Frontiers in Arts, Humanities
& Social Sciences

A Study on the Adaptive Design of Intelligent Aromatherapy Massage Products Based on Dynamic User State Perception

Hongling Jiang[1], Xingyao Ye [1], Gao Hongyi[2]

1. Guangzhou Huashang College，Guangdong, China；2. Tianjin Tianshi College, Tianjin, China

Correspondence: Hongling Jiang, Guangzhou Huashang College, Guangdong, China.

Abstract: As the pace of modern life continues to accelerate, the physical and mental stress faced by urban populations has become increasingly prominent, leading to a significant growth in market demand for aromatherapy and massage health products. However, existing products of this type generally suffer from design flaws such as rigid functional modes and an inability to respond to changes in users' dynamic states, making it difficult to truly meet users' personalized and context-specific needs. This paper adopts a research perspective centered on dynamic user state perception, primarily employing qualitative research methods. By integrating in-depth interviews, situational observation, and user journey analysis, it examines the usage behaviors, emotional needs, and patterns of state changes among the target user group. The study found that users' emotional desire to be perceived and understood represents the most prominent gap in current product design, while the temporal regularity of usage scenarios and individual state variability serve as the two driving dimensions for adaptive design. Based on these findings, this study proposes a three-layer adaptive design framework—"Perception—Decision—Output"—and completes a product design implementation. By constructing a closed-loop system comprising perception, response, and learning layers, the product can effectively respond dynamically to users' real-time states, demonstrating significant design value in both functional adaptability and emotional care experiences.

Keywords: Dynamic user state perception; Adaptive design; Smart aromatherapy

Received: April 21, 2026
Revised: May 13, 2026
Accepted: May 20, 2026
Published: May 23, 2026

1. Introduction

The deepening of contemporary urbanization and the rapid iteration of digital technologies have jointly shaped a high-intensity, fast-paced modern lifestyle [1]. Psychological burdens arising from workplace competition, interpersonal relationships, and economic pressures have continued to accumulate across multiple dimensions, making physical and mental health issues a common reality among urban populations. According to the World Mental Health Report 2022: Transforming Mental Health for All, compiled by the World Health Organization in 2022, mental health needs remain high

worldwide, while existing responses are still insufficient and uneven [2]. In China, survey data from the National Health Commission similarly indicate that the proportion of urban residents experiencing suboptimal mental health has been increasing year by year. Against this backdrop, wellness products aimed at physical and mental relaxation, such as aromatherapy products and massage therapy products, have attracted growing consumer attention because of their convenience, gentle user experience, and ability to address both physiological and psychological well-being [3]. According to iiMedia Research's 2023–2024 China Sleep Economy Industry Development and Consumer Demand Research Report (industry report), China's sleep economy and related health consumption markets have continued to expand, reflecting consumers' growing demand for products that support relaxation, stress relief, and sleep improvement. Therefore, personal relaxation products such as aromatherapy devices and massage products have become important product categories within the broader context of health and wellness consumption [4].

However, current aromatherapy and massage products on the market have significant design limitations. The vast majority of aromatherapy devices can only provide mist diffusion at a fixed intensity and lack the ability to dynamically sense the user's emotional state. While some massage products incorporate adjustable settings and timer functions, they essentially still rely on passive, preset program outputs, requiring users to manually configure parameters before each use. This "set-and-forget" interaction model proves particularly unsuitable in real-world scenarios where users' stress levels fluctuate frequently. A more fundamental issue lies in the fact that existing products generally treat user states as static, one-time input variables rather than dynamic, continuous quantities that evolve throughout the entire usage process.

Based on this analysis, this paper proposes a design philosophy centered on dynamic user state perception and conducts systematic research on adaptive systems for smart aromatherapy massage products. Dynamic user state perception refers to a product's ability to integrate multimodal data collection modules to perform real-time, continuous, and multimodal sensing and comprehensive assessment of the user's physiological, behavioral, and emotional states during use. Based on this, the product automatically adjusts its output parameters, thereby achieving a shift in the design paradigm from "users adapting to products" to "products adapting to users." Therefore, this study establishes a multidimensional user state model through qualitative research and constructs a three-tier adaptive design framework of "perception—decision—output," verifying the framework's feasibility through prototype design practices. This study targets daily home usage scenarios for urban working populations aged 18 to 45, using a smart aromatherapy massage set as the primary product vehicle, and does not involve the realm of professional medical rehabilitation equipment.

2. Related Concepts and Theoretical Foundations

2.1 Conceptual Definition of Dynamic User State Perception

The concept of user state perception originated from context-aware research in the field of human-computer interaction. Dey [5] defined context-awareness as "the ability of a system to utilize contextual information to provide relevant information or services to

users." Its core idea is to capture and understand users' behavioral patterns, physiological signals, and psychological states at specific times and locations through technological means. With the continued maturation of wearable sensor technology, artificial intelligence algorithms, and Internet of Things infrastructure, the application scope of user state awareness has significantly expanded to multiple fields, including smart health products and emotional support devices.

In the context of this study, dynamic user state perception specifically refers to the real-time, continuous, and multimodal sensing and comprehensive assessment of users' physiological states (e.g., heart rate, skin temperature), behavioral states (e.g., usage duration, operation frequency, historical preferences), and emotional states (e.g., stress levels, relaxation levels) while using aromatherapy massage products. Dynamic user state perception emphasizes the fusion analysis of multi-source signals and temporal dynamic modeling, while also implying a high degree of sensitivity to individual user differences and changes in usage contexts.

