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The Dilemma and Path of Intelligent Elderly Care Services

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Abstract:

As the aging population deepens, the smart elderly care services have attracted attention due to their potential for efficiency and convenience. However, privacy security, ethical security, and personal security issues occur frequently, and the existing research has insufficient exploration of multi-dimensional security collaborative governance, resulting in research importance and gaps. This study focuses on the three major dilemmas of privacy, ethics, and personal safety in smart elderly care, using the indirect method to analyze policy texts, sort out typical security incident cases, systematically analyze the causes of problems and explore solutions. The study found that privacy security faces risks such as excessive data collection and rough storage management; Ethical security has problems such as algorithmic decision-making replacing human care and blurred guardianship boundaries; Personal safety is threatened by the equipment failure and the absence of emergency response mechanisms, and these three factors are intertwined, hindering the promotion of smart elderly care.

Keywords: Smart elderly care, Dilemma and path analysis, artificial intelligence.

1. Introduction

The current progress in smart elderly care services Inin today's society, population aging is more serious than ever. By the end of 2024, the population aged 60 and above in China was 310.31 million, accounting for 22.0% of the total population, and the population aged 65 and above was 220.23 million, accounting for 15.6% of the total population [1]. More seriously, the number of births in 2024 is only 9.54 million, with a birth rate of 0.677%, while the number of deaths is 10.93 million, with a death rate of 7.76%. The natural growth rate of the population has turned negative, indicating a decline in the number of working-age people, while the number of people who are incapacitated and need special care is increasing. It further amplifies the drawbacks of aging [1]. As a result, the burden of social elderly care is increasing, and many people are facing the double dilemma of having to raise their children and support their parents. At the same time, the shortage of human and material resources has led to many elderly people not having a good experience in their old age. However, smart devices - including smart earables, care robots and artificial intelligence - have developed rapidly in recent years, providing new ideas for solving this

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problem. The use of smart devices can largely makeup for the shortcomings of the current traditional elderly care model, such as the shortage of labor and material resources, high labor costs, and poor elderly care experience. At the same time, smart elderly care also faces certain predicaments. Most elderly people do not trust smart elderly care and are unlikely to accept smart devices in the short term. In addition, if AI tools are poorly designed, it could lead to „dehumanization" of care and services, exacerbating the isolation of the elderly in society [2]. Solving this series of problems is of great significance: for the elderly, the quality of life in old age can be significantly improved and happiness in their later years can be enhanced. or young people, the burden of retirement is greatly reduced, allowing them to devote more energy and time to work. For society, more productive capacity can be put into production more efficiently, promoting economic development, enhancing people's well-being and improving the image of society. The topic of the article is to analyze the current situation and predicaments of smart elderly care and to further explore possible solutions. The final conclusion is drawn by collecting and integrating data from authoritative academic websites and research institutions, and then comparing and analyzing them.

2. Current Progress

2.1 Analysis of the Prospects fr Smart Wearables

Smart wearable devices are a class of miniaturized electronic devices that are worn directly on the surface of the human body or implanted in the body and have real-time data collection, processing and networking capabilities. They work together with smart sensors, chips, algorithms and cloud platforms to continuously monitor the physiological, behavioral and environmental information of the elderly, and provide immediate feedback, warnings or remote services to users and their families, and have become the core entry point of „mobile health + smart elderly care". The market size of smart wearable devices is growing at a compound annual rate of 15%, driven by „Healthy China 2030" and home-community-institutional coordinated elderly care policies, and will reach 9.2 billion yuan in 2025, according to the „2022-2031 China Elderly Safety Watch Industry Panoramic Research and Investment Feasibility Report". This also indicates that smart wearable devices are deeply embedded in elderly care service scenarios and are becoming an indispensable „digital tentacle" in the smart elderly care ecosystem. From real-time monitoring of vital signs such as heart rate, blood pressure and blood oxygen to functions like fall alerts, lost location and sleep analysis, wearable terminals are upgrading the traditional „passive response" care model to „active early warning" continuous health management. Further, AI algorithms fuse and model massive physiological data in the cloud to generate personalized health portraits for each elderly person, and link information with community hospitals, family doctors, home care workers, and even children's apps to form a „cloud-edge-end" collaborative closed-loop service system. The aging population has led to a surge in the adoption of AI technology among the elderly, and the elderly are using AI devices to meet previously neglected needs, demonstrating the potential of smart devices in this field [3].

