Integration of Smart Elderly Care and Artificial Intelligence: Opportunities, Challenges, and Development Trends

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Abstract: As the population ages, traditional elderly care models struggle to meet the growing demand for care. Smart elderly care has emerged as a new approach to address traditional issues. Research shows that smart elderly care can improve the quality of life for the elderly but also faces challenges such as technology and application maturity, data security and privacy protection, and legal and ethical issues. This paper aims to explore the integration of smart elderly care and artificial intelligence, analyzing the opportunities, challenges, and development trends in elderly care services, with the goal of addressing traditional elderly care problems. To this end, the paper proposes solutions including technological innovation, policy and social driving forces, cross-sector collaboration, and international cooperation, and looks ahead to future research directions.

Keywords: Smart elderly care, Artificial intelligence, Population aging.

1. Introduction

As the issue of population aging becomes increasingly prominent, elderly care has gained widespread attention globally. The main difficulties in elderly care security are the rapid pace of aging and the slow rate of younger population growth, with China's elderly care challenges being particularly severe. According to data from the National Bureau of Statistics of China, by the end of 2023, the population aged 60 and above in China reached 296.97 million, accounting for 21.1% of the total population, and the population aged 65 and above reached 216.76 million, accounting for 15.4% of the total population, with this proportion still on the rise [1].

In the current context, the limitations of traditional elderly care models provide significant development opportunities for the integration of smart elderly care and artificial intelligence. These opportunities are manifested in several ways: first, traditional elderly care models face dual challenges of labor resource shortages and rising costs. Traditional elderly care services rely heavily on human resources, leading to a tight labor market and high service costs [2]. Second, in terms of service quality, due to limitations in human resources and the standardization of services, the differentiated needs of the elderly are often not fully met [3]. Third, in terms of management efficiency and safety risks, the informationization level of elderly care institutions is generally low, and management efficiency is not high, which is particularly evident in responding to emergencies and risks [4]. However, the deep integration of smart elderly care and artificial intelligence can effectively overcome these challenges. For example, the application of automation and intelligent

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technologies can significantly reduce dependence on labor and thereby lower service costs; data analysis and algorithm optimization can provide more precise elderly care services. Furthermore, the use of information technology tools will greatly improve management efficiency and effectively reduce safety risks. These advantages help address the problems of traditional elderly care models and significantly enhance the quality of life for the elderly.

Overall, the integration of smart elderly care and artificial intelligence is crucial and is a key strategy for addressing the challenges of an aging society and a significant driving force for innovation in the elderly care industry. The primary aim of this study is to explore the potential opportunities, challenges, and development trends of integrating smart elderly care with artificial intelligence in responding to the challenges of an aging society. This research is significant for a deep understanding of the extensive impact of an aging society and can provide new perspectives and methods for the reform and innovation of elderly care systems.

2. Exploration of the Integration of Smart Elderly Care and Artificial Intelligence

The development of smart elderly care and artificial intelligence shifts scientific and technological efforts from striving for societal development to serving societal development. The goal of development is consistent: to improve service efficiency, enhance service effectiveness, better allocate resources, and meet the growing demand for elderly care.

2.1. Definition of Smart Elderly Care and Artificial Intelligence

"The concept of 'smart elderly care' was first proposed by the UK Trust Fund. Its core idea is to break the time and space limitations of traditional elderly care models by integrating modern technological means to connect service entities such as the government, community, and medical institutions on an Internet of Things platform, forming a comprehensive service system to improve the quality of elderly care services" [5]. Smart elderly care utilizes information technology, intelligent technology, and medical and health technology to enhance the quality of life for the elderly. It includes aspects such as intelligent service devices, personalized health management, and convenient living services, emphasizing comprehensive, personalized services with characteristics of intelligence, informatization, personalization, and specialization [6].

Artificial intelligence is a cutting-edge science focused on researching and developing theories, methods, and technologies that simulate, extend, and enhance human intelligence. It includes key technologies such as machine learning, deep learning, natural language processing, and computer vision, enabling machines to process big data, make intelligent decisions, and provide services [7]. Artificial intelligence systems can mimic human cognition and behavior, with self-learning and optimization functions, capable of making independent decisions through data analysis and solving various complex problems.

2.2. Analysis of the Internal Relationship between Smart Elderly Care and Artificial Intelligence

The internal relationship between smart elderly care and artificial intelligence is primarily reflected in technological support and practical application scenarios. Artificial intelligence provides strong technical support for smart elderly care, promoting the realization of personalized and precise services, while smart elderly care provides specific scenarios and needs for the application of artificial intelligence technology [8]. Although there are differences in focus and application areas—smart elderly care mainly aims to improve the quality of life for the elderly, while artificial intelligence has a broader goal of simulating, extending, and expanding human intelligence and being applied in various fields—these differences enable both to play professional advantages in their respective fields, thus forming a complement.

