

Design of Intelligent Health Detection Robot for the Elderly at Home

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Abstract. By the end of 2023, China's elderly population aged 60 and above will reach 297 million, accounting for 21.1%; The elderly population aged 65 and above is 217 million, accounting for 15.4%, and has entered a moderately aging society. The elderly population base is large and the aging rate is fast, and the demand for pension services is growing rapidly. According to a survey, more than ninety percent of the elderly in China tend to care for the elderly at home, and it is imperative to develop home-based community elderly care services. The relevant research on the home health testing products for the elderly on the market has been carried out, and the following conclusions have been drawn: the function is single and cannot meet the various testing needs of the elderly; With the progress of science and technology, products continue to be intelligent and digital, but this does not match the unique cognitive level and individual behavior of the elderly, and it is easy to misoperate in the process of operation; There are fewer portrait and companion elements in the design, resulting in less interactive experience; The synchronization between the product and the hospital is low, and it does not have the function of timely feedback on the user's physical health. This design uses holistic, modular, and human factors engineering design thinking, combined with five directions: telemedicine, voice accompaniment, external environment detection, physical health detection, and personalized design. Focusing on the concrete interactive experience of the elderly, we provide home intelligent health consulting services for the elderly.

Keywords. Aging, intelligent detection, service robots, health consultants

1. Background

1.1. Trends in ageing and home-based care

Since the beginning of the 21st century, China has entered an aging society, and more than 20 years have passed so far, and China's aging is about to reach a moderately aging society. According to the current situation, China's aging has the following characteristics: the total number of elderly people is large, the aging process is fast, and the difference between urban and rural areas is large.

By the end of 2023, China's elderly population aged 60 and above will reach 297 million, accounting for 21.1%; There are 217 million elderly people aged 65 and above, accounting for 15.4%, and China has entered a moderately aging society[1]. China's

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elderly population base is large and the aging rate is fast, and the demand for pension services is growing rapidly. On the other hand, according to a survey, more than ninety percent of the elderly in China tend to care for the elderly at home, and it is imperative to develop home-based community care services.

1.2. The demand for intelligent products for home care for the elderly

From the demand side, in the face of the continuous growth of the elderly population, the purchasing power of the elderly and the demand for elderly consumption are growing. Since it is difficult for most elderly people to accept complex intelligent products, the demand for simple and easy-to-operate intelligent elderly care equipment will gradually expand in the future[2].

From the perspective of the supply side, although China's intelligent pension products are rich in variety, there is a serious polarization phenomenon. The market entry threshold for low-end products is low, and there are many products that are similar to each other; The technical requirements for high-end products are relatively high, but in the entire market, there are very few companies that produce high-end smart products. On the whole, in the future, China's intelligent pension equipment products will develop in the direction of simplicity and high-end.

1.3. Technological innovation and development

The research technology of home detectors for the elderly has developed rapidly:

- **Intelligent monitoring and early warning system:** Modern home health detectors have intelligent monitoring and early warning systems, which can monitor the user's physiological data in real time through built-in sensors, such as heart rate, blood pressure, blood sugar level, etc. Once abnormal data is detected, the system can send an alarm in time to alert users or medical staff to help the elderly avoid potential health risks[3].
- **Integration of telemedicine services:** Some home health testing instruments are combined with the telemedicine services of medical institutions, so that the elderly can directly communicate, consult and remote diagnose and treat doctors or nurses through the equipment, which greatly improves the medical security and convenience of the elderly.
- **Personalized recommendations for big data analysis:** The home health testing device generates personalized health reports and recommendations through data recording and analysis. Targeted health programmes for older people. Through big data technology, devices can more accurately predict health risks and help the elderly take more effective preventive measures.
- **Intelligent health management application:** The supporting smart phone applet can enable the elderly to easily view health data, set health goals, record diet and exercise and other information, so as to better manage their health status. This convenient app interface enhances the user experience.
- **Comfort and fashion design:** With the development of science and technology, the design of household health detection instruments pays more and more attention to comfort and fashion, which is more in line with the aesthetic

needs and wearing habits of the elderly, so that the elderly are more willing to wear and use these devices for a long time[4].

- Multi-functional integrated equipment: Some of the latest home health testing instruments integrate a number of functions, such as monitoring heart rate, sleep, exercise, blood pressure, blood oxygen saturation, etc., to achieve a multi-functional intelligent management of the equipment and simplify the health monitoring process of the elderly.

The emergence of these emerging technologies not only improves the functionality and convenience of home health detectors for the elderly, but also brings more possibilities for the health management of the elderly, and promotes the realization of the goal of healthy and long life for the elderly. In the future, with the continuous progress and innovation of technology, home health testing instruments will continue to develop to provide better health management services for the elderly.

