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Case Study on User Interface Design of Home Blood Pressure Monitors

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Abstract: ***Background:*** Blood pressure monitors are medical devices that accurately measure blood pressure, enabling individuals to monitor their blood pressure levels. As hypertension has become more prevalent and awareness of blood pressure management has increased, the demand for these monitors has grown significantly high, making them essential tools for household health management. In this context, designing efficient and comfortable user experiences for blood pressure measurement has become a critical focus for deisgners, who aim to support users in effectively managing their blood pressure levels . ***Purpose：*** This paper aims to enhance the design of user interface (UI) for innovative blood pressure monitors. ***Methods:*** An integrated approach combining literature review and case comparison was used to examine UI designs of home-use blood pressure monitors, with a focus on the characteristics of tangible user interfaces (TUIs) and graphical user interfaces (GUIs). ***Results:*** For physical interfaces, function buttons using letters or graphic symbols were more difficult to recognize than those with plain text, resulting in underutilization of certain functions. For graphical interfaces, a comparative analysis of five brands' measurement displays revealed variations in information layout, data volume, and graphic design. Among these Omron J735 and Yuwell S67XR exhibited relatively better performance. ***Conclusion:*** Blood pressure monitor display must be optimized to better address users' specific needs. Enhancing information layout, data quantity, and graphic clarity will ensure easy access and accurate interpretation of health information for users of all ages and abilities.

Keywords: Home blood pressure monitor, Tangible User Interface (TUI), Graphical User Interface (GUI), User Interface Design, User experience

1. Introduction

1.1 Research Background

Hypertension is no longer just a disease of the elderly; the average age of patients is continuously decreasing. On September 19, 2023, the World Health Organization (WHO) released the "Global Hypertension Report" titled "The Race Against a Silent Killer." The report indicates that one-third of adults worldwide have hypertension, with nearly half of these patients being unaware of their condition and about four-fifths not receiving appropriate treatment (Yu, 2025). According to preliminary results from the "Cardiovascular Disease and Its Risk Factors Surveillance among Chinese Residents" project, the prevalence of hypertension among residents aged 18 and above in China was 31.6% between 2020 and 2022. This prevalence was higher among males (36.8%) than females (26.3%), and was common in rural areas (33.7%) compared to urban areas (29.1%). The awareness, treatment, and control rates for hypertension were 43.3%, 38.7%, and 12.9% (Yu, 2025), respectively. Based on these figures, it can be inferred that 89.4% of those aware of their condition are receiving treatment, and among those being treated, 33.3% have their hypertension under control (National Center for Cardiovascular Diseases et al., 2024).

Given that the diagnosis and treatment of hypertension depend on accurate blood pressure measurements and precise readings, the demand for blood pressure monitors is surging as the number of hypertension patients increases and awareness of blood pressure management grows. Home blood pressure monitors are becoming essential tools for health management in many households, enabling individuals to better manage and monitor their health conditions.

Current Status of Market Research on Blood Pressure Monitors Abroad: According to the "In-depth Analysis and Prospect Outlook Report on the Global and Chinese Blood Pressure Monitor Market - 2021 Edition," the global market size for blood pressure monitors grew from $9.181 billion in 2016 to 12 billion, showing a steady upward trend. The United States, as the world's largest consumer market for blood pressure monitors, has a market size exceeding $3.5 billion, accounting for approximately 32% of the global market.

Countries like France, Germany, the United Kingdom, and other European nations are the major production and sales hubs for electronic blood pressure monitors, representing about 25% of the market. In Asia, China and Japan hold around 20% and 13% of the global market size, respectively, as shown in Figure 1.

In developed countries and regions such as the United States, Japan, and Europe, the penetration rate and market saturation of blood pressure monitors are relatively high. Notably, Japan has achieved a market penetration rate of 60%, which has driven rapid development and technological innovation within its blood pressure monitor industry. Currently, Omron Corporation of Japan has become one of the world's largest manufacturers of blood pressure monitors and had significant brand influence in this sector (Wang, 2023).

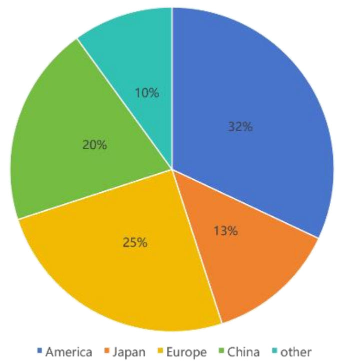

Figure 1: Blood Pressure Monitor Market Size by Country (Wang, 2023)

Current Status of Blood Pressure Monitor Market Research in China: According to a report by the China Pharmaceutical and Healthcare Materials Association, the market size for electronic blood pressure monitors in China reached approximately 2.5 billion RMB (about $390 million) in 2020 — a significant increase compared to previous years. In 2015, the market size was estimated to be slightly over 1.5 billion RMB (approximately $234 million) (Zhang et al., 2022). Another report from ResearchAndMarkets.com indicates that the Chinese electronic blood pressure monitor market reached around $301 million in 2020, with a projected compound annual growth rate (CAGR) of 8.6% from 2021 to 2026 (Zhou, 2021).

