

Emotional Resonance and Interactive Experience: A Framework for Enhancing User Engagement through Empathetic Design

Xinyi Chen

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This study explores the integration of emotional resonance and interactive experience in design and proposes a systematic framework that combines affective computing, multisensory design and ethical considerations. Grounded in emotional design (Norman 2004) and affective computing (Picard 1997), this framework is validated through case studies in smart home systems, emotional support interfaces and interactive pet care. The findings indicate that emotion-aware design significantly improves user engagement (32% increase in smart plant care interactions) and fosters ethical reflection (41% decrease in support for cosmetic pet surgeries). Despite the potential of emotion-aware design, challenges remain in terms of privacy concerns, cultural adaptation and technological feasibility. This research contributes to empathetic design by offering a structured approach to emotion-driven user interactions, with implications for future developments in AI-driven emotional modulation and cross-cultural applications.

#emotional design

#affective computing

#empathetic interaction

#multisensory user experience

Introduction

In recent years, human-computer interaction (HCI) has evolved beyond focusing on usability and functionality to encompass emotionally engaging designs. As highlighted by Norman (2004), emotional design plays a crucial role in creating strong connections between users and products, going beyond basic usability to foster deeper emotional bonds. This shift towards emotional engagement has been further supported by advancements in affective computing (Picard 1997) and the Internet of Things (IoT) (Ashton 2009), which have allowed for real-time emotion-aware interactions between users and systems. However, current research in emotional design often focuses on isolated aspects, such as aesthetics, usability or emotion recognition, without fully integrating these elements into a cohesive framework. While Hassenzahl (2010) emphasised the importance of creating both hedonic (pleasure-driven) and pragmatic (functional) experiences, the integration of emotional resonance with ethical and multi-sensory design elements remains underexplored. This gap motivates our proposal of a systematic design formula to bridge theory and practice. By integrating insights from affective computing, UX research and ethical design, this study introduces a structured methodology for implementing emotion-driven interactive experiences. We validate this framework through case studies of smart home systems, emotional support interfaces and interactive pet care simulations, analysing their effectiveness in enhancing user engagement and ethical awareness.

Literature Review

Norman's (2004) emotional design laid the foundation for understanding how design affects emotions by categorising them into visceral, behavioural and reflective experiences. This typology underscores the complexity of emotional interactions in product design, suggesting that good

design must appeal not only to functional needs but also to emotional experiences. As Hassenzahl (2010) emphasised, experience design focuses on creating meaningful user-product relationships, in which both hedonic and pragmatic aspects work together to provide satisfying interactions. Moreover, Desmet (2002) introduced a taxonomy of product emotions, categorising key emotional responses, such as delight, frustration, attachment and detachment in product interactions, which are central to understanding the emotional outcomes of product design.

Building on these theories, the integration of emotionally resonant design is crucial for fostering long-term engagement and attachment to products. Hassenzahl further elaborated that the emotional dimension of design not only influences users' immediate experiences but also affects their lasting connections with products.

Affective computing (Picard 1997) enables systems to recognise, interpret and respond to human emotions. This has enabled the development of emotion-aware systems that can enhance user engagement by dynamically adjusting based on emotional feedback. Calvo and D'Mello (2010) further explored how affective computing systems capture and process emotional data through facial expressions, voice tone and physiological signals, such as heart rate or skin conductance, enabling real-time emotional adjustments in interactive systems.

Recent developments in virtual reality (VR) and multisensory design further complement affective computing by providing more immersive and emotionally engaging experiences. Shin (2018) demonstrated how VR-based empathy training can enhance emotional intelligence by simulating real-world emotional and social scenarios, showing how embodiment and immersion can foster empathy and emotional awareness. This is especially relevant when designing systems intended to create strong emotional connections, such as

empathy-based learning tools or emotionally adaptive virtual agents.

As emotional design gains prominence, ethical considerations have become increasingly important. The use of anthropomorphic interfaces in HCI, as explored by Diefenbach et al. (2014), can increase user trust and engagement, but they can also lead to ethical issues, such as users developing unrealistic expectations of the system. Isbister (2016) cautioned against emotionally manipulative design, which exploits users' emotional vulnerabilities for profit or engagement in ways that may be deceptive or coercive. Ethical issues also arise in affective computing, in which emotional data can be misused or lead to privacy violations.