2.2 Theoretical Foundations of Adaptive Design

The theoretical roots of adaptive design can be traced back to cybernetics and systems theory. The feedback control mechanism proposed by Norbert Wiener [6], the founder of cybernetics, provides a foundational conceptual framework for constructing adaptive systems. In Wiener's cybernetic logic, a system continuously perceives changes in its environment or internal state and adjusts its behavior through feedback in order to approach a predefined goal. When this logic is applied to product design, adaptive design emerges as a design paradigm centered on dynamic response to user needs, transforming products from passive tools with fixed functions into active systems capable of perception, judgment, adjustment, and continuous optimization.

This study divides the adaptive design framework into three layers: the perception layer, which uses sensor networks to acquire real-time user status information and serves as the informational foundation for adaptive capabilities; the decision layer, which processes and infers from perception data based on algorithmic models and serves as the intelligent core of adaptive behavior; and the response layer, which adjusts the product's physical output parameters according to decision outcomes and represents the final stage in realizing design value. These three layers form a complete closed-loop system, while the learning layer continuously accumulates historical data to enable the framework's long-term evolution and personalized optimization.

2.3 User Experience and Affective Design Theory

In Emotional Design, Norman [7] divides user experience into three dimensions: the instinctive, behavioral, and reflective levels, revealing the complete psychological process by which users progress from sensory perception and operational experience to the construction of emotional meaning. With the widespread adoption of smart products, Hassenzahl and Tractinsky [8] further argued that user experience is fundamentally about creating value beyond the instrumental, emphasizing the subjective, situated, and dynamic nature of experience in human-product interaction. With the widespread adoption of smart products, user expectations extend beyond the effective fulfillment of functions to include respect for individual differences and proactive intervention in

emotional states. Emotional design theory emphasizes that products should proactively focus on establishing an emotional connection with users, stimulating positive emotional responses through the organic integration of design language, interaction methods, and functional experiences. In the field of health-related products, emotional design is particularly significant, as users' motivations for using aromatherapy massage products often stem from emotional-level needs such as stress relief and mood regulation.

2.4 Current State and Review of Related Research

In the field of adaptive design for smart health products, a relatively rich body of academic research has accumulated in recent years. Overall, it exhibits a continuous trend of deepening in two directions: from single-function automation toward multimodal perception fusion, and from generic group-oriented design toward individual adaptive customization.

Regarding multimodal physiological signal perception and fusion, Picard's [9] pioneering research in the field of affective computing demonstrated that effective identification of users' emotional states can be achieved by integrating multi-source signals such as skin conductance, heart rate variability, and facial expressions. Building on this, Calvo and D'Mello [10] conducted a comprehensive interdisciplinary review of affect detection models and methods, confirming that multimodal fusion approaches consistently outperform single-modality systems in emotional state recognition accuracy. However, these studies mostly remain at the level of algorithm validation, with few exploring the coupling relationship between perception capabilities and functional response mechanisms from the perspective of complete product system design. Research on the intelligent development of massage-based health products has primarily focused on the integration of massage mechanisms with ergonomics, as well as the application of intelligent control algorithms; however, few studies have utilized the user's real-time physiological state as the core input variable driving the adaptive adjustment of massage parameters. Regarding aromatherapy products, research in aromatherapy has thoroughly validated the effects of specific scents on anxiety relief and sleep improvement [11], but none have fully addressed the core issue of how to adjust aroma release parameters in real time based on users' dynamically changing physiological and emotional states. Research on user stress and fatigue detection has advanced significantly with the widespread adoption of wearable devices; non-invasive physiological indicators such as heart rate variability (HRV) and photoplethysmography (PPG) have been widely validated as effective biomarkers for stress assessment [12]. In an early foundational study, Healey and Picard [13] demonstrated that physiological sensors embedded in everyday contexts—such as vehicles—could effectively detect driver stress levels in real-world settings, providing an important proof of concept for non-intrusive physiological monitoring. However, how to translate physiological signal detection into instructions for adjusting product functional parameters—thereby achieving a complete design closed-loop from perception to response—remains a weak point in existing research.

In summary, existing research suffers from three major limitations: First, there is a disconnect between technical research and design research, making it difficult to translate sensor algorithm outcomes into implementable design solutions; second,

research on adaptive design for aromatherapy massage products is extremely scarce, and the logic of multisensory collaborative intervention has not been systematically elucidated; third, existing research generally lacks in-depth consideration of individual user differences, leaving personalized adaptive mechanisms at the conceptual level. Based on these research gaps, this study takes dynamic user state perception as its core driver to construct a three-tiered adaptive design framework—"perception-decision-output"—that integrates multimodal perception, state inference, and multidimensional responses.

3. User Research

3.1 Research Methods and Design

This study adopts a qualitative research approach primarily because its core focus is on users' deep-seated experiences and emotional needs within complex contexts; such context-dependent research questions, rich in connotation, are difficult to fully elucidate through standardized questionnaires or quantitative metrics. Qualitative research methods emphasize a deep understanding of the research subjects' lifeworlds, focusing on contextuality and meaning-making [14], which aligns closely with the research questions of this study. Specifically, this study comprehensively employs three complementary qualitative research methods: in-depth interviews, situational observation, and user journey analysis. The user journey mapping technique, as described by Stickdorn and Schneider [15], provides a structured means of visualizing the complete user experience across time and touchpoints, making it particularly suitable for capturing the dynamic, context-sensitive nature of product interactions.