Currently, foreign brands still dominate the domestic blood pressure monitor market in China. Among them, Omron holds as much as 45% of the market share, establishing itself as an industry benchmark. The company demonstrates significant technological advantages, research and development, product quality, and brand influence (Zhou, 2021).

According to publicly available data from the Disease Prevention and Control Bureau of the Ministry of Health, the household penetration rates for electronic blood pressure monitors in the United States, Japan, and China are approximately 50%, 60%, and 1.2%, respectively (Zhu et al., 2020). This indicates that the adoption rate of home-use blood pressure monitors in China remains very low. However, it also suggests substantial potential for future market growth.

1.2 Research Purpose

Designing intelligent blood pressure monitors with excellent user experience tailored to the needs of hypertensive patients not only carries important practical significance but also addresses urgent market demands. Enhancing the intelligence and user experience of these monitors can help improve self-management among patients with hypertension and promote overall industry advancement. This paper aims to provide essential information for the user interface design of new intelligent blood pressure monitors.

1.3 Research Content

Firstly, this paper outlines the theoretical foundation of user interface design based on prior research. Secondly, compares and analyzes the interface designs of existing home blood pressure monitors based on the theoretical basis of the previous user interface design through market research. The research focused on two key aspects: First, an investigation and analysis of the Tangible User Interface (TUI) of various home-use blood pressure monitors to identify their composition and design characteristics. Second, an examination of the measurement display interfaces of five different brands of home-use blood pressure monitors to understand their design features. Based on the results of these analyses, this paper proposes targeted improvement suggestions aimed at enhancing the design quality of user interfaces for home-use blood pressure monitors, thereby better meeting user needs. The specific research process is shown in Figure 2.

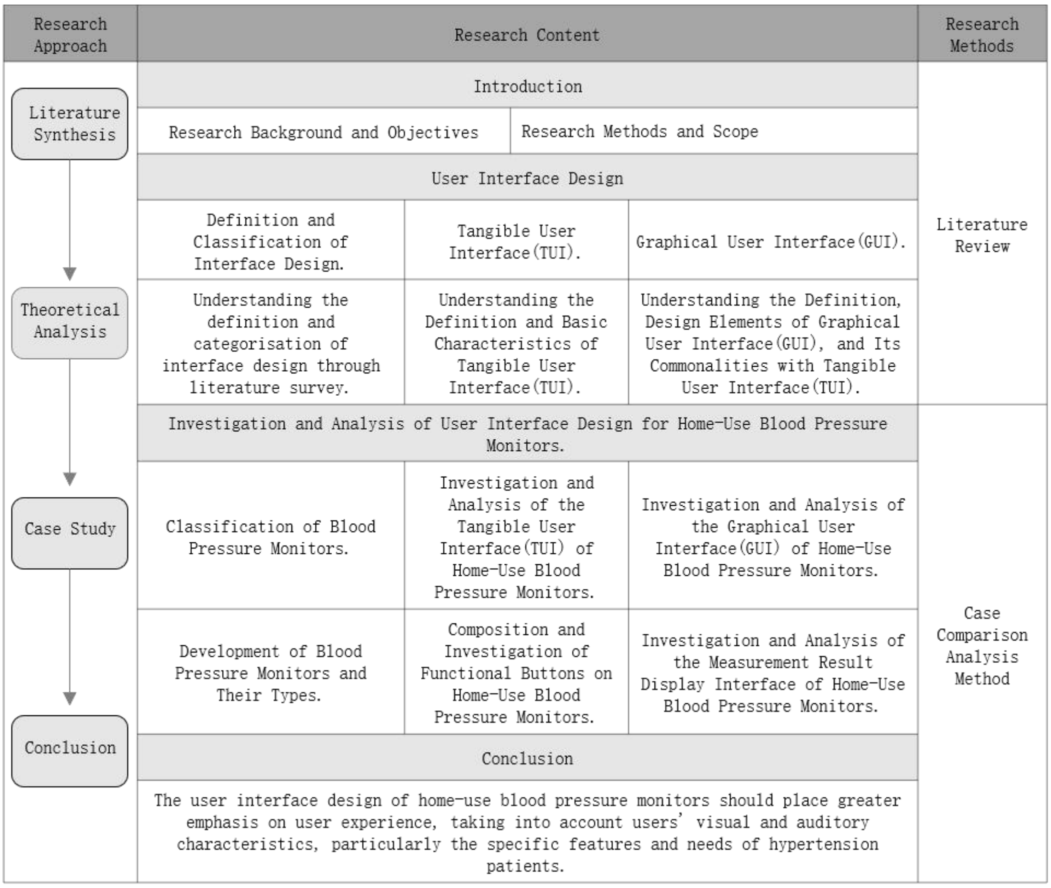

Figure 2: Research Process Flowchart

1.4 Research Methods

This paper adopts a method that combines literature review and case comparison analysis. First, by extensively reviewing relevant literature in the fields of design, medicine, marketing, and sociology, the study aims to understand the current status of hypertension and its management methods. It further explores the current state of the blood pressure monitor market and the theoretical foundations of user interface design. Second, in the case comparison analysis section, this study conducted a detailed comparative analysis of the user interface designs of home-use blood pressure monitors through online investigations.

