Application of Smart Wearable Device Interaction Design Based on User Experience Map

*Jiahao Yang**

Swinburne College of Shandong University of Science and Technology, Jinan, China

Received: 18 Nov 2025
Revised: 22 Nov 2025
Accepted: 25 Nov 2025
Published: 28 Nov 2025

Abstract: This paper addresses the interaction design challenges faced by smart wearable devices in limited screen space and diverse usage scenarios, proposing and systematically demonstrating an interaction design method based on user experience maps. By constructing a closed-loop design framework of "user research - journey description - pain point analysis - solution generation - prototype verification," the user experience map is elevated from an analysis tool to a core navigator throughout the entire design process, effectively solving the problems of experience breakpoints and scenario disconnects in traditional design methods. In a case study of a smartwatch's sports and health monitoring function, this framework successfully guided the design process from identifying pain points such as inconvenient data viewing and cumbersome operation to implementing specific solutions such as interface simplification, gesture optimization, and voice feedback. Empirical data shows that after optimization, task operation time was reduced by 45%, the completion rate reached 100%, and the system usability scale improved to an excellent level. This research innovatively establishes a systematic experience design method applicable to smart wearable devices, not only providing an operable process guide for design practice but also laying a theoretical foundation for exploring the integration of user experience maps with new technologies such as artificial intelligence and promoting the development of adaptive interaction.

Keywords: User experience map; Smart wearable devices; Interaction design; User research; Touchpoint optimization

1 INTRODUCTION

With the deep integration of IoT and AI technologies, smart wearable devices have evolved from geek toys to mass-market consumer electronics, and their market is characterized by continuous expansion and fierce competition. Smartwatches, fitness trackers, smart glasses, and other product forms are emerging in large numbers, and their functions are becoming increasingly similar, making it difficult for simple hardware parameters or feature stacking to constitute a lasting competitive advantage. Against this backdrop, user experience has become a key differentiating factor determining product success or failure [1]. However, due to their inherent physical form, these devices face a series of unique challenges in interaction design, such as small screen display areas, limited input methods, battery anxiety, and dynamically changing usage scenarios. Traditional, function-centric interaction design methods often struggle to systematically address these complex issues, leading to user frustration during actual use and ultimately resulting in idle devices.

To fundamentally understand and solve these experiential dilemmas, user experience mapping, as a user-centric, visual narrative design thinking tool, is increasingly demonstrating its value. It can organically connect scattered interaction touchpoints, user behavior, subjective emotions, inner thoughts, and exposed pain points by depicting the complete journey that users experience to achieve their goals, thereby providing design teams with a global perspective of empathy and insight [2]. When dealing with complex systems such as smart wearable devices that are scenario-driven and have scattered touchpoints, user experience maps help to transcend the boundaries of hardware, software, and services, reveal experience breakpoints, and accurately locate design opportunities. Therefore, the core research question of this paper is: how to go beyond the level of user experience maps as a single analysis tool, systematically construct its integration path and application framework with the interaction design process of smart wearable devices, to effectively guide design practice and ultimately achieve a substantial improvement in user experience.

In response to the above questions, it is necessary to sort out the current research status in related fields. In terms of interaction design of smart wearable devices, existing research is mostly focused on the implementation of specific interaction technologies, such as optimizing gesture recognition algorithms, improving haptic feedback effects, or exploring the application of voice interaction, but often lacks top-level planning from the perspective of the complete user journey. Meanwhile, in the theoretical and application fields of user experience maps, the academic and industry communities have fully affirmed their effectiveness in service design and user experience research. However, their systematic and process-oriented application model in the specific hardware product category of smart wearables lacks in-depth discussion. Existing cases are mostly scattered practical sharing, without forming a universal methodology. This research gap is precisely the starting point of this study [3]. Therefore, this study aims to achieve the following objectives: First, to construct a complete and operable "Application Framework for Interaction Design of Smart Wearable Devices Based on User Experience Maps," clarifying the various stages from user research to design verification and their relationships. Second, to verify the effectiveness and guiding value of this framework in real design scenarios through specific case studies. The significance of this study lies in enriching and developing the application theory of user experience maps in the field of embedded smart hardware interaction design from a theoretical perspective; and from a practical perspective, to provide a clear and systematic methodology and toolset for the design and development teams of smart wearable devices, helping them to more efficiently identify experience pain points, generate innovative design concepts, and achieve user-centric continuous product optimization [4].

