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# *An Analysis of Wearable Device Design for Pet Cats Based on Emotional Design Theory*

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***Abstract:*** With the booming development of the pet market in China, smart devices for pets are becoming increasingly diverse. While wearable smart products for pets, particularly pet cats, have begun to take shape, existing products often overlook the emotional needs between owners and pets while meeting basic pet needs. This paper proposes a design methodology for wearable devices for pet cats based on emotional design theory. By constructing interview outlines and questionnaires, this study delves into pet owners' emotional needs. Analyzing the survey results reveals user expectations for wearable devices for pet cats, providing a basis for subsequent designs. Finally, based on design scheme guidelines, this paper proposes the functional points of wearable devices for pet cats based on emotional design theory.

***Keywords:*** pet market, smart pet devices, emotional design theory, wearable device design

## 1. Introduction

### 1.1. Rapid Development of the Pet Market Economy

With economic development, China's per capita disposable income has increased, and the pet industry has also undergone rapid development and upgrading. According to the *2023 China Pet Industry White Paper*, the industry is rapidly evolving towards diversification and specialization. By 2022, the market size of the Chinese pet industry had reached 84.7 billion yuan, ranking second in the global pet market. Compared to the world's largest pet economy, the United States, China still has significant growth potential. From 2019 to 2023, China's pet industry grew at a compound annual growth rate of 15%, far exceeding the 8% growth rate of the United States. It is expected that from 2024 to 2028, the industry will continue to maintain double-digit growth.

As consumption levels improve comprehensively and new pet-keeping trends emerge, pet needs gradually extend to emotional care. Pet services are becoming richer, and pet product categories are more diversified, with smart devices growing rapidly. Pets are increasingly playing the role of emotional companions in families, and luxurious pet-keeping is becoming a mainstream trend. This reflects the growing maturity of pet-keeping concepts and continuous iteration and upgrading of pet-keeping methods in the market [1].

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## 2. Overview of Existing Smart Devices in the Pet Market

### 2.1. Status of Wearable Smart Products for Pets

In recent years, smart pet products have attracted much attention, showing rapid growth in quantity, sales, and user numbers. According to data from Tianyancha, the sales of smart pet products in the first three quarters of 2023 doubled, with the sales of smart pet nests increasing nearly sixfold year-on-year, and smart pet toys growing by 844.4%, leading the pet life market. In terms of product type penetration, smart tracking wearable devices reached 49.9%. These data indicate that pet supplies are continuously upgrading in intelligence, with growth rates increasing annually.

Current research on wearable smart products for pets mainly falls into three categories: integrating wearable devices into pet companionship devices, applying technological developments in the field of pet wearable products, and proposing the development direction of pet wearable products based on market research [2].

### 2.2. Analysis of Smart Products for Pet Cats

Pets have become "havens for rich human emotions" and "objects for safe emotional investment" [3]. Based on this, smart products for pet cats aim to become emotional bonds between pets and people. Therefore, enhancing the applicability, user experience, and emotional intelligence of pet smart products is crucial. Smart devices must incorporate emotional design to meet users' emotional needs [4]. Promoting emotional communication is essential to truly win users' favor and increase user stickiness. Current smart pet products in the market mainly include smart anti-lost collars, smart feeders, smart massagers, and smart toys [5]. Table 1 below analyzes these four types of products.

Table 1: Analysis of Smart Products for Pet Cats

| Product Name | Audio/Video Function | Occupied Volume | Mobility | Disturbance to Cats | Degree of Emotional Design | Advantages | Disadvantages |
|---|---|---|---|---|---|---|---|
| Smart Anti-lost Collar | Can perform audio, video interaction | Small | Yes | Low | Strong reflective layer experience, behavior layer provides positive feedback, instinct layer small and delicate appearance | Highly accurate positioning system, long battery life, ensures pet safety | Signal instability, requires regular charging |

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Table 1: (continued)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Smart Feeder | Can perform audio interaction | Large | No | Moderate | Weak reflective layer experience, simple basic behavior layer, clunky unattractive instinct layer | Timed feeding, intelligent food measurement, suitable for different pets' needs | Some pets may resist automatic devices |
| Smart Massager | No interactive function | Medium to small | Yes | Moderate | Strong reflective layer experience, simple operation behavior layer, average aesthetic instinct layer | Provides intelligent massage control, making pets more comfortable | Some pets may find the applied force and method uncomfortable |
| Smart Toys | Some include interactive functions | Medium to small | Yes | Low | Strong reflective layer experience, simple operation behavior layer, attractive and practical instinct layer | Reduces pet anxiety, enhances interaction with the owner, provides entertainment and exercise opportunities for pets | Some features may not be sensitive to spe |