2. User Interface Design

With the rapid development of the Internet of Things (IoT), information, and communication technologies, both academia and industry have increasingly focused on research in the fields of interaction design, user interface design, and user experience design in order to better meet user needs and enhance the overall user experience. This paper focuses on the user interface design of home blood pressure monitors, exploring the characteristics of their interfaces to provide foundational insights for the development of new intelligent blood pressure monitoring devices. The theoretical basis for the user interface design research in this study is outlined through preliminary studies (as shown in Table 1).

Table 1: Preliminary Studies on User Interface Design

Researcher	Thesis	Content of User Interface Design Related to This Thesis
Hong, 2024	Research on Interactive Panel Design of Intelligent Washing Machine from the Perspective of User Behavior	Research on the Interactive Interface of Smart Washing Machines: Color, Function, and Layout Design
Chen et al., 2023	Origin, evolution, and future trends of entity user interfaces	Classification and Characteristics of Physical User Interfaces
Chen, 2022	Research on software interface interaction design of intelligent washing machine based on brand filter method	Interface Design: A Survey and Analysis of the Interactive Interface for Smart Washing Machines
Wang, 2021	Design and Research of Hardware Interface in Human-Computer Interaction Experience	Analysis of Interactive Design for Hardware Interfaces, Design of Graphical User Interfaces (GUI), and Basic Principles of Human-Computer Interaction (HCI) Interfaces
Xu, 2020	Human-Robot Interaction Design of Walking Assistance Rehabilitation Robot	Design Trends in Interactive Hardware Interfaces and Interactive Software Interfaces
Jang, 2021	Design and Research of Intelligent Teaching Aids Based on Tangible User Interaction	Theory and Product Case Analysis of Physical Interface Interaction
Li, 2015	The Experience Design Research of Smart Washing Machine Software User Interface	Software User Interface Design, Interface Layout

2.1 Definition and Classification of Interface Design

The term “interface” can be defined in two ways. In its narrow definition, it refers specifically to the design of control and informational components. However, in the broader sense, "interface" encompasses the entire product design that interacts with the user (Xin, 2015). This includes all aspects of the interaction between the user and the product. According to Guo Bensi's perspective, the interface is not entirely within the tool itself, but rather exists in the interaction among the user, the actions taken, and how the tool is used (Fernando et al., 2015). The design of the interface determines the range of behaviors from the product's users(Bonsiepe, 1999).

From the perspective of interaction design, the user interface is the medium through which information is transmitted and exchanged between humans and "objects." Here, the term "object" refers not only to physical entities but also to non-physical ones (Fang, 2009). In the human-machine system model, an interactive "surface" between the human and the machine exists, known as the user interface. The interface serves as a medium for information exchange and control activities between the user and the machine (Li, 2015). Through this interface, users can input commands and receive feedback from the system, thereby enabling effective interaction. Modern user interfaces have developed a variety of interface elements, styles, and interaction paradigms, resulting in greater diversity, openness, and spontaneity(Myers et al., 2000).

User interfaces can be categorized into hardware and software interfaces based on their form of existence. A hardware interface refers to the physical components of a product that users can directly touch and perceive; it serves as the tangible point of interaction between the user and the device (Wang, 2021). In contrast, a software interface is responsible for recording and processing the exchange of information between humans and machines. It primarily communicates with users through screen-based visual elements and interactive features.

Hardware and software interfaces are closely interdependent and inseparable. The hardware interface serves as the physical carrier for the software interface, providing users with a platform for operation. At the same time, the software interface manages the display and feedback of information, making the operations of the hardware interface meaningful and functional. Together, these interfaces form a control-and-feedback relationship (Wang, 2010): users input commands through the hardware interface, and the software interface receives these inputs and delivers corresponding responses via output devices such as screens. This interaction completes an entire cycle of human-computer communication.

User interfaces can be classified into various types based on the technological methods used to implement them, such as Graphical User Interfaces (GUI), Tangible User Interfaces (TUI), and Natural User Interfaces (NUI) (Xin, 2015). Different types of user interfaces differ significantly in terms of their technical implementation and interaction.

For example, GUIs depend highly on graphical rendering techniques, while Voice User Interfaces (VUIs) are mainly based on speech recognition and synthesis techniques (Hirschberg & Manning, 2015). Haptic UI can provide feedback that mimics the real sense of touch and enhance the user's immersive experience . As for interaction scenarios, the physical user interface (TUI) is often used in environments that emphasize natural interaction, such as pervasive computing, due to its physical operability (Wang et al., 2022). This thesis focuses on the user interface design of home blood pressure monitors, with particular attention on both tangible and graphical user interface designs. Therefore, this paper will provide a detailed discussion of these two types of user interface design.