2.2 The Ue of Life Assistance Devices

In China, the problem of elderly care has become serious. At present, there are more than 200 million people over 60 years old, accounting for about 14 percent of the total population [4]. This has expanded the market demand for smart elderly care services, along with the emergence of many life-assisting devices such as big data analysis, wheelchair robots, blood oxygen meters [4]. Big data analysis requires the collection and comparison of large amounts of data through data mining, and the development of algorithms for clinical analysis and chronic disease management [5]. Wheelchair robots, by integrating lidar, vision and AI algorithms, achieve centimeter-level indoor and outdoor positioning and fully autonomous obstacle avoidance, can enter and exit elevators, pass through narrow doorways, and even cross thresholds and ramps, significantly expanding the mobility range of the elderly; Built-in fall detection and remote call system automatically notifies family members or community centers within 3 seconds of an accident, significantly reducing the risk of living alone; Voice, eye control, APP multimodal interaction enables people with upper limb disabilities to operate independently. Combined with a retractable robotic arm, it can perform daily actions such as fetching medicine, opening the door, and pouring water, delaying the process of disability while reducing a significant physical burden on families and professional caregivers, truly enhancing the dignity and quality of life of the elderly. The blood oxygen meter, through non-invasive fingertip or wrist sensors, can continuously and in real time monitor blood oxygen saturation and pulse within 5-10 seconds, helping the elderly detect hypoxemia caused by chronic obstructive pulmonary disease, heart failure, sleep apnea, etc. early and avoiding the risk of sudden „silent hypoxia". The data can be automatically uploaded to the cloud for family members and doctors to view remotely, enabling early warning and early intervention for chronic disease management; The device is lightweight, portable and one-click operable, and can be used at home, on the go or at night, significantly reducing hospitalization rates and emergency costs, and is hailed as a „life sentinel in

your pocket".

2.3 AI Conversations

AI dialogue is one of the early adoptions of smart elderly care services. It can be online 24/7, automatically handle 85% of regular inquiries in scenarios such as customer service, government affairs, and medical care, significantly saving labor costs for enterprises and generating personalized answers in real time through deep semantic understanding, significantly improving user satisfaction and retention rates. In the fields of elderly care and special education, the AI voice assistant supports multimodal interactions such as dialects, sign language, and visual assistance, providing equal information access for the elderly and disabled, while acting as a 24-hour „digital companion" for emotional comfort, cognitive behavioral therapy conversations, alleviating loneliness and reducing the risk of depression. At the same time, the knowledge update mechanism enables it to continuously evolve as the number of interactions increases, and quickly expand into scenarios with high professional barriers such as law, medicine, and finance. However, the current system still has significant concerns: First, there is a lack of genuine emotion and empathy, and the long-term replacement of interpersonal communication may exacerbate social degradation. Secondly, the illusion of large models leads to the generation of content that is „serious nonsense", giving false advice in critical areas such as healthcare and law, directly endangering user safety. Third, conversation data contains a large amount of personal health, financial, location and other sensitive information. If not encrypted or transmitted across borders, there is a risk of leakage, abuse and precise advertising push. Fourth, algorithmic bias and improper inducement may produce discriminatory, violent or illegal content, while accountability and error correction mechanisms are unclear. Therefore, in the future, more robust „guardrails" need to be established in dimensions such as model interpretability, privacy computing, ethical review, and human-machine collaborative education, so that AI conversations can truly serve human well-being.

3. Development Dilemmas

3.1 Safety Issues

3.1.1 Personal safety

Design flaws in smart elderly care products can pose a direct threat to the personal safety of the elderly. For smart wearable devices, although they are unlikely to cause direct physical harm, if they fail to detect and alert abnormal signals from the elderly person's body in a timely manner due to problems with their sensing components or algorithms, it is very likely to lead to serious consequences. For example, a manufacturer has launched a smart mattress with a health monitor that can monitor health indicators such as the heart rate and breathing of an elderly person while they sleep. However, some users reported that their father, who had a heart attack, had a heart rate that did not reach the alarm standard of the device while sleeping, resulting in the illness not being detected in time and nearly causing irreversible consequences. Moreover, if the problem really occurred, it would be difficult to determine responsibility [6]. In addition, the risks associated with life assistance devices are even more pronounced. Since most of these devices come into direct contact with the human body, a mechanical failure can easily cause serious and substantial harm to the elderly.

3.1.2 Privacy and security

While smart devices serve the elderly, large amounts of data often need to be collected for monitoring physical conditions and human-computer interaction. However, the process of collecting and processing data is difficult to supervise, and if privacy leaks occur, it is difficult for the elderly and their families to detect or identify the root cause of the data breach in time. At the same time, existing laws such as the Personal Information Protection Law of the People's Republic of China and the Action Plan for the Development of Smart Health Care Industry (2021-2025) refer to certain data protection issues, but there are no specific legal provisions on the clear boundaries of data collection [7]. This could lead to fraud or harassment of the elderly by lawbreakers, causing serious economic losses and great distress to the elderly and their families [8]. Therefore, the problem of excessive data collection by devices and privacy leaks cannot be ignored. According to statistics, 83% of the elderly are concerned about privacy leaks during use [9].

