LIFEELING: A "Detox" Metaphor-Based Fitness Tracking and Reminder Device Designed for the Elderly

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Abstract

With society aging, electronic wearable devices (EWDs) can be a viable option to promote healthy living among the elderly. However, these devices often present complex graphics, difficult interfaces, and inappropriate assistance features, which hinder their use by older individuals. To address this, we conducted a formative interview and found that the elderly need simple and positive signals, psychological support through objects, and guidance for preventing over-exercise in EWDs. Thus, we propose LIFEELING, a fitness tracking and reminder system that combines the traditional bracelet form factor with the prevalent concept of "detoxification" among the Chinese elderly. Additionally, LIFEELING can provide positive psychological sustenance using the metaphor of "detoxification" and mimic design. Meanwhile, it can monitor the user's heart rate and assist with breathing adjustments. A preliminary study helps us understand how the elderly perceive it and better position our contributions.

CCS Concepts

• **Human-centered computing → Interaction devices**.

Keywords

Elderly; Wearable Device; Fitness; Metaphor Design

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1 Introduction

As society ages, promoting healthy lifestyles among the elderly becomes increasingly crucial. Visualizing exercise data through charts can encourage self-reflection among older adults. In this context, electronic wearable devices (EWDs) have garnered significant attention as effective tools for capturing and visualizing physiological data. Various wrist EWDs, such as WaveTrace [35] and WristEye [6], have become a hot topic in this field.

However, the complexity of these devices has led to a low adoption rate among seniors, with only 7% of users aged 65 and above utilizing them [32]. One major issue is that complex charts and graphs can easily cause frustration [22]. Limited screen space and age-related vision decline further complicate data comprehension, resulting in confusion and decreased usability [13]. For instance, experiments with older adults using Sony wristwatches showed that the multitude of features, such as Nike's Fuel points indicator and metrics like steps, distance, sleep, calories, and activities, left some participants confused [32]. Additionally, small buttons, intricate interfaces, cumbersome controls, and complex operations in EWDs limit their effectiveness [4].

Numerous efforts have been made to improve information presentation in EWDs for the elderly. Existing studies have attempted to solve these problems by incorporating features such as larger fonts and optimized colors [31]. However, such age-friendly designs often result in a pervasive sense of shame among older adults when using EWDs [21]. This stems mainly from designers and researchers misunderstanding aesthetic preferences, sensitive identity symbols, and acceptable usage behaviors, while neglecting the privacy concerns of older users. For example, larger fonts may provide clearer visual effects but overlook the psychological fear of being perceived as aging.

Given the issues with complex charts and insufficiently human-centered age-friendly designs, designing EWDs that cater to the mental needs of the elderly and better convey information has become a key focus of our research. Inspired by the abstract visualization of exercise data in information art [9] and considering the impact of cultural factors [3], we aim to explore localized information transmission methods within the context of Chinese culture, a topic that has been rarely discussed [15].

Therefore, we conducted a field survey and user study. The research revealed that the psychological reliance on objects, positive signals from the body, and reluctance to accept aging leading to exercise injuries are some particularly noteworthy concerns among elderly individuals in China. In traditional Chinese culture, detoxification holds significant importance. Jade bracelets are regarded as talismans and older adults associate their health with jade conditions. They believe that when the jade bracelet is smooth and lustrous, one's health will also improve, symbolizing a "detoxification" process. Such metaphors can provide emotional support for the design of elderly wearable devices.

Building upon this work, we propose LIFEELING, a fitness tracking and reminder system that aligns with the elderly's "detoxification" health concept and psychological reliance on objects. This system consists of a wrist-worn wearable device and a data collection terminal, incorporating elements of traditional bracelets with the metaphor of "detoxification." The LIFEELING bracelet mimics the shape and aura of jade artifacts, with its color brightening after prolonged physical activity. During exercise, the bracelet emits flowing light rays symbolizing vitality. Additionally, built-in sensors monitor the user's heart rate and flash red warning lights in case of elevated heart rate or irregular breathing, while assisting in adjusting breathing frequency through gentle vibrations to prevent excessive exercise and exercise injuries.