2.2 Tangible User Interface

TUI is a type of human-computer interface that allows users to interact with digital information through touchable physical objects and real-world environments (Chen, 2014). It maps the ways in which people interact with objects and surroundings in daily life onto the virtual world, thereby achieving an integrated connection between the physical and digital realms. Compared to traditional GUIs, tangible user interfaces emphasize the presentation and manipulation of digital information through physical actions. This approach offers a more intuitive, immersive, and interactive user experience (Chen, 2023).

Physical interface interaction is gradually being developed in the context of the Internet of Things (IoT) era, based on product design in the industrial era and interaction design in the Internet era. Therefore, it cannot be separated from the theoretical and methodological support of product design and interaction design. Its core goal is to seamlessly connect the real physical world with the virtual digital world through innovative design approaches. This aims not only to utilize the interaction advantages of the physical world that are natural, intuitive and easy to perceive, but also to make full use of the digital world's powerful capabilities in information storage, transmission and computation (Mi et al., 2018).

In contrast to the traditional interface design, which often focuses on the visual appearance of the interface, physical interface interaction emphasizes the behavior of interaction itself. It stresses the richness of human movement through natural actions such as grasping, manipulating, and assembling to achieve in-depth interaction between humans and physical objects (Jang, 2021). TUI aims to transform intangible digital information into a physical form, allowing users to engage with it through touchable entities, thus enhancing the ability to collaborate, learn, and create. This design approach fully leverages human perception and manipulation of physical objects and materials, thereby promoting a more natural and immersive form of human-computer interaction.

The concept of physical interface interaction was first introduced by Professor Hiroshi Ishii and his student Brygg Ullmer at the Massachusetts Institute of Technology (MIT) Media Lab in a paper entitled "Tangible Bits" in 1997. This paper introduced the term 'Tangible' for the first time to describe a new form of interactive interface (Ishii & Ullmer, 1997). The Tangible Bits concept proposed in the paper, instead of the visually oriented Painted Bits of GUIs, aims to transform typically intangible data into perceptible, manipulable physical entities (Ishii & Ullmer, 1997). It aims to transform usually intangible data into physical entities that can be sensed and operated. This concept breaks through the limitation that users must rely on the screen for interaction in the traditional graphical user interface. It aims to connect the previously separated physical space with the digital space, thus constructing a new type of input and output based on physical operation. This approach seeks to provide a more natural and intuitive human-computer interaction experience.

The development of physical interface interaction can be summarized as follows:

Unattached stage: In the early stages of the development of physical interface interaction, research primarily focused on how to use physical entities to achieve a richer and more natural form of interaction. During this period, most physical interfaces served mainly as a medium for information input, while the output still needed to rely on the display to be completed. As a result, these interfaces were characterized by their 'passive' nature. (Jang, 2021).

A number of representative studies emerged during this period, including:

MetaDesk (1997): its core feature is to introduce the concept of operating digital content through physical controls on the desktop, creating a precedent for physical interactive desktops; SandScape (2002): based on flexible materials, it realizes the presentation of information that can be shaped arbitrarily, which enhances the user's perception of data and interactive experience; SLAP Widget (2009): constructed a more complete set of physical operation components on the desktop, providing an interaction mode closer to the real physical operation (Mi et al., 2018).

These cases laid the foundation for the subsequent development of physical interfaces and promoted the evolution from traditional screen interaction to a more immersive and operational hybrid interaction mode.

Active phase: The research focus of TUI has gradually expanded from merely inputting information to creating a physical output of that information, especially in the form of ‘active’ interaction that can produce physical motion feedback. Compared with the earlier passive physical interfaces, the research in this phase emphasizes the active response of the system to the user. A notable example is the “Actuated Workbench,” a device that uses magnetic actuation to move objects in two dimensions on the desktop. The system is innovative because it works with existing desktop physical interfaces by providing an additional feedback channel to the computer output. This approach helps mitigate interaction inconsistencies caused by the inability of the computer to directly manipulate physical objects.

In addition, the system can track the position and motion of objects on the plane in real time and visualize the user's physical interactions through images. This provides a solid hardware and software support framework for 2D object manipulation in desktop-based environments. This research lays the foundation for the development of physical interfaces from static interaction to dynamic feedback, marking an important transition from 'passive interaction' to 'active response' in TUI. (Pangaro et al., 2002).

Physical assembly stage: Researchers have begun to focus on the concept of “Embodied Kinetic Tangibles,” which explores how users can dynamically engage with information in the digital space through freely assembled physical models. This marks another important direction in the study of TUIs and the rise of physically assembled interactions. One notable case in this field is Topobo (2004), an interactive device that combines the functions of assembled structures and action memory. Users can freely build structures through modular components, while the system can record and play back the movement states of these structures, thus achieving a two-way mapping between physical forms and digital behaviors. The system not only demonstrates TUI's innovation in physical construction flexibility but also its potential for dynamic interaction and embodied cognition.

Fitzmaurice (1996) proposed five fundamental characteristics of tangible user interfaces:

•Multi-channel spatial input and output of information: Supports the transmission of information through multiple sensory channels.

•Parallel use and operation of interface components: Multiple interface elements can be operated and responded to simultaneously.