Currently, people's needs have shifted from basic sustenance to the pursuit of self-realization, from material needs to spiritual and emotional needs [6]. Analyzing Table 1, we find that the pet smart device market is still in its infancy. Although the devices mentioned above have their advantages, there is still considerable room for development. While smart toys can assist owners in providing entertainment and exercise services for pets, more innovation is needed to meet various emotional needs. For example, personalized designs are needed to cater to different pet types and personalities, and increasing interaction with the owner is a future development direction. In summary, the pet smart device product market has huge development potential. In-depth user research, technological

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innovation, and accurate satisfaction of different pet needs will be the key to the development of this field.

## 3. Emotional Design Theory

### 3.1. Three Levels of Emotional Design Theory

American psychologist Donald Norman, in *Emotional Design*, divides the human emotional system into three levels: visceral, behavioral, and reflective [7]. These three levels form the core of emotional design, significantly impacting product design and user experience.

First is the visceral level, which focuses on the product's appearance design, aiming to satisfy instant sensory experiences. At this level, the appearance of the product is considered crucial because products with strong visual appeal are more likely to attract consumers.

Second is the behavioral level, where emotional design focuses on meeting the user's functional needs. In addition to necessary functionality, product design must consider comprehensibility and usability to ensure users can use the product easily and pleasantly. This level emphasizes solving practical problems while ensuring the product is functional and easy to use.

Finally, the reflective level is more complex and uncertain, related to the user's environment, cultural background, educational experience, and identity. The design goal at this level is to deepen the cultural connotation of the product, evoke reflective value, create brand culture, and establish a long-term relationship with the user, thereby increasing user loyalty [8].

These three levels are interrelated, with each level influencing the other two. This means that in product design, deep emotional connections can affect more basic visceral feelings. This theory provides designers with a framework to consider users' emotional experiences on multiple levels.

### 3.2. Application of Emotional Design Theory in Product Design

Emotional design is a widely used design concept in product design, capable of positively promoting product development. The core idea of this design concept is user-centered, requiring designers to fully consider users' personal needs and living environments to achieve harmonious development between products and users. This design strategy focuses on satisfying psychological and emotional needs, combining emotional design with products to achieve a balance of beauty and practicality, making users feel more comfortable when using the products and satisfying them emotionally.

## 4. Design Method for Pet Cat Wearable Devices Based on Emotional Design Theory

### 4.1. Constructing Interview Outlines Based on Three Dimensions of Emotional Design Theory

The interview outline is divided into two parts: the first part focuses on researching users' interests, social preferences, and consumption concepts to create typical user personas and product application scenarios; the second part, based on the three dimensions of emotional design, delves into users' needs and expectations for pet wearable smart products.

### 4.2. Compiling Questionnaires Based on the Needs of Wearable Devices

The questionnaire survey aims to quantify users' willingness for pet cat wearable smart devices and the demand for functional modules under the three dimensions of emotional design. The content and design goals of the questionnaire are detailed in Table 2.

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Table 2: Questionnaire Content Structure

| Questionnaire Structure | Content | Design Goals |
|---|---|---|
| Basic User Information | Age, occupation, location | Collect basic user information for convenient statistical data collection |
| Willingness to Use Wearable Devices for Pets | Likert nine-point scale | Understand a larger scale of target users' attitudes towards using wearable devices |
| Needs for Pet Wearable Devices Based on Emotional Design Theory | Appearance, safety, aesthetics, interest, functionality, belonging, ease of learning | Understand user groups' demand for pet wearable products, detailed to specific functions for the next step of prototype output |

## 4.3. Analysis of Questionnaire Results for Wearable Devices

This survey used Tencent Questionnaires and received a total of 447 questionnaires. After removing invalid questionnaires, 371 valid questionnaires were obtained, with a recovery rate of 83%. The following content describes the statistical data of the questionnaires.

Table 3: Descriptive Statistics of Demographic Information

| Statistical Variable | | Number (N) | Percentage (%) |
|---|---|---|---|
| Gender | Male | 139 | 37.5 |
| | Female | 232 | 62.5 |
| Age | Under 20 years old | 115 | 31.0 |
| | 20-30 years old | 139 | 37.5 |
| | 30-40 years old | 72 | 19.4 |
| | Over 40 years old | 45 | 12.1 |
| Occupation | Student | 75 | 20.2 |
| | Company Employee | 256 | 69.0 |
| | Freelancer | 40 | 10.8 |
| Education Level | Below High School/Technical School | 92 | 24.8 |
| | Associate Degree | 93 | 25.1 |
| | Bachelor's Degree | 137 | 36.9 |
| | Master's Degree and Above | 49 | 13.2 |
| Total | | 371 | 100 |

Based on the data collected in Table 3, female users account for 62.5%, while male users account for 37.5%. This is consistent with the gender distribution of cat owners in China, indicating that the data source is representative. Additionally, the respondents are mainly concentrated in the 20-30 age group, and the majority are company employees, which aligns with the overall characteristics of cat owners in China.

