

Research on Interaction Design of Health-Oriented Smart Home Products Based on Multisensory Experience

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Abstract: With technological advancements and the growing emphasis on health and well-being, the development of smart home products in the health sector has rapidly progressed. This study examines the interaction design of health-oriented smart home products from the perspective of multisensory experience. It proposes innovative design strategies that encompass visual, auditory, tactile, and other sensory dimensions. By exploring the relationship between multisensory experiences and health-oriented smart home products, the study identifies existing shortcomings in product interaction design. The aim is to provide a theoretical foundation and practical insights to enhance user experience, meet the health and lifestyle needs of users, and contribute to the innovative development of the smart home industry in the field of health-oriented design.

Keywords: Multisensory Experience; Healthy Lifestyle; Smart Home Products; Interaction Design

1. Introduction

1.1 Background

As digitalization and smart technologies continue to evolve, smart home products are increasingly becoming a part of everyday life in households worldwide. This study focuses on the interaction design of health-oriented smart home products, particularly from the perspective of multisensory experiences. It seeks to analyze the fundamental connection between users' health-related needs and their interaction with these products, while also identifying effective design strategies and methods. By contributing to the development of multisensory design theories in the smart home industry, this research aims to provide

designers with fresh ideas and approaches to create products that better align with users' health and lifestyle needs, enhancing the overall user experience. Moreover, from a user-centric standpoint, the study encourages the sustainable growth of the smart home industry within the healthcare sector, aiming to raise awareness of smart home products, improve user satisfaction, and support users in their pursuit of healthier living through advanced smart home experiences.

1.2 Current Research Status in China and Internationally

International research on multisensory experiences and the interaction design of smart home products began earlier and has achieved significant advancements, particularly in areas such as multisensory interaction technology development and user experience evaluation. For instance, the EU-funded "MULTISENS" project focuses on developing multisensory interaction technologies to enhance the user experience of smart home systems[1]. Additionally, the Massachusetts Institute of Technology (MIT) Media Lab has conducted extensive theoretical and practical explorations in the field of multisensory interaction design, providing cutting-edge concepts and methods for the interaction design of smart home products. In recent years, Chinese research has seen rapid development, particularly in integrating local user needs and cultural backgrounds, and applying multisensory experiences to smart home product design[2]. Numerous universities and research institutions have undertaken relevant studies, while enterprises have actively invested in product development, launching a variety of smart home products featuring multisensory interaction functions[3]. However, both Chinese and international research still face some limitations. For example, there is a lack of in-depth studies on

multisensory interaction design for specific health-related living scenarios, and the integration of multisensory interaction technologies with users' health needs requires further improvement.

This study employs a comprehensive approach, including literature review, to examine the current state and trends in both Chinese and international research. User surveys are conducted to gather insights and feedback on user needs regarding the multisensory interaction experiences of health-oriented smart home products. Additionally, case analysis methods are used to analyze both successful and failed Chinese and international cases, drawing lessons from their experiences. By focusing on healthy living, this research systematically constructs an application framework for multisensory experiences in the interaction design of smart home products. It aims to deeply explore users' health needs from various multisensory dimensions, propose innovative interaction design strategies, and provide new perspectives and methods for the study of smart home product interaction design.

2. Multisensory Experience and Overview of Health-Oriented Smart Home Products

2.1 The Essence and Components of Multisensory Experience

Multisensory experience refers to the integrated interaction that humans have with their surroundings through various sensory channels, including vision, hearing, touch, smell, and taste [4]. Each of these senses contributes uniquely to how users perceive and engage with their environment. In terms of visual experience, elements such as product color, shape, material texture, and display interfaces all play a pivotal role in shaping users' emotional responses[5]. For instance, smart health-monitoring devices often employ clear digital screens with refreshing colors and minimalistic designs to convey a sense of professionalism and reliability, enabling users to quickly and effectively interpret health data. Auditory elements in smart home products encompass sounds such as alarms, voice prompts, and ambient effects. Smart speakers, for example, not only deliver health-related information but can also provide soothing music to help relax users. These auditory cues

significantly contribute to the emotional and psychological well-being of users. Tactile experiences influence user comfort and convenience. The texture of materials, how they feel to the touch, and features such as vibration feedback all affect how pleasant and intuitive the product is to use. Although less commonly utilized, olfactory and gustatory elements can also enhance the user experience in specific contexts. Smart aroma diffusers, for example, can emit pleasant scents that promote relaxation and contribute to the user's overall health and well-being.