A total of 30 participants were recruited for the interviews, including 18 women and 12 men, aged between 25 and 40 (mean age = 31.6). Participants were recruited through three channels: announcements posted in online communities related to aromatherapy, massage, and home wellness products; social media recruitment posts distributed through WeChat and Xiaohongshu; and snowball referrals from partner design and health-related institutions. All participants resided in first-tier or new first-tier cities, had at least six months of experience using aromatherapy or massage products, and worked in various industries, including design, internet services, finance, education, and healthcare. The six-month use-experience requirement was verified through a pre-interview screening form, in which participants self-reported the product types they had used, frequency of use, duration of use, and recent usage scenarios. This information was further checked during the opening stage of the interview. No purchase records or platform account data were requested, in order to protect participants' privacy.

The interviews were conducted in batches between January and March 2026 using a semi-structured format, lasting 60-90 minutes each. Before the interviews began, all participants received an informed consent statement explaining the study purpose, interview procedures, recording method, data-use scope, anonymity measures, and their right to withdraw at any time. Written or electronic consent was obtained from all participants, and the sessions were recorded in their entirety only after consent had been granted. The interview outline focused on five key areas: daily stress experiences and patterns of physical and mental well-being; current product usage behavior and

satisfaction; usage contexts and temporal rhythms; expectations and concerns regarding product smart features; and privacy boundaries and willingness to grant data access. After transcribing all interview recordings verbatim, the researchers read and annotated the texts repeatedly to identify key statements and recurring themes. Concurrently, by integrating situational observation records and user journey mapping, they visualized users' usage behaviors, emotional shifts, and pain points. To ensure the authenticity and reliability of the research, the researchers fed back preliminary thematic conclusions to a subset of participants for confirmation and refinement.

3.2 Key Findings from User Interviews

Through systematic analysis and in-depth interpretation of 30 interview transcripts, four core demand dimensions were identified, collectively constituting users' deep-seated expectations for smart aromatherapy massage products.

First, users have a strong emotional desire to be understood. When describing their ideal user experience, many participants independently used emotional expressions that conveyed a sense of being perceived. "I'm already exhausted when I get home from work. Sometimes I don't even have the energy to choose a product mode, so I just press a button at random. As a result, I end up using the wrong setting, which leads to a poor experience, and then I don't want to use it anymore." (P3, female, 29, UI designer) "I wish it could tell how tired I am today. It would be great if it could figure out what I need right now on its own." (P7, male, 34, internet industry professional) These statements reveal users' reluctance to make active decisions when highly fatigued, as well as their emotional need to be "cared for"—the most prominent gap in current product design.

Second, changes in user states follow distinct contextual and temporal patterns. Users' physical and mental states adhere to relatively stable circadian rhythms throughout the day. Weekday evenings are the period when fatigue accumulates most noticeably, with primary needs centered on physical relaxation and emotional relief; weekend days exhibit a relatively positive state; and bedtime is the most emotionally sensitive period, where even slight noise or excessive stimulation can trigger significant discomfort. "On weekends, I like to try out different features, but on weekday evenings, I really just want to lie down and not mess with anything." (P11, female, 32, finance professional) This temporal regularity provides important clues for the product's situational awareness and predictive capabilities.

Third, the feedback mechanisms of existing products make users feel disconnected. A significant portion of respondents' dissatisfaction with current products centers on the feeling that "it doesn't know how I'm feeling." "I think it should ask me, 'How are you feeling today?' or at least give me a way to speak up, rather than just finishing and being done with it." (P5, female, 28, teacher) This need points to the design potential of establishing emotional connections and proactive care after product use. Users expect not only functional satisfaction but also an emotional experience of being noticed and acknowledged.

Fourth, users have a clear understanding of privacy boundaries and a strong sense of protection regarding them. In the interviews, some respondents expressed a willingness to share data in exchange for a more personalized experience, but a significant number adopted a conservative stance, expressing concerns about data

security and privacy breaches. "I don't really want it to be constantly 'watching' me; it might be better if I could choose whether to enable it or not." (P9, Male, 37, Healthcare Professional) This imposes a significant constraint on perception design: perception features must be based on informed user consent and provide clear control options.

3.3 Categorization of User States

Based on interview content and situational observation data, four representative user state types were identified. Considering the continuity and situational dependency of user states, this study positions these classifications as reference prototypes rather than absolute categories.

High-Pressure Fatigue Type is primarily caused by long-term excessive workloads, manifesting as generalized muscle soreness, scattered attention, and irritability. It typically occurs in the evenings following high-intensity workdays, and users in this state have the most urgent need for deep physical relaxation.

Anxiety-Tension Type is often triggered by short-term stressful events, characterized by increased heart rate and shallow, rapid breathing. Emotional unease outweighs physical fatigue, making it more necessary to stabilize emotions through calming interventions via the olfactory channel.

Physical Ache Type is typically caused by maintaining a fixed posture for extended periods, manifesting as localized soreness and stiffness in specific areas. The overall emotional state remains relatively stable, but there is a high demand for targeted massage functions and precise control of pressure.

Mild Low-Mood Type is often associated with seasonal changes, social fatigue, or disrupted daily rhythms. It is characterized by low mood and a lack of motivation, but with no significant physical discomfort. This type requires emotional support through a warm product experience.