2.3. Feasibility Analysis of the Integration of Smart Elderly Care and Artificial Intelligence

The integration of smart elderly care and artificial intelligence is an inevitable result of technological development and the evolving needs of the people under the new conditions in China. In practice, there have been achievements in integrating smart elderly care and artificial intelligence. For example, Hangzhou has pioneered the country's first digital twin elderly care facility, fully integrating technological elements and application scenarios to create a new type of smart elderly care environment that provides personalized, warm, and precise elderly care services, closely aligning with the daily life needs and habits of the elderly [9]. Similarly, Wuhan has developed a comprehensive smart elderly care service network through multiple forms and levels, integrating elderly care service resources to provide intelligent equipment for elderly people to browse videos, read books, make phone calls, etc. [10]. These specific examples indicate that methods and approaches in smart elderly care will continue to innovate, serving as models and achievements for the integration of smart elderly care and artificial intelligence.

3. Opportunities for Integration of Smart Elderly Care and Artificial Intelligence

3.1. Policy Support Provides Significant Opportunities for Integration

Policy support brings significant development opportunities for the integration of smart elderly care and artificial intelligence. The government has issued a series of policy documents to promote the development of smart elderly care, such as the "14th Five-Year Plan for National Aging Cause Development and Elderly Care Service System Construction," which clearly proposes building a complete elderly care service system and advocates for the development of intelligent products and services [11]. Correspondingly, the "Implementation Plan for Effectively Solving the Difficulties Elderly People Face in Using Intelligent Technology" aims to help the elderly better integrate into the information society [12]. In the field of artificial intelligence, the Ministry of Science and Technology, along with five other departments, jointly issued the "Guiding Opinions on Accelerating Scenario Innovation to Promote High-Level Application of Artificial Intelligence for High-Quality Economic Development," increasing support for key technology research and industrial applications to enhance China's global competitiveness [13]. These policies not only create a favorable environment for the integration of smart elderly care and artificial intelligence but also provide solid guarantees.

3.2. Rapid Advances in Modern Technology Provide Strong Technical Support for Integration

Based on current technology levels and future development trends, the integration of smart elderly care and artificial intelligence is undoubtedly feasible. Current technologies for monitoring, processing, and analyzing data, such as the Internet of Things, big data, and cloud computing, better serve smart elderly care [14]. Technologies such as machine learning and deep learning in artificial intelligence handle data better and assist in data understanding. The development of sensing devices and smart hardware for elderly people's physical signs, health status, and daily behavior, combined with big data technology, allows algorithms to predict and warn of health risks [15]. The development of complex analysis technologies in artificial intelligence enables smart elderly care systems to better serve the elderly, such as analyzing which diet and exercise methods are most effective for improving health and providing personalized recommendations for implementing these suggestions.

3.3. Industry Collaboration Provides Shared Resources for Integration

Smart elderly care involves various types of products and services including medical care, rehabilitation, home care, and community services. Collaboration among industries in smart elderly care fosters integration, stimulates industry advantages, and forms a service chain that merges elderly care services. Knowledge and resource exchanges between different types of industries in smart elderly care can integrate effective service products and quality, allowing industries to complement each other's technologies and models, shorten the time for popularizing and refining elderly care services, and more effectively solve aging problems. Such exchanges can create new development drivers for different types of industries and bring new ideas for collaborative intelligent applications, such as integrating artificial intelligence medical care with elderly services to achieve "home-based remote medical consultation" or "smart living." Industry exchanges can effectively build a collaborative ecosystem among various industries and promote platforms for industry development, thereby continuously improving the service level and scale of elderly care services [15].

4. Challenges of Integrating Smart Elderly Care and Artificial Intelligence

4.1. Issues with Technology and Application

The integration of smart elderly care with artificial intelligence faces several challenges, mainly concerning the maturity of technological development and the acceptance and adaptation of the elderly population. In terms of technological maturity, current smart elderly care devices on the market still have deficiencies in data collection and analysis, affecting the accuracy of health assessments. Meanwhile, smart home care platforms need to rely on advanced data analysis and artificial intelligence technologies to achieve real-time monitoring and prediction of elderly health status, but the application of big data processing and artificial intelligence technologies still faces technical challenges [16]. Regarding the acceptance and adaptation of the elderly, due to differences in age, health status, and educational background, the elderly generally have weaker capabilities in mastering new technologies. They may lack basic skills in operating smart devices and understanding artificial intelligence technologies, which limits their full enjoyment of the conveniences of smart elderly care [17].

4.2. Data Security and Privacy Protection Issues

The provision of smart elderly care services necessarily involves a large amount of personal privacy information. The consequences of leaks or secondary use of this information can be dire, compounded by the fact that smart elderly care services rely on artificial intelligence technologies. The widespread use of artificial intelligence increases the risk of privacy being misused or exploited [18]. For example, artificial intelligence technology can easily discern an elderly person's lifestyle habits through their health information, thereby revealing their personal life details. Moreover, when third parties require data sharing, different privacy authorizers and control strategies are needed for different scenarios. However, how artificial intelligence can achieve coarse-grained privacy control and prevent unauthorized use of one's privacy data remains an urgent problem to address [19].