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Table 4: Likert Nine-Point Scale for Willingness to Use Wearable Devices for Pets

| Questionnaire Content | Number of Responses (1-9 points) (1-3 points strongly disagree, 4-6 points neutral, 7-9 points strongly agree) | | | Average Score |
|---|---|---|---|---|
| I believe wearable devices have a positive impact on pet happiness | 1 point:7 | 2points:24 | 3 points:35 | 5.86 |
| | 4 points:48 | 5 points:37 | 6 points:56 | |
| | 7 points:54 | 8 points:65 | 9 points:45 | |
| I worry that wearable devices might affect pets' comfort and freedom | 1 point:3 | 2 points:12 | 3 points:23 | 6.01 |
| | 4 points:45 | 5 points:70 | 6 points:61 | |
| | 7 points:56 | 8 points:63 | 9 points:38 | |

According to the data collected in Table 4, the study uses a nine-point scale to assess "whether wearable devices have a positive impact on pet happiness" and "whether wearable devices might affect pets' comfort and freedom," with average scores of 5.86 and 6.01, respectively. Overall, users show a neutral attitude towards the use of wearable devices for pets, indicating that there is still significant room for improvement in user experience with current pet wearable devices. Additionally, users have a favorable attitude towards wearable devices, affirming the future development prospects of pet wearable devices.

Table 5: Survey Results on Specific Functions of the Six Demand Modules Under the Three Dimensions of Emotional Design

| Emotional Design Dimension | | Statistical Variable | Number (N) | Percentage (%) |
|---|---|---|---|---|
| Visceral Level | Safety Needs | Durable product texture | 281 | 75.7 |
| | | Can flexibly identify and alert in emergencies | 312 | 84.0 |
| | | No noise during use | 175 | 47.2 |
| | | Physical shape needs to fit various stages of a cat's body | 210 | 56.6 |
| | Aesthetic Needs | Color style conforms to modern aesthetics | 301 | 81.2 |
| | | Strong sense of design, not too complex | 172 | 46.4 |
| | | Can choose custom colors | 145 | 39.0 |
| Behavioral Level | Fun Needs | Immersive interaction with cats | 210 | 56.6 |
| | | Mobile products equipped with entertainment mini-games | 189 | 50.9 |
| | | Interact with pets from their perspective | 64 | 17.3 |

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Table 5: (continued)

| | | | | |
|---|---|---|---|---|
| | Functional Needs | Needs video, audio communication functions | 336 | 90.6 |
| | | Check real-time location and movement track of pets | 278 | 74.9 |
| | | Check pets' physiological health status | 222 | 59.8 |
| | | Understand pets' eating habits | 198 | 53.4 |
| Reflective Level | Sense of Belonging Needs | Equipped with custom pet name tags | 115 | 31.0 |
| | | Product interface can display information related to the pet | 92 | 24.8 |
| | | Personalized account login | 150 | 40.4 |
| | | Interact with other pet owners to feel social support | 290 | 78.2 |
| | Ease of Learning Needs | Functional entry points of the product interface should not be deep, easy to find | 315 | 84.9 |
| | | Similar operation process to most existing products | 192 | 51.8 |
| | | Quick to learn and use | 356 | 96.0 |
| | | Comprehensive but not complex system | 281 | 75.7 |

According to the data collected in Table 5, in the visceral level's safety needs, 84% of respondents emphasize the ability to flexibly identify and alert in emergencies, indicating that this function should be considered in the design of wearable devices. In the aesthetic needs of the visceral level, 81.2% of users hope that the device's appearance conforms to modern aesthetics and prefers a minimalist style. Moreover, the design of pet products affects not only the aesthetic level but also the behavior of pets [9]. Therefore, the appearance of pet wearable products should also meet the "aesthetic standards" of pets. In the behavioral level's fun needs, the demand for immersive interaction with cats is the highest, and most users who chose immersive interaction also prefer mobile products equipped with entertainment mini-games. One of the important purposes of raising pets is to gain more life fun and emotional compensation [10], indicating that the development of mobile mini-games should be considered in the design process. In the functional needs of the behavioral level, 90.6% of users believe that video and audio communication functions are necessary, and these functions have already been widely adopted, so they should be included in the design. In the reflective level's sense of belonging needs, 78.2% of users hope to interact with other pet owners, which can improve the communication among pet owners and enhance the ecological vitality of the pet-keeping environment. Therefore, adding social functions to the device is also a trend. In the reflective level's ease of learning needs, most users hope that the product is easy to learn and use, and can be operated quickly, which is an important factor to consider in product design.

