Smart Homes Facilitate Age-Friendly Home Design

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Abstract. With the development of advanced science and technology era and the intensification of population aging, people's demand for elderly living space is increasing. In order to improve the living space environment of the elderly, this paper aims to solve a series of obstacles in the living space for the elderly, improve the convenience and security of the living space for the elderly, and create a livable environment by taking the home-based elderly care group as the research object, combining the physiological activity characteristics and psychological needs of the group, integrating the concept of barrier-free and smart home technology. Actively respond to the problem of aging, and provide solid support for the construction of a livable environment for the elderly.

Keywords: age-appropriate design; Barrier-free design; Smart home; Home care for the elderly.

1. Introduction

According to the results of China's seventh population census, the population aged 60 and above in China is 26.402 million, accounting for 18.70%, of which 1.964 million are aged 65 and above, accounting for 13.50% [1]. Therefore, the demand for age-appropriate housing is growing, and most of the current age-appropriate living Spaces have problems such as unreasonable space movement lines and lack of age-appropriate facilities, which are easy to cause elderly residents to bump, fall and other injuries, and even lead to the loss of rescue golden time in serious cases. According to the physical function and life needs of the elderly, this paper follows the principles of safety, comfort and applicability, and combines the concept of smart home to design barrier-free and age-appropriate facilities from the overall level of the interior, so as to provide a livable indoor space environment for the elderly. Such as: necessary auxiliary facilities, such as handrails, non-slip ground, etc. At the same time, the introduction of smart home systems, such as intelligent lighting, emergency call systems, etc., will further enhance the safety and convenience of living for the elderly.

2. The existing residential elderly living status

At present, there are obvious defects in the design of residential buildings to meet the needs of the elderly, especially in the spatial layout and path planning, the living habits of the elderly are not fully considered. The problem is particularly pronounced in older residential areas. Due to the limitation of design concept and technical level in early construction, there are many shortcomings in the functional space design of residential buildings. For example, the distance between the bedroom and the dining room and the living room is far, the placement of furniture is not conducive to the daily activities of the elderly, and the unreasonable layout increases the risk of falling when getting up at night. In addition, the insufficient space size, such as the small area of bedrooms and bathrooms, is extremely inconvenient for the elderly who use wheelchairs, coupled with poor lighting and ventilation conditions, affecting the comfort of living. In addition, the lack of necessary aging hardware facilities, such as bathroom lack of grab bars, kitchen and bathroom floor poor skid resistance, all pose potential safety risks.

In the face of these problems, it is particularly urgent to retrofit existing residential buildings for aging. The renovation work needs to be carried out from multiple dimensions, including the re-planning of space, the optimization and adjustment of the moving line, the addition of safety facilities

and the refinement of the detailed design, so as to comprehensively improve the living environment of the elderly and make it more convenient and safer. This can not only better meet the needs of the elderly, but also an important step to promote the construction of a healthy aging society.

Through careful space design, we can ensure that the residential space is safe and comfortable, meeting the physical and psychological needs of the elderly. This involves reasonable adjustments to existing Spaces, such as adding barrier-free access, improving furniture layout, and introducing smart home systems to enhance the convenience and safety of living. For example, you can install handrails in the bathroom, use non-slip floor materials, and set up an emergency call system. Through these measures, we aim to create a more friendly and safe living environment for the elderly, so that they can enjoy the convenience of modern technology while enjoying family life.

3. The development status of smart home

With the popularization of smart home technology and the improvement of people's quality of life, the construction of a highly integrated intelligent and digital home ecosystem integrating network communication, audio and video processing, security monitoring technology, so as to achieve a comprehensive intelligent management of the home environment, to improve residential safety, convenience and comfort of aging space residence, combined with mature communication technology and software ease of use to improve, It lowers the threshold of use and accelerates the popularization. At present, the smart home market is booming, the brand to build product system and platform ecology, such as: Millet MIoT, Ali ALink, Apple HomeKit and other open collaboration, from smart home appliances to all kinds of sensors, a comprehensive sense of the home environment, to provide personalized services. With the gradual collapse of brand ecological barriers, the emergence of unified connection protocols such as Matter and the deepening of manufacturer cooperation have promoted cross-brand device interconnection, enhanced the flexibility of user choice, and promoted the healthy development of the market.

As shown in the following figure, this paper analyzes the organic combination of age-appropriate design and age-appropriate home for existing residential buildings and integrates the age-appropriate space design of intelligent home from the aspects of space layout, facility configuration, device selection, lighting and ventilation design, furniture soft installation and ergonomics.