In our work, the main contributions are:

- Summarize three key concerns for elderly wearable devices, which include: the need for simple and positive signals, the psychological reliance on objects, and the expectation of guidance to prevent over-exercise.
- Introducing LIFEELING, a wearable device designed for elderly fitness tracking and reminders based on the metaphor of "detoxification."
- Considering the important roles of psychological cues and mimic design in elderly wearable device research.

We hope that in future research, "metaphors" design can be integrated into elderly wearable devices as important considerations.

2 Related Work

2.1 Metaphor Design in Wearable Devices for the Elderly

Metaphor design is a powerful cognitive tool used in product design to create intuitive user experiences by leveraging familiar concepts. This approach is particularly beneficial in designing wearable devices for the elderly, as it helps bridge the gap between advanced technology and users who may be less familiar with digital interfaces. Metaphors in interface design have been extensively studied as a means to enhance usability and user satisfaction. Johnson explored the use of everyday metaphors in software interfaces to improve user comprehension and interaction [14]. Mark Treglown discussed the role of metaphors in programming languages, highlighting their importance in making abstract concepts more tangible [34].

The cognitive benefits of metaphors are well-documented. Lakoff and Johnson's seminal work on conceptual metaphors laid the foundation for understanding how metaphors shape our thought processes and perceptions [19]. This theoretical framework has been applied in various design contexts, demonstrating that metaphors can significantly improve the cognitive accessibility of technology for elderly users [26]. Metaphor design has been widely applied in health and medical devices. O'Keefe et al studied metaphor-based interfaces in medical devices and found that they enhanced patient comprehension and engagement [28]. Additionally, Mankoff et al explored the use of ambient displays using metaphoric representations to convey health-related information unobtrusively [24].

Wearable devices for the elderly require simplicity and ease of use, and metaphor design can be an effective approach. Henkemans emphasized the importance of user-centered design in developing health monitoring systems for elderly patients, advocating for intuitive and non-intrusive interfaces [11]. Similarly, Li highlighted the role of familiar metaphors in designing interfaces for elderly-friendly wearable devices [23]. Several case studies have demonstrated the effectiveness of metaphor design in wearable devices for elderly users. For example, Oladapo Oyebode described the development of a persuasive exergame for promoting physical activity that uses tree metaphors to represent physical activity levels, making it more relatable and engaging for elderly users [29]. Another study by Gonçalo F Augusto explored the use of metaphoric design elements in smartwatches for seniors, finding that such designs significantly improved user acceptance and satisfaction [2].

Metaphor design offers significant insights for designing wearable products for the elderly in China. In China, there is a prevalent concept of "detox" through physical activity. The "detox" health concept suggests that detoxification can promote the smooth flow of vital energy and bodily fluids, thereby enhancing organ functions and their coordination, boosting the body's positive energy, and maintaining a healthy state, avoiding sub-health or disease conditions [1]. Additionally, elderly people in China often have a psychological attachment to certain objects, frequently linking their health status with specific religious items. According to the 2010 Third Survey on the Social Status of Women in China, 15.3% of the 10,547 elderly respondents had religious beliefs, with Buddhism being the primary religion among the elderly in China [6]. In this context, many elderly people carry jade, silver bracelets, bead strings, and other religious items, believing that these objects reflect their health status. This "detox" health concept and the psychological attachment to objects can be metaphorically applied to the design of health wearable devices for the elderly. Therefore, we tried to design a health wearable device for the elderly by combining "detox metaphor" and object styles with "psychological sustenance", and initially explored whether this "metaphor" could be more in line with the psychological cognition of the elderly in East Asia. Improve the ease of use of the product to a certain extent.

2.2 Wearable Devices for the Elderly

Wearable technology refers to smart electronic devices worn by users to track their physical activities [7], such as Xiaomi band, Apple Watch, and Fossil Gen. Older adults exhibit varying attitudes towards wearable devices across different body locations, with the wrist being the most favored wearing position [10]. Especially, they show a positive inclination towards smartwatches [20]. Due to the increased affordability of wearable devices, they are becoming increasingly popular in the market [5]. However, a survey shows that users aged 55 and above, especially those aged 65 and above, only occupy 16% and 7% of the user group, respectively [32]. Older adults face challenges with small buttons, cumbersome controls, complex interfaces, and intricate command and operation procedures [4], which may contribute to the low adoption rate of wearable health devices among older adults.