To achieve the above research objectives, this paper will unfold the following core contents in sequence: systematically expound the theoretical basis of the interactive characteristics of smart wearable devices and user experience maps; focus on constructing the application framework and analyze its core links in detail; select typical design cases for full application and effect verification [5]. In terms of research methods, the literature research method will be comprehensively used to consolidate the theoretical foundation, the best practices and shortcomings will be analyzed through case analysis, user research methods (including in-depth interviews and questionnaires) will be used to obtain first-hand user insights, and the design solutions will be iterated and evaluated by prototyping and testing methods. The structure of this paper will follow the logical thread of "proposing problems - analyzing

Yang., ISTAER. 2573 (2025)., 28 Nov 2025 https://doi.org/10.71451/ISTAER2573

problems-constructing solutions-verifying solutions-summarizing and looking ahead" to ensure the rigor of the research process and the clarity of the discussion.

2 RELEVANT THEORETICAL FOUNDATIONS

To delve into the application of user experience maps in the interaction design of smart wearable devices, it is essential to first clarify their core concepts and theoretical foundations. Smart wearable devices typically refer to miniature computing devices that can be worn directly on the body as accessories or clothing and have data collection, processing, and wireless communication functions. They are diverse and can be mainly divided into wrist-worn devices (such as smartwatches and wristbands), head-worn devices (such as smart glasses and AR/VR helmets), and smart clothing and footwear. The most essential interactive characteristic of these devices stems from their physical attribute of being "always online and always with the body," which determines that their interaction mode must be highly integrated with the user's daily behavior and unconscious state [6]. Therefore, its interaction design faces unique core challenges: on the one hand, limited by extremely small display area and limited battery capacity, information presentation must be extremely concise, and the interaction process must be extremely efficient; on the other hand, the interaction scenario has shifted from a static, focused desktop environment to a dynamic, distracting mobile environment, requiring the interaction method to possess the qualities of glanceable, minimalist, and ambient. Any design that requires users to continuously invest a large amount of attention is likely to fail.

Faced with the above complexity, a User Experience Map (UX Map), as a powerful visual narrative and diagnostic tool, provides a systematic analytical perspective. Essentially, it is a method of graphically depicting the overall experience flow, subjective feelings, and underlying logic experienced by a specific user during interaction with a product or multiple service touchpoints. A complete UX Map typically includes several core components: user personas, chronologically arranged journey stages, specific user behaviors at each stage, accompanying emotional fluctuations, interaction touchpoints used, and pain points and potential opportunities encountered. Its construction is not a one-step process, but an iterative process that requires the integration of qualitative research and quantitative data. It usually begins with user research, and the team collaborates in the form of workshops to map, analyze, and gain insights. The greatest value of this tool is that it can elevate the team's perspective from isolated functional points to a complete user experience flow, promote cross-departmental consensus, and accurately locate experience breakpoints. However, it is not omnipotent. Its quality is highly dependent on the authenticity and comprehensiveness of the input data, and it cannot directly generate solutions. It must be closely integrated with the subsequent design conception stage [7].

Whether it is building an experience map or carrying out specific interface and interaction design, it is necessary to follow the basic principles of interaction design as the benchmark for judgment and creation. Classic interaction design principles, such as Nielsen's 10 Usability Principles, emphasize the visibility of system state, the matching of system with reality, user control and freedom, consistency and standards, error prevention, etc., which are the cornerstones for ensuring product usability. However, when these general principles are applied to the specific field of smart wearable devices, they need to be interpreted and strengthened in a contextualized manner. In response to the characteristics of small screens, the information architecture must follow the philosophy of "less is more," prioritizing the display of core information and avoiding interface congestion through layered navigation [8]. For limb interaction, the design should fully consider the "thumb-friendly" hotspot, make full use of multi-channel input such as gestures, voice, and physical buttons, and provide immediate, non-intrusive tactile or micro-motion feedback to ensure that key operations can be completed even when the user is distracted, such as walking or exercising. These principles together constitute the theoretical filter for evaluating and optimizing the interactive experience of smart wearable devices.

