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MONITORING SYSTEM INTERFACE DESIGN BASED ON TYPOLOGY[1]

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Abstract. This article analyzes the main concepts and the process of typology development, and also explores the application of typology in the field of interface design.

Purpose. *The aim of the study is to systematize the elements of monitoring system interfaces, such as icons and color characteristics, types of interface design, and to provide recommendations for further optimization of monitoring system interface design.*

Methodology. *The study involved a literature review to examine the principles of monitoring system interface design. Additionally, a systematic analysis of 70 samples of monitoring system interfaces was conducted. The analysis covered the study of icon types, element placement on the screen, and the color schemes used in these interfaces.*

Results. *The study generalized the types of monitoring system interface icons and characterized 10 common interface design styles, including linear rectangular, rounded corner linear, open, multicolor, gradient, overlay, linear surface, flat, skeuomorphic, and light skeuomorphic styles. It was found that the style of monitoring system icons evolves with system version updates and exhibits certain characteristics of continuity. From the analysis of monitoring interface layout design, 9 interface design styles with different layouts were summarized, which combine with types of Chinese characters for image processing, making the style more recognizable. A total of 90 HSB interface colors were identified. It was found that the most widely used and high-frequency HSB color range is $180° < H \leq 240°$, $0\% \leq S \leq 20\%$, and $20\% < B \leq 40\%$, represented by dark blue. This interface color range can provide a theoretical foundation and support for design optimization for developers working with monitoring interfaces.*

Scientific novelty. *For the first time, icon types and optimal color solutions for monitoring system interfaces were identified. The principles of interface design were further developed.*

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Practical significance. *Through the analysis of monitoring system examples, interface design elements such as icons, layout, general design style types, and high-frequency monitor color features were developed to provide informational support for the design of monitoring system interfaces.*

Keywords: monitoring system, graphic design, icon, color, style, layout, interface design, typology, design trends, human-computer interaction.

INTRODUCTION

The development of human-machine interface mainly includes four stages. The first stage is the physical user interface, where the operator interacts with the machine through natural and real actions, and interacts with the controller, indicator light and mechanical switch to realize the operation and interaction of the machine. The second stage is the command line interface, where computer-related practitioners operate the computer by inputting the computer language of the command line. The third stage is the graphical user interface currently used by people, where users can click and feedback through the element controls in the interface to achieve functional use requirements [4]. The fourth stage is the natural human-computer interaction stage, which can get rid of the limitations of physical input devices and realize a completely natural interactive control method with the machine [7]. Among them, Zhou constructed the development trend of human-computer interface research through citespace, and found that the current human-machine interface has focused on user experience [20]. The human-machine interface is to fully consider the human factors, adhere to the people-oriented design concept [17]. It is a comprehensive research of user behavior, physiology and psychology, so as to ensure that the device can interact with users in a natural and friendly method [9]. So as to reduce human operation errors and other problems, so as to improve the user's actual experience [15].

With the widespread application of information technology in the field of security, it has changed from the early human-machine security mode to a digital and intelligent security form [10]. The human-machine interface of the monitoring system has also improved, from the information display screen to the interactive digital display screen, which contains a lot of information in addition to the monitoring information, such as personnel information, vehicle information, equipment operation status, etc., requiring operators to perform daily patrol monitoring and special event processing according to task requirements. However, the innovation of technology and the increase of cost make the original single monitoring system collect a large number of complex information, bringing a series of problems to the operator [1]. In order to meet the growing safety of personnel, society, and property, the design of the monitoring system interface plays a very important role in the operation of the entire monitoring system [14].

ANALYSIS OF PREVIOUS RESEARCHES

Typology is a system of grouping and classification, which means to compare, distinguish and deduce types or categories. The typology method is divided into two basic steps. The first step is to analyze the specific form of the object in the historical development trend, and the second step is to combine the form of its special time period with the development characteristics of the modern period to evolve into a new form type, that is, to analyze and extract elements and perform modern transformation. And is widely used in the field of construction trades and is called architectural typology. It was first proposed by Italian architect Andrea Palladio in 1570. In his "Four Books on Architecture", buildings are classified according to their appearance, internal structure, functional use and other characteristics. The function or form of the architectural design type is analyzed according to the construction history, cultural tradition, and modeling evolution [19].