There is a prevalent sense of shame among older adults when using wearable devices [21]. This stems from designers often misunderstanding aesthetic preferences, sensitive identity symbols, and acceptable usage behaviors, and neglecting the privacy concerns of older users. Therefore, maintaining a visually clear and straightforward presentation is crucial when designing wrist-worn wearable devices for seniors [8]. Krippendorff suggests that semantics are the new foundation of product design [17], emphasizing the importance of aligning wearable device designs with recognizable meanings for older adults and addressing the compatibility of wearable devices with the values and needs of middle-aged and elderly individuals [18]. Most older adults believe wearable products should resemble the form of a watch, with rounded or curved designs being more favored [30]. Designers can also explore preferences for customized accessories or jewelry among older adults to create a more engaging user experience [21].

Older adults encounter difficulties in understanding data. For older adults, the operation of applications, the comprehensibility of data, the graphical user interface of applications, and the operation of wristbands are the four most important aspects [32]. Due to limited screen space on devices and age-related vision decline [13], information and components can easily become confusing [25]. Existing technologies on the market have not fully met their needs; research indicates that for older adults, the comprehensibility of applications and data is more important than the devices themselves [32]. Therefore, user interfaces and data communication for older adults should be made clearer.

Research has provided feasible suggestions for the functionality of sports and health wearable devices. Studies indicate that older adults primarily use health and exercise functions, so these areas should be prioritized [12]. For example, utilizing heart rate to guide exercise intensity to ensure safety, and measuring post-exercise resting heart rate to assess exercise effectiveness and mortality risk [27]. Additionally, technical support for older adults should consider the social environment, not just the diversity of functions [21]. Research shows that older adults continue to use wearable device functions not only for exercise and leisure but also for enjoyment and flow experiences [16], thus perceived enjoyment is a significant driver of positive attitudes and continued usage [12].

Addressing these issues, this study focuses on the humanization of wearable devices for elderly sports and health, exploring the balance between technological capabilities and human requirements for appearance design, data understanding, and auxiliary health functions [31, 33], aiming to propose user-friendly and comfortable electronic wearable devices for older adults to enhance their user experience and regular exercise levels.

3 LIFEELING

3.1 User Interviews

An 8-hour field study was conducted in the park and in-depth interviews were conducted with five of the participants. Details of the interviewees are given in Table 1. The interview outline covered the following topics: 1) attitudes of older adults towards exercise, 2) attitudes towards existing exercise monitoring devices (e.g., bracelets, etc.), and 3) expectations of forms of interaction in exercise scenarios. Data analysis methods included qualitative coding, thematic analysis, and descriptive statistical analysis to gain a comprehensive understanding of older adults' exercise habits and interaction preferences. Each participant was paid accordingly.

Table 1: Basic information and characteristics of interview participants

Number	Age	Gender	Exercise level
1	68	Female	high-frequency
2	69	Male	high-frequency
3	65	Female	mid-frequency
4	73	Female	mid-frequency
5	70	Male	low-frequency

3.1.1 Need Simple and Positive Signals. Observations and interviews revealed that older adults were dissatisfied with the interactive format of existing exercise monitoring devices and found the data from these devices to be complex and difficult to understand. One participant stated, *"I can't read much of the data from those smartwatches, I just want to know if I'm exercising enough and if I'm healthy."* (P3) Elderly people expect simple, easy-to-understand, and visible signals to recognize the positive effects of exercise.

3.1.2 Have Psychological Reliance on Objects. Influenced by traditional Chinese Buddhist culture, some older people tend to assign health-related symbolic meanings to specific objects, seeing them as important safeguards for their health. For example, Auntie Wang shared her experience, *"I was in average health before, but when I went to Tibet as a volunteer two years ago, a Buddhist guru gifted me two bracelets, which I have been wearing every day since then, and I feel that my physical health has improved significantly and my athletic vigor has increased."* (P1)

3.1.3 Expect Guidance to Prevent Over-exercise. In addition, they wanted to stay energized through exercise and felt that challenging exercise could increase confidence and physical health. For example, a participant stated, *"This exercise is really quite difficult at the beginning, when I practiced it before, my shoulder was particularly painful and I had strained it, and after practicing it more, it gradually got better and my tendons stretched out, and now I can do a lot of movements."* (P1) These views indicate that they have expectations for guidance and aids to prevent over-exercise.