3 CONSTRUCTION OF AN INTERACTION DESIGN FRAMEWORK FOR SMART WEARABLE DEVICES BASED ON USER EXPERIENCE MAPS

To address the systemic challenges in the interaction design of smart wearable devices, this study constructs a design framework centered on the user journey, integrating quantitative and qualitative data, and emphasizing closed-loop iteration. The overall idea of this framework is to abandon the traditional design logic that starts with functional modules and instead use the user's experience flow throughout the entire lifecycle as the core thread [9]. It emphasizes discovering problems from real user behavior and feelings, transforming insights into specific design strategies through a structured process, and ultimately verifying them in the scenarios revealed by the user experience map, thus forming a complete closed loop from insight to verification, driving continuous product optimization.

The initial stage of the framework focuses on a comprehensive understanding of the user. The core task of this stage is to create vivid user profiles and draw detailed user experience maps. First, user profiles representing different behavioral patterns and goals are constructed using mixed research methods (such as interviews, questionnaires, and on-site observations), injecting demographic characteristics and intrinsic motivations into them, making them a reference for subsequent design decisions. Following this, based on the evolution of the user-device relationship, the journey was divided into several key stages, such as initial setup, daily commuting, sports and health monitoring, and even charging and maintenance [10]. On this basis, the team visualized the collected user data through collaborative workshops, depicting the user's specific behaviors, inner thoughts and confusions, accompanying emotional fluctuations, and physical and digital touchpoints at each stage, ultimately identifying significant pain points and potential design opportunities. This map became a shared, empathetic design blueprint for the team.

With a comprehensive experience blueprint, the second stage task was to conduct in-depth diagnosis and focus. The team needed to systematically categorize and prioritize all identified pain points based on the user experience map, typically ranking them according to their frequency of occurrence, the degree of disruption to user goals, and the feasibility of repair, thereby concentrating resources to solve the most critical problems [11]. Subsequently, a key creative transformation step is to rephrase the selected high-priority pain points into clear design opportunities, such as the pain point of "difficulty in switching songs with one hand while running" is transformed into the design proposition of "designing a quick audio control method for sports scenarios that does not require looking at the screen." This process naturally guides the analysis to focus on core interaction scenarios, such as lightweight message processing, real-time monitoring of sports data, and interpretation of health trends, ensuring that subsequent design efforts can be invested in the links that have the greatest impact on user experience [12].

After clarifying the design direction, the third stage enters the specific solution generation and strategy formulation. Here, it is necessary to transform the design opportunities into practical interaction design solutions. The information architecture needs to be reshaped, adopting a flat or context-adaptive layout to ensure that users can reach the core functions within three clicks. The interaction flow and gesture design needs to follow the principle of "minimizing cognitive load," giving high-frequency operations intuitive and easy-to-remember swipe gestures or combination buttons. The visual and motion design needs to serve the clear communication of information, using high-contrast colors, appropriate white space, and subtle motion effects to guide attention and provide operational feedback [13]. Furthermore, the device must be considered within a larger ecosystem, with careful design of its collaborative interactions with companion devices such as smartphones to achieve seamless task handover and intelligent notification filtering.

The final stage of the framework aims to complete the validation loop from concept to experience. Here, the design strategy needs to be translated into an interactive, high-fidelity prototype, which should realistically simulate the hardware characteristics and software responses of the final product. Subsequently, usability testing will no longer be limited to isolated task operations, but instead, based on the user experience map created in the first stage, invite target users to revisit key journey stages in simulated real-world scenarios to observe their behavior and collect feedback. By setting quantitative indicators such as task completion rate, operation time, error rate, and subjective satisfaction, combined with qualitative user evaluations, the optimized experience can be objectively measured. The collected data and insights will provide direct input for the next round of design iterations, ensuring that the product experience is continuously improved and refined in each iteration.

4 CASE APPLICATION AND PRACTICAL VERIFICATION

To verify the effectiveness and feasibility of the framework, this study selects the core "sports and health monitoring" function module in the smartwatch field as a specific application case. This function, due to its dynamic and varied usage scenarios, clear user needs, and extremely high requirements for interaction efficiency, has become an ideal touchstone for testing a user experience map-centered design approach. We use a mainstream smartwatch with multiple sports modes as a prototype. While its health monitoring function is comprehensive, it often draws criticism in actual user experience due to insufficient interaction design. This section aims to fully project the theoretical framework constructed in Section 3 into this real and typical design scenario, demonstrating the entire process from insight to implementation through concrete practice.