As early as 1737, Carolus Linnaeus, the founder of biology, published the first work on plant taxonomy, "Systema Naturae", which classified the types, sizes, quantities, and arrangement methods of plants according to the concepts of class, order, genus, and species. He unified the botanical names in response to the confusing naming differences at the time and promoted the development of botany [11].

In 1955, Chinese architectural historian, Mr. Liang Sicheng, was the first architect to analyze Chinese architecture using typological methods. In "History of Chinese Architecture", he stated that Chinese urban architecture needs to retain its own artistic and cultural characteristics, and should not completely abandon the original style and combine it with Western design forms, but should create its own national architectural

style [13]. In 1966, Aldo Rossi, an important figure in architectural typology, published the book "Urban Architecture", abandoning the principle of modernism that function follows form, and mainly through a more systematic and rational typological method, sorting out the types of buildings, cities, places, and spaces, requiring architects to deeply analyze the basic archetypal characteristics and essence of buildings in their designs, so that human culture can be fully reflected in architecture. In 2007, architect Robert Creel published the book "Town Space: A Contemporary Interpretation of Traditional Urbanism", which use typological methods to analyse the city composition, such as buildings, squares, public facilities. To construct a series of typological methods based on the urban space system to protect the historical buildings and the design of new buildings [5].

In addition to relevant research of the architecture, according to Jing Nan's research, typology is combined with product stylization characteristics. The complete design workflow of product design, namely planning, conception, design, and implementation, is used to extract and classify the style prototypes of its shapes. Through the hereditary and transitional characteristics of the typological prototypes, to optimize and iterate the image of the product while retaining its original style [6]. According to Zhang Hanning's research, the innovative method of introducing typological method to analyze the design of new Chinese furniture avoids blindly imitating antique design and eclectic design. By abandoning the drawbacks of boring and rigid traditional classical furniture, carrying forward the advantages of lively and charming historical culture, extracting the characteristics of the type for diversified evolution and unification, the reconstruction and transformation of new Chinese furniture design is realized. By abandoning the boring and rigid drawbacks of traditional classical furniture, carrying forward the lively and charming historical culture over the years, extracting the type characteristics for diversified evolution and unification, the reconstruction and transformation of new Chinese furniture design is realized [18]. Li Zhimei proposed a study on the design method of car front face style innovation based on prototype typology. By classifying and enumerating the front face styles of different models and extracting the prototype features, the innovative design in form was finally realized [8]. Hong Nana analyzed the information visual design based on the typology theory. In the information visual design, the most basic and simple points, lines and surfaces are included. However, when complex information is integrated into a single plane content, designers need to classify and process the information, which not only includes the classification of design styles, but also sorts the information level and spatial level according to the importance, so that the information is more directional, so that users can understand the displayed content more quickly [3]. Fang Xuebing took the visualization of human-computer interface information as the analysis target. By summarizing the information expression of graphic visual symbols, he sorted out the types of computer system interface icon design from 1981 to 2001 and summarized them into four principles of graphic category information design, namely the principle of unified visual elements, the principle of bionics, the principle of stylization and the principle of culture [2].

Therefore, the typological method applied in the field of design focuses on analyzing the historical background, cultural characteristics, location and other related characteristics of the object, analyzing the fit between its historical and traditional characteristics and modern development, and retaining the continuity characteristics of its traditional culture in the update and iteration. In the interface design field, human-machine interface will rapidly iterate with the development of technologies. In the design process, it is easy for designers to ignore the continuity characteristics such as system version and function type. Through the analysis of the development of monitoring interface, it is found that the monitoring interface has changed from the early physical user interface to the graphical user interface, and the application in the actual monitoring system has also changed accordingly. Through the typological method, the time axis evolution trend of monitoring system design can be summarized and sorted out, thus providing a reference for designers and the iterative development of monitoring interface.

RESULTS AND DISCUSSION

Interface type analysis of the monitoring system

Analysis of monitoring system interface icon types

The different interface icon design styles often affect the recognition and operability of interface information in the actual experience process. Through the analysis of the current monitoring system, it can be divided into the following 10 common icon design styles (table 1).

1. **Linear rectangular style.** Using simple line and right transition and the design of the icon type, the overall visual perception

contracted, suitable for the consistency of standardized design requirements, is currently applied in the complex information system interface, through low interference contracted icon, help to reduce the complexity of the functional control, to improve the recognition of the icon, but its appearance effect is too simple, lack of the meaning of the icon, and the lack of intimacy.