3.4 Analysis of User Needs Hierarchy

After systematically organizing user needs identified in interviews, this study categorizes them into three progressive levels (see Figure 1). Functional-level needs include effective physical relaxation, localized massage stimulation, and the synergy between aromatherapy and massage during the experience. Experience-level needs encompass personalized experience expectations—such as the desire for the product to remember personal preferences—a sense of ritual, and ease of use, particularly the need for simple operation when feeling fatigued. Emotional-level needs represent the deepest layer and are the most easily overlooked in design. They include the emotional desire to be understood and cared for, the need for a sense of security and psychological support during times of stress, and the desire to build an emotional connection with the product through continued use. Satisfying these emotional needs is key to enabling health products to transition from mere tools to trusted companions.

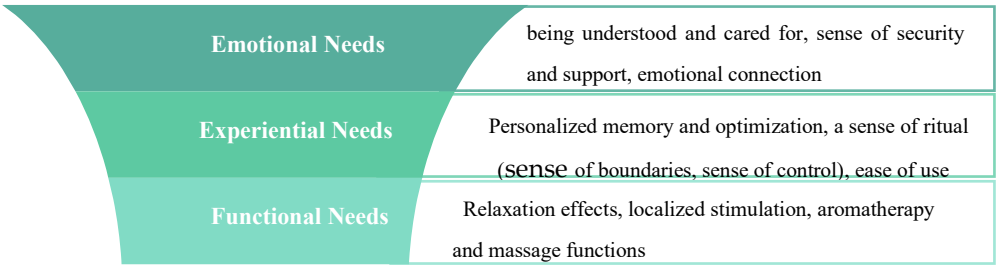

Figure 1 User Needs Hierarchy

3.5 User Journey Analysis

Taking the typical scenario of using an aromatherapy massage product on weekday evenings as an example, this study mapped out a user journey, tracing the complete experience from the user's awareness of fatigue, through active product use, to the conclusion of the session.

The journey analysis reveals significant cognitive friction during the pre-activation stages of state awareness and mode selection: users in a fatigued state are often unwilling to spend time browsing options and tend to make random or repetitive choices, which directly impacts the adaptability of the subsequent experience. During use, the user's focus gradually shifts from active control to passive sensation, with the desire to fully relax without any operational interruptions. After use, users generally expect some form of emotional feedback or a concluding experience, rather than the device simply shutting down abruptly. Based on this, three key design touchpoints were identified: pre-activation state awareness and intelligent recommendations; dynamic adjustments and an uninterrupted experience during use; and emotional closure and data accumulation after use (Figure 2).

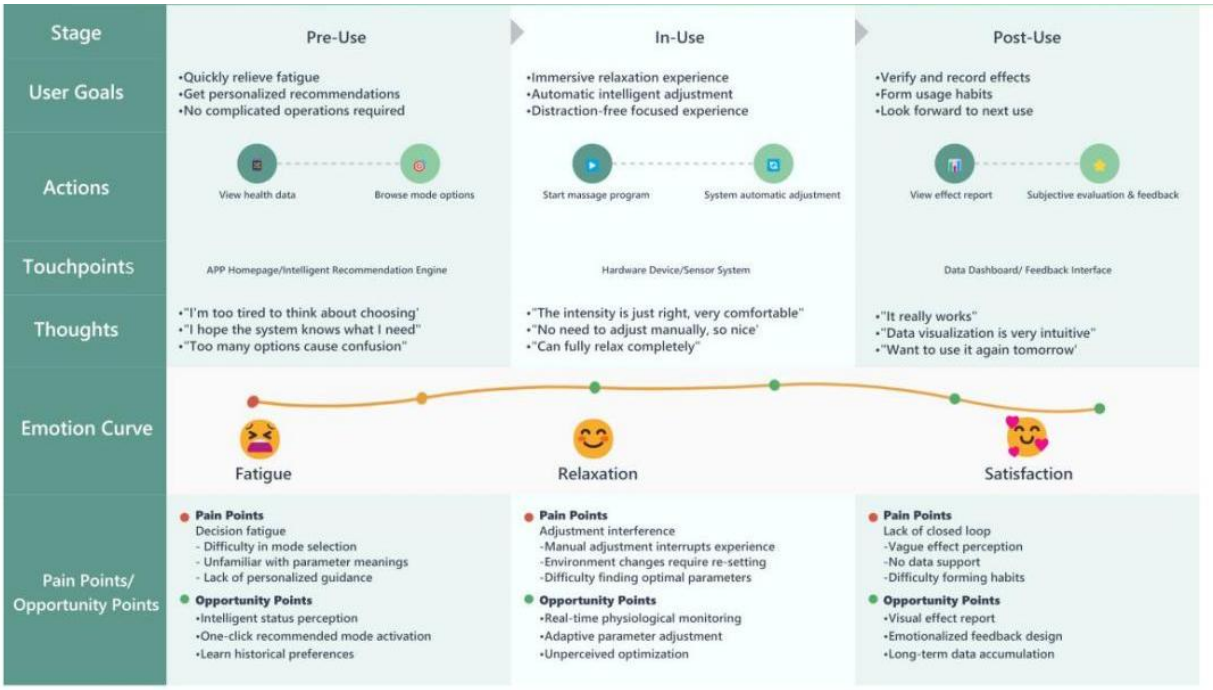

Figure 2 User Journey Analysis

4. Adaptive Design Framework

4.1 Construction of the "Perception—Decision—Output" Three-Layer Framework

Based on the user research, this study constructs a three-layer adaptive design framework for smart aromatherapy massage products. Its core logic is to transform the one-way model of static functional provision in traditional product design into a closed-loop system featuring state awareness, dynamic response, and continuous learning. The framework consists of three interconnected layers—the Perception Layer, the Response Layer, and the Learning Layer—forming a complete "Perception—Decision—Output" design logic (Figure 3).

