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Research on the Bionic Product Design of Smart Home Robots for the Urban Youth

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ABSTRACT

With the rapid development of science and technology, smart home robots have entered our lives. By analyzing the related concepts of smart home robots and bionic design, and studying the characteristics of the youth group, this paper puts forward the bionic design of smart home robots for the youth, and finally puts this design idea into practice from the aspects of product effect, product size and APP design etc. In this way, it is expected to provide ideas and methods for the design of smart home robots.

Keywords: Youth, intelligence, robot, bionics, product design.

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ANALYSIS OF RELATED CONCEPTS

Smart Home Robot

Smart home robot is one kind of smart mobile robot, a new generation of robots in response to the development of science and technology. Smart home robot boasts strong ability to self-regulate and adapt to the home environment. Because the robot is equipped with various sensor devices, it can perform the functions of information learning and interaction. (Jin, 2017) Smart home robot is a personal assistant in the smart home, applying artificial intelligence and language interactive processing ability. It can analyze the owner's needs so as to provide the necessary help with no intervention of the owner.

Smart home robot is a combination of the Internet of Things and artificial intelligence, whose functions cover all aspects of home automation, maintenance and control. With them, the users can create smart home according to their wishes. The technological breakthrough in the field of smart home is to strengthen the connection between owners and houses through robotics and the Internet of Things. By understanding the needs of owners and providing customized services, smart homes will achieve a higher level of personalized experience.

Development Status at Home and Abroad

As the country with the most advanced intelligent robot technology, the United States boasts the robots with strong adaptability, stable performance, complex functions, and high accuracy. Meanwhile, such technology has been widely used in industries such as aerospace and automobile industry. Thus, technologies, like sensory bionic and artificial intelligence, have achieved continuous growth in the United States. In Japan, robotics technology has got rapid development with the assistance from various supporting policies, and a series of robotic equipment used in medical, technology and other fields has been developed. Compared with other countries, European countries studied the development and application of intelligent robots even much earlier. Although China is a late starter in intelligent robot technology, it has received strong government support and attracted enterprises to participate in actively in recent years, which has made the robot industry advance considerably. Moreover, intelligent robots have been regarded as the carrier of changes and innovations in the entire manufacturing industry.

Modern intelligent robots are not only widely used in national defense, service, sports and other fields, but also penetrate into every corner of life. However, the global research on smart home robots is still in its infancy. It is estimated that the market penetration rate of our smart home robot industry will gradually increase in the next five years. At present, the research directions of smart home robots are mainly in unmanned systems, bionic robots, technologies caring for the disabled, intelligent prostheses, etc. In the future, smart home robots such as escort robots, monitoring robots, learning robots and pet robots will quickly integrate into users’ lives (Li & Li, 2018). In order to make high-quality services of intelligent robots provided in all aspects of human activities, companies and designers hope to build intelligent home service robots into an industry larger than the pet market to meet people’s home life needs.

Bionic Design

The subject of bionics was born in the early 1960s, when bionics was defined as "the science of imitating biology." In the process of continuous evolution and reproduction, nearly 1.4 million life forms appeared. Specifically speaking, the bionic design includes the imitation of form, function, structure, color etc. (Zhang, 2009). It combines the aesthetics and use functions...
of modern products with the structural modeling of animals and plants in nature, and applies them to the intelligent robot bionic products design, so that intelligent robots can provide much more excellent experience than general product design does in terms of sense, shape and structure. Thus, bionics and bionic design have made outstanding contributions to the research of home intelligent robots.

Bionic design is a new interdisciplinary subject developed on the basis of bionics and design. In the way of observing and studying the characteristics of animals and plants in nature, design inspiration is obtained, which then is reasonably applied to design works after analyzing and processing (Quan et al., 2019). When using bionics to deal with problems in industrial design, bionics is only an enlightenment, where skeuomorph is the key. However, it is not a simple imitation, but the emphasis of the subjective initiative of designers to highlight the characteristics of visualization through analogy (Xu, 2019).

Generally speaking, bionic design is to use the relevant knowledge of bionics to design industrial products. Its methods include imitating biological form, biological structure, biological function, biological color, biological texture etc. Among them, the imitation of biological form can be divided into the concrete one and the abstract one. The bionic form is divided into concrete and abstract. The concrete one is an obvious biological prototype, which is more common in children or scene products. The image bionic product is in pursuit of similarity in spirit, featuring suggestive and associative, such as Jacobson's swan chair etc. Bionics of structure and function is to get inspiration from organism's body structure and then realize the similar functional structure, such as honeycomb sandwich structure board designed by imitating honeycomb. Texture bionics is to make the products get the required touch and look through the design of materials such as the shark skin design of swimwear greatly, which greatly improves the swimming speed (Gao et al., 2019).