2. **Linear rounded corner style.** Compared to linear rectangular icons, the rounded corner transition form can make the visual perception of interface icons appear more friendly and soft, while also having a modern and simple performance effect, and can form good compatibility with different systems and interfaces. However, its disadvantages are similar to those of the linear right-angle style, that is, the lack of in-depth expression of details, and the recognition of complex function controls is slightly lower, requiring users to spend a certain amount of learning cost to adapt.

3. **Open style.** Different from fully closed icons, the open icon design type presents an open and visually active effect, and the consistency of the opening direction can also serve as a directional tendency for the overall picture information. However, the readability of this style is relatively weak, and when there are too many icons, it is easy to produce an overall messy and damaged visual effect.

4. **Multi-color style.** The use of multiple colors to fill the icon is consistent with the overall style color of the interface and the semantic characteristics of the specific control function, which has a certain concrete expression effect and reduces the user's learning cost. However, in the design process, it is necessary to consider the color coordination of multiple functional types to avoid the interface confusion caused by too many colors.

5. **Gradient style.** The gradient filling effect of color gives the thin icon a more three-dimensional light and shadow effect, increasing the visual level and appeal. Its design style has a certain timeliness and is generally adjusted according to the computer system style and design trends.

6. **Superimposed style.** Superimposed style icons are a design method that combines specific functional controls and operation feedback information for expression. The icon outline and shape are superimposed on the front and back hierarchical relationship, which enriches the visual hierarchy effect and can highlight more precise control operation information in a simple icon. However, if the design is not good, it is easy to overlay too much information, resulting in the icon style type appearing too complicated, affecting the operator's recognition.

7. **Line-surface style.** The outline of the icon is constructed through simple lines, and the corresponding colors are filled inside. It has both the simplicity and beauty of the icon. It can highlight the focus of the functional icon in terms of visual perception, making it more flexible and more attractive than single linear or surface icons.

8. **Flat style.** Flat style originates from the flat processing of the management mode, which can effectively realize the communication and processing between various departments, reflect the intuitiveness of the interface design, and shorten the visual search time of users [12]. Flat style icons are three-dimensional, gradient, and decorative icons that have been flattened and expressed by pure color filling. They can not only retain the basic semantic type of the functional control, but also have a larger visible area than linear style icons.

9. **Skeuomorphic style.** The Skeuomorphic style icon is to imitate the real object in real life, focusing on restoring the real shape, color and light and shadow performance effect of the object. It is a 100% reduction of the semantics of functional controls, and is suitable for novice or elderly users. It is also the icon type with the strongest sense of art and design performance among all the icon categories. However, the design of this kind of icons is very difficult. With the increasing number of functional applications, it can not find the corresponding reference in the real world [16]. When a large number of irregular shapes and different color icon appear in the limited and regular interface, the use of the whole interface is disastrous.

10. **Light skeuomorphic style.** Light skeuomorphic style icons are a design expression style between flat and skeuomorphic. They retain the realistic characteristics of skeuomorphic icons while simplifying some shapes, details or shadows of functional icons, making the icons both visually intuitive and easy to understand.

In the process of sorting out the icon design style types, it is found that the monitoring system icon type style often changes with the update of the computer system (table 2). Among them, the pixel style icon type in the Windows 98 system is designed based on the resolution of the display device at that time. As the most popular version of the Windows system, the XP version uses a crystal-textured gradient skeuomorphic icon as the design style, which not only represents the functional controls in a concrete way, but also shows a beautiful texture. With the iteration of versions, the mainstream system trend has

Table 1

Icon design types (Zhou T., 2024)

ICON TYPE	REAL-TIME	REPLAY THEATER	ALARM
Linear rectangular style			
Linear rounded corner style			
Open style			
Multi-color style			
Gradient style			
Superimposed style			
Line-surface style			
Flat style			
Skeuomorphic style			
Light skeuomorphic style			

Table 2

Computer system icon types (Zhou T., 2024)

ICON TYPE	SYSTEM VERSION	REAL-TIME	REPLAY THEATER	ALARM
Pixelated style	Windows 98			
Crystal style	Windows XP			
Line and surface style	Windows 8			
Superimposed style	Windows 10			
Round corner flat style	Windows 11			

evolved towards a flat and simple style. In Windows 8, the icon style design is mainly based on the combination of lines and surfaces. On this basis, the update of the Windows 10 system, its fluent design design language has added some changes to the original rigid combination of lines and surfaces, highlighting the lightweight structure of the system. Today, with the update of the Windows 11 system, the flat icon design style has begun to become more rounded and three-dimensional, and has shifted towards a light skeuomorphic and flat style.