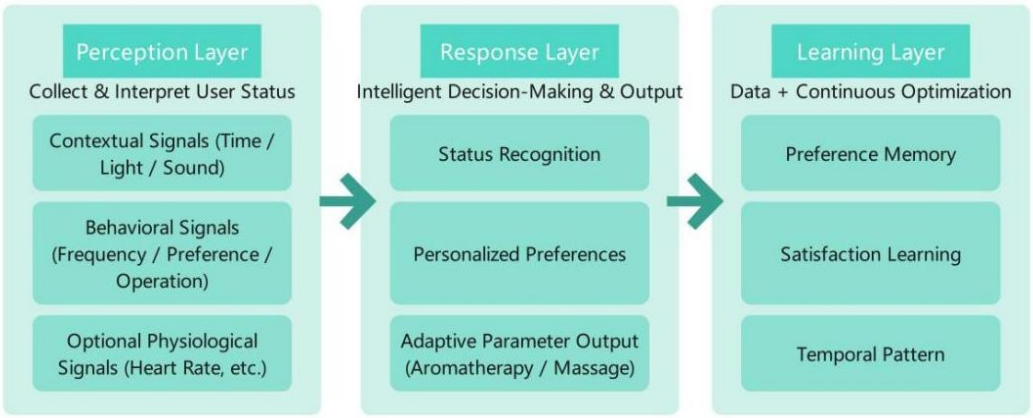

Figure 3 Construction of the "Perception—Decision—Output" Three-Layer Framework

The perception layer serves as the foundational front end, responsible for collecting and interpreting users' multidimensional state information. Taking into account signal reliability, non-invasive data collection, and user privacy acceptance, this study identifies environmental signals (time, light, sound) and behavioral signals (operation mode, usage frequency, historical preferences) as the primary perception channels, with lightweight physiological signals (heart rate, skin temperature) serving as auxiliary channels. The collection of auxiliary channels is configured as an optional feature that users can actively choose to enable, thereby fully respecting user privacy boundaries.

The Response Layer serves as the framework's core execution unit, undertaking dual functions of "decision-making" and "output." The decision-making component uses a weighted rule engine to fuse and analyze multi-source data from the perception layer. By combining this with the user's historical usage data, it infers the current state type and outputs a state label along with a confidence score. The output component then maps the decision results into specific parameter combinations for the product across the two dimensions of aromatherapy and massage. The response layer adheres to the principle of "recommendation rather than enforcement," allowing users to enter manual adjustment mode at any time through simple operations.

The learning layer is key to the framework's long-term value. By continuously accumulating and analyzing data from each user session—including state inputs,

parameter selections, usage duration, and satisfaction feedback—the learning layer can continuously refine and optimize the personalization model. This ensures that recommendations increasingly align with a specific user's true preferences over time, forming a personalized adaptive feedback loop.

4.2 Perception Layer: Design of the Multimodal Perception Mechanism

Multimodal perception is the technical core for achieving dynamic user state recognition. The theoretical basis for multimodal emotion recognition was systematically established by Calvo and D'Mello [10], who demonstrated that integrating multiple physiological and behavioral modalities significantly improves the robustness and accuracy of affective state classification. Building on this foundation, Kim and Andre [16] specifically validated the effectiveness of combining physiological changes—including skin conductance and heart rate—in recognizing emotional states, providing direct empirical support for the multimodal perception strategy adopted in this study. This study proposes the following design principles and specific solutions for the perception mechanism.

First, prioritize the use of contextual signals. Compared to directly collecting physiological data, contextual signals are less costly to acquire, have higher user acceptance, and are sufficient to support state inference in many scenarios. Time signals are the most fundamental and reliable contextual parameters; there are significant differences in user state distributions between 10 PM on weekdays and 2 PM on weekends, allowing the product to establish preliminary state prior estimates based on the time dimension. Lighting signals can assist in determining the ambient atmosphere of the user's environment; sound signals, through analysis of ambient noise via the microphone (rather than monitoring conversation content), can help assess the current level of environmental quietness.

Second, in-depth analysis of behavioral signals. The user's interaction methods when launching the product (touch pressure, operation speed, use of shortcut keys), historical selection patterns, and adjustment behaviors during use are all behavioral signals indicative of state. By interpreting these signals in real time and comparing them with historical data, the system can make reasonably confident inferences about the user's current state without relying on any physiological sensors.

Finally, supplementary collection of lightweight physiological signals. For users willing to enable physiological sensing features, the product can collect heart rate data via a built-in photoplethysmographic (PPG) sensor and surface temperature data via a skin temperature sensor. Given the limited accuracy of consumer-grade sensors, they should be treated as supplementary references rather than primary decision-making criteria in the design of state-determination logic. This study places particular emphasis on the principle of perceptual transparency: whenever the product collects any user data, it must inform the user through clear visual or audio feedback and provide an easily accessible option to disable the feature.