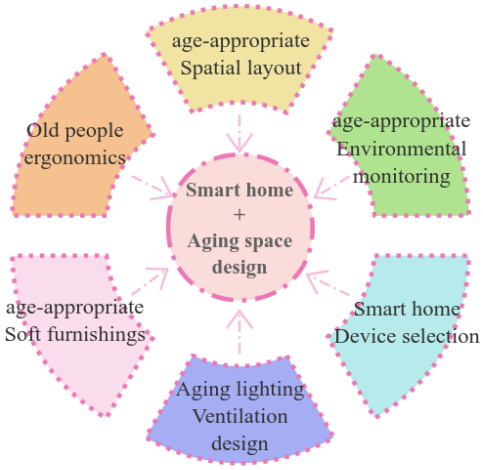


Fig. 1 Relationship between smart furniture and age-appropriate design

4. The influence of smart home on the aging design of existing residential buildings

Traditional aging design focuses on the transformation of the physical environment, such as non-slip ground, barrier-free facilities, etc., and the addition of smart homes has injected new vitality into this field. The deep integration of artificial intelligence technology with the Internet of Things has redefined the standard of elderly living environment, and also improved the quality of life and safety of elderly people. Smart home through intelligent means to achieve a comprehensive optimization of the living environment, more in line with the physical and mental needs of the elderly, reflecting the "people-oriented" core concept. Compared with the traditional design in the design concept, operation convenience, environmental comfort and resource utilization efficiency and other dimensions, smart home pays more attention to details and personalized, such as intelligent lighting system can automatically adjust the light intensity according to the living habits of the elderly, to avoid the light is too strong or too weak to cause damage to vision; The intelligent temperature control system can automatically adjust the indoor temperature according to the indoor and outdoor temperature difference and the sensitivity of the elderly to the temperature, so as to maintain a comfortable living environment. These designs not only enhance the comfort of the living environment, but also reflect the deep concern for the elderly community.

4.1. Provide a convenient home experience

Traditional age-appropriate design can improve the living environment in terms of hardware, but there are still shortcomings in terms of operation convenience. The introduction of smart home reduces the difficulty of the elderly learning mechanized equipment by simplifying the operation interface, adding voice control and remote-control functions. Smart home devices can convert some devices that need to be operated into simple voice commands according to the needs of the elderly and the home environment and can also predict the occurrence of some situations in combination with the surrounding environment and take pre-planned measures in advance [2]. For example, after setting instructions in advance, the intelligent voice assistant can recognize and execute the voice instructions of the elderly, such as turning on and off the light, adjusting the volume of the TV, etc., without the elderly to find the remote control or button, or complete the work according to the setting program without additional operations of the elderly user. In addition, family members can also remotely monitor the situation at home through mobile phone apps to provide timely help for the elderly. These intelligent means make the daily life of the elderly easier and more convenient.

4.2. Create a comfortable living environment

Smart home systems play an important role in improving the comfort of the environment. By integrating a variety of sensors, smart homes can monitor indoor environmental parameters in real time, such as: air quality, humidity, noise, etc., and automatically adopt prefabricated procedures for corresponding adjustment, such as: smart air purifier can automatically adjust the working mode according to indoor air quality, keep the air fresh; The smart curtain can automatically open and close according to the light intensity to adjust the indoor light. Intelligent control not only creates a more comfortable living environment for the elderly, but also helps to improve their quality of life.

4.3. Create a life concept of reducing cost and increasing efficiency

In terms of resource utilization, smart homes also show significant advantages. Through refined energy management, smart home system can effectively reduce energy waste, such as: intelligent lighting system can automatically adjust the brightness of lighting according to the indoor light intensity, so as to avoid excessive lighting and glare affect the living safety of the elderly; The intelligent temperature control system can ensure comfort while minimizing energy consumption and provide a living environment for the elderly. In addition, smart homes can also provide more accurate energy-saving suggestions for the elderly through data analysis, to meet the elderly's pursuit of good

habits of energy conservation while reducing the cost of living, so as to integrate the concept of sustainable development.