2.2 Classification and Characteristics of Health-Oriented Smart Home Products

Health-oriented smart home products come in a wide range of types, which can be broadly categorized into three groups: health monitoring devices, environmental regulation devices, and health assistance tools. The health monitoring category includes products such as smart wristbands, smart blood pressure monitors, and smart sleep trackers, which are designed to continuously track users' physiological metrics and provide data support for health management. The environmental regulation category encompasses devices like smart air purifiers, smart humidifiers, and smart ventilation systems, all of which focus on creating a comfortable and healthy indoor environment. The health assistance category includes products like smart fitness equipment and smart sleep aids, which assist users in physical exercise, alleviating body fatigue, and improving sleep quality. These smart home products share several key characteristics: intelligence, personalization, and data-driven functionality. The intelligent nature of these devices is evident in their ability to autonomously sense changes in the environment and user needs, enabling automatic control and adjustments. Personalization is evident in how these products tailor services and functions based on individual health conditions and lifestyle habits. The data-driven aspect comes from the collection and analysis of user health data, which provides users with accurate health advice and decision-making support, contributing to more informed and proactive health management.

2.3 The Role of Multisensory Experience in

Health-Oriented Smart Home Products

Multisensory experiences play a pivotal role in health-oriented smart home products. From a functional standpoint, multisensory interactions broaden the ways in which users engage with the products, improving both the efficiency and precision of these interactions. For instance, in fitness settings, users can experience a smoother and more effective interaction, making it easier to achieve their fitness goals. Through voice commands, users can control smart fitness equipment, while vibration feedback from the devices allows for real-time adjustments to exercise intensity, providing a more intuitive workout experience. From the perspective of user experience, multisensory interactions enhance emotional engagement and a sense of participation, creating an immersive and interactive environment. In sleep scenarios, for example, multisensory smart home devices work together to provide a holistic comfort experience. Soft lighting, soothing music, and pleasant fragrances help users relax, unwind, and quickly fall into a restful sleep, fostering a more serene and effective sleep environment. Additionally, multisensory experiences improve the overall usability of these products, especially for diverse user groups such as the elderly or those with disabilities. By incorporating multiple sensory cues, smart home devices lower the barriers to use, making them more accessible and easier to operate, contributing to a healthier and more enjoyable lifestyle.

3. Current Issues in the Interaction Design of Health-Oriented Smart Home Products

3.1 Limited Interaction Methods and Lack of Multisensory Integration

Currently, most smart home products primarily rely on mobile applications as the main interface for user interaction, predominantly depending on app controls and simple voice commands. However, they fail to fully integrate multisensory experiences to enhance the interactive effect[6]. While voice interaction is convenient, its accuracy diminishes in noisy environments and it lacks the capacity to provide rich emotional feedback. The reliance on a single mode of interaction limits the depth of user engagement and fails to meet the diverse

interaction needs of users. For example, in the case of smart health monitoring devices, users typically access health data through mobile apps, lacking intuitive visual displays or other sensory feedback.

3.2 Insufficient Sensory Experience Design, Leading to Poor User Experience

The majority of smart home products focus primarily on simplifying voice interaction and visual presentation in their sensory experience design, often neglecting the finer details of user experience. Visually, some products feature cluttered and disorganized interfaces that make it difficult for users to quickly access the health information they seek. Auditory design is often weak, with limited human voice interaction and inadequate emotional expression[7]. In terms of tactile design, there is a lack of attention to the selection of materials for a better tactile experience, and control buttons are often not ergonomically designed, reducing their practicality. These flaws in sensory and tactile design significantly affect the overall user experience, leading to lower product satisfaction and customer loyalty.

