



Research on Modular Design of Wearable Device for Elderly Pet Dogs

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Abstract. In recent years, with the rapid development of artificial intelligence technology, wearable devices have gradually entered the operation stage. [1] The design focus of wearable devices has shifted from technological breakthroughs to personalization and customization in use and experience. Based on the analysis of the development status of wearable devices, this paper puts forward the modular design method of wearable devices. In this paper, React front-end interaction technology is adopted, and MVC development mode in ASP.NET [2] is adopted at the back end. Infrared spectrum sensor module hc-sr501 is used to realize information transmission, realizing a friendly graphical interactive interface. Caretakers (pet owners and linked accounts) are better connected and act as a bridge between the two.

Keywords: modular design · elderly pet dogs · wearable devices

1 Introduction

In recent years, in first- and second-tier cities in China, pet dogs are moving away from the function of housekeeping and nursing homes, and are evolving to pure emotional sustenance. The pet dog market has great potential for development, and more and more consumers are willing to pay for pets: The global market size of wearable medical devices was \$5.31 billion in 2016 and will reach \$12.14 billion in 2021, with a CAGR of 18.0% from 2016 to 2021. The growth of the market is mainly driven by technological advances in medical devices, more and more smart healthcare applications compatible with wearable devices, and more and more medical service providers' preference for wireless connectivity. Among them, the raising of pet dogs has become a new highlight of modern residents' consumption. However, a pet dog's life span is only ten years, and it slowly begins to grow old after the age of seven, thus driving the strong development of smart wearable devices in the pet dog aging industry.

China's development has entered an intelligent and digital society, and wearable products are quietly emerging. The global market for electronic pet devices was estimated to be worth about \$1 billion at the end of 2016, according to market research firm Transparency. China's market share is set to exceed 20 percent by 2024, when Transparency Market Research predicts the global market will be worth at least \$2.5 billion. The wearable device can collect physiological signals of aging pet dogs in real time,

and transfer the data to the database for calculation, so as to scientifically provide corresponding intervention and guidance for aging pet dogs' health problems. As a result of the rapid development of social living environment, economy, science and technology and cultural atmosphere, the "new elderly dog" as a social new elderly pet dog group comes into being. For the new elderly pet owners, they will be more active to accept and use intelligent products. However, the current wearable devices on the market can not meet the actual demand for wearable products for new elderly pet dogs. Based on this, this paper proposes an empathy design process for a new wearable product for elderly pets by adopting the empathy design method. To help designers build a bridge of communication with new-aged pet dogs, so that designers can fully explore the practical needs of new-aged pet dogs, and provide ideas for the design of wearable products for new-aged pet dogs.

2 Research Status of Wearable Products for New Elderly Pet Dogs

2.1 Definition and Characteristics of New Elderly Pet Dogs

The life expectancy of pet dogs is generally between 12–15 years old, and the highest longevity record is 34 years old. 2–5 years old is the prime period of the dog, the phenomenon of aging begins to appear after the age of 7, and the reproductive capacity stops around the age of 10. Purebred pet dogs live longer, small pet dogs live longer than large pet dogs, male pet dogs live longer than female pet dogs, indoor pet dogs live longer than outdoor pet dogs, and even black pet dogs live longer than other colored pet dogs. Raised in the highest proportion of long-lived pet dogs. With the development of intelligent society, the group of "new senior dogs" is being paid more and more attention by more and more people. This new senior dog has rich life experience, a relatively high level of education, a relatively strong ability to accept new things, and a good physical fitness, but there will be health problems due to age. The research objects in this paper are defined as half-senior dogs and "new elderly dogs" who are 7 years old and above and have experience in using smart products. Due to the differences in behavioral characteristics caused by physiological characteristics and psychological characteristics, the behavioral characteristics of new aged dogs and those of past aged dogs are also very different. Behavioral characteristics can be analyzed from the perspectives of physiological changes and psychological changes. [3] (See Table 1).