The current development of bionic robot is in the fourth stage. In the original exploration period, it imitates the prototype of biology, which helped give birth to the first generation of something like human-driven aircraft. In the middle and late 20th century, it entered the period of macro bionic shape and motion bionic when designers used electro-mechanical systems to design robots, making them able to jump, run, fly and do other actions. After entering the 21st century, more complex integration took place, such as the integration of traditional structures and bionic materials, and the combination of electro-mechanical systems and biological properties began to be used to develop a series of bionic robot devices applied in various fields. At present, we are moving towards the fourth stage of robotic human life system, which means the combination of structure and biological performance.

**Analysis of Robot Sensory Bionic Technology**

As the cutting-edge technology of robots, the sensory bionic technology of robots has been continuously developed. As human being is the only creature defined as the advanced animal, the higher the degree of robot anthropomorphism is, the more difficult such technology will be. In order to realize sensory bionics, the smart home robot is equipped with a variety of external sensors so as to perform sensory functions such as listening, seeing, touching smelling and so on. All of them constitute an important perception system for robots to communicate freely with the users.

Through research and analysis, it is concluded that in order to achieve a high degree of robot bionics, product design is mainly based on the following important sensory elements for its bionic analysis. Among them, the information obtained by vision accounts for 4/5 of all the information that humans can perceive, so we use cameras to shoot and record foreign objects, and analyze the obtained images in the robot system to complete their identification, recognition, and positioning, so as to perform the functions of remote home monitoring, patrol and GPS positioning. Hearing is used to analyze the user's language information and perform human identification. To obtain sound information, we use a microphone and the sound card to transmit it into the equipment system. The user communicates with the robot in natural language, allowing the robot to find the voice target in the certain environment and realize intelligent voice interaction with the user, so as to complete the corresponding task. In addition, the integrated voice interaction system of the robot is integrated into the design of the home intelligent robot companion, by which the user can control and monitor the home environment through voice commands (Shen, 2017).

Although the robot olfactory function is not yet mature, it has also achieved some development. For example, a service robot “RI-MAN”, developed by Japanese scientists for the accompaniment of the elderly, uses the artificial olfactory device, “electronic nose”, in the gas sensor. It can distinguish eight different odors. In this way, smart home robots can use the olfactory function to detect the content of harmful gases in the air. Once it reaches a certain level, it can be sent to the mobile phone of the user and the emergency contact, providing a safety guarantee for people’s lives.

At present, the artificial taste is realized mostly by the application of electronic tongue devices based on taste sensors. If you want to make the robots react to the taste substances, you should use similar bio-taste sensing materials as sensitive membranes, and make them interact with the taste substances, changing the potential on both sides of the membrane, which makes multiple taste substances interact with each other and produce the same way of biological taste feeling, so as to realize the function of artificial taste. With this technology the robots can be equipped with high bionicity so as to have its sense of reality improved (Gao et al., 2019). However, the product's perceptual personification also affects the degree of user satisfaction. Female voices are better than males in voice emotional interaction. Therefore, the voice of smart home robots is prone to be female timbre. At the same time, there is a certain degree of danger. For example, once the robot's anthropomorphization level is too high, it will
show the uncanny valley phenomenon, which will bring the opposite feeling to the user. Thus, as the main body of the service, the user occupies a dominant position in the dialogue. We need to control the degree when researching (Liu et al., 2019).

**Robot Appearance Bionic**

Bionic robot product design integrates various biological experiences, perceptions and social abilities by imitating the appearance and movement functions of creatures. First of all, in terms of its appearance, a high-level bionic intelligent robot can make users feel intimacy, reducing the psychological and physical barriers between humans and robots, and enhancing interaction and social skills. Secondly, products designed for specific groups of people should follow three principles. The first is experiential design with strong emotional output, whose most critical part is the sensory experience, so that users can enjoy the interactive experience brought by cognition, hearing and vision (Liao et al., 2019). The second is to meet the use principles of emotional design, combining the specific people's psychological and emotional needs with their life use needs, making humans and robots coordinate with each other. In this way, a size and functional structure which conforms to common sense can be designed (Chen & Xue, 2019). The third is the popular principle of appearance design, which requires the characteristics of the times to be shown and the public's aesthetics to be satisfied.

Thus, the design of bionic products of smart home robots requires novel appearances and diverse structures. Meanwhile, bio-like design in the robot skin, senses, expressions and other parts is needed to achieve emotional upgrades. What's more, in order to follow the demand principle, designers need to conduct user research to analyze their needs, making the products more intuitively presented. In addition, designers should have a keen insight into the changes of the specific group's life attitudes and lifestyles so as to discover potential social needs in the future: a. Use interactive humanization design b. Use simulation scenarios for naturalization c. Use information processing for agility (Zhao, 2018).