4.3 Response Layer: Adaptive Strategies for Aromatherapy and Massage Parameters

Adaptive aromatherapy parameter strategy. Extensive research in olfactory psychology has shown that specific scents have a significant regulatory effect on human

emotional states and the autonomic nervous system [11,17]. Regarding the mapping of scent types to emotional states, we refer to clinical research findings in aromatherapy: for users experiencing high stress and fatigue, we prioritize calming scents such as lavender and chamomile to help reduce cortisol levels; for users experiencing anxiety and tension, we prioritize anti-anxiety scents such as bergamot and ylang-ylang; for users experiencing physical aches and pains, cooling and invigorating scents such as peppermint and eucalyptus are prioritized; and for users with mild low moods, mood-lifting scents such as neroli and rose are prioritized. Regarding the dynamic control of release intensity, a three-phase aroma release curve is employed, consisting of a gradual onset, a peak, and a gradual fade-out (see Figure 4): a low-intensity, gradual release is used for the first 5 minutes of use; maintain a moderate, stable intensity during the middle phase; and gradually reduce intensity during the final 10 minutes to create a natural olfactory conclusion, synchronizing with the dynamic changes in massage intensity to form a coordinated rhythm.

Adaptive Massage Parameter Strategy. The adaptive design of massage parameters involves four dimensions: intensity, rhythm, area focus, and coordination with heat therapy. Regarding intensity adaptation, the system uses the user's historical preferences as a baseline and dynamically adjusts them by ±20% based on current state signals: in high-pressure fatigue states, it prioritizes medium-to-light intensity to avoid additional stimulation of highly tense muscles; in states of bodily soreness, the proportion of deep pressure can be appropriately increased within the user's tolerance range. Regarding rhythm design, this study integrates massage rhythms with the body's autonomic nervous system regulation patterns: low-frequency rhythmic stimulation at approximately 0.1 Hz has a positive effect on activating the parasympathetic nervous system [12]. Based on this, two basic rhythms are designed: a relaxation mode (a slow rhythm close to 0.1 Hz) and an activation mode. Regarding the non-intrusive fine-tuning mechanism, upon detecting changes in the user's state, the system adjusts parameters in small, incremental steps rather than interrupting the user with pop-up windows or audio prompts. In other words, the product's response to the user's state should resemble that of an experienced massage therapist, who adjusts their technique by sensing subtle user reactions without verbal communication.

4.4 Learning Layer: Design of Personalized Evolution Mechanisms

The learning layer continuously optimizes personalized models through the ongoing accumulation and analysis of user usage data. Understanding the factors that influence users' willingness to engage with and continuously use a personalized system is essential for designing effective learning mechanisms. Venkatesh et al. [18] established in their Unified Theory of Acceptance and Use of Technology (UTAUT) that perceived usefulness and ease of use are primary determinants of technology adoption and sustained engagement, which directly informs the design principle that the learning layer must produce visibly improved and effortless recommendations to sustain user trust. Its core mechanism comprises three components: preference memory treats users' manual adjustments as implicit feedback signals to correct recommendation schemes in real time; satisfaction learning utilizes simple emotional feedback (a satisfaction slider) after each session to provide explicit learning labels; temporal pattern modeling analyzes

historical user state data to identify individual-level patterns in temporal state distributions, enabling the system to make increasingly accurate predictions of future states. The ultimate goal of the Learning Layer is to advance the framework from "generic group responses" to "precise individual adaptation," transforming the product into a personalized companion that truly understands a specific user's preferences over the long term.

5. Design Practice: "Xi" Smart Aromatherapy Massage Set

5.1 Product Positioning and Concept Description

The product developed in this design practice is named "Xi," drawing on the dual meanings of "rest" and "breath" to metaphorically represent the product's pursuit of a dual relaxation experience for both body and mind. "Xi" is positioned as a home-use smart aromatherapy massage set targeting urban professionals. It consists of two products: an emotion-sensing aromatherapy diffuser and a handheld smart massager. The core usage scenarios are private home spaces, such as bedrooms or living rooms, with usage concentrated during weekday evenings, weekend rest periods, and bedtime (see Figure 4).

Figure 4 Rendering of the “Xi” Smart Aromatherapy and Massage Set

The product concept can be summarized as "a relaxation partner that understands you." Guided by a three-tier adaptive framework, the design of "Xi" clearly corresponds to each level of the framework: the perception layer corresponds to the facial expression recognition camera and behavioral data collection module built into the emotion-sensing aromatherapy diffuser; the response layer (decision-making and output) corresponds to the state inference algorithms and parameter mapping rule library in the app's backend, as well as the diffuser's multi-chamber essential oil release mechanism and the massager's multi-mode adaptive switching function; the learning layer corresponds to the app's personalized growth database and emotional calendar modules. Together, these three layers form a complete perception-decision-output closed loop. The product's differentiated positioning is reflected in two key aspects: first, true proactive state perception, rather than remote control disguised as intelligence; second, the synergistic and adaptive output of aromatherapy and massage, rather than a simple combination of two independent functions.

5.2 Product Form Design

The Emotion-Sensing Aromatherapy Diffuser (see Figure 5) features a rounded, flat-elliptical form as its primary design language. Its overall silhouette is full and substantial, with smooth, flowing lines that convey a sense of warmth and stability, allowing it to blend naturally into a home desktop environment. The product features a soft wicker yellow as its primary color, conveying a warm and comfortable emotional atmosphere. The surface is treated with laser engraving, and the material is ABS plastic, which is lightweight, durable, and suitable for mass production.