5. Space design strategy of smart home enabling elderly care residence

5.1. Strategy for the intelligent transformation of the access control system for aging residential buildings

In order to adapt to aging, existing houses are equipped with intelligent access control system, and multiple sensing technologies such as infrared, luminosity, temperature and humidity are selected to build a fine aging environment management and security protection system. Access control system integrated indoor intelligent intercom system, the system set dynamic monitoring, remote door opening and visual intercom in one, significantly enhance the flexibility and efficiency of family communication, in the face of sudden visitors when the elderly go out, through mobile phone binding can achieve remote operation, easy to deal with visitor reception, showing the convenient advantages of smart home. In addition, in view of the deterioration of functions and personalized living habits caused by the elderly with the increase of years, the unlocked prompt function uses intelligent technology and 24-hour outside door monitoring service combined with mobile phone applications to instantly feedback the elderly's access information to the children to strengthen the security monitoring bond between families, so that family members can keep abreast of family dynamics. Instant communication improves the intelligence and real-time of home security management.

5.2. Layout strategy of home intelligent system in entrance of aging housing

Porch, as one of the key moving nodes of the house, the security needs are first among them. Through intelligent processing strategy, the security system is deeply integrated with intelligent access control and induction light source. At the level of light source control, in view of the characteristics of slow movement and vision degradation of the elderly, the intelligent light source sensing system is finely configured in key areas such as corridors, which can accurately perceive the elderly in and out, and automatically adjust the lighting, both to optimize the comfort of the living environment and effectively avoid the security risks caused by insufficient light. And integrated with the unlocking linkage mechanism, to unlock the synchronous operation of the curtain, lighting and fresh air system, especially for the elderly who return home at night, the automatic lighting mechanism greatly simplifies the operation process, enhances the safety of living at the same time, improve the convenience of life, and achieve that the elderly can quickly get enough light under any circumstances. In addition, the entrance area needs to be connected to the internal alarm protection system, which complements the intelligent access control and light source induction, and jointly builds a comprehensive security protection network, which not only meets the basic security needs of the elderly group, but also gives them an intelligent and convenient life experience.

5.3. Intelligent induction setting strategy for aging space light source

In the aging space design, the intelligent induction setting strategy of light source is the key link to improve the living quality and safety. Its principle is similar to the light source induction of the access control system, based on infrared or microwave sensor technology, which automatically activates the light source when the elderly are detected. On this basis, the manual switch function is added to allow the elderly to turn on the steady light source according to their personal needs, which not only retains the familiarity of traditional operation, but also takes into account the convenience brought by intelligence. When the light source is activated or the elderly leave the entrance area, the intelligent induction light source is automatically extinguished, effectively avoiding energy waste. In order to further optimize the living environment of the elderly, PWM (pulse width modulation) dimming technology is used to fine-adjust the brightness and color temperature of the light. This technology can not only automatically adjust to the most suitable visual comfort for the elderly according to the ambient light, but also create a diversified light environment for the elderly through

the preset scene mode (such as reading, resting, etc.), add fun to life while accurately controlling the light output, reduce excess power consumption, and achieve the perfect integration of energy saving and environmental protection and human care.

5.4. Intelligent alarm protection policy for aging space

In the framework of aging space design, intelligent internal alarm protection system occupies a pivotal position, especially for the key link of water and electrical safety. In view of the special needs and potential risks of the elderly population, the system needs to integrate cutting-edge monitoring equipment such as smoke alarms and gas detectors and be accurately deployed in the key intersection areas of indoor moving lines to build a safety barrier. For example, the sensing technology used by Huawei Home, once found smoke accumulation, gas leakage and other security risks, the system will respond quickly, through high-decibel alarms, flashing lights and instant communication with the smart home platform, to ensure that the elderly immediately perceive and react, effectively contain potential dangers. Achieve the core concept of aging space design, that is, close combination of intelligent technology and humanistic care, greatly improve its safety performance through intelligent means, and build a guardian barrier for the elderly to feel at home.

6. Smart home enables aging home design

For the intelligent treatment of the aging residential space design, the three core elements of intelligent scene adaptation, intelligent environmental regulation and intelligent security system are deeply integrated, aiming at improving the comfort and safety of the living space in an all-round way, accurately connecting with the daily life, physical and psychological needs of the elderly, and effectively reducing their life pressure. The design focuses on the humanized intelligent living room, simplifies the operation process, and makes the space operation more efficient and convenient. According to the personalized living habits of users (the elderly) and their family members, set a variety of life scene modes such as returning home, leaving home, getting up at night, going to bed, entertainment, etc., and for the special needs of the elderly, such as: sensitivity to temperature changes, the system can automatically fine-tune to provide a more comfortable living environment; Integrated into the intelligent security system, for the elderly home safety built a solid line of defense; Integrated video surveillance, intrusion alarm, emergency call and other functions, in the event of an abnormal situation, can quickly respond and notify the relevant personnel, effectively prevent and deal with potential security risks. For the home-based elderly care group, the Internet can better realize the advantages of information exchange, storage, processing, mining and maintenance. With the perfect combination of multiple terminals, the elderly can not only provide life care, but also upgrade the layout of health management, medical care and spiritual care [3]. At the same time, the personalized design simplifies the operation process to ensure that the elderly can easily get started in the use process and enjoy the convenience brought by intelligence.