•Dedicated interactive devices: Achieve efficient human-computer interaction through specialized hardware.

•Integration of spatially aware computing technologies: The system is capable of sensing and understanding users' physical spatial behaviors.

•Devices with spatial reconfiguration capabilities: Allow users to influence digital information by changing the position or state of physical objects.

In actual design practice, different forms of tangible user interfaces should be flexibly applied according to various user types and specific needs, in order to achieve more effective information display and transmission, as well as an improved user experience.

2.3 Graphical User Interface

A Graphical User Interface (GUI) is a user interface for computer systems that displays information and operational controls in graphical form (Chen, 2014). When a device receives external input - whether from a user or another machine - it guides the user through the operation process by presenting visual symbols, thereby achieving the intended functionality. The design of a GUI is based on users' behavioral characteristics and the functional requirements of the software system.

The development of GUI began in the 1970s and 1980s. With significant advances in hardware technology, the screen as a display device and the mouse as a positioning device began to be widely used. This began a new era of computer interfaces - the Graphical User Interface (GUI). Initially, GUIs were used for essential computer interaction, then expanded to widespread use in many product areas, especially in the driving interfaces of cars and smartphones. GUIs have become an indispensable part of modern technological products. Among various types of user interfaces, GUIs are favored for their strong visual intuition and high efficiency in information transfer.

In particular, GUIs in virtual reality (VR) and augmented reality (AR) environments exhibit unique characteristics such as spatial, immersive, and multimodal interactions. For example, in "Virtual Reality Ring Giant Screen" and "Augmented Reality Spatial Floating Graphical Interfaces," the GUI not only enhances user immersion but also provides a rich interactive experience (Sirohi et al., 2020). Compared to traditional display-based GUIs, the generation and presentation of such GUIs rely on smart glasses and various wearable terminals, and thus have unique spatial requirements and technical challenges (Zhao, 2009).

It conveys the information architecture through five key design elements (Cao, 2023):

Layout: Arrange the positions of interface elements based on visual perception characteristics to ensure clear and understandable information presentation. The Element Layout Specification sets out guidelines for the layout of interface elements to optimize the usability and visual impact of user interfaces. Donald Norman's concept of 'Affordance' emphasizes the interconnection of interface functionality and components, showing that well-designed interactions can significantly enhance its usability (Wang et al., 2018). The concept also suggests that user experience can be enhanced by correlating user intent with product metaphors to increase the consistency of the interface (Schoop et al., 2022). In addition, the five basic principles of Gestalt psychology (proximity, similarity, continuity, closure, and symmetry) enhance the overall usability of an interface from a variety of perspectives, including the placement of related icons, and reduce the cognitive load on the user (Liang, 2018). These principles help designers create interfaces that are more intuitive and easier to understand, allowing users to more quickly identify information and perform desired actions.

Color: Use color appropriately to enhance visual appeal while maintaining readability and improving user experience.

Icons: The physical elements of icon design include color, size, shape, border, background, and other elements. The design must also consider the usage environment, application area, and user visual characteristics. Employ intuitive and easily recognizable icons to represent functions or operations, helping users quickly identify and perform tasks.

Text: Provide concise and clear textual instructions to offer necessary guidance and feedback to users.

Charts: Utilize charts and graphs to display complex data, making it easier for users to understand and analyze information.

These design elements work together not only to improve users' understanding and operational efficiency but also to enhance the overall user experience. When designing the graphical user interface for a home blood pressure monitor, considering these factors is essential for creating an intuitive, user-friendly, and efficient interface.

Whether it is a TUI or a GUI, the ultimate focus of design is user behavior (as shown in Figure 3). During the process of information exchange between humans and machines, both types of interfaces aim to create a sense of trust, reliability, and ease of use for the users. This helps meet user needs and enables them to complete tasks efficiently and comfortably, thereby enhancing their confidence in and satisfaction with the system. Specifically, good interface design should ensure that users feel at ease while interacting with the system. It should allow them to quickly understand how to operate the interface and provide immediate and clear feedback, ultimately achieving an efficient and comfortable user experience.

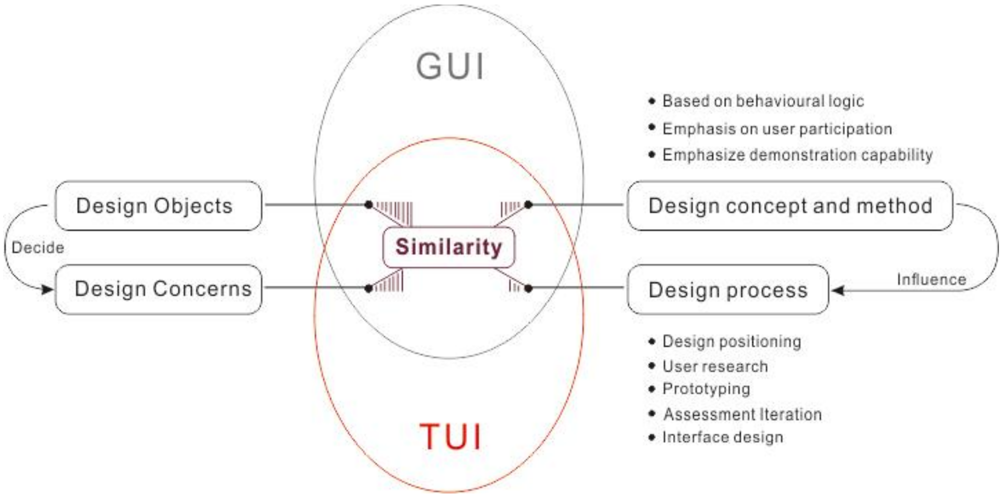

Figure 3: Similarities between TUI and GUI (Chen, 2014).