Analysis of monitoring system interface layout types

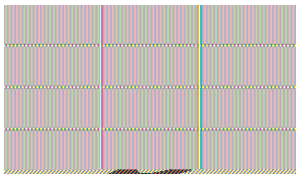
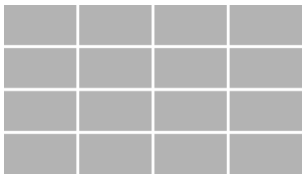
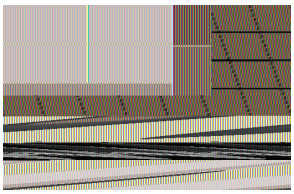
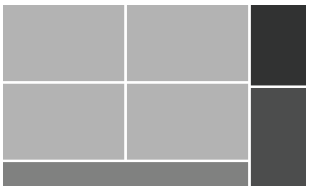
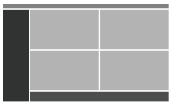
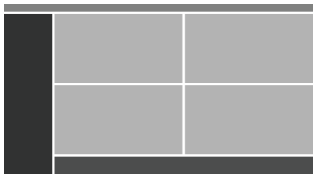
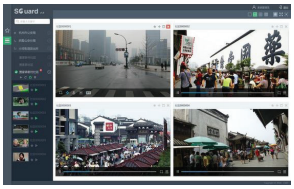
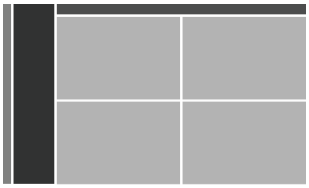
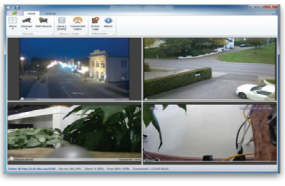
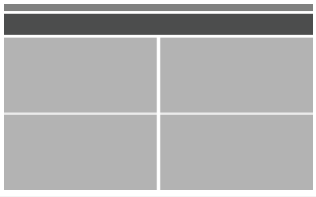
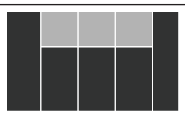
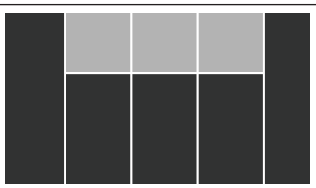
By analyzing the layout types of monitoring system interfaces, it is found that

the monitoring interface layout is mainly divided into monitoring window area, menu task area, tool area and function control area. According to certain functional divisions, formal aesthetics rules, user cognitive psychology and other methods, various types of information in the interface are reasonably laid out to achieve a balance between the interface layout form and actual functions.

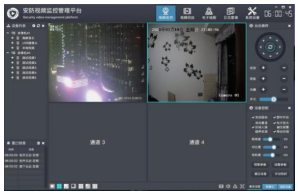
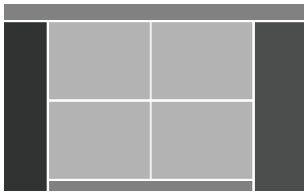
This paper lists 9 common monitoring interface layout types (table 3). The main functional areas are extracted and color-processed, and they are classified according to specific Chinese character styles. It can be seen that the monitoring interface layout basically conforms to the visual cognition law of the human eye, that is, from left to right and from top to bottom. At the same time, the most

Table 3

Monitoring system interface layout types (Zhou T., 2024)

	Name	Chinese character	Monitoring interface cases	Simplify the monitoring interface layout
1	TV wall layout	田		
2	Corner layout 1	丿		
3	Corner layout 2	匚		
4	Corner layout 3	厂		
5	Up-down frame layout	三		
6	One-line layout	二		
7	List-type layout	川		

Continuation of table 3

8	Close-type layout	口		
9	Discrete layout	井		

important information is placed in the upper left corner of the interface (function control area or main monitoring screen area). The simplified hierarchical expression form is used as much as possible to avoid users from performing deep retrieval behaviors in the monitoring page, and the main function controls are placed in the most eye-catching area of the interface.