6.1. Home intelligent bedroom design

As the main place of living space for the elderly, to ensure the comfort of their rest should also be designed to store, read and activity functions. When reserving the space size, the rotation and placement of the wheelchair should be considered, and unnecessary furniture should be reduced as much as possible. The position of a single row of love seats can be reserved at the head of the bed, and the visit of relatives and care of nurses can be preset when the elderly cannot take care of themselves in the later stage of life [4]. As we age, the quality of sleep decreases. It is a good choice to integrate smart home products in the age-appropriate bedroom to improve the quality of sleep for the elderly. The smart sleep system is used to monitor the sleep quality of the elderly, and through quantitative analysis of sleep indicators (such as heart rate, respiratory rate and number of times of getting up at night), personalized sleep environment and health monitoring for the elderly can be

customized. When abnormal conditions are found, the family can be immediately notified to ensure that the safety and health of the elderly are paid timely attention.

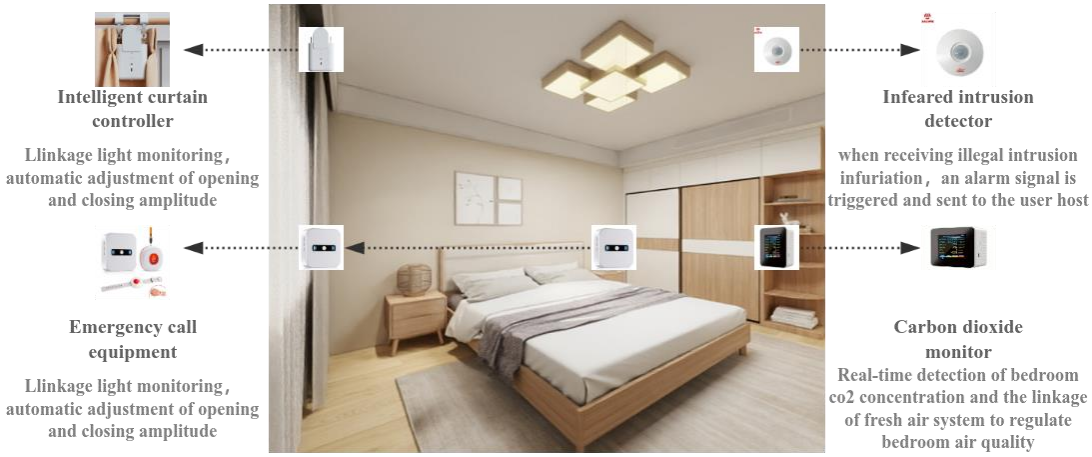


Fig. 2 Smart home enables aging bedroom design layout

6.2. Home intelligent kitchen design

As a high-frequency area for the daily activities of the elderly, the kitchen needs to deeply integrate smart home security and intelligent scenarios through intelligent processing solutions to fully meet the needs of the elderly for cooking safety, convenience, comfort and emotion. While improving cooking efficiency and experience, it also emphasizes environmental sustainability and functional humanization, which not only ensures the home safety of the elderly, but also greatly improves the convenience, comfort and emotional experience of cooking, creating a more livable and intelligent living environment for the elderly.

For kitchen safety, smart home security system through the integration of gas switch remote control, emergency button, danger detection alarm and other functions to build a full range of safety protection network. When the "safe kitchen" mode is enabled, the system can automatically close the gas valve, effectively preventing safety risks caused by forgetting to close. The gas leak detector is linked to the manipulator, which can quickly close the valve, open the window for ventilation when the leak is detected, and immediately send an alarm to the family to ensure quick response and disposal. At the same time, the "one-click help" function provides a convenient way for elderly people with physical emergencies to contact their families in an emergency, enhancing home security. The kitchen design integrates intelligent scene system and lighting optimization strategy, which automatically adjusts light intensity and color temperature according to different scenes such as meal preparation and dining, creating a comfortable and pleasant cooking and dining environment, while complying with the concept of green energy saving. The ventilation system and temperature and humidity control are also intelligently managed to ensure the air circulation in the kitchen and the temperature and humidity are appropriate to further enhance the living comfort of the elderly. According to the cooking habits and physical characteristics of the elderly, the touch operation interface is adopted to simplify the operation process and improve the convenience of use.

