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Original Paper

Analysis of Intelligent Living for Elderly in Smart Aging

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Abstract

This paper conducts an in-depth investigation into smart home systems and their developmental trajectory. It systematically dissects the constituent elements of smart homes, encompassing the perception layer, transmission layer, platform layer, and application layer. The paper analyzes the intelligent living forms and types for elderly individuals at home, including environmentally proactive monitoring and types of intelligent living such as life assistance, health and safety, and leisure and entertainment. The research explores interaction modes in smart home systems, incorporating mechanical interaction, voice interaction, and screen interaction. It underscores the significance of screen interaction as a primary control method in the intelligent living of elderly individuals at home. This paper provides profound theoretical foundations and practical guidance for the intelligent living of elderly individuals at home.

Keywords

smart home, elderly at home, intelligent living

1. Research on Smart Homes

1.1 Developmental Trajectory of Smart Homes

Smart homes, as a paradigm, leverage user living spaces as a foundation. Supported by technologies such as the Internet of Things (IoT), cloud computing, and artificial intelligence, they establish an integrated ecosystem where smart devices and information management systems organically converge. Unlike the simple aggregation of smart products, a smart home represents a highly integrated system. In the smart home framework, individual smart products and their terminals are defined as intelligent products. However, the true core of a smart home system lies in the interconnectedness and collaborative coordination among multiple intelligent products. Through interaction methods like voice commands and

gestures, users can achieve real-time control and remote monitoring of smart homes, thereby enhancing the comfort, convenience, and security of their living environment.

The development of smart homes has roughly undergone three stages. In the phase of home electronics (pre-1984), smart homes were in a nascent stage, characterized by individual appliances existing independently without forming a network. Smart products operated independently, lacking collaborative functionality. This period marked the initial exploration into smart technology. The stage of residential automation (1984-1997) witnessed the formation of rudimentary networks among a few appliances, enabling specific single functions. In 1984, the American National Association of Home Builders introduced the concept of "smart homes," laying the theoretical groundwork for smart homes. In 1997, Microsoft founder Bill Gates' smart home, equipped with a Windows NT server, became a highlight of this phase, realizing the automation control of multiple household appliances, lighting fixtures, doors, and windows. The phase of home intelligence (1997-present) represents the current stage of smart home development. Most appliances are interconnected, facilitating resource sharing, interaction, and various functionalities. With the maturity of internet technologies, smartphones, laptops, and other smart products have entered the market, providing a foundation for the evolution of smart homes. The rise of IoT has further propelled the continuous updating of products such as televisions, washing machines, microwaves, smart curtains, and intelligent door locks.

1.2 Composition of Smart Home Systems

Smart homes, stemming from IoT (Internet of Things) technology, represent an evolved and mature branch within the realm of IoT. The IoT integrates sensor technology and intelligent processing to collect information through sensors, enabling detailed analysis and processing for real-time control and management of smart products. Currently, there is no universally defined structure for the composition of smart home systems. Therefore, from the perspective of IoT systems, we can analyze the components of smart home systems from the top down, spanning the perception layer, transmission layer, platform layer, and application layer.

The perception layer, also known as the device layer, encompasses various sensors and interconnected intelligent devices. In smart homes, sensors are primarily employed for environmental perception, categorized into natural environmental perception and human-induced environmental perception. Natural environmental perception includes the acquisition of data such as temperature, humidity, light, and sound. These sensors, by perceiving information and controlling relevant devices, realize home automation, forming a system of "perception + control" with a multitude of sensors.

The transmission layer is a crucial component of the IoT responsible for data transfer, including various data transfer devices. In smart home systems, data is predominantly transmitted via the internet, hence the transmission layer is also referred to as the network layer. Information transfer and data exchange occur through both wired and wireless channels. Wired transmission encompasses ethernet and power line transmission, while wireless transmission includes technologies like Wi-Fi and Bluetooth.

The platform layer serves as the central control point enabling coordinated operation of all devices. The gateway plays a pivotal role in devices that facilitate the functionality of the platform layer in smart homes. As the core of smart home intelligence, the gateway connects the perception layer and the application layer, serving as the central device for the entire smart home system. Through the gateway, the smart home system can collect sensor data from the perception layer, upload the data to the cloud platform in a specific protocol format, and consequently achieve centralized control, remote control, and coordinated control of various smart devices.