Analysis of monitoring system interface color types

In addition to monitoring the interface layout and icon design, the most easy to be observed by the human eye is the color in the interface. The information in the interface will be strengthened with the display effect and semantic characteristics of the color, so that users can make the correct operation of the event. Considering the monitoring personnel need to spend a lot of time on the monitoring interface observation and task execution, eyes need a long time gaze in the monitoring screen, interface color reasonable choice will directly affect the operator's cognitive load, fatigue and work performance, but also need to consider emergency visual feedback effect of intuitive features. In this paper, 70 cases of different monitoring interface have been collected. After analyzing the overall color of the interface by professional color software ColorDesk and Adobe Illustrator, 1–2 main HSB parameters were extracted for each interface, and a total of 90 HSB colors were obtained.

After analysis, the main hue (H) of the monitoring interface is shown (fig. 1). Among them, there are 5 types of $0° \le H \le 60°$, 1 type of $60° < H \le 120°$, 0 types of $120° < H \le 180°$, 77 types of $180° < H \le 240°$, 6 types of $240° < H \le 300°$, and 1 type of $300° < H \le 360°$. It can be found that the main hue of the monitoring interface is concentrated in the range of 180° to 240°, showing a blue hue range, which reflects the sense of technology while avoiding overly glaring bright colors.

According to the main saturation (S) of the monitoring interface (fig. 2), there are 39 types of $0\% \le S \le 20\%$, 13 types of $20\% < S \le 40\%$, 6 types of $40\% < S \le 60\%$, 9 types of $60\% < S \le 80\%$, accounting for about 10.00%; there are 23 types of $80\% < S \le 100\%$. It shows that the color saturation of the monitoring interface is relatively low, and it is necessary to avoid using colors with higher purity, so as to achieve the effect of grayscale color tone.

According to the main brightness (B) of the monitoring interface (fig. 3), there are 28 types of $0\% \le B \le 20\%$, 42 types of $20\% < B \le 40\%$, 9 types of $40\% < B \le 60\%$, 1 type of $60\% < B \le 80\%$, and 10 types of $80\% < B \le 100\%$. It indicates that the color brightness of the monitoring interface is low, and avoid using colors with too high brightness, which will cause users to have a dazzling and tiring visual experience.

After summarizing and processing, the color design set range of the monitoring interface can be obtained, that is, $180° < H \le 240°$, $0\% \le S \le 20\%$, and $20\% < B \le 40\%$ (fig. 4). By listing the current interface design types and summarizing them, the commonly used ranges of interface color design can be obtained, which can provide theoretical basis and data support for interface color design for relevant designers, thereby providing reference for subsequent design optimization and improvement, and designing a monitoring system interface suitable for the daily work and processing of staff.

CONCLUSIONS

In this paper, the monitoring system is taken as the research object of the monitoring system, and the icon, layout and color of the monitoring system interface. 10 common monitoring interface icon design styles are summarized, including Linear rectangular style, Linear rounded corner

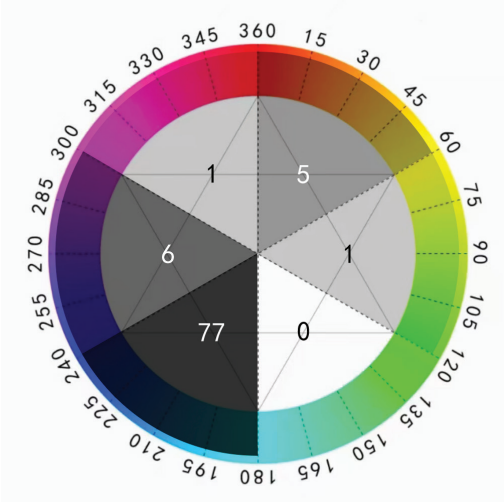


Fig. 1. The main hue of the monitoring interface (Zhou T., 2024)