2. Design methods and related theories

2.1. Holistic design theory

The theory of holistic design thinking is used, so that this product can solve different problems in different environments. The purpose of holistic design is to emphasize that the parts are seen as a whole that can be related to each other. This methodology doesn't just look at the effects of individual elements, but rather integrates the parts into each other to form an intelligent ecosystem. This holistic design includes the design objectives, functions, materials, forms, environments, etc., from a holistic point of view, the overall consideration of various factors and interrelationships, in order to achieve the optimization of the design effect[5].

As an indispensable key factor for home care, the home health detector for the elderly is combined with hospitals and families as a whole to bring continuous and long-term companionship to the elderly group.

2.2. Modular design theory

The modular design theory originated in the 50s of the last century and is an advanced design method widely used in the production of products in developed countries. This theory originates from the expansion of the contradiction between supply and demand of products in the European and American markets, and the core concept is to systematically decompose the product into several levels of subsystem functional modules, which are generally divided into four categories according to functional differences: basic modules, auxiliary modules, special modules and adaptive modules.

2.3. Human Factors Engineering Design Theory

Human factors engineering design theory is a discipline that focuses on improving the efficiency and safety of human-computer interaction. It is based on an in-depth understanding of the physiological and psychological characteristics of the human body, as well as consideration of machine and environmental conditions, with the aim of designing products and systems that are both ergonomic and functional[6]. The core

philosophy includes "people-centric", that is, all designs should be centered on the needs of the user, ensuring that the product or system is not only functional, but also easy to operate, comfortable and safe. The design also needs to follow the principle of adjustability to adapt to the body size and operating habits of different users

3. Research on the design elements of household intelligent health detection robot for the elderly

3.1. Functional elements

According to the daily health testing needs of the elderly at home, the main functions include the following five points:

- Set up 3 drawers that can be popped up and opened to store commonly used drugs, reading glasses, and health testing equipment for the elderly, so as to facilitate the health testing of the elderly.
- Equipped with an auxiliary handle that automatically lifts, when the elderly need to get up or need support, the handle automatically rises to provide a stable support point to help the elderly stand or move safely.
- Equipped with a millimeter-wave radar sensor, with the help of advanced artificial intelligence, biometric signals and sleep breathing are detected every 15 seconds, providing detailed health analysis without compromising safety, thanks to 60GHz millimeter-wave radar waves that reflect off the skin without penetrating the tissue[7].
- It has a voice interaction function, can have a dialogue with the elderly, provide anti-fraud education, and automatically intervene when the elderly answer suspected fraud calls, help identify and prevent fraud, and protect the property safety of the elderly.
- Equipped with a charging station, it can be automatically charged when idle to ensure continuous operation and provide worry-free health testing and companionship services for the elderly[8].

3.2. Form factors

Home health detectors for the elderly should be easy to operate. Most of the elderly have a declining learning ability, low acceptance of scientific and technological products, and high learning costs. Therefore, the design function should be simple and intuitive, and the voice-based intelligent operation should be more versatile[9]. On the other hand, considering the user's long-term use, the holding part, the button part, and the display part should be more comfortable to reduce the fatigue caused by long-term use.

3.3. Color elements

The color of the home health detector for the elderly needs to focus on mildness and comfort. Older people tend to prefer mild, pastel colors that can bring a sense of

comfort and serenity. Colors such as pale blue, off-white and light gray provide a sense of calm and relaxation, making them ideal for the overall tone of a health monitor. At the same time, the color can not be single, and different colors are used to identify the measurement area, display area and operation button, etc., to help the elderly understand and operate the equipment[10].

3.4. Material elements

The materials used in the home health tester for the elderly are durable. Ensure that the product can maintain stable performance during use. At the same time, choose materials with certain aesthetics to improve the overall texture of the product and increase the pleasure of use. Users may be exposed to the detector for long periods of time during use, so it is crucial to choose a biocompatible material that is harmless to humans and non-irritating to the skin.

4. Design practice of home intelligent health detection robot for the elderly

4.1. Sketching

According to the existing products on the market, the thinking is divergent from the aspects of structure, modeling, proportion, etc., and the design scheme is explored.

Scheme 1, due to the monotonous appearance, does not have affinity; The design scheme has a single function and does not have room for functional expansion; The elderly are troublesome about the operation of the product and do not have promotion value, as shown in Figure 1.

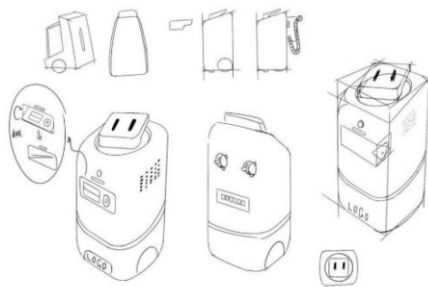


Figure 1. Scheme 1.

Scheme 2, due to the large volume, the design space is wasted; Modular design conditions are not available; The product does not meet the ergonomic requirements, and the user is inconvenient to operate the product, and does not have practical value, as shown in Figure 2.