The application layer encompasses the application systems of smart homes and the human-machine interfaces of these systems, primarily focused on providing comprehensive solutions for product application terminals and application software. Systems at this level include but are not limited to home security systems, home lighting systems, and household appliance systems. Currently, widely adopted human-machine interfaces for smart homes in the market include smartphones, smart speakers, and intelligent panels.

2. Smart Living Types for Elderly at Home

With the flourishing development of smart home technology, the lives of elderly individuals at home have entered a new era of intelligence. Smart home products in this context can be classified into two major categories: foundational products and application products. Foundational products encompass sensor devices and network equipment, facilitating information collection and transmission and serving as crucial components in constructing smart home systems. Application products are key factors determining the realization of intelligent home living functions.

2.1 Intelligent Living Assistance

Intelligent living assistance aims to provide elderly individuals with intelligent control over kitchen appliances, cleaning devices, bathrooms, and other household appliances. Through functions such as scheduled control and remote control, the elderly can lead more convenient daily lives. For instance, the use of robotic vacuum cleaners can alleviate the household burdens of the elderly. By activating the “away mode” on their smartphones while leaving home, the elderly can effortlessly operate the robotic vacuum cleaner, maintaining a clean and hygienic living environment.

2.2 Health and Safety Intelligent Living

Health and safety intelligent living is built upon smart products such as home blood pressure monitors, blood glucose meters, weight scales, sleep monitors, and others. Elderly individuals can conduct basic physiological parameter checks at home, facilitating health supervision and management and avoiding unnecessary outings. Additionally, safety protection products like smoke detectors and smart door locks establish a home safety system for the elderly. When the intelligent home environment detection system detects potential dangers indoors, immediate alerts are sent to the elderly, enhancing their residential security.

2.3 Leisure and Entertainment Intelligent Living

Leisure and entertainment intelligent living is constructed through smart audio-visual entertainment products, home robots, intelligent learning products, and more, aiming to enhance the richness and entertainment of the elderly's home life. The application of smart TVs enables elderly individuals to actively search for and choose their preferred programs, coupled with intelligent lighting products to create a suitable viewing environment. This form helps elderly individuals relax both physically and mentally, alleviating life stress and anxiety, and enhancing their overall quality of life.

3. Interaction Modes for Intelligent Living of Elderly Individuals at Home

With the rapid development of smart home technology, the interaction modes of elderly individuals at home are undergoing profound changes. This paper analyzes three main modes of interaction: mechanical interaction, voice interaction, and screen interaction, exploring their applications and characteristics in the intelligent living of elderly individuals at home.

3.1 Mechanical Interaction

In the daily lives of elderly individuals at home, mechanical interaction refers to control through physical buttons on smart devices and traditional remote controllers. Physical buttons on smart panels have become the most familiar operation method for the elderly, possessing a more traditional nature compared to touchscreen interfaces. In emergency situations, mechanical interaction retains manual buttons and rotary knobs, ensuring quick and convenient operation of smart devices when needed. However, due to limitations in muscle strength and precision of operation for the elderly, mechanical interaction primarily exists as an auxiliary control method, making it challenging to fully control the comprehensive functions of the entire smart home system.

3.2 Voice Interaction

Voice interaction plays a crucial role in smart homes and is considered a natural and effective human-machine interaction method. Currently, voice control in smart homes mainly revolves around basic functions such as product on/off, parameter adjustment, and intelligent searches. Through voice commands, the elderly can perform operations like turning on the TV, searching for channels, and adjusting the volume. However, voice interaction imposes high requirements on the quality of the elderly's speech and the surrounding environment; clear pronunciation and concise voice commands are prerequisites for its effective operation. Influenced by age-related physiological changes, such as unclear speech and regional accents, voice recognition may be impacted. Therefore, although voice interaction is a natural human-machine interface, it is more suitable as an auxiliary control method than the primary control method in the intelligent living of elderly individuals at home.