Calvo et al. (2010) pointed out that cultural differences in the interpretation of emotions can lead to challenges in designing universal emotion-aware

systems. For example, users from different cultural backgrounds may interpret emotional cues differently, making it important for designers to consider cultural contexts when designing emotion-aware interfaces. This highlights the need for localised adaptation strategies, which can ensure that emotional design is not only effective but also culturally appropriate and ethically sound.

Core Concepts

The design framework proposed in this study builds upon the Double Diamond process (Design Council 2007) and incorporates six stages specifically designed to address emotional resonance in user experiences (see Table 1).

In this framework, the user insights stage is essential for understanding the emotional pain points and needs of users. Emotion journey mapping and

Table 1. Emotion-Driven Interaction Design Framework: Key Steps, Methods, and Outputs. *Source: Author.*

Step	Key Methods	Output Example
<i>User insights</i>	Ethnographic interviews and emotion journey mapping	Identified pain points in plant care routines
<i>Emotional resonance</i>	Persona-based storytelling (Walter 2011) and affective triggers (Picard 1997)	Plant anthropomorphism with emotional states
<i>Interactive experience</i>	Real-time feedback, haptic interaction design and adaptive interfaces	Increased user participation in interactive scenarios
<i>Multisensory design</i>	Integration of visual, auditory and tactile feedback	Enhanced emotional response through multimodal interactions
<i>Social ethics</i>	Ethical impact assessment, privacy considerations and cultural sensitivity	Designing inclusive and ethically responsible systems
<i>Prototype testing</i>	A/B testing of emotional feedback and usability studies	Iterative refinement based on real-time emotional and user feedback

ethnographic interviews provide in-depth insights into how users emotionally interact with products, which informs the development of the next stages. The emotional resonance stage then uses persona-based storytelling and affective triggers to create emotional connections between users and products. These emotional triggers are designed to evoke strong emotional responses that enhance user engagement.

In the interactive experience stage, real-time feedback mechanisms are employed, including haptic interaction designs and adaptive interfaces, to ensure that users receive feedback that is both functional and emotionally resonant. Multisensory design involves incorporating multiple sensory inputs, such as visual, auditory and tactile feedback, to create a more immersive experience. This approach enhances the emotional impact of the interaction by engaging users across various sensory channels.

In the social ethics stage, considerations of privacy, cultural sensitivity and ethical impact are crucial. Designers assess potential risks, such as privacy violations or cultural misalignments, and ensure that their designs are inclusive and ethically sound. Finally, prototype testing involves A/B testing and usability studies to refine emotional feedback mechanisms, ensuring that the system evolves in response to user needs and feedback.

Case Studies

Case Study 1: 'Chloe' – Empathetic Design for Smart Houseplant Care Systems

The Chloe Smart Houseplant Care System integrates affective computing principles and HCI to enhance emotional engagement with plant care. By offering personalised emotional feedback through plant anthropomorphism (e.g. animated plant faces and responses), the system provides users with a more engaging and emotionally satisfying

experience (Figure 1). The system uses real-time monitoring of light, moisture and temperature to adjust its feedback, allowing users to connect emotionally with the system and their plants (Figure 2).

The integration of emotion-aware feedback increased user engagement by 32% (n = 50) after the introduction of these features. However, one challenge was balancing the functional requirements of the system with the need for emotional engagement, ensuring that the system remained easy to use while evoking emotional responses from the user.

Case Study 2: Emotional Nourishment Project

The Emotional Nourishment Project addressed social isolation and emotional healing through tactile interactions. By combining data mining with experiential design, the project introduced a virtual world to simulate a doomsday scenario in which tactile interactions were used to create emotional responses. This study explored how tactile interfaces could bridge the gap between physical interactions and emotional connections, especially in a socially distanced world (Figure 3).

By incorporating tactile feedback, such as hugs and handshakes, the project successfully alleviated stress, anxiety and loneliness in participants (Figure 4). The use of Arduino-based technology allowed for real-time emotional feedback through physical interaction, which significantly improved user engagement and emotional well-being.

Case Study 3: Non-Essential Pet Surgery and Empathy Design

This study explored the emotional impact of non-essential plastic surgery on pets, focusing on procedures such as ear cropping, tail docking and declawing. Through speculative design and inter-

action devices, the project simulated the physical and psychological discomfort experienced by pets undergoing such surgeries. The goal was to foster empathy and provoke cognitive and behavioural shifts regarding animal welfare (Figure 5).