3.3 Poor Adaptability to Health Scenarios and Lack of Targeted Interaction Design

Many products today still struggle with the issue of scene adaptability[8]. For instance, in fitness settings, users require quick and convenient control of exercise equipment, but traditional interaction designs do not allow for easy access to operation interfaces during physical activity, and lack the type of interactive feedback suited for an active state. In sleep environments, some smart devices produce noise or reflections that disturb sleep, undermining the user experience. This lack of adaptability to health-related scenarios limits the effectiveness of smart home products in providing high-quality, health-oriented services in real-world applications.

4. Interaction Design Strategies for Health-Oriented Smart Home Products Based on Multisensory Experience

4.1 Visual Interaction Design Strategies

4.1.1 Information Visualization Design

Health data such as heart rate, step count, and sleep duration collected by a smart bracelet

should be presented in intuitive forms, such as bar charts or line graphs, allowing users to easily understand their data at a glance. Clear and simple visual elements, such as graphs and charts, can be used to showcase health metrics[9]. Color coding techniques can be employed to highlight different health indicator ranges, such as normal or warning thresholds, enabling users to quickly assess their health status. For instance, green could signify a normal health metric, yellow a mild deviation, and red an alarming condition, indicating abnormal health indicators. Optimizing the layout of the interface to align with user visual habits reduces the time and effort needed for users to find the information they need, positioning key details in prominent locations. For example, on a smart health monitoring device's interface, real-time health data could be displayed centrally, with other functional entry points around it.

4.1.2 Emotional Visual Design

Designing color schemes suitable for different life scenarios based on user needs is crucial. In a sleep context, cool tones could be employed to create a tranquil atmosphere, while vibrant reds and oranges could be used in fitness environments to stimulate the user's enthusiasm for exercise. Additionally, crafting personalized and approachable product designs that complement home environments enhances visual appeal. For instance, a smart air purifier could be designed with a circular shape and a wood-grain finish on the outer shell, blending aesthetically with various home styles while enhancing both beauty and functionality. Furthermore, dynamic visual effects like animations, transitions, and interactive elements can increase engagement and emotional impact. For example, a simple animation could be used in monitoring devices to notify users during the data loading process, enriching the interaction with playful and engaging visuals.

4.2 Auditory Interaction Design Strategies

4.2.1 Voice Interaction Optimization

Advanced voice recognition technology can be employed to enhance the accuracy of speech recognition, minimizing the impact of environmental noise on performance. With deep learning algorithms, the voice interaction system can achieve more precise recognition of voice commands, adapting to varying

accents, speaking speeds, and tones. Additionally, the emotional expression in voice interaction can be enriched by adjusting the voice's timbre, tone, and pace based on the context of interaction and the user's emotional state. For example, when a user accomplishes a health goal, the voice assistant might congratulate them with a cheerful tone, offering an emotional reward; conversely, if the user's health metrics are abnormal, a concerned and serious tone could alert the user. Expanding the functionality of voice interaction beyond basic command control, the system can also provide services such as health knowledge Q&A, voice navigation, and reminders. Through voice navigation or reminders, for instance, users could inquire via voice commands about disease prevention or fitness tips through a smart speaker.

4.2.2 Sound Notification Design

Designing distinctive audio cues for different health scenarios is essential. In smart health monitoring devices, the characteristics of the notification sound—such as timbre, rhythm, and volume—can be varied to signify the urgency of different events. For example, different sounds can be used to alert the user to abnormal heart rates, high blood pressure, or achieving fitness goals. During sleep, the volume of notifications may automatically be reduced, or vibrations could be used instead. The use of multi-channel audio technology can further enhance the auditory experience, creating an immersive sound environment that enriches the user's interaction with the device.

