed. Another 27 documents used user-centred design (UCD) when designing user interfaces, including focus groups, questionnaires and other forms. When developing a prototype, these studies showed that involving elderly users (such as collecting opinions) could result in more accurate understanding of user needs. Older people often needed more practice to learn how to use new technologies. Therefore, it was essential to consider the needs of the elderly when designing new technologies for the elderly.

In terms of evaluation methods, most reviewed articles used qualitative research, using historical review, literature analysis, interviews, observations and other ways to obtain experimental data and analyse them. Research with prototype development mostly used usability testing, demonstration prototypes and interview methods. No prototype development was researched mainly using interviews, observations and questionnaires.

Also, interdisciplinary cooperation with professionals could improve interface design. In a research by Srisuphab et al. (2016), they developed a mobile phone application called REDEL with a fall alarm, which could push notifications and provided the location were the elderly fall, as well as the

location and phone number of the nearby hospital. This prototype was developed in collaboration with medical professionals that helps to determine the elderly fall injuries' application design.

4. Discussion

According to the results of this literature review, the primary purpose of the interface designed for the elderly in Asia is to improve the health of the elderly, enhance the self-care ability of the elderly living alone, and make it easier for the elderly to conduct social activities with family and friends and avoid self-isolation. When developing the prototype, many studies have adopted a design method centred on elderly users. In the prototype design, the text size, colour contrast, and button position changes are the most direct ways to help elderly users use the interface effectively. This method is designed for elderly users' exercise ability, vision and other physical functions.

But a simple and magnified interface does not mean sacrificing the aesthetics of the interface. The elderly also need elements of beauty. The design of the interface should consider the elderly's physical and cognitive functions and pays attention to the aesthetic issues of the elderly. In this literature review, no relevant research was found; thus, the lack of the current interface design research field.

Another challenge that elderly users face when using the interface is cognitive decline. In the past decade, many studies have focused on elderly users with cognitive decline. Cognitive functions are related to age. Cognitive ageing is an essential human experience. The degree varies from person to person. Reducing attention and reduced working memory are the main factors affecting user interfaces by the elderly. The decline in cognitive function prevents older users from completing scheduled tasks, which may cause more senior people to abandon APPs and become frustrated. In the literature reviewed in this review, the primary method to deal with the cognitive decline of the elderly is to avoid complicated menus, design clear navigation to deal with the problem of memory decline of the elderly, and set instructions or necessary operation prompts in prominent locations. Adapting to the elderly with less computer experience by reducing the colour of advertisements or illustrations can improve the attention of the elderly in the operation interface.

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5. Conclusion

This systematic literature review found that the elderly in Asia face more challenges in life. Elderly people living alone may not know how to use new life tools. In order to solve these problems, it is necessary to consider the cognitive and physical abilities of the elderly when designing the interface of life tools. Elderly people living alone need to solve their life problems. The new crown pneumonia is currently raging worldwide, and the government encourages people to reduce going out. Online shopping is a convenient way to solve home life. Still, tricky navigation is not friendly to elderly users, causing elderly users to abandon online shopping and have to go shopping. Elderly people living alone will feel lonely. Helping the elderly use social software to communicate with family and friends is the right solution. It is even possible to develop stranger social software or software for organizing activities for the elderly to promote the integration of the elderly into social movements.

Research on the home health of the elderly is extensive. Related examinations include providing healthy diets for the elderly and strengthening exercises for the elderly through games. This software can help the elderly stay healthy. The design of the interface needs to be designed with elderly users as the centre of consideration. Otherwise, it may cause the elderly fail to start the game and give up. Providing information for the elderly can keep them in line with the times. The design of the information interface or learning interface should focus on the vision problems of the elderly. The ability to change the size of text or pictures is an essential function.

Different countries in Asia have different definitions of the age group of the elderly. Some studies may also be aimed at the elderly, but did not use the keywords in this search. Therefore, relevant research documents did not appear in the search results. Besides, this search did not target domestic

literature search databases in various Asian countries; resulted in some papers being ignored. In short, it is hoped that this literature review can inspire more relevant researchers to design interfaces for elderly users to increase the happiness of the elderly in their later years.

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