These interview findings emphasize older adults' need for simple, easy-to-understand, culturally appropriate forms of interaction with exercise monitoring devices, as well as their habit of assigning health symbolism to specific objects. These findings provide important guidance for our subsequent designs, suggesting that we should design interfaces that are simple, intuitive, and easy to understand while considering how to incorporate cultural elements and symbolism.

3.2 System Design

3.2.1 Design of LIFEELING. LIFEELING provides an exploratory solution to fulfill the three core demands: simple signals, psychological support on objects, and guidance for preventing over-exercise. This proposal emphasizes the importance of the metaphor design for the Chinese elderly. It uses vibration sensors, ECG sensors, and flexible light strips to support the elderly physically and psychologically.

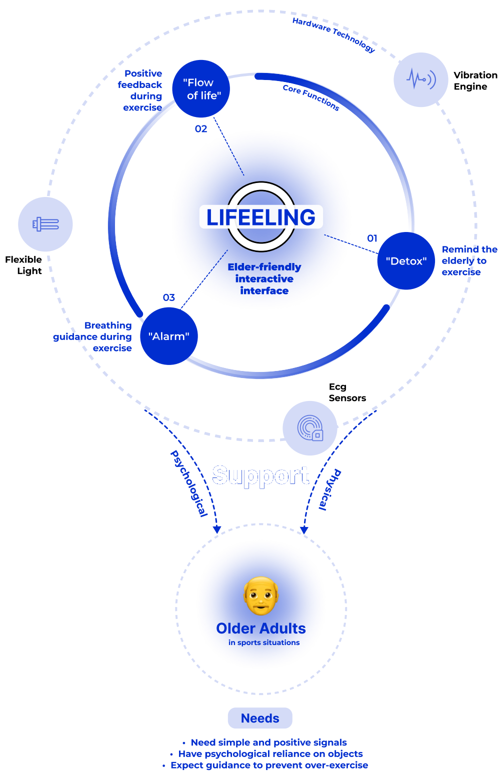

Figure 1: System Map: LIFEELING is designed to fulfill the three important needs of the elderly through the three functions of detox, alarm, and flow of life, forming a link between the product and the user

LIFEELING is designed as a three-dimensional ring with an outer diameter of 70mm and an inner diameter of 10mm. It is planned to be embedded with an FPCB(Flexible Printed Circuit Board) that serves as the basis for the overall technical realization of the product, where a flexible power supply covers the periphery to support the operation of the entire product. The part of the product close to the hand houses the ECGsensor, which is used to acquire and monitor the user's heart rate. A vibration sensor can also be built into the product to alert the user that they are currently in a particular state and to guide their breathing. The product is surrounded by a circle of light strips to visualize the user's status. The overall construction of the product weighs about 35g and is predicted to be easily worn by the user for exercise.

3.2.2 Data visualization design. LIFEELING features three core data visualizations: The first, named "Detox Metaphor," represents

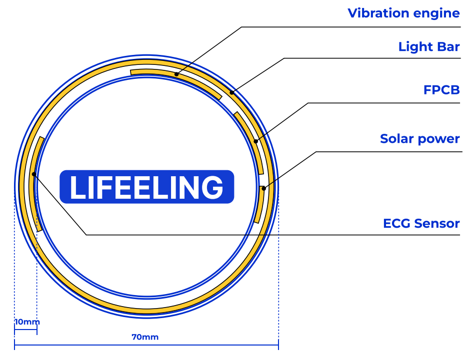

Figure 2: Product Structure: Five hardware architectural components that support the implementation of LIFEELING functionality

the difference between regular and irregular exercise through variations in color intensity. The second, "Health Feedback," visualizes heart rate changes from light green to red hues. The third, "Rhythm of Life," uses the flow and flickering of light beams to indicate safety status.