### 4.4. Design Guidelines for Wearable Devices Based on Emotional Design Theory

Based on the above questionnaire analysis, the design guidelines for wearable devices are shown in Table 6.

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Table 6: Specific Functional Guidelines for the Six Demand Modules Under the Three Dimensions of Emotional Design

| Emotional Design Dimension | Functional Category | Design Guidelines |
|---|---|---|
| Visceral Level | Safety | Automatically trigger an alarm and notify the pet owner through a companion app when the device falls off. |
| | | Integrate pressure sensors to detect dragging actions, and automatically release the buckle if continuous dragging exceeds 10 seconds. |
| | | Use low-energy technology to extend battery life and ensure the device's reliability and stability. |
| | Aesthetics | Adopt a minimalist, eco-friendly style to make the product look fresh and clean. |
| | | Offer multiple color options. |
| | | Use high-quality materials to enhance the overall sense of quality. |
| Behavioral Level | Fun | Introduce a mood index system to rate the cat's mood based on its behavior and sounds. |
| | | Equip mobile products with a variety of fun mini-games. |
| | Functionality | Provide timely health alerts and advice. |
| | | Include positioning features to allow owners to track their cat's real-time location. |
| | | Offer video and audio functions for owners to observe and communicate with their cats remotely. |
| Reflective Level | Sense of Belonging | Provide features for interaction and chat with other pet owners to establish a pet community. |
| | | Display owner and pet information on name tags. |
| | Ease of Learning | Maintain the usage habits and operation paths of existing products to reduce the learning cost for users. |
| | | Keep the interface clean, remove unnecessary elements, and focus on clear information presentation. |
| | | Design an intuitive interface to ensure that important and frequently used functions can be easily found. |

## 5. Functional Design Points of Pet Wearable Devices Based on Emotional Design Theory

### 5.1. Visceral Level Functional Points

At the visceral level, understanding users' safety requirements for the device is crucial. Based on the design guidelines mentioned above, the visceral level functional points for wearable device design primarily include:

(1) Device detachment alarm system

(2) Drag action recognition function

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(3) Low-power operation technology
(4) Minimalist design
(5) Color options
(6) High-quality materials

### 5.2. Behavioral Level Functional Points

The behavioral level focuses on the product's effectiveness, ease of use, and the enjoyment of the usage process. According to the design guidelines mentioned above, the behavioral level functional points for wearable device design primarily include:

(1) Emotional recognition function
(2) Entertainment games
(3) Mood index feedback
(4) Physiological monitoring function
(5) Audio-visual interaction function
(6) Nutritional intake recording function

### 5.3. Reflective Level Functional Points

The reflective level explores the improvement of product satisfaction and the reduction of usage difficulty. Based on the design guidelines mentioned above, the reflective level functional points for wearable device design primarily include:

(1) Social interaction function
(2) Information name tag display
(3) Personalized interface design
(4) Usage habit path recording
(5) Easy-to-find entry points
(6) Clean style

## 6. Feasibility Analysis

### 6.1. Feasibility of Emotional Design Theory

Emotional design theory focuses on the emotional connection between users and products. The bond between pets and their owners is deep and unique, adding richer dimensions to design. By deeply understanding users' emotional needs, the device can better fulfill owners' desires to care for their cats, improving the product's acceptability and user satisfaction.

### 6.2. Feasibility of User Needs

Through this study's survey, we found that the primary user group has a strong and widespread demand for enhancing their cats' quality of life and deepening their emotional connection with their pets. The device can meet users' concerns about their cats' health, behavior, and emotions, aligning with user expectations. This demand feasibility provides a clear direction for device design, ensuring that the product has broad acceptability and application prospects in the market.

## 7. Conclusion and Prospects

Guided by emotional design theory, this paper conducts a survey on six demand modules across three dimensions and formulates a comprehensive design guideline. Based on this guideline, an effective pet wearable device design solution is proposed. This solution offers valuable references for the

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development of smart wearable devices. Through feasibility analysis, pet wearable devices for cats are expected to become a market innovation focus, providing more detailed and thoughtful care experiences for pet owners. In the future, as technology continues to advance, smart pet devices will better meet owners' emotional needs.

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