3. Investigation and Analysis of User Interface Design for Home-Use Blood Pressure Monitors

A blood pressure monitor is a medical device designed to measure blood pressure, allowing individuals to accurately assess their blood pressure levels. As awareness of health management increases and the number of people with hypertension rises, the demand for blood pressure monitors continues to grow.

3.1 Development and Classification of Sphygmomanometers

1) Development of Blood Pressure Monitors

In the field of blood pressure measurement, technological advancements and the growing medical needs of users have led to significant developments in blood pressure monitors. These devices have evolved from invasive to non-invasive methods, from manual to automatic functionality, and from single-purpose devices to intelligent systems. Currently, the development of blood pressure monitors can be categorized into four generations: First-generation invasive blood pressure measurement, Second-generation mercury sphygmomanometers, Third-generation oscillometric blood pressure monitors, and Fourth-generation Hanwang Korotkoff sound electronic blood pressure monitors (Sun, 2018). The specific details are presented in Table 2. The development of domestic sphygmomanometers began in the late 19th century with the introduction of the second generation of mercury sphygmomanometers, and has evolved to the current use of smart sphygmomanometers.

Table 2: Development and Characteristics of Blood Pressure Monitors

Blood Pressure Monitor	**First-Generation Invasive Blood Pressure Measurement**	**Second-Generation Mercury Sphygmomanometer**	**Third-Generation Electronic Blood Pressure Monitor**	**Fourth-Generation Hanwang Korotkoff Sound Electronic Blood Pressure Monitor**
Image				

Measurement Principle	By puncturing the artery and directly inserting a catheter into it, the catheter is then connected to a pressure sensor to directly measure the pressure inside the artery.	Korotkoff Sounds Method (i.e., Auscultatory Method) The blood pressure value is determined by listening to the arterial pulsation sounds through a stethoscope.	Oscillometric Method (Electronic Measurement Method) This method estimates blood pressure values by monitoring changes in oscillatory waves during the deflation of the cuff and applying statistical coefficients and mathematical formulas.	Korotkoff Sounds Method The blood pressure value is calculated using artificial intelligence technology.
Time	"In the 18th century, British physician Stephen Hales pioneered blood pressure measurement through vascular puncture, laying the foundation for the first-generation invasive measurement technology."	In the early 20th century	In the 1990s	2025
Features	While this method provides highly accurate blood pressure measurements, it involves a complex procedure and carries relatively higher risks. Therefore, it is not suitable for daily home use and is primarily employed in clinical environments such as intensive care units (ICUs) and operating rooms, where continuous and precise hemodynamic monitoring is essential.	This method involves a relatively complex procedure and requires professional training to perform accurately. Additionally, mercury is a toxic substance that can cause environmental contamination and presents potential health and safety risks.	It is widely used, but its accuracy is susceptible to various influencing factors.	The device is user-friendly and provides highly accurate measurements.

The fourth-generation blood pressure monitor was introduced by Hanwang Technology at the 91st China International Medical Equipment Fair (CMEF 2025). It integrates artificial intelligence technology and employs the Korotkoff sounds measurement method, achieving high precision in blood pressure readings. The Korotkoff sounds method, recognized as the international gold standard for non-invasive blood pressure measurement, offers superior accuracy and reliability. Although most current electronic blood pressure monitors primarily utilize the oscillometric method, Hanwang Technology's new product demonstrates the potential of combining traditional techniques with modern intelligent technologies, paving the way for new directions in blood pressure measurement.

2) Types of Blood Pressure Monitors

Currently, there are various types of blood pressure monitors available on the market. First, based on their technical principles and usage methods, blood pressure monitors can be classified into three categories: electronic sphygmomanometers, mercury sphygmomanometers, and aneroid sphygmomanometers. Among these, mercury sphygmomanometers have been discontinued since 2020, and electronic sphygmomanometers have completely replaced both mercury and aneroid types (Cao, 2023). Secondly, based on the measurement site, they can be divided into upper-arm blood pressure monitors (including cuff-style and wrap-around upper-arm types), wrist monitors, and finger monitors. The specific classification is shown in Table 3.