**LIFESTYLE AND CHARACTERISTICS OF THE URBAN YOUTH**

Young people are the most energetic people, full of dreams. They are both builders and consumers. They grasp the right to decide the future lifestyle, and the future of the world belongs to the younger generation. China has a huge youth population. By the end of 2016, there were 433 million people in total, among which urban young people reached 268.91 million. With the process of population aging and urbanization, the number of young people is shrinking, while the urban young people group is expanding (Deng et al., 2019).

**Lifestyle of the Urban Youth**

The life of urban youth can be summarized from the aspects of life service, social style and personal habits and so on. First, in terms of life services, with the development of new things such as the Internet and the express industry, people can meet their daily needs through various food delivery platforms and e-commerce software without leaving their homes. Second, in terms of social networking, the popularization of the Internet reduces the chances for people to communicate face-to-face, and young people’s home life is more of online communication through dating software and self-media platforms. Third, in terms of personal habits, young people are used to having independent private space and prefer self and personalized life (Gao, 2019). The home activities of the youth can be mainly divided into four main stages: tidying up, replenishing energy, spiritually communicating and washing and rest. Among them, playing with pets and socializing on the Internet are the emotional high points, while taking care of pets, waiting for takeaway and some other stages tend to be the emotional low points (Wang, 2018). According to the analysis of the home activities of youth groups, what the youth need is to increase the opportunities for face-to-face communication on the basis of retaining independent private space and personalized lifestyle.

**Life Characteristics of the Urban Youth**

The contemporary urban youth prefer to maintain their own ideas and protect their private space. They often gather in circles based on their interests and preferences, create their own discourse systems and become the starters of many online popular cultures. The lives of young people are characterized by independent living space and extensive network communication. The life characteristics of urban youth groups mainly include: First, their lack of face-to-face communication. The urban youth groups’ home life features living alone, lacking language communication. Second, their preference for independent private space. The new generation of youth generally pay more attention to privacy, so they hope to have independent private space. Third, their higher degree of acceptance of new things such as the Internet. Meanwhile, they prefer a personalized lifestyle.

**DESIGN IDEAS OF THE BIONIC PRODUCTS OF SMART HOME ROBOTS FOR THE URBAN YOUTH**

**Design Research**

According to the analysis of the urban youth's home life, their emotional high points are shown when playing the pets and socializing online. Therefore, the combination of pets and social interaction can better enhance the emotional interaction experience at home. Young people pay more attention to the intelligent, automatic, and emotional products, which not only meet their emotional interactive experience, but also reduce unnecessary troubles in the use process. And Smart home robots can provide more accurate choices for such users. In addition, designers are more proactive in the design of robot’s function, structure, and appearance. Young users have high demands in aspects of safety, companionship and care, which means that emotional robot companions will enjoy great popularity.
Sketch design
Through design research, designers have certain knowledge and ideas about the product. They carry out the idea through hand-drawing sketches, designing the appearance and internal structure of the product. Home robots are products featured with daily companionship, which shows that all involved elements are extracted from all things in nature, and the bionic objects are processed in terms of form, structure, and color and so on.

Ideas at this stage are often instant, lacking precise size information and geometric information. Based on the designer's idea, they record in the form of sketching, draw various forms or mark and record the design information so as to determine three to four directions, and then the designers implement brainstorm and in-depth discussion, as shown in Figure 1.

Modeling and designing drawings
Based on the conclusions of the brainstorming meetings, the designers use modeling software to create a three-dimensional model to generate a multi-angle effect diagram to show the final effect of the product. Three-dimensional model is a process of describing the product's shape and structure, which can reflect the intuitiveness of the design and the authenticity of the product. By observing and adjusting the shape of products from multiple angles, conceiving the structure of products more intuitively, expressing the conception of products more accurately, the quality of product design can be improved and communication with customers can be facilitated.

Design Proposal Report
By providing different product design schemes, explaining the shape, color matching, process and application of the product, the designer can form a design scheme report based on the design scheme and explains it to the company or customers.

THE PRACTICE OF BIONIC PRODUCT DESIGN OF SMART HOME ROBOTS FOR THE URBAN YOUTH
Extract Bionic Prototype
Home robots are products featured with daily companionship, which shows that all involved elements are extracted from all things in nature, and the bionic objects are processed in terms of form, structure, and color and so on. Elements such as cute pets, animation, sports and desserts, preferred by the youth today can be the source of design inspiration. The contemporary youth prefer cute pets, which means the pets featured with "cute" in that they can relieve people's mental stress and bring happiness. Giant panda, cute and innocent, is a unique rare animal in China. Therefore, its classic black rim of the eye and big head are used as the source of animal elements in product design, as shown in Figure 2a. Most young people love cartoons. Whether it is online drama chasing, offline collection or role playing, it is the practical action of the youth to show love. Nezha is a well-known character in China. With generations of Chinese growing up, his lively, cute, brave and kind-hearted image is deeply rooted in the hearts of the people. Therefore, Nezha's round bun image in cartoons is used as a design element, as shown in Figure 2b.