4.3 Tactile Interaction Design Strategies

4.3.1 Material Selection and Tactile Design

The selection of appropriate materials based on the product's functionality and usage context is essential to create a comfortable tactile experience. For wearable devices such as smart bracelets and smartwatches, soft, skin-friendly silicone materials are used for straps to avoid skin irritation. In handheld devices such as smart switches and remote controllers, materials with a certain level of friction are chosen to facilitate secure and comfortable grip for users. The feedback strength of smart buttons should be moderate, ensuring a clear tactile sensation when the user completes an action. For sliders, the movement should be smooth with consistent resistance. To enhance the interactive

experience, real-time feedback can be provided using micro-vibration technology. For instance, when a user interacts with the touchscreen of a smart device, subtle vibrations can confirm that the device has received the input, thereby improving the sense of realism and accuracy in the interaction.

4.3.2 Vibration Feedback Design

In health monitoring and fitness scenarios, vibration feedback can be used to provide users with information about their current status. For example, when a user reaches their fitness goal in terms of steps, the smart bracelet may deliver a vibration alert. In cases where the user's heart rate is too high or exercise intensity is excessive, vibrations of varying frequencies and intensities can signal the user about the status of their heart rate. Customized vibration patterns can be tailored for different health scenarios and user preferences. Additionally, multisensory collaborative feedback can be achieved by combining other sensory channels. For instance, in a smart fitness device, users could experience a combination of vibration feedback, flashing lights, and voice prompts when performing a series of exercises, thereby enhancing both their sense of accomplishment and overall workout experience.

4.4 Olfactory and Gustatory Interaction Design Strategies

4.4.1 Olfactory Interaction Applications

Based on various health and lifestyle scenarios, smart home products may incorporate intelligent aroma devices to diffuse corresponding fragrances. In sleep environments, lavender scents can be diffused to soothe both the body and mind, inducing sleep. In study or work settings, fragrances like lemon or mint can be dispersed to refresh and invigorate the user, enhancing focus and concentration. These devices can automatically adjust fragrance intensity and diffusion time while utilizing sensors to monitor the surrounding air quality and the user's emotional state. For example, if indoor air quality deteriorates, the device will activate its air purification function. Additionally, when the user feels mentally anxious, the fragrance intensity can be increased to promote relaxation. The aroma module can also be customized to change according to the

user's olfactory preferences.

4.4.2 Gustatory Interaction Exploration

While examples of gustatory interaction in smart home products are currently rare, the advancement of technology suggests future applications of virtual taste technology in fostering healthy lifestyles. For instance, smart devices could simulate the tastes of various foods, accompanied by oral sensors, to help users select foods that suit their preferences and health needs[10]. Virtual gustatory technology could assist in developing healthy eating habits, allowing users to enjoy delicious flavors while consuming low-calorie, low-sugar, and low-sodium foods. Personalized taste recommendations could be provided, integrated with health monitoring data. If a user's blood sugar levels are too high, the system might advise avoiding sugary foods and recommend low-sugar alternatives, using virtual gustatory technology to simulate the flavors of foods rich in specific nutrients. If the user lacks certain nutrients, the system could guide them toward modifying their dietary habits accordingly.

5. Conclusion and Outlook

This study, which explores the interactive design of smart home products based on multisensory experiences, highlights the crucial role of sensory interaction in this field. At present, the interaction design of smart home products is primarily focused on promoting health and wellness, but it remains limited in its approach—relying mostly on a single mode of interaction and lacking integration of comprehensive sensory experiences. As a result, the adaptability of these products to different health scenarios is often insufficient. This research proposes a multisensory approach to interaction design, incorporating visual, auditory, tactile, olfactory, and gustatory dimensions. By enhancing the usability, engagement, and functionality of smart home products, it is possible to offer more personalized and holistic health services, thus enabling these products to seamlessly integrate into users' daily lives. Looking ahead, future research should prioritize the development of interaction designs for smart home products with a focus on health and well-being. Furthermore, to create more inclusive and personalized smart home solutions for diverse user groups, such as the

elderly, children, and individuals with disabilities, further studies will be needed to explore the specific multisensory interaction needs in health-related contexts.

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