2.2 Development of Wearable Products for Elderly Dogs

The product is a miniature electronic device that can be worn on the body and go out to carry out activities. It is composed of lightweight devices and small mechanical and electronic parts such as watches. It is similar to a head-mounted display, making the computer more portable. Useful for applications that require more complex computing support. [4] From the perspective of the industry chain, the technical highlights of wearable products have three aspects: convenience, immediacy, intelligent interaction and continuous contact. In terms of related technologies, it can meet the functional requirements of the aged pet dog.

Table 1. Comparison of characteristics of general aged pet dogs and new aged pet dogs

General senior pet		New senior pet dog	
Physiological characteristics	Basic features	Physiological characteristics	Basic features
Vision loss	Vision will begin to deteriorate and the eyes will start to become cloudy	Vision loss	Decreased vision, but still has the ability to discern
Hearing loss	Dog is unresponsive, as if not hearing	Hearing loss	Hearing loss, but still discernment
Mental disorder	Barking and panting with clear sign of distress	Mentally weakened	Accept technology products and actively participate in health and wellness activities
Deterioration of motor function	Slow movement and show response	High physical fitness	Accessibility for daily movement

(Source: author's own drawing).

As far as the existing senior dog wearable products on the market are concerned, the smart wearable devices for senior pet dog users are basically designed and implemented according to traditional problems and needs. The objects of use are mostly concentrated in the middle-aged and elderly groups, such as the need for health monitoring of heart rate, inconvenience of movement, etc., ignoring the differences between the new and traditional elderly groups, and cannot meet the needs of new-aged dogs. Although the combination of wearable devices and mobile medical care can greatly help senior dogs improve their aging lives. However, in terms of design, it is limited to focus on the general elderly group among the elderly dogs, and ignores the fact that the new elderly group cannot meet the actual needs of wearable products of the new elderly, which directly affects and hinders the development of the field industry. At present, pets are still marginal users of smart wearable products, and there is still a lot of room for development of smart wearable devices for new senior dogs.

2.3 Demand Analysis of Wearable Products

2.3.1 Functional Requirements

- (1) Medical and health needs. Newly aged dogs have a higher level of physical fitness and are more energetic. However, to a certain extent, its physiological functions are still weakened and degenerated. With the development of science and technology and the improvement of medical level, new senior dogs can follow instructions to participate in exercise activities to improve their physical fitness, which is a great improvement compared to traditional senior dogs. Through the use of wearable devices, it is hoped that the related work can be completed more efficiently and conveniently by using technological means.

- (2) Playful contact needs. Newly aged dogs still have a lively and positive attitude, showing a positive and willingness to accept new things for their own learning and adaptability to everything in the surrounding environment. More and more “newly aged” groups will actively accept technological products.

2.3.2 Aesthetic Needs

The owners of new senior dogs are generally highly educated, have unique preferences for aesthetic taste, are willing to pursue fashion elements and like young and interesting things, and give more care to pet dogs.

2.3.3 Spiritual Needs

In addition to meeting the basic needs of senior dogs, it also pays more attention to the spiritual needs of senior dogs. Provide more humane and professional services for senior dogs. In particular, elderly dogs who cannot take care of themselves and semi-self-care, they need more love from their owners and are more eager for affectionate care. People should help senior dogs rebuild their self-confidence and meet their psychological needs.

2.3.4 Market Demand

At present, the wearable device market is still dominated by consumer attribute products, while the market share of medical attribute wearable products is low and the market competition pattern is relatively loose. However, third-party data show that the market size of wearable medical devices in China has grown from 1.2 billion YUAN in 2015 to 7.1 billion yuan in 2018, is expected to exceed 12.2 billion yuan in 2020, and will exceed 20 billion yuan in 2023. This also shows that the future of the wearable medical device industry is broad.

3 Modular Design

3.1 Construction of New Path of Product Model

Nowadays, the functions of pet smart wear are mainly prevention of loss, checking the amount of exercise pets do, and health detection (measuring heart rate and breathing rate). Facing various problems such as homogeneity and safety, what are the breaking points of pet smart products?

3.1.1 Category Innovation

Compared with the domestic market of highly homogenous pet intelligent products, most overseas pet intelligent equipment enterprises have concentrated and single products, which is conducive to the construction and promotion of brand concept and has reference significance for domestic enterprises.