Table 3: Blood Pressure Monitors Based on Three Measurement Sites

Blood Pressure Monitor		Upper-Arm Blood Pressure Monitor		Wrist Blood Pressure Monitor	Finger Blood Pressure Monitor
		Arm-Cuff Blood Pressure Monitor	Cuff-Style Upper-Arm Blood Pressure Monitor		
Image					
Measurement Principle		Oscillometric method	Oscillometric method	Oscillometric Method	Measuring the heart's systolic and diastolic blood pressure through the finger artery
Usage Location		Home, Hospital	Primarily Used in Hospitals or Health Centers, and at Home	Home	Home
Features	Advantages	This device is user-friendly, features a clear display screen, offers strong immunity to external noise interference, and supports voice playback of test results.	This blood pressure monitor offers exceptionally simple operation, a high-definition display, excellent immunity to external noise interference, voice-enabled test data playback, and highly precise measurement performance.	This device offers convenient measurement without the need to remove clothing, is compact and portable, easy to use, and includes a voice playback function for test data.	Easy to use and portable
	Disadvantages	For accurate measurement, it is necessary to remove clothing, which can be somewhat inconvenient.	It is not convenient to move around, and clothing must be removed for accurate measurement.	The measurement values may have some deviation.	Low measurement accuracy (there is a certain gap between the pulse pressure value at the fingertip and the actual blood pressure).

3.2 Investigation and Analysis of the Physical User Interface of Home Blood Pressure Monitors

The interface of a home blood pressure monitor refers to the operational system that allows users to directly interact with the device. This falls within the scope of the narrow definition of an interface, specifically, a human-machine interaction interface composed of hardware, software, and the user. It can also be viewed as a physical interface, a graphical interface, and the user, forming a human-machine interaction system.

The main focus of this study is on the upper-arm wrap-around blood pressure monitor, whose interface consists of two parts: a physical user interface and a graphical user interface.

Physical User Interface of Home Blood Pressure Monitors

The physical user interface of home blood pressure monitors mainly includes various function buttons, the cuff, ports (for power or connecting the cuff), power cords, and battery compartments. The physical user interface may vary across different models of blood pressure monitors. For home upper-arm blood pressure monitors, the user interface is primarily conveyed through their overall design, helping users better understand and interact with the device. The specific design of the interface is shown in Figure 4.

Figure 4: Designs of Different Home Upper-Arm Blood Pressure Monitors (Cao, 2023).

The distinctive features of different home upper-arm blood pressure monitors can be summarized as follows:

Main Unit and Cuff Configuration: Currently, most home upper-arm blood pressure monitors consist of two main components: the main unit and the cuff, which are connected by a rubber tube. However, Omron has introduced an integrated model that eliminates the need for a rubber tube. In this design, the main unit is shaped to fit around the arm, providing a more streamlined user experience. Cuff Design Variations: There is relatively little variation in the cuff designs across different models. Instead, the primary differences are found in the design of the main unit. Specifically, while most units are based on a rectangular form, manufacturers often differentiate their products through variations in the rounding of corners. Function Buttons and Display Screen: The main unit typically includes various function buttons and a display screen. Different blood pressure monitors exhibit significant variation in screen size, layout, and design of their function buttons.

This thesis primarily focuses on the design of various function buttons on home blood pressure monitors. Users complete the operation process through these buttons to achieve their intended goals. The button designs of different home-use blood pressure monitors are shown in Figure 5. As illustrated, the shapes of the buttons are mostly round or square, with variations in corner rounding resulting in different rectangular forms. The function buttons include the power button, memory/recall button, diastolic and systolic blood pressure buttons, time-setting button, and user-differentiation button, among others. The shape, size, and number of buttons vary across different models. Blood pressure measurement results are delivered to users through voice playback, making it easier for individuals with poor eyesight or elderly users to access the information.

Figure 5: Button Design of the Hardware Interface of Different Home Blood Pressure Monitors (Cao, 2023).

To help users easily identify function buttons, designers often use a combination of icons, English letters, text, and color to differentiate the functions. However, studies have shown that new users, especially elderly patients with hypertension, find buttons labeled with letters or graphic symbols more challenging to recognize than those labeled with plain text. These users often struggle to complete operations based on the symbolic information displayed on the buttons. Therefore, when designing the physical user interface for home blood pressure monitors, it is important to consider the special needs of older users. Button designs should be as simple as possible, using clear and easily understandable combinations of text and icons. Additionally, ensuring sufficient visual contrast and clarity is crucial to enhance user experience and facilitate easier operation.

3.3 Investigation and Analysis of the Graphical User Interface (GUI) of Home Blood Pressure Monitors

This study selected five brands of blood pressure monitors as research subjects based on product sales data and user feedback: Omron, Yuwell, Jiuan, Cofoe, and Panasonic. A comparative analysis was conducted on the blood pressure measurement result display interfaces of these brands. The information displayed on the blood pressure measurement result interface typically includes the following elements: Measurement values: including diastolic pressure, systolic pressure, and pulse rate. Time: displays the exact time of the measurement. Pulse information: distinguishes between regular and irregular pulse. Storage information: provides functions for storing and retrieving historical data. Error message: alerts the user to any incorrect operation. Cuff fit self-check information: indicates whether the cuff is worn correctly or incorrectly. Blood pressure status information: includes notifications for normal blood pressure and elevated blood pressure. Atrial fibrillation (AFib) prediction: some models support AFib risk detection. User information: most devices can store data for two users. The detailed interface features are presented in Table 4.