Figure 5 Rendering of the Aromatherapy Diffuser

Functionally, the aromatherapy diffuser can be divided into three distinct zones: the interactive control zone is located at the front of the product and features five parallel physical adjustment sliders. Users can manually adjust the intensity of the fragrance release, supporting both single-essential-oil diffusion and custom blends of multiple oils; the essential oil atomization zone is situated at the top of the product, featuring mist and liquid outlets. It contains six independent essential oil compartments that can release scents individually or in combination according to user preferences; the mood recognition zone is integrated into the top of the product and includes a built-in camera module. Using facial expression recognition technology, it captures the user's current emotional state and transmits the results to the app, where the system automatically matches the appropriate aroma release—this serves as the core hardware component of the perception layer within the physical product.

The handheld smart massager continues the overall design language of the set, featuring smooth, flowing lines that soften the cold, rigid feel of traditional massage devices (Figure 6). The body also uses a wicker-yellow hue as its primary color, creating visual unity with the aromatherapy diffuser. The product features an ergonomic grip design with a slender handle that allows for comfortable, natural one-handed use; the massage head is equipped with multiple circular silicone massage nodes that conform to the contours of the neck, shoulders, and other body surfaces; the massage head is connected to the body via a horizontal swivel mechanism, supporting multi-angle adjustment, and comes with interchangeable massage heads. The product features a built-in heat therapy function that alleviates muscle tension and fatigue through the synergistic effects of warmth and vibration—this is precisely the functional output

carrier of the response layer in the physical product.

Figure 6 Handheld Smart Massager with Replaceable Massage Heads

5.3 Interaction Interface Design

The "Xi" interaction system consists of the physical interaction zone on the product itself and the accompanying mobile app interface (see Figure 7). The app's overall visual style is warm and bright, using off-white and bright yellow as the primary background colors, paired with simple linear icons and rounded fonts to create a relaxed and friendly user experience.

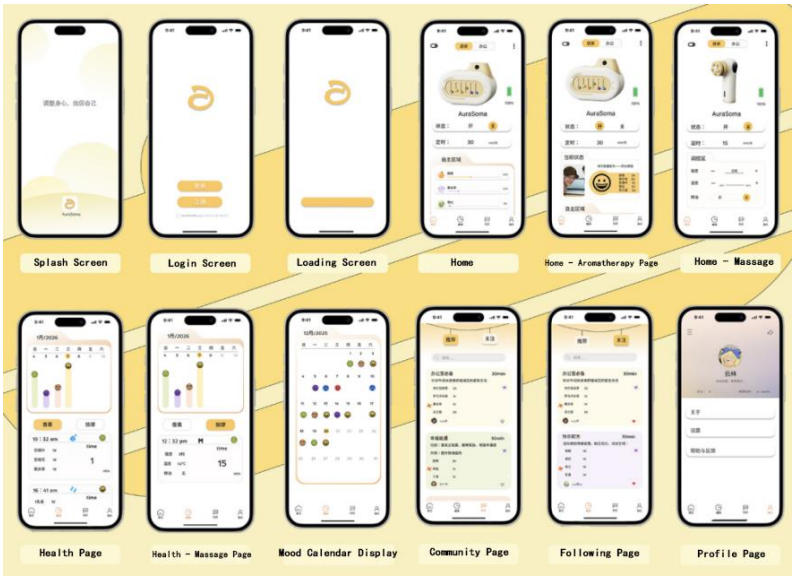

Figure 7 App Interface

The startup screen defaults to adaptive mode, with the system's recommended settings displayed visually for intuitive understanding; users need only confirm once to begin the experience. Manual selection options are retained but designed as secondary actions to reduce the decision-making burden—a design that directly addresses users' need for minimal operational effort when fatigued.

The usage process employs an "immerse upon screen off" interaction logic: after the user confirms launch, the product automatically enters an immersive mode with the screen off, using light effects and vibration as the primary channels for perceptual feedback to avoid visual stimuli from the screen interrupting the state of relaxation.

Only when the system detects a state change requiring user confirmation does it gently draw the user's attention through subtle changes in lighting.

The conclusion of the experience is a crucial element of this design and a concentrated expression of the emotional output at the response layer. Five minutes before the session ends, the system automatically enters the conclusion phase: massage intensity gradually decreases, aromatherapy concentration fades, and the ambient lighting slowly shifts to a warm yellow hue; upon program completion, the screen gently illuminates to display personalized care messages generated from the session's usage data (e.g., "You're feeling a bit better tonight than yesterday—get some rest"), accompanied by a simple satisfaction slider for user feedback. This satisfaction data is immediately fed into the learning layer, serving as a key feedback point for optimizing the personalization model.

5.4 Usage Scenario Demonstration

The product's typical usage scenario is set during the transitional period when the user returns home after a day's work (see Figure 8). The user places the aromatherapy device on a bedside table or a corner of a desk. Upon powering on, the camera automatically initiates the emotion recognition program (perception layer activated), capturing the user's facial micro-expressions and combining them with historical usage data to generate a daily emotional assessment result in the app. If the system determines that the user is in a state of anxiety or fatigue, the app pushes recommendations for soothing fragrance blends. After the user confirms, the device releases essential oil aromas according to the specified parameters (response layer output). At the same time, the user retrieves the massager. Based on the perception results, the app recommends a corresponding massage mode. The massage head conforms to the contours of the shoulders and neck to perform rhythmic pressure, while the heating function activates simultaneously. After use, satisfaction feedback data is transmitted back to the learning layer, completing the full closed-loop of this session.