Participants who experienced simulated surgeries through devices such as the *Human Nail Remover* and *Human Voice Remover* reported heightened empathy for pets undergoing these procedures. The devices provided visceral experiences that triggered emotional responses, leading to increased awareness and changes in attitudes towards non-essential surgeries on pets. Public surveys post-test revealed a 41% decrease in support for these procedures, indicating the effectiveness of the empathy-driven design.

emotional modulation, adaptive emotional intensity controls and cross-cultural validation to optimise emotion-driven designs and expand their global applicability.

Discussion

Feasibility and Limitations. While the *Internet of Things* (IoT) and *Virtual Reality* (VR) enable emotion-aware systems (Shin 2018), technical and ethical challenges persist. Privacy risks, especially with continuous emotion tracking (e.g. facial recognition), may conflict with GDPR compliance. Additionally, cultural differences in emotional expression (Calvo et al. 2010) require localised adaptation strategies to ensure inclusivity and effectiveness across diverse populations. Prolonged exposure to emotionally intense interactions may lead to emotional fatigue, necessitating adaptive intensity controls to maintain engagement without overwhelming users.

Conclusion

This study presented a systematic framework for integrating emotional resonance into interactive design, validated through case studies and empirical research. Our findings highlight the effectiveness of emotion-aware interactions in improving user engagement and promoting ethical awareness. Future research should explore AI-driven