3.2 Ethical Issues

Some companion robots ------, such as ai dialogue systems and pet robots, provide emotional interaction and assistance to the elderly. When the elderly rely too much on the company of these machines, it is inevitable that they will develop a certain degree of emotional dependence on them, weakening to some extent their identity and status as family members and distancing them from their children. At the same time, the responsibility of children to support the elderly is weakened, and thus the traditional culture of filial piety is impacted and challenged [8].

3.3 Acceptance Issues

Some elderly people have difficulty accepting smart care and are more accustomed to the traditional care model, that is, the company and care of children. This is often due to the limitations of the algorithms of smart devices:

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these devices only respond to the information they receive based on the conditions learned autonomously from pre-designed programs or services, lacking the unique human „emotional intelligence“ and sincere care, and are difficult to ensure that every time they accurately perceive the changes in human emotions and provide matching services. More importantly, for the majority of elderly people, the core value of elderly care lies in the return and gratitude of their own children. Even if smart elderly care services can cover all aspects, they only meet the needs of life or physiology and cannot replace the genuine feelings of children, and the lack of such feelings leads to the elderly‘s resistance to smart devices.

3.4 The Digital Divide

Some manufacturers, when designing smart elderly care products, focus only on „smartness“ and neglect „elderly care“, without considering the difficulty and convenience of human-computer interaction. At the sametime, due to aging, most elderly people have lost or nearly lost the ability to learn and have difficulty using network devices and smart devices, which poses a significant threshold for them to learn and use some smart products. For example, a nursing home has introduced a „senior code“, which requires the elderly to scan the code with their mobile phones to access the system for operations such as ordering food or checking health status, causing great trouble for the elderly and their families.

4. A Solution to the Safety Hazard

4.1 Safety Issues

4.1.1 Personal safety

The design and testing of products need to be optimized. For smart wearables and health monitoring products, manufacturers are required to conduct multi-scenario and multi-case simulation tests. For example, for common geriatric diseases such as myocardial infarction and cerebral infarction, test the accuracy of monitoring and alarming data such as heart rate, respiration, and blood oxygen at different stages of attack (such as the precursors and attacks of myocardial infarction), and establish a more precise and pathologically accurate alarm threshold system to avoid delays in treatment due to unreasonable threshold Settings. At the same time, the after-sales system needs to be improved. Create a traceability and responsibility determination platform for smart elderly care products, requiring manufacturers to embed unique identification codes in the products and record information such as production batches, test reports, and user usage data. In the event of a safety incident, the platform can quickly trace the source to determine whether it is due to product quality defects, algorithm problems or improper use by users, clearly divide the responsibilities of manufacturers, sellers and users, and protect the rights and interests of all parties. And manufacturers are required to set up dedicated after-sales response teams for elderly care products, commit to responding to fault reports within 24 hours, provide remote guidance and troubleshooting within 1 hour upon receiving feedback of faults related to personal safety, and have local service points inspect and repair within 4 hours to solve equipment hazards in a timely manner if there are hardware problems.

4.1.2 Privacy and security

Due to reasons such as the unclear legal status of intelligent elderly care machines, the complexity and variable number of infringing subjects, the handling of infringement has become more difficult [10]. To address the privacy and security issues of smart elderly care devices, a trinity system of „regulations + technology + supervision“ needs to be constructed. At the regulatory level, accelerate the refinement of legislation to define the „positive list“ of data collection for smart elderly care, limiting the collection to only necessary information such as health monitoring (such as heart rate and sleep data) and security guarantee (such as location and anti-loss), and strictly prohibiting the expansion to unrelated privacy areas such as social interaction and consumption. At the same time, introduce detailed rules to standardize data storage periods and sharing processes. Let companies clearly know the boundaries of data collection. Technically, enforce the use of technologies such as blockchain, federated learning, etc. Blockchain is used for full-process evidence storage of data to ensure traceability of data modifications; Federated learning enables multi-party collaborative modeling without sharing the original data, taking advantage of the value of the data while protecting privacy. On the regulatory side, establish a dedicated smart elderly care data regulatory department, regularly spot-check the data management of enterprises, require enterprises to publicly disclose data flow reports, establish a fast response channel for elderly privacy leakage complaints, once violations are found, in addition to heavy fines, the involved enterprises will be blacklisted in the elderly care service industry to build a „protective wall“ for elderly privacy. To create effective intervention measures for the elderly and consider their needs in a people-oriented way, sufficient technical governance is also needed to meet the requirements of promotion, transparency and effectiveness [2].