Balance scooter is a popular transportation tool for young people for its simple, portable, stylish features, and it has become a cool toy for young people. Therefore, the power wheel of balance scooter is used as a design element, as shown in Figure 2c.

Ice cream is a very attractive and delicious frozen dairy product. In China, it has been transformed from a seasonal heat-relief consumer product to a four-season snack food. It is deeply loved by young people. Therefore, the shape and color of ice cream are used as design elements, as shown in Figure 2d.
The redesign of the bionic prototype is to integrate various bionic elements as a whole. By drawing on the dark circles and big heads of giant pandas and combining the cartoon Nezha's bun shape, the head shape of the product is designed as the round one with round ears and dark circles, so as to make the whole head shape naive. By drawing on the shape of the power wheel of the balance car, the designer designs the flexible legs and feet in the shape of wheels for the product. Drawing on the ice cream shape, the designer presents the whole product as a straight shape with a slightly narrow lower body.

Design Presentation
The product is named as “Zhi Ling”, with the homophonic "command" in Chinese, which means the companion robot that satisfies the user's instructions. “Zhi” stands for intelligence, and "Ling" is the robot nickname, Xiaoling, which also has the pronunciation of dear "darling" in English, giving people a sense of intimacy. The Zhiling series robot products can be set to two kinds of personality, one being "the adventurer who rides the wind and waves", the other being "a well-behaved little adult", who can continuously "grow" according to the user's personality.

The robot is also equipped with a computing chip with the same speed as a car, which can make it conduct indoor maps so as to automatically recognize obstacles, and walk freely indoors. The robot has a removable magnet camera. According to the patrol monitoring, it can shoot a certain space image screen to realize the function of automatically appearing when the owner goes home or goes out. The robot brain system is equipped with four microphones, a hemisphere camera, a temperature camera and a depth camera, and the whole body has various sensors such as air pressure, distance measurement and so on. The face and eyes of "Xiaoling" use a mix of metal material and transparent glass mirror material, as well as a plush material head and cloth cloak, which makes users involuntarily show affection. At the same time, the robots Aling and the Zhiling APP are connected to the smart home system, by which the owner can easily control the use of household appliances.

Function and shape design
The main body of the robot is composed of a robot brain, a head camera, a facial expression display screen, and a sensor power wheel. The robot brain is equipped with sensing tentacles, a 360 degrees’ dome camera, microphone, thermal camera and other equipment. When the button behind the robot brain is pressed, it is turned on. A removable magnetic camera is used to connect to the robot head. The external information can be photographed so as to make outside objects recorded. After analysis in the robot system, it can blink, wink and roll eyes through the facial expression display screen, and give feedback according to the user's behavior, as shown in Figure 3.
The size of the smart home robot is 44cm high, 26cm wide. The head size is 14cm high, and 20cm wide. The total height with the hat is 20cm and the width is 26cm. The hat is slightly larger and looks more cute. With the cape the length is 16cm and the width is 18cm. The wheels are 12cm high and 6cm wide. The ice cream backpack is 80cm tall and 40cm wide. The cylinder is 45cm long, and the diameter of the cross-section is 34cm. The diameter of the spherical cover is 40cm, and the top contains ventilating holes, as shown in Figure 4.

Source: This study.  
Figure 3: Product color scheme.

Color matching design
In order to make the product design diverse and choices personalized, four different styles have been derived from color matching to meet the needs of different people: The mature business style is black with gray texture, showing a mature and stable style, as shown in Figure 5a. The casual holiday style is tan with bright yellow, conveying a sunny and free life attitude, as shown in Figure 5b. The intellectual style is mainly milky white and supplemented by the haze blue, showing a sense of fashion maturity, as shown in Figure 5c. The exquisite girly style is orange-pink with milk tea to highlight the delicate and soft feeling, as shown in Figure 5d.

Source: This study.  
Figure 4: Product size diagram.
**APP design**

The APP is designed to enhance the interactive experience based on the design of smart home robot bionic products. Figure 6 is the mobile phone APP interface design derived from the robot device. When you open the homepage, you will see "Xiao Ling"'s home, including functional icons such as air detection, emergency contact, Xiao Ling's moments, etc, which can be used to control the behavior and language of Xiaoling at the terminal.

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**CONCLUSION**

Product design needs to follow the process of social development, guiding and meeting the needs of consumers. With the development science and technology, smart home robots begin to enter people's lives. As a kind of smart home products, it can meet people's needs of companionship and communication. In this paper, we design smart home robots with young people as the target group. The bionic design ideas are adopted to design smart home robots for the youth from the aspects of product effect, product size and APP design and so on. It is expected that through the research in this paper, new cognition and ideas concerning the smart home product design can be generated.

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