At the beginning of the application process, we first conducted in-depth target user research focusing on the group of "smartwatch users with regular exercise habits." Through interviews and observations, we created two representative user profiles: one is an amateur running enthusiast focused on data tracking and improvement, the "ambitious runner"; the other is an urban fitness enthusiast who prioritizes convenience and consistency in exercise, the "efficiency-oriented post-workout." Based on these user profiles, we created a comprehensive user journey map for "Sports and Health Monitoring," clearly divided into four core stages: pre-exercise goal setting and equipment preparation, real-time data tracking and operation during exercise, data saving at the end of exercise, and post-exercise data review and analysis. The map presents user behaviors, thoughts, and emotions at different touchpoints (such as mobile app, watch interface, and physical buttons), accurately revealing several key pain points: such as during exercise, viewing different data pages requires multiple clicks and is prone to accidental touches; after exercise, data synchronization to the mobile app is slow, and the analysis reports are difficult to understand; and throughout the process, there is a lack of effective real-time voice encouragement or warning feedback. These pain points were systematically transformed into specific design opportunities, such as "designing a display mode that makes core data readily apparent during exercise," "establishing a clearer and more intuitive way to visualize and interpret data," and "introducing contextualized voice coaching functionality."

Based on these clear design directions, we generated a series of specific interaction design optimization solutions. To address the challenge of viewing data during exercise, we redesigned the information architecture, integrating the three most crucial data points-heart rate, duration, and distance-into a single, scroll-free "core dashboard" interface. A user-defined quick data page switching gesture is activated by long-pressing the crown, significantly reducing the number of steps required. To address the difficulty of understanding data after exercise, we optimized the data visualization design in the mobile app, replacing lengthy raw data lists with trend graphs and easily understandable "Exercise Effect Evaluation" labels. Simultaneously, we introduced a crucial voice progress prompt function for high-intensity interval training. All these solutions were integrated into a high-fidelity interactive prototype that accurately simulates the interaction between the watch hardware and the accompanying app. Subsequently, we recruited users matching our profile and conducted usability tests in realistic environments, such as treadmill exercises, based on previously created journey map scripts, focusing on observing the differences in their experience before and after optimization.

To objectively evaluate the application's effectiveness, we set several evaluation metrics, including the completion rate of key tasks, the average operation time per task, and subjective satisfaction scores measured using the System Usability Scale (SUS). Comparative analysis of the optimized prototype and the original design revealed that, on the task of "switching to view specific data during exercise," the average operation time was reduced by approximately 45%, and the task completion rate reached 100%. The SUS score improved from the "acceptable" range to the "excellent" level. In qualitative feedback, users generally praised the new interaction flow as "more intuitive" and "less distracting," especially allowing them to focus more on the movement itself during exercise rather than being distracted by device operation. One user commented, "The voice prompts allow me to maintain my rhythm without looking down at my watch; it feels more like having a personal coach." These quantitative data and qualitative evaluations together demonstrate that the design optimization guided by this framework effectively addressed the core pain points identified in the user experience map, significantly improving the usability and user satisfaction of the "sports and health monitoring" function in real-world scenarios. This verifies the clear guiding value and effectiveness of the design framework in practice.

5 DISCUSSION

Through the practical verification of the case studies, the design framework constructed in this study demonstrates its unique effectiveness and application value. The framework's greatest advantage lies in its systematic and closed-loop characteristics, successfully transforming the user experience map from a relatively isolated analytical tool into a core driving force throughout the entire design process. Compared to the limitations of traditional methods that may only address symptoms, this framework forces design teams to start from the complete user lifecycle journey, ensuring a comprehensive screening of potential problems and precise focus on core scenarios. In the case studies, we see that this holistic perspective allows design interventions to not only solve the single pain point of "inconvenient operation during movement" but also to collaboratively optimize the overall experience flow from pre-movement preparation to post-movement understanding, achieving consistency and coherence in the experience. Furthermore, the framework explicitly anchors the "verification" stage to the initial user experience map, making testing not merely a simple functional confirmation but a regression test of the pre-defined journey, effectively ensuring that the design solution truly addresses the initially identified user challenges.