4.2 Ethical Issues

Because an elderly person relies on artificial intelligence for a long time, it may lead to less communication with his family and thus a weakened relationship with them. Family members‘ excessive reliance on AI can also lead

to a decrease in their sense of family responsibility. To address the ethical dilemmas caused by companion robots in smart elderly care, a collaborative mechanism of „technology assistance + family empowerment + cultural guidance“ needs to be established. On the product design side, companion robots (such as dialogue systems, pet robots) should be implanted with the „family awakening“ function. When it is recognized that an elderly person interacts with the device for an unreasonable amount of time in a single day (which can be set based on geriatric psychology research, such as 3 hours), it will automatically push warm reminders to guide the elderly person to proactively contact their children and share interesting interactions with the robot. At the same time, send reminders to the children, encouraging them to respond promptly and participate in the interaction. At the family level, children should reshape their perception of „technology + affection“ in elderly care, regularly participate in robot usage training, understand the interaction between the elderly and the device, view the device as a communication „bridge“ rather than a „substitute“, and regularly carry out „device-free companionship time“ every week, such as family dinners, shared gardening, etc., to strengthen the identity of the elderly as family members and restore emotional connections. Society also needs to enhance the promotion of filial piety culture, through forms such as community ethics classes and short video science popularization, to convey to the elderly and children the connotations of emotional companionship and responsibility in traditional filial piety, and make technology a tool to assist in elderly care.

4.3 Acceptance of AI by the Elderly

To address the issue of low acceptance of AI among the elderly, efforts should be made in four dimensions: lowering the threshold, building trust, releasing concerns, and integrating into tradition. At the operational level, „Silver-haired AI classes“ are carried out. Communities regularly organize volunteers to visit and teach the elderly how to use the devices through hands-on demonstrations, such as simplifying the operation of smart speakers to steps like „press the red button and shout ‚play opera‘“ to reduce the difficulty of learning the technology. In terms of emotional construction, the companion AI incorporates the „family affection transmission“ function. Children can remotely input voice messages and old photos to the AI, and the device presents them in a timely manner during the interaction, such as a pet robot playing „Mom and Dad, I miss you today“ recorded by the children, using technology to convey real family affection and bring the elderly closer to the AI. In terms of eliminating concerns, the community, in collaboration with enterprises, launched an „AI Security Experience Week“, where data encryption storage and abnormal alarm mechanisms were demonstrated on the spot, allowing the elderly to directly see the ability of AI to protect privacy and security. In terms of traditional integration, AI services are combined with traditional elderly care scenarios, such as smart health monitoring devices linked to community TCM clinics. After AI analyzes health data, it recommends appropriate TCM physiotherapy plans, allowing the elderly to embrace technology in familiar elderly care logic and gradually increase their acceptance of AI.

4.4 The Digital Divide

To solve this problem, we need to build a series of „education, application, protection“ systems. In terms of teaching, the community collaborates with senior universities and public welfare organizations to setup regular „silver-haired digital classrooms“ that follow the learning pace of the elderly, starting from basic mobile phone on/off and Wi-Fi connection to practical functions such as video calls on social software and online medical registration, using „one-to-one assistance + scenario simulation“ teaching, such as simulating the online registration process of a hospital, Let the elderly follow the practice of volunteers. In terms of applications, companies need to simplify the operation interface and process when developing age-friendly products, such as setting up „senior mode“ for mobile apps with large fonts and one-click access to core functions (such as setting up „one-click call + voice report destination“ for taxi-hailing apps), and providing paper-based operation guides and voice tutorials for smart elderly care devices. In terms of protection, banks, e-commerce platforms, etc. strengthen risk warnings for elderly users, automatically identify abnormal operations during transactions and manually verify them, communities form „digital assistance for the elderly“ volunteer service teams, regularly visit the elderly to check devices and clean up fraud software, and help the elderly cross the digital divide and integrate into smart life in multiple dimensions.

5. Conclusion

In summary, smart elderly care is mainly reflected in three aspects: data detection, physical assistance, and spiritual comfort. There has been some development, but there is still much room for improvement and enhancement. The main problems lie in four aspects: safety (personal safety and privacy security), ethics (family relationships and social skills), acceptance of the elderly and the digital divide. To address these issues, it is essential to optimize products, improve laws, focus on needs, incorporate family affection, and take the initiative to lead. This study explores the current development, predicaments and possible solutions of smart elderly care to provide references for solving the problems of smart elderly care and

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promote the healthy development of the smart elderly care industry. At the same time, this study has problems such as insufficient data argumentation and insufficient specific cases, which have led to the discussion not being very broad and in-depth. In future studies, the sources of information and data will be further expanded to provide more specific, accurate and powerful evidence for the research.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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