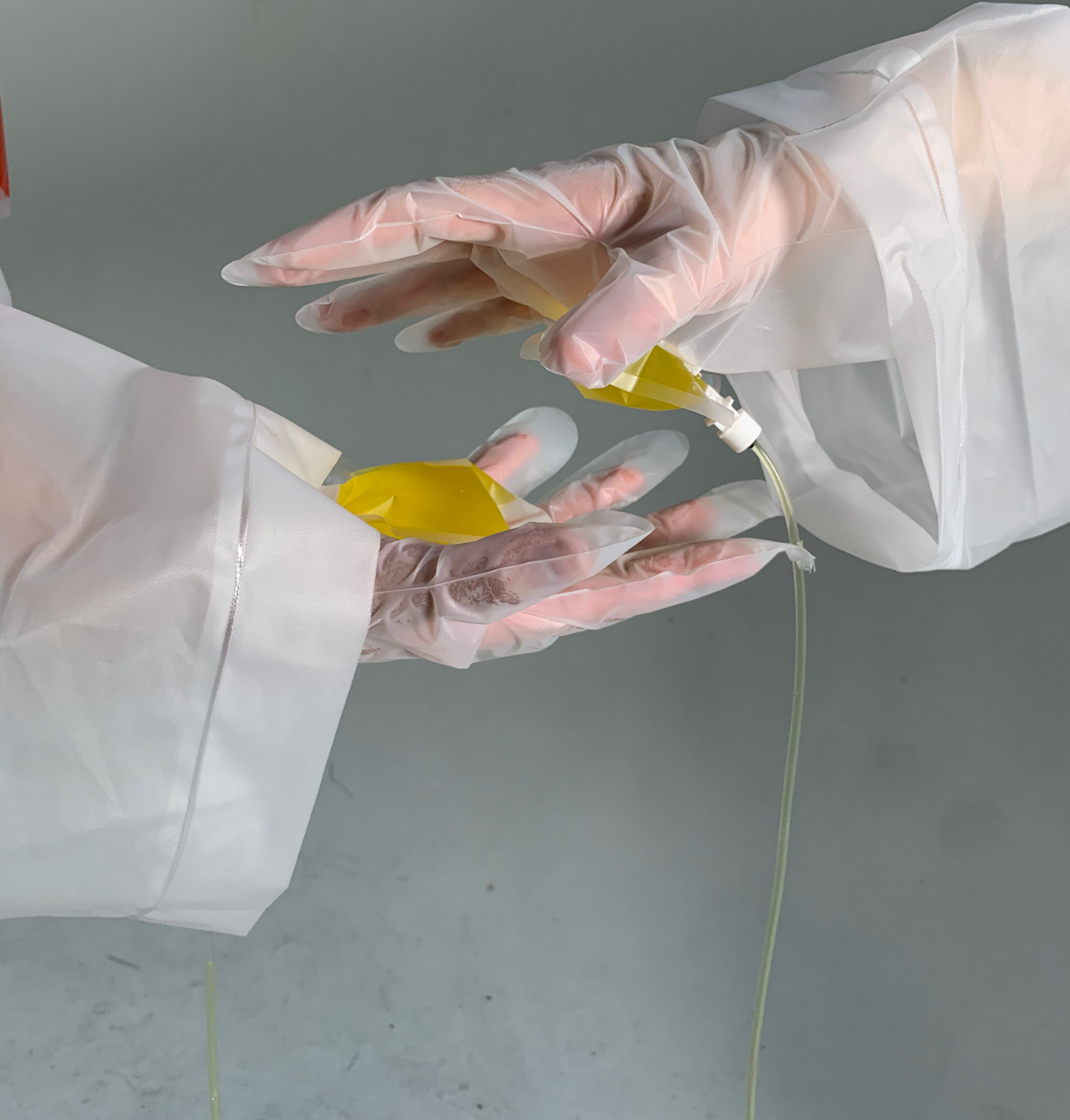


Figure 1. Scenario for 'Chole'. Source: Author.



Figure 2. Application for 'Chole'. *Source: Author.*

Figure 3 (next page). Prototype of 'Emotional Nourishment Project'. *Source: Author.*



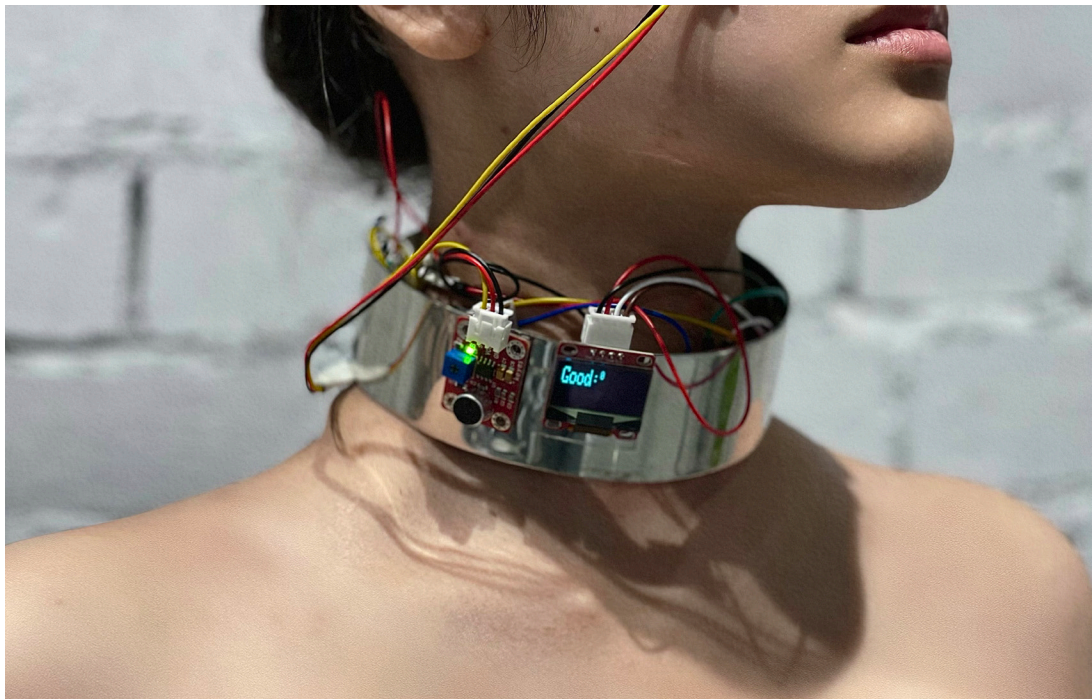


Figure 4 (top). Experimental procedures of 'Emotional Nourishment Project'. *Source: Author.*

Figure 5 (bottom). Mode Testing of 'Non-Essential Pet Surgery'. *Source: Author.*

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Bio

Xinyi Chen is a designer and researcher whose work lies at the intersection of emotional design, human-computer interaction, and interactive media. Her recent projects explore empathy-driven interfaces, affective computing, and ethical technology design in contexts such as virtual care, smart environments, and speculative design. She holds a Master's degree in Design and is currently engaged in interdisciplinary research involving AI, sensory feedback systems, and user engagement in digital experiences.