A deeper exploration of the user experience mapping method itself reveals its high applicability in the field of smart wearable device design, while also highlighting its inherent limitations. Its applicability is rooted in the essence of the smart wearable device experience-a dynamic process spanning time, space, and multiple touchpoints. The powerful narrative and visualization capabilities of maps are perfectly suited to capture and present this fragmented, scenario-based experience, subtly weaving together hardware performance, software interaction, and user emotions. This is crucial for understanding and designing an "always-on" personal device. However, we must also recognize its limitations. The quality of user experience map construction heavily relies on the breadth and depth of user research data. If the initial user profile is inaccurate or the journey stages are improperly segmented, it may lead to an incorrect design direction. Furthermore, the map itself is a highly condensed "diagnosis report," revealing "where the discomfort is" and "why the discomfort is," but it doesn't automatically provide a "how to treat it." Its full value must be realized through close collaboration with subsequent rigorous design concepts and engineering implementation.

This research also provides some key insights into the future evolution of smart wearable device interaction design. First, with the increasing diversification of device forms (such as smart rings, fabric sensors, etc.) and the penetration of AI capabilities, the focus of interaction design will gradually shift from "how to complete a task" to "how to seamlessly predict and meet user needs." This means that future user experience maps may need to incorporate more context-aware data layers to depict the implicit dialogue between users and devices in more complex environments. Second, design methodologies themselves also need to evolve. A single user experience map may need to be used in conjunction with tools such as service blueprints and ecosystem maps to address the complexity of devices as nodes in a vast Internet of Things. Ultimately, the paradigm of interaction design may shift towards "adaptive experience," where devices can dynamically adjust their interaction patterns and information presentation based on preferences and pain points revealed in the user experience map at different stages of the journey, thereby achieving truly personalized and human-centered companionship.

6 CONCLUSION AND OUTLOOK

This study, through systematic theoretical construction and case verification, establishes the effectiveness and practical value of an application framework for interaction design of smart wearable devices based on user experience maps. The main conclusion is the successful construction of a closed-loop design framework centered on the user journey and spanning the entire process of "research-insight-design-verification." Its core lies in elevating the user experience map from a static analytical tool to a dynamic design navigator, ensuring that every design decision stems from a deep understanding of users' real-world scenarios and emotional fluctuations. By focusing on the typical scenario of "sports and health monitoring," the study finds that following the interaction optimization schemes proposed by this framework-such as integrating core data interfaces, introducing custom gestures, and contextualized voice feedback-significantly reduces users' operational load and cognitive burden. This is reflected not only in the quantitative improvement of task completion time and error rate but also in the positive evaluations of "more intuitive" and "more focused" in users' subjective experience. This powerfully demonstrates that the framework has clear guiding significance for solving specific interaction challenges of smart wearable devices and improving the overall user experience.

The innovation of this study mainly lies in the integration and advancement of its methodology. It didn't create entirely new design tools, but rather deeply embedded existing user experience mapping methods into the interaction design process of complex hardware products like smart wearable devices, forming a concrete and actionable application paradigm. The framework's outstanding value lies in its ability to guide design teams beyond the limitations of single touchpoints, discovering potential experience breakpoints and contradictions between isolated functionalities from a holistic perspective of the experience flow, thereby fostering more collaborative and consistent integrated design solutions.

Of course, this research also has certain limitations. While the case studies are typical, they primarily focus on the sports scenarios of smartwatches. Its universality in other device forms (such as smart glasses and smart clothing) or more complex social and medical scenarios needs further testing. Furthermore, the application cost of the framework, especially the resource and time requirements for user research and collaborative workshops, may pose a challenge for small teams; its efficiency optimization is an issue worthy of in-depth discussion.

Looking to the future, this research opens two promising directions. One is the deep integration of user experience mapping with other design tools. Such as integrating it with service blueprints can bridge the gap between the user's perspective and the backend technology/service support perspective. This allows for the optimization of frontend interaction while clarifying and ensuring the backend data flow and service touchpoints required for a seamless experience, which is crucial for building a mature smart wearable ecosystem. Second, it explores the evolution of this framework driven by AI. With the development of context awareness and machine learning technologies, future smart wearable devices are expected to evolve from "tools" to "partners." Based on the deep insights accumulated from user experience maps, devices can be trained to understand the user's intentions and emotional states at specific stages of the journey. This enables dynamic reconstruction of the interface, adaptive filtering of information content, and intelligent switching of interaction methods (such as touch and voice), ultimately moving towards a new paradigm of "predictive" and "seamless" adaptive interaction. This will open a new section in the experience design of smart wearable devices.