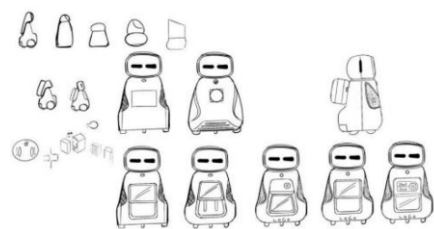


Figure 2. Scheme 2.

Scheme 3, from the perspective of ergonomics and other disciplines, learn the design scheme of other artificial intelligence robots on the market, and express the design of the home health detector product for the elderly, with complete functions, selected as the final scheme, as shown in Figure 3.

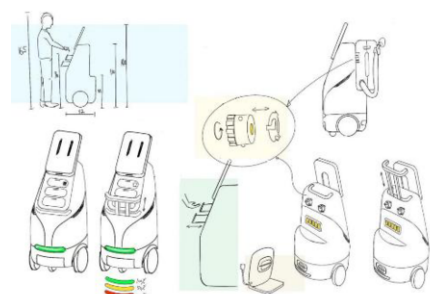


Figure 3. Scheme 3.

Sketch of accessory functional accessories, preliminary version of home health detector for the elderly, and also equipped with an oxygen breathing system backpack that can be loaded and unloaded, as shown in Figure 4 and Figure 5.

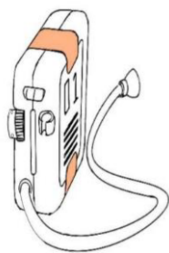


Figure 4. Oxygen breathing backpack.

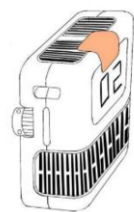
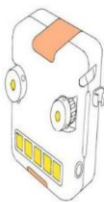


Figure 5. Air purifying backpacks.

4.2. Dimensional design

Studies have shown that the elderly aged 60 and above with a height of 1500-1800 mm can have a suitable range of 1000-1300 mm for standing operation, which can obtain a better field of vision and ensure the comfort of operation. The normal and more recognized on the market provides standing armrests, and the suitable height is about 73~85 cm.

The height of the home intelligent health detection robot for the elderly, according to the average height of the elderly and the actual use scenario of the product, considering the support height required by the elderly, the design height is 1200mm, and the height of the handrail is 800mm. The following is the three views of the model, unit: mm.

4.3. Modeling renderings

The home intelligent health detection robot for the elderly, the shell is made of PPO material, with a variety of functions such as intelligent health detection, voice interaction, automatic auxiliary handle and classified storage drawer, providing intelligent solutions for the health and companionship of the elderly at home. This is shown in Figure 6.



Figure 6. Product model diagram.

4.4. Usage scenarios e

As shown in Figure 7, the elderly home intelligent health detection robot standby effect picture in the living room, always detect the air quality in the living room, and the air purifier backpack runs to purify the air[11].



Figure 7. Robot standby scenario.

As shown in Figure 8, the robot remotely detects the movement of breathing and carotid arteries during sleep through the millimeter-wave radar sensor, compares the data with the hospital's polysomnography database, and immediately calls the 120 emergency ambulance number if there is an abnormality, so as to protect the health of the elderly 24 hours a day[12].

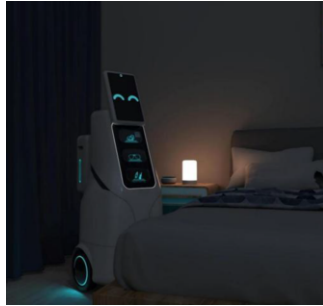


Figure 8. Robot sleep monitoring scenario.

As shown in Figure 9, the elderly are provided with an auxiliary night function, guide the elderly to the bathroom, eliminate the danger of the elderly tripping because of dim lights, and provide handrail support at the same time, so as to facilitate the elderly to support themselves.



Figure 9. Robot sleep monitoring scenario.

5. Conclusion

In this study, we designed a home intelligent health detection robot for the elderly, and deeply discussed how to care for the health and life of the elderly in an all-round way through intelligent technology. Through the study of the daily habits and physical conditions of the elderly, this design integrates diversified functions such as intelligent health detection, voice interaction, automatic auxiliary handles and classified storage drawers, and provides a health detection equipment that is both practical and humanistic for the elderly.

In today's society, the elderly have an increasing demand for health and life, and traditional health testing equipment often cannot meet their needs. It is hoped that the development of science and technology can maintain the health and safety of the

elderly, provide convenient life services, and allow the elderly to enjoy the convenience brought by science and technology, while also feeling the warmth of science and technology.

In the future, it is hoped that this home intelligent health detection robot for the elderly can be more widely promoted and applied, providing a full range of health care and life convenience for the elderly. At the same time, it is also expected that more researchers can pay attention to the needs of the elderly, combine science and technology with humanities, achieve more functions, and bring benefits to the health and life of the elderly.

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