3.3 Screen Interaction

Screen interaction refers to users interacting with touch screens to perform smart home-related functions. It is mainly divided into interaction with fixed terminals and interaction with mobile terminals. Fixed terminals include indoor wall-mounted or embedded smart control panels, while mobile terminals

encompass devices like smartphones, computers, and smartwatches. The greatest advantage of mobile terminals is that they are not restricted by physical location, enabling remote control of smart homes. Smartphones have become the most commonly used human-machine interaction interface for elderly individuals at home, achieving control and monitoring functions through apps. In situations where carrying a phone is inconvenient, computers, watches, and other devices can serve as alternative means. Compared to mechanical interaction, screen interaction is more flexible, allowing the integration of all control systems into a single interactive interface. Therefore, in the environment of intelligent living for elderly individuals at home, screen interaction becomes the primary control method.

4. Terminal Analysis of Intelligent Living for Elderly Individuals at Home

According to forecasts from relevant aging research institutions, the annual demand for elderly intelligent terminals in urban areas alone exceeds 100 billion RMB. China's elderly population residing at home demonstrates a significant market demand and development potential for intelligent living terminals. The "Guidelines White Paper for Age-Friendly Smartphone Terminals" and the "Evaluation Report for Age-Friendly Smartphone Terminals," published by the China Academy of Information and Communications Technology, explicitly state that smartphones, as key carriers of smart technology and digital services, play a crucial role in serving the intelligent lives of the elderly and meeting their digital life needs. Enhancing the age-friendliness design level of smartphones is currently one of the key tasks in serving the elderly.

Therefore, this study selects smartphones as the terminal interaction devices to provide intelligent living services for elderly individuals at home through smartphone operations. Recognizing that most elderly individuals experience cognitive and physical decline with age, thorough analysis of terminal interaction design for elderly individuals at home is essential to address the adaptation issues in the design of intelligent living systems for the elderly. Additionally, considering the corresponding needs of the elderly for a safe and independent living environment, it is necessary to gain an in-depth understanding of various factors influencing the intelligent living of elderly individuals at home and conduct a comprehensive analysis of the terminal aspects of intelligent living systems for the elderly.

4.1 Optimization of Medium to Reduce Cognitive Load

The cognitive abilities and physical functions of the elderly decline, leading to cognitive burdens in complex smart home operating systems. To alleviate this burden, this study opts for smartphones as terminal interaction devices since they are among the most familiar and commonly used products in the daily lives of the elderly. By basing the selection on commonly used products by the elderly, their practical needs can be better met, reducing demands on memory and cognition, and constructing a system that aligns more closely with the intelligent living preferences of the elderly.

4.2 Integrated System, Complete Closed Loop

As an integrated system, the smartphone terminal possesses robust functionality and universality, capable of connecting and controlling all household devices to form a complete closed-loop system. In comparison to optimizing aging for a specific product, the integrated design of the smartphone terminal is more efficient and universal. Through the interactive features of the smartphone, users can conveniently manage and control all smart devices, creating a seamless, integrated system from setup to final usage, enhancing the overall user experience.

4.3 Interaction Modes, Tailored Interface Design

To meet the needs of the elderly, age-friendly design of the smartphone terminal should embrace natural interaction modes, reducing resistance towards smart products. Voice interaction, as a natural and intuitive method, aids in overcoming issues related to text input and other operations for the elderly. Diverse interaction modes, including sound and gestures, enable the elderly to interact more naturally with the system, providing a more convenient experience. Through the optimization of age-friendly interface design, making it easier for the elderly to comprehend and use intelligent products, a seamless experience of intelligent living can be achieved.

5. Conclusion

Through an in-depth exploration of smart home systems and their developmental trajectory, this paper systematically dissects the constitutive elements of intelligent homes, encompassing the perception layer, transmission layer, platform layer, and application layer. By elaborating on the three developmental stages of smart homes and their interactive processes, a comprehensive analysis of the intelligent living forms and categories of the elderly is presented, including environmentally proactive monitoring and intelligent lifestyles such as life assistance, health and safety, and leisure and entertainment. Building upon this foundation, the paper thoroughly discusses the interactive modalities of smart home systems, underscoring the significance of screen interaction as a primary control method.

This paper provides a profound theoretical framework and practical guidance for the intelligent living of the elderly. Through meticulous research on smart home systems and a reasoned analysis of terminal selection, the feasibility and prospects of applying smart home technology to the elderly population are elucidated. In the future, with the continuous advancement of technology, smart home systems will become more intelligent and personalized, offering the elderly a more comprehensive, convenient, and secure suite of intelligent living services.

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