REFERENCES

[1] Zhang, Q., & Liu, Y. (2022). Smart user experience medical app interface design based o n mobile devices. *Expert Systems*, *39*(5), e12808. DOI: https://doi.org/10.1111/exsy.12808

[2] Chen, G. (2024). Design and Application of Scenario-Based Perception of Smart Wearable Device Interaction Method. *International Journal of Interactive Mobile Technologies*, *18*(1 3). DOI: https://doi.org/10.3991/ijim.v18i13.49071

[3] Hu, L., Chen, Y., Cao, E., & Hu, W. (2025). User experience & usability of wearable he alth device: A bibliometric analysis of 2014–2023. *International Journal of Human–Compu ter Interaction*, *41*(8), 5100-5119. DOI: https://doi.org/10.1080/10447318.2024.2357905

[4] Ren, X. (2024, December). User Experience Design of Wearable Devices using Fuzzy Lo gic. In *2024 IEEE 16th International Conference on Computational Intelligence and Com munication Networks (CICN)* (pp. 1284-1288). IEEE. DOI: https://doi.org/10.1109/CICN6305 9.2024.10847376

[5] Li, Z. (2024, December). User-Centered Design and Implementation of an Intelligent Wearable Device for Real-Time Health Monitoring in IoT Ecosystems. In *2024 4th International Conference on Electronic Information Engineering and Computer Communication (EIECC)* (pp. 1290-1293). IEEE. DOI: https://doi.org/10.1109/EIECC64539.2024.10929262

[6] Baskan, A., & Goncu-Berk, G. (2022). User experience of wearable technologies: a comparative analysis of textile-based and accessory-based wearable products. *Applied Sciences*, *12*(21), 11154. DOI: https://doi.org/10.3390/app122111154

[7] Khan, A., & Khusro, S. (2022). A mechanism for blind-friendly user interface adaptation of mobile apps: A case study for improving the user experience of the blind people. *Journal of Ambient Intelligence and Humanized Computing*, *13*(5), 2841-2871. DOI: https://doi.org/10.1007/s12652-021-03393-5

[8] Yin, R., Wang, D., Zhao, S., Lou, Z., & Shen, G. (2021). Wearable sensors-enabled human–machine interaction systems: from design to application. *Advanced Functional Materials*, *31*(11), 2008936. DOI: https://doi.org/10.1002/adfm.202008936

[9] Srivastava, R., Alsamhi, S. H., Murray, N., & Devine, D. (2022). Shape memory alloy-based wearables: a review, and conceptual frameworks on HCI and HRI in industry 4.0. *Sensors*, *22*(18), 6802. DOI: https://doi.org/10.3390/s22186802

[10] Liu, W., Lee, K. P., Gray, C. M., Toombs, A. L., Chen, K. H., & Leifer, L. (2021). Transdisciplinary teaching and learning in UX design: a program review and AR case studies. *Applied Sciences*, *11*(22), 10648. DOI: https://doi.org/10.3390/app112210648

[11] Prati, E., Villani, V., Grandi, F., Peruzzini, M., & Sabattini, L. (2021). Use of interaction design methodologies for human–robot collaboration in industrial scenarios. *IEEE Transactions on Automation Science and Engineering*, *19*(4), 3126-3138. DOI: https://doi.org/10.1109/TASE.2021.3107583

[12] Rui, Z., & Gu, Z. (2021). A review of EEG and fMRI measuring aesthetic processing in visual user experience research. *Computational Intelligence and Neuroscience*, *2021*(1), 2070209. DOI: https://doi.org/10.1155/2021/2070209

[13] Šumak, B., Brdnik, S., & Pušnik, M. (2021). Sensors and artificial intelligence methods and algorithms for human–computer intelligent interaction: A systematic mapping study. *Sensors*, *22*(1), 20. DOI: https://doi.org/10.3390/s22010020