Spending on pet monitoring devices is expected to reach \$2 billion by 2023. For example, FitBark, a pet dog movement data monitoring device, records the daily movement data of pets and generates pet health index through analysis, which has a certain popularity overseas.

There are wearable devices for pets that monitor their movements around the clock, allowing owners to know whether their pets are doing enough to prevent their dogs from being unhappy. And the smart anti-loss tracking wearable device for pets, which integrates the functions of LED lighting at night, temperature sensing, activity tracking and location positioning. The category innovation can pay attention to details in pet eating, drinking, playing, health and other fields and constantly optimize.

3.1.2 Enhance the Practicality and Experience of Smart Pet Products

To achieve remote command visualization, real-time on-site monitoring, automatic data collection, dynamic information display, integrated system application support system business development, production safety and fine management. In addition to real-time extraction of products, equipment, production, environment and business data, dynamic monitoring can timely issue alarms and early warnings, precise positioning of alarms and early warnings, convenient management, timely handling of operational problems, and improve the company's efficiency, efficiency and effectiveness.

3.2 Modular Design Introduces Product Design

In today's world, with the rapid development of economy and technology, more and more people are truly enjoying the convenience brought by high-tech products, especially in smart wearable devices. The unified mass production of a single product can no longer meet the market demand, and personalized and customized product experience is more popular, making product diversification and great segmentation an important competitiveness. However, these functions are not used by elderly pet dogs, especially now that many pet owners have a lot of work pressure and have no time to take care of their pets, resulting in more or less, more or less, more or less mental emptiness. The function in this article is developed for the care service between the new and elderly pet dogs and the owner. The health information module in it can send the physical condition of the elderly pet dog to the owner in real time, and realize online care for the elderly pet dog all the time.

Introduce the idea of modular design into the product design process, fully tap the similarities of functions and structures in the product design and work process, and divide multi-functional and relatively complex products into different functions and relatively simple sub-products or modules, so that Enable efficient utilization and personalization.

For the modular design of wearable devices, how to evaluate effectively and quickly, continuously promote the improvement and development of the modular design of wearable devices, and provide reference and reflection for the innovative development of modular products are the main research issues of this paper. In the research on the evaluation of the modular design of the wearable device, through the analysis method of the characteristics and comprehensive evaluation of the modular wearable device, a set of wearable wearable device combining the idea of graphical interface design and the

mathematical theory of the combined analysis method is integrated. Equipment modular design. Through the research on the setting of the autonomous target module, the results of each set index are obtained, and the actual data of each set index in the modular design of the wearable device is obtained through accurate analytic hierarchy process calculation. Improvements and further innovations in wearables provide a reliable and accurate reference.

3.3 Design Ideas and Testing

This project is based on the premise of the interaction between the owner and the new elderly pet dog, and produces a function to promote communication. In order to make the elderly pet no longer feel lonely, the main ideas are as follows:

- (1) Collect relevant information on the life of elderly pets Needs, daily hobbies and health problems are classified and summarized to obtain the daily information needed by elderly pets;
- (2) Modular design, classify functions, and design a graphical interface; [5]
- (3) Using the combined analysis method, design the corresponding mathematical model, obtain the relevant interface, and obtain the association;
- (4) Debug the project and change the problems in the code design; [6]
- (5) Actual test and application.

The system uses React for front-end interaction, Andt is used for the style, and the MVC development model under .NET is used for the back-end. After one setup, after entering the information, senior pets can be easily brought into the system. The functional design of the product is shown in Fig. 1.

Health guard module: record the time every time the pet uses the system and synchronize it to the server. In addition, other smart devices in the house, such as cameras or other devices, also synchronize the time when they detect activity. If there is no activity for a long time or an abnormality is found through the algorithm, the pet owner and related management personnel will be notified, and the management personnel can timely verify the specific situation of the pet dog and remove the abnormal state in time.