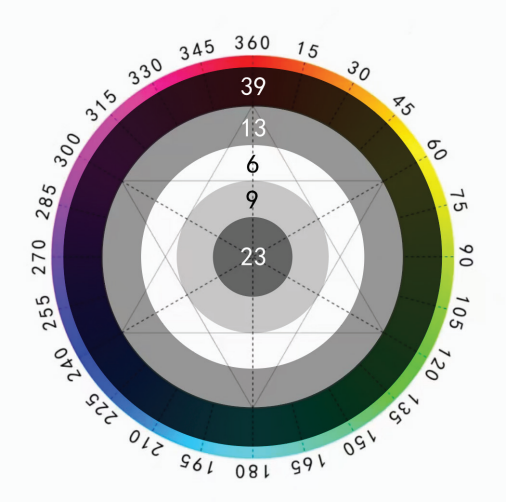


Fig. 2. The main saturation of the monitoring interface (Zhou T., 2024)

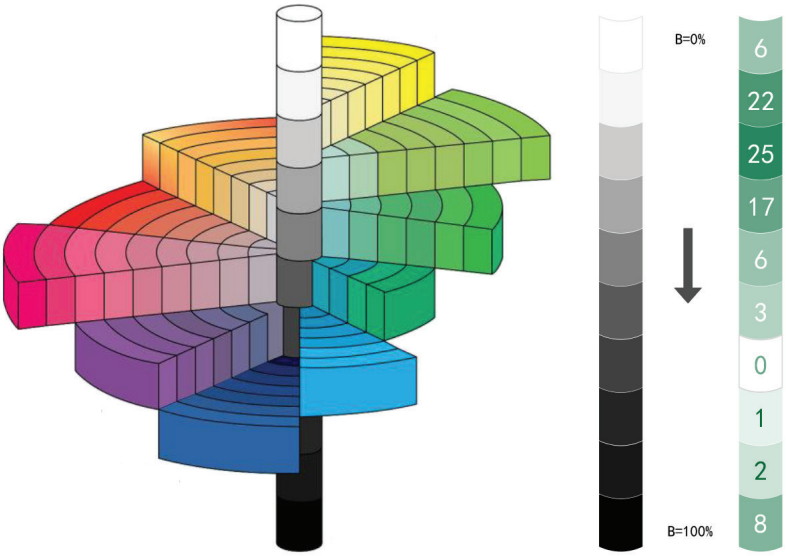


Fig. 3. The main brightness of the monitoring interface (Zhou T., 2024)

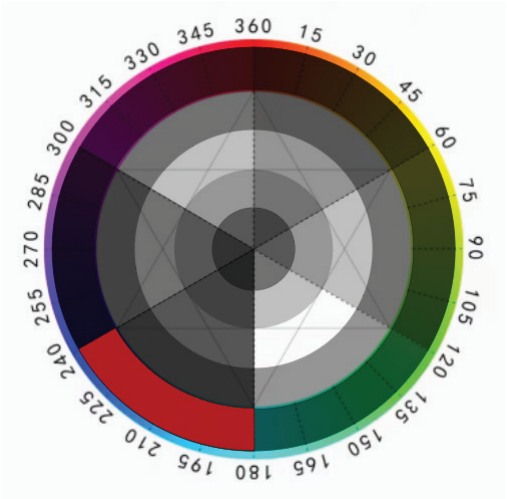


Fig. 4. The color range of the monitoring interface (Zhou T., 2024)

style, Open style, Multi-color style, Gradient style, Superimposed style, Line-surface style, Flat style, Skeuomorphic style and Light skeuomorphic style. It is found that the design style of monitoring system icons changes with the update of computer system versions, and has certain continuity characteristics. From the analysis of monitoring interface layout design, 9 interface design styles with different layouts are summarized, and they are combined with Chinese character types to be figuratively processed, making the style more recognizable. Finally, through the analysis of monitoring system interface samples, a total of 70 sample interfaces are analyzed, and 90 HSB colors are extracted. After analysis, it is found that the most widely used and high-frequency interface color HSB range is 180° < H ≤ 240°, 0% ≤ S ≤ 20%, and 20% < B ≤ 40%, represented by the dark blue interface, which can provide theoretical basis and case support for design optimization for designers related to monitoring interfaces.

At the same time, according to the analysis results, the commonly used interface design color interval range, which can provide design reference for the optimization of subsequent monitoring interface.

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АНОТАЦІЯ

Чжоу Тяньюй, Єжова О. Дизайн інтерфейсу системи моніторингу на основі типології

У статті проаналізовано основні концепції та процес розробки типології, а також досліджено застосування типології на прикладі дизайну інтерфейсів систем моніторингу.

Мета. *Мета дослідження полягає в систематизації елементів інтерфейсу моніторингових систем, таких