4.3. Legal, Regulatory, and Ethical Issues

The integration of artificial intelligence with smart elderly care will also trigger legal and ethical issues. The current legal system continually faces contradictions due to gaps in legal frameworks caused by technological and societal advancements [7]. For instance, when technical faults or program errors occur in artificial intelligence elderly care services, determining responsibility can be

challenging, with potential liabilities falling on manufacturers, service providers, or the elderly themselves [20]. Artificial intelligence may also alter familial relationships. Excessive reliance on artificial intelligence services may reduce face-to-face communication opportunities with family members, transforming direct emotional bonds into indirect relational networks, thereby diminishing the emotional relationships within the family and causing feelings of loneliness and estrangement among the elderly [20]. Additionally, if artificial intelligence elderly care services assume most or even all caregiving responsibilities, there are concerns about whether modern technology can adequately replace the responsibilities traditionally held by humans [21]. Furthermore, if service devices become almost human-like, they may significantly restrict the elderly's social interactions, leading to emotional dependence on machines and potentially damaging their psychological well-being and normal social interactions [22].

5. Trends in the Integration of Smart Elderly Care and Artificial Intelligence

The deep integration of smart elderly care and artificial intelligence is continually promoting innovation in elderly care service models and is an indispensable part of future elderly care services. The following are key trends in the development of this integration:

5.1. Technological Innovation: High-Quality Elderly Care, Creating Smarter and More Human-Centric Services

With technological advancements, the integration of smart elderly care and artificial intelligence is becoming increasingly tight, indicating that services for the elderly will become more intelligent, convenient, and personalized, greatly enhancing their quality of life. Internet of Things and sensor technologies collect physiological data in real time through smart monitoring devices, enabling health warnings; voice recognition and natural language processing technologies make interactions between the elderly and smart devices more natural; big data analysis and machine learning help identify elderly users' personalized needs and preferences, offering customized services; smart home systems provide safety and convenience for elderly living with features like smart locks, lighting, and appliances [23].

5.2. Policy and Social Drivers: Building Strong Support and Expanding the Development Space of Smart Elderly Care

As smart elderly care and artificial intelligence become more integrated, policies and social environments are gradually being optimized to support this field's development. In terms of financial support, the government is investing heavily by setting up special funds, implementing incentive policies, and providing tax reductions to promote the research and commercialization of smart elderly care technologies, thereby reducing the burden on enterprises and facilitating widespread deployment of products [11]. In terms of regulatory and standardization efforts, the development and improvement of relevant laws and standards aim to ensure product safety and reliability, protect consumer rights through quality certification systems, and participation, governments and private enterprises can conduct experience activities to deepen consumers' understanding and trust in smart elderly care solutions.

5.3. Cross-Sector Collaboration: Multilateral Cooperation to Advance Smart Elderly Care

The implementation of smart elderly care services requires the involvement of multiple parties, including technology companies, medical institutions, research organizations, and community

organizations [16]. Technology companies can independently develop smart elderly care product technologies, improve product design for usability and personalization; medical institutions can provide consulting services and rehabilitation care directly to the elderly, teaching them how to use smart products; research institutions can engage in cutting-edge theoretical research, utilize human-machine intelligence systems for smart elderly care analysis and policy consulting, and provide multidisciplinary training; community organizations can disseminate the impact of activities within local areas and assist in promoting elderly care services.

5.4. International Cooperation: Sharing Experiences and Technologies to Address Aging Challenges

With the continued advancement of artificial intelligence technology, smart elderly care has entered a new stage of development. Under the impetus of international cooperation, countries can share experiences and cutting-edge technologies to jointly address the challenges of aging. The scope of cooperation includes multiple aspects, from technology research and development to application practices, covering areas such as smart homes and medical care, with the aim of promoting suitable smart elderly care solutions for different cultures and societies [24]. Considering the impact of cultural and social differences on elderly care services, international cooperation helps to develop universally applicable and sustainable elderly care solutions [24]. Sharing successful cases enhances understanding of elderly needs and mindsets. International conferences and seminars focus on exploring future trends and challenges, promoting resource sharing and international collaboration, thus supporting the development of smart elderly care. In summary, international cooperation plays a crucial role in promoting the integration of smart elderly care with artificial intelligence and helps address the challenges posed by aging on a global scale.

6. Conclusion and Future Outlook

The integration of smart elderly care with artificial intelligence holds significant potential for enhancing the quality of elder care services, promoting the development of the elder care industry, and addressing the challenges of an aging population. However, it also faces considerable challenges in terms of technological maturity, data security and privacy protection, legal and ethical considerations. Therefore, the state should place greater emphasis on the development of smart elderly care integrated with artificial intelligence, ensuring its advancement through technological research and development, policy support, coordinated development, and international cooperation to effectively address the issue of an aging population. Nevertheless, this study has certain limitations and deficiencies: firstly, it primarily relies on literature, lacking empirical data support; secondly, while it focuses on the opportunities, challenges, and development trends in the integration of smart elderly care with artificial intelligence, it falls short in addressing some specific aspects.

In the future, the integration of smart elderly care with artificial intelligence should pay more attention to the actual needs and emotional care of the elderly, to prevent the application of technology from becoming impersonal. Additionally, interdisciplinary research should be strengthened, integrating expertise from fields such as medicine, sociology, and psychology, to provide more comprehensive theoretical support for smart elderly care.

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