Table 4: Graphical User Interface Analysis of Five Brands of Home Blood Pressure Monitors

Brand	Omron J735	Omron HEM-7361T	Yuwell S67XR	Jiuan KD-5918	Cofoe KF-66CP	Panasonic EW-BU20
Interface Image						
Systolic Pressure, Diastolic Pressure, and Pulse	118 78 72	2:30 118 78 70 148 88 86 7:30	118 78 72 120 73	114 75 02 89	136 88 70	100 68 70
Time	7:30	7:30	12:12	12:20	18:06	0:01
Irregular Pulse				/		
Regular Pulse	/	/	/			
Storage Icon			MEMORY	M		
Misoperation Icon				/		
Cuff Fit Self-Check Icon	OK	OK	OK	/	OK	
Correct Cuff Fit Icon		OK		/	OK	
Incorrect Cuff Fit Icon			/	/		/
Normal Blood Pressure Icon		/		/		/
High Blood Pressure Icon	血压偏高	血压偏高	血压偏高	/	血压偏高	/
AFib Icon	/			/	/	/

User Icon				/		/

As shown in Table 4, the measurement display interfaces of home blood pressure monitors utilize a combination of numerals, icons, and textual elements to convey essential health data. The interface background is commonly designed in gray, while icons, numerical values, and text are rendered in black. Despite these commonalities, notable variations exist across models regarding information layout, content density, and the design of graphical symbols.

First, in terms of information layout, the measurement display interfaces of Omron HEM-7361T, Yuwell S67XR, and Cofoe KF-66CP all include historical measurement data. However, the layout of the Omron HEM-7361T reverses the primary and secondary information positions. According to common visual habits, which follow a left-to-right pattern, the most important information should appear on the left side of the screen. In the case of the Omron HEM-7361T, however, the left side displays historical measurements while the new measurement appears on the right. Both occupy a large portion of the screen and have only slightly different font sizes, making the distinction minimal. Combined with other displayed information, the overall interface appears quite cluttered.

In contrast, the layouts of the Yuwell S67XR and Cofoe KF-66CP are relatively similar: the new measurement value is placed prominently in the center of the screen, displayed clearly and in large font, while the historical measurement appears in the lower-right corner. Other information is arranged on the right side and the lower-left area of the screen. The Omron J735, aside from lacking historical measurement data, shares a similar layout style with the Yuwell S67XR. The Jiuan KD-5918 and Panasonic EW-BU20 also feature similar layouts, both displaying the measured values on the right side of the screen.

Secondly, regarding the amount of information displayed, the Cofoe KF-66CP contains the richest set of data, followed by the Omron HEM-7361T and the Yuwell S67XR. In contrast, the Jiuan KD-5918 presents the fewest informational elements on its interface.

Lastly, in terms of graphical symbol design, the icons representing the same command or function differ across devices. Even within the same brand, such as Omron's J735 and HEM-7361T, the icon designs are not entirely consistent. In addition, the irregular pulse and misoperation icons on the Panasonic EW-BU20 model are relatively complex in design, making them difficult to recognize and remember.

4. Conclusion

This thesis analyzed the user interface designs of different home blood pressure monitors. The specific summary is as follows:

Research has shown that the design of physical control buttons on home blood pressure monitors typically uses symbols such as letters, text, and graphics to convey functional information. However, buttons that combine letters or graphic symbols are more difficult to recognize compared to those featuring pure text. This difficulty can lead to lower utilization of certain functions. Therefore, when designing the control buttons of home blood pressure monitors, it is important to consider the characteristics and needs of different hypertensive user groups, especially elderly patients with hypertension. This demographic generally has a lower ability to interpret button-related information. To enhance the user experience, button designs should be simplified as much as possible, using clear combinations of text and icons, along with sufficient visual contrast and clarity.

During the investigation and analysis of the measurement display interfaces of five brands of blood pressure monitors, it was found that the displayed information varies across different models. These differences are mainly reflected in three aspects:

information layout, amount of information, and design of graphical symbols. Overall, considering the information layout, content, and icon design in relation to visual function and its characteristics, the Omron J735 and Yuwell S67XR demonstrate relatively well-designed measurement interfaces. These designs not only enhance user operational convenience but also improve the readability and understandability of the displayed information.

Based on the research findings, it is apparent that there is a lack of standardized guidelines for icon design in home blood pressure monitors as medical devices. Numerous icons present significant recognition challenges when used without accompanying textual annotations, preventing users from accurately interpreting the information conveyed by these icons. This not only diminishes user experience but can also adversely affect the efficiency and accuracy of the device's usage.

Therefore, the user interface design of home blood pressure monitors should prioritize user experience by considering the visual and auditory characteristics of users, especially those of hypertensive patients. Standardizing icon design, integrating text labels, optimizing visual presentations, and introducing auditory feedback mechanisms can enhance the usability and accessibility of these devices. Such improvements would better address the needs of various user demographics, leading to a more effective and user-friendly operation.

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