3.2.3 Scenarios. **Lack of exercise and normal healthy scenario.** When users wear this device in daily life, the ECG sensor continuously monitors their heart rate and uses deep learning to assess their exercise status, analyzing the data accordingly. If the user has not exercised for an extended period, the device displays a dark green color, aligning with the "Detox Metaphor" to signal a high level of toxicity and the need for detoxification through exercise.

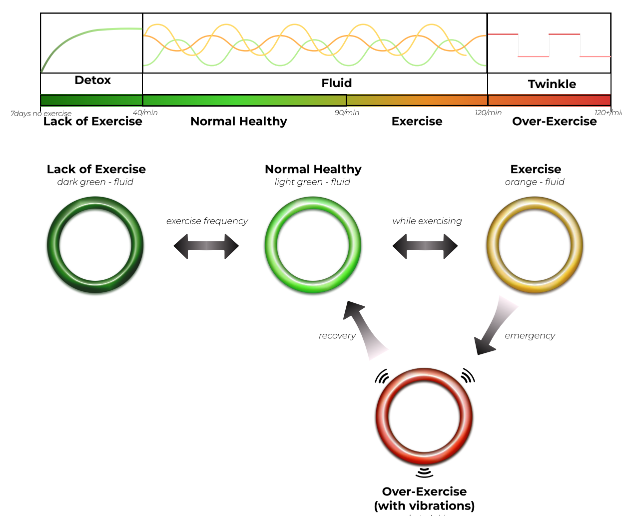

Figure 3: Three key data visualizations and displays in four different scenarios

Exercise scenario. During physical activity, the device continually monitors heart rate data via the ECG sensor, adapting its color based on the user's current exercise state. During normal exercise, LIFEELING maintains an orange-yellow color.

Over-exercise scenario. If heart rate data indicates an abnormality, following the metaphorical foundation, LIFEELING's light strip turns deep red and activates a vibration sensor that vibrates every three seconds to alert elderly users that they are in a dangerous state. At this stage, the light strip also integrates a breathing light mode, alternating between strong and weak flashes twenty times per minute to guide users in adjusting their breathing. Once breathing normalizes, the light strip returns to light green and stops vibrating.

3.3 User Feedback

A user test was conducted at another park with 20 people aged 60 and over. A prototype of the design was shown to users, and the design concept was combined with images and concept videos to explain the design and illustrate its use. The interview outline included topics such as acceptance of the design concept and use of the device, design expectations of the "detoxification" metaphor, and suggestions for additional features to assist with exercise. Data analysis methods included qualitative coding, thematic analysis, and descriptive statistical analysis to assess the feasibility and scalability of our design in the older adult population.

Table 2: Basic information and characteristics of test participants

Number	Age	Wearing a bracelet	Exercise level
1	65	Yes	high intensity
2	72	No	mid intensity
3	68	No	mid intensity
4	68	No	mid intensity
5	66	Yes	high intensity
6	70	No	low intensity
7	71	No	low intensity
8	65	Yes	high intensity
9	60	Yes	high intensity
10	62	Yes	mid intensity
11	62	No	low intensity
12	67	No	low intensity
13	69	Yes	low intensity
14	74	Yes	mid intensity
15	68	Yes	mid intensity
16	75	Yes	mid intensity
17	72	Yes	mid intensity
18	71	Yes	mid intensity
19	71	No	low intensity
20	66	No	low intensity

3.3.1 *Acceptance of the Prototype Device's Concept and Form.*

The majority of participants expressed acceptance of the prototype device's concept and form. After understanding the device's functions and design philosophy, participants generally found the device user-friendly and its design intuitive. For instance, one participant remarked, *"The design of this device is very intuitive; I quickly learned how to use it"* (P1, P10). Another participant added, *"It looks modern and its functions are practical"* (P2, P13, P14, P19). Additionally, many participants particularly appreciated the device's portability and durability, making it suitable for everyday use.

a. Hand objects worn by users during exercise

b. One user is showing the "secret text" on the bracelet

c. An old woman who challenges difficult movements

Figure 4: Hand objects worn by users during exercise

3.3.2 *Expectations for the "Detoxification" Metaphor Design.*

Participants showed great interest in the "detoxification" metaphor design and anticipated further optimization. Specifically, they hoped the device could more clearly convey physical condition and exercise effects through colors or symbols. One participant noted, *"It would be helpful if different colors could represent the body's detoxification state"* (P6, P17). Another participant mentioned, *"This design makes me feel more at ease because I can visually see my health status"* (P4). Some participants also suggested incorporating ciphers or specific symbols to enhance their psychological strength: *"I would like some symbols with ambiguous meanings; they make me feel more empowered"* (P5, P20). This feedback suggests that the "detoxification" metaphor design has the potential to enhance user experience and increase device appeal.

3.3.3 *Suggestions for Exercise Tracking Functions.*

Participants provided numerous suggestions regarding the device's exercise assistance functions, indicating high expectations for the device in exercise guidance and health monitoring. Some participants wanted the device to record and analyze their long-term exercise data to better track progress and adjust exercise plans: *"If the device could show me my exercise results over the past few months, I could adjust my workout plan more scientifically"* (P2, P8, P12). These suggestions underscore the elderly's desire for the device to provide long-term and comprehensible feedback mechanisms.

4 Discussion and Limitation

Design based on the "detox" metaphor provides a novel and culturally diverse approach, providing new ideas for product innovation for the elderly. We conducted the prototype design and user test for the LIFEELING exercise wearable product, targeting the needs and preferences of the elderly in China. The test results initially validate the feasibility of our solution and demonstrate that "metaphor" design can somewhat enhance the willingness of the Chinese elderly to use exercise wearable products. The user test conclusions indicate that the "detox" metaphor is well accepted by most elderly individuals in East Asia. The interaction mode based on color changes is easily understood by the elderly. The jade bracelet appearance is particularly favored by elderly women. Our conclusions provide new ideas for future designers when designing products to promote exercise motivation in the elderly. We call on future designers to pay more attention to the real needs of the elderly when designing sports products for them, consider the special physiological and psychological characteristics of the elderly, and try to use "metaphors" to design wearable sports products that are more suitable for the elderly.

However, our research has certain limitations. Firstly, it was confined to the Shanghai area, with a lack of diversity in test subjects, who were not numerous enough and had regional characteristics. In future studies, we will further explore the genuine feedback from elderly participants across different regions of East Asia regarding our wearable exercise device, as well as their willingness and extent to use these devices in their daily fitness activities. We recognize that as fitness devices become increasingly integrated into the daily lives of the elderly, ensuring user privacy will be a critical design consideration. Therefore, future research will gather quantitative and qualitative data on these aspects through surveys and semi-structured interviews. Additionally, the study will consider the openness of different participants to sharing fitness data to understand the role and potential barriers of data-based social connections in promoting exercise among the elderly. Furthermore, the comfort of wearing the product is a significant factor for the elderly when choosing wearable products. Future research will compare different shapes and materials to improve comfort. In future research, we will continue to develop our product and conduct user testing in real scenarios.

Metaphor design is effective not only in health and fitness wearable devices but also can be extended to other fields such as education, home automation, and smart home devices. By using familiar concepts and symbols, designers can create more intuitive and user-friendly interfaces that help users of different ages and backgrounds better understand and use new technologies. With globalization, product design needs to consider the needs of users from different cultural backgrounds. Metaphor design has great potential in this regard, as it can incorporate local cultural symbols and concepts to create products that better meet the needs of users in specific regions. For example, in East Asia, traditional cultural concepts such as "yin-yang balance" and "qigong" can be applied to the design of health monitoring and management devices. As society ages, the demand for smart assistive devices will continue to grow. Metaphor design can play an important role in smart home devices, mobile health applications, and personal assistant devices, helping the elderly better manage their daily lives and improve their quality of life.

5 Conclusion

Effective physical activity interventions are crucial for the proactive health of the elderly. Our product, LIFEELING is a wearable fitness tracking and reminder device designed in the style of a bracelet and incorporating a "detox" metaphor. This design aligns more closely with the psychological preferences of elderly individuals in China. Its simple and intuitive interface provides usable progress feedback, thereby enhancing the exercise experience for the elderly. Through this work, we aim to improve the exercise experience for elderly individuals in China and inspire researchers to focus on the cognitive characteristics of this demographic, exploring intelligent products that better align with their mental models.

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