Figure 8 Usage Scenario Diagram

6. Conclusions

This paper adopts dynamic user state perception as its research perspective and conducts systematic research and practical exploration centered on the adaptive design

of smart aromatherapy massage products. The main contributions of this study are reflected in the following aspects:

In terms of user research, through in-depth interviews, situational observations, and user journey analysis of 30 target users, the study systematically revealed the underlying demand structure and dynamic state characteristics of the target user group. The study found that users' emotional desire to "be perceived and understood" represents the most prominent gap in existing product designs; the temporal regularity of usage scenarios and individual state variability together constitute the dual dimensions driving adaptive design. The induction of four user state prototypes provides an actionable analytical framework for designing product perception-response mappings.

At the methodological level, this study proposes a three-tier adaptive design framework of "Perception—Decision—Output," integrating the product's perception capabilities, inference logic, output responses, and long-term learning and evolution into a comprehensive design methodology, thereby providing a theoretical tool for the design of similar smart health products. The three-tier structure of the perception, response, and learning layers within the framework, along with the design of perception pathways that combine passive sensing with active input, constitute the primary methodological contributions of this study.

At the design practice level, the "Xi" smart aromatherapy and massage set validated the operational feasibility of the three-layer adaptive framework. In practice, the emotion-sensing aromatherapy diffuser, handheld massager, and app interaction system clearly correspond to the three layers of the framework, respectively, exploring concrete implementation methods for the adaptive design philosophy across three dimensions: product form, interaction design, and emotional experience.

This study still has several areas worthy of future exploration: First, as lightweight biosensing technology continues to advance, the core challenge will be how to maintain user trust and privacy security while improving sensing accuracy. Second, while this study is limited to private home environments, future research could expand to more diverse contexts such as office settings and travel; third, the incorporation of interdisciplinary perspectives from psychology, neuroscience, and ergonomics will further enrich the theoretical foundation for evaluating the effectiveness of sensory interventions.

Funding: The research is financed by 2024 Guangzhou Huashang College Featured Project “Research on Evidence-Based Health Design Based on the Elderly’s Health Information Poverty” (2024HSTS10), and the 2025 Ministry of Education Humanities and Social Sciences Planning Fund Project "Evidence-Based Mechanisms and Design Intervention Strategies for Elderly Health Information Poverty from the Perspective of Digital Inclusion" (25YJAZH082). and the 2024 Tutorial System Scientific Research Project of Guangzhou Huashang College Research on Adaptive Design of Health Care Products for the Elderly Under the Rural Community Elderly Care Model (2024HSDS21).This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

[1] Weiser, M. (1991). The Computer for the 21st Century. Scientific American, 265(3), 94-105.

[2] World Health Organization. (2022). World mental health report: Transforming mental health for all. World Health Organization.

[3] Riva, G., Baños, R. M., Botella, C., Wiederhold, B. K., & Gaggioli, A. (2012). Positive technology: using interactive technologies to promote positive functioning. Cyberpsychology, Behavior, and Social Networking, 15(2), 69-77.

[4] iiMedia Research. (2023). 2023 China health and wellness consumer goods market research report. iiMedia Research.

[5] Dey, A. K. (2001). Understanding and using context. Personal and Ubiquitous Computing, 5(1), 4-7.

[6] Wiener, N. (1948). Cybernetics: Or control and communication in the animal and the machine. MIT Press.

[7] Norman, D. (2007). Emotional design: Why we love (or hate) everyday things. Basic Books.

[8] Hassenzahl, M., & Tractinsky, N. (2006). User experience-a research agenda. Behaviour & Information Technology, 25(2), 91-97.

[9] Picard, R. W. (1997). Affective computing. MIT Press.

[10] Calvo, R. A., & D'Mello, S. (2010). Affect detection: An interdisciplinary review of models, methods, and their applications. IEEE Transactions on Affective Computing, 1(1), 18-37.

[11] Koulivand, P. H., Khaleghi Ghadiri, M., & Gorji, A. (2013). Lavender and the nervous system. Evidence-Based Complementary and Alternative Medicine, 2013(1), 681304.

[12] Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. Frontiers in Public Health, 5, 290215.

[13] Healey, J. A., & Picard, R. W. (2005). Detecting stress during real-world driving tasks using physiological sensors. IEEE Transactions on Intelligent Transportation Systems, 6(2), 156-166.

[14] Lewis, S. (2015). Qualitative inquiry and research design: Choosing among five approaches. Health Promotion Practice, 16(4), 473-475.

[15] Stickdorn, M., & Schneider, J. (2011). This is service design thinking: Basics, tools, cases. BIS Publishers.

[16] Kim, J., & André, E. (2008). Emotion recognition based on physiological changes in music listening. IEEE Transactions on Pattern Analysis and Machine Intelligence, 30(12), 2067-2083.

[17] Diego, M. A., Jones, N. A., Field, T., Hernandez-Reif, M., Schanberg, S., Kuhn, C., & Galamaga, M. (1998). Aromatherapy positively affects mood, EEG patterns of alertness and math computations. International Journal of Neuroscience, 96(3-4), 217-224.

[18] Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425-478.