The following is a simple activity detection designed using Raspberry Pi, infrared spectrum sensing module HC-SR501, as shown in Fig. 2:

Part of the code looks like this:

```
continue
time.sleep(60)
print("No activity detected")
def targetDiscovery(lastActiveTime):
print ("Detection Succeeded time is" + lastActiveTime)
print ("Try data update")
url = url + "/" + lastActiveTime
requests = requests.get(url)
if(requests == "1")
print ("Data up dated successfully")
```

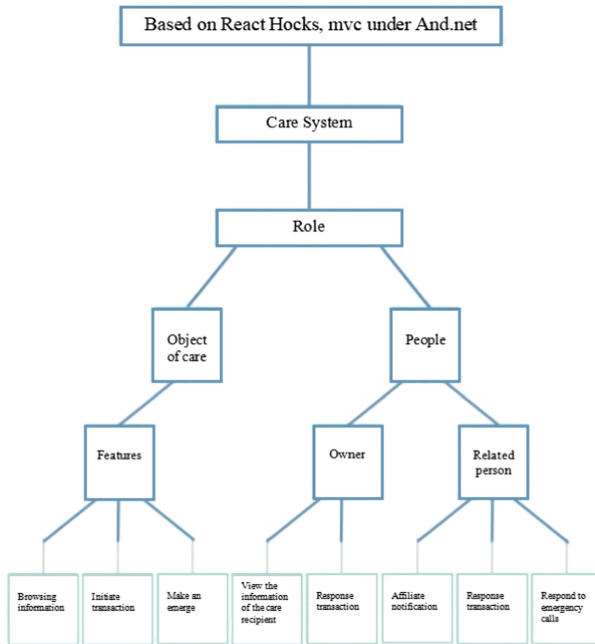


Fig. 1. System design

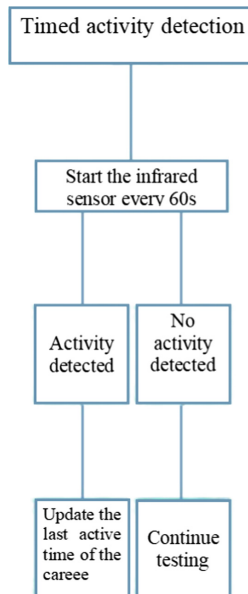


Fig. 2. Activity detection implementation principle

```
else
print (“Data up dated failed”)
```

3.4 Basic Theoretical Support

- (1) React.js (React) is a JavaScript library specially designed by Facebook to build user interfaces. Facebook open sourced React, and using React makes it easier to create interactive UIs and update components more efficiently. Currently, React is the oldest solution. UI engine has become a complete solution for web functions acting on the front and back ends. [7]
- (2) NET was born in 2002. It is a free and open source development platform for building a variety of applications. It can be used to develop Web applications and Web APIs. It has the characteristics of cross-platform, cross-language and security. The platforms that .NET can support are Unix, Linux, Windows, etc. [8] In addition, .NET includes the WebForm framework, which can encapsulate the user’s request and response as a control, and can use its shortcut method to quickly store the form data in the model object.

Raspberry Pi (Chinese name “Raspberry Pi”, abbreviated as Rpi) is an ARM-based microcomputer motherboard that can be connected to external sensor devices, so RaspberryPi has the ability to communicate with the outside world. It is a single-chip computer based on Linux, with SD card as storage hard disk, using Linux system, it can provide basic network reading, character editing and network learning needs. [9].

4 Conclusion

With the development of modern technology and the acceleration of people’s life rhythm, the safety hazards and physical conditions of elderly pet dogs need to be paid enough attention by pet owners and society. The purpose of this system is to care for the safety of elderly pet dogs. By providing feedback information to detect the activities of elderly pet dogs and establishing a user portrait data model, it can objectively and accurately determine the health information of elderly pet dogs, and can feed back the data to the pet owner., associated with the client, pet dogs can also easily use the system to collect data and initiate requests. These functions can facilitate the connection between senior pet dogs (caregivers) and caregivers (pet owners and linked accounts) and become a bridge between the two.

To sum up, the design process proposed in this scheme mainly focuses on the effective refinement of the key parts of the operation, so that the product design can achieve the functions of health, leisure and entertainment, and has the characteristics of simple structure and convenient use, in order to solve the problems efficiently. The design of the pet dog owner problem, the design with various functions has great practicability and development potential.

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