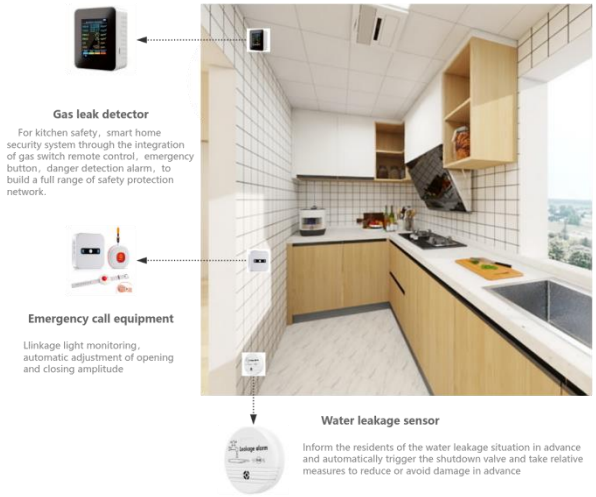


Fig. 3 Smart home enables aging kitchen design layout

6.3. Suitable for aging home integration of intelligent bathroom design

The strategy of integrating the smart home system with the aging bathroom in the existing residential buildings includes the following two categories: one is the iteration of the aging hardware facilities, and the other is to build a smart bathroom ecology with the help of smart bathroom products and intelligent lighting, emergency buttons, etc., to improve the overall comfort of the aging bathroom while improving the safety factor for the elderly.

First of all, the hardware level was upgraded iteratively, avoiding the use of bathtubs to choose shower equipment, and fundamentally reducing the risk of slip by setting up reasonable dry and wet separation areas combined with non-slip floor materials. At the same time, the shower area is equipped with waterproof and filleted bathroom benches and handrails, which not only enhances the sense of security of use, but also provides necessary support for subsequent care intervention. The installation of an emergency call button, as an important part of the security line, can quickly trigger a help signal in an emergency to ensure that the elderly can get timely assistance and treatment.

Secondly, compared with the traditional squat toilet, the introduction of smart toilet provides great convenience for the elderly with functional degradation, and its additional health monitoring and massage cleaning improve the comfort of use and health management efficiency. It is important to provide convenient and safe visual navigation for the elderly, especially at night. Combined with intelligent lighting system, according to the needs of specific scenes such as washing, bathing, getting up at night, automatic adjustment of light brightness, color temperature, anti-glare, etc., combined with mobile sensing technology to achieve energy saving and humanized light environment control. In addition, the intelligent environmental system through the integration of temperature and humidity sensing and adjustment mechanism, with fresh air and exhaust system, to maintain the indoor environment comfort and air quality, effectively prevent health problems caused by bath temperature difference or air circulation.



Fig. 4 Smart home to enable aging toilet design layout

7. Summary

With the aggravation of the aging trend of the country and the extensive penetration of intelligent technology, this paper carefully conceived a set of smart home system customized for the residential space of the elderly, aiming to optimize the aging design through the power of science and technology, and improve the living safety and quality of life of the elderly. In terms of intelligent environment detection, the system deeply considers the physiological and psychological needs of the elderly, accurately regulates indoor temperature and humidity, air quality and other environmental factors, and creates a comfortable and healthy living environment, and carries out fine design for key living areas such as bedrooms, kitchens and bathrooms. The bedroom pays attention to the creation of a sleeping environment and ensures that the elderly have high-quality rest time by intelligently adjusting the light and sound; The kitchen emphasizes easy operation and safety, smart kitchenware and non-slip design make cooking easy and enjoyable; The bathroom is equipped with emergency call and non-slip facilities to ensure the daily safety of the elderly. Not only to achieve real-time monitoring of home safety conditions, but also to respond quickly in emergency situations, effectively enhance the psychological security of the elderly, so that the home becomes the most solid haven.

In the future, we will continue to explore the unique needs of the aging society, in-depth analysis of the functional and comfort requirements of aging homes, and constantly promote the application and innovation of intelligent technology in the design of home care homes. Through interdisciplinary cooperation and technological innovation, we will improve the overall level of domestic home care homes, and create a safer, more comfortable and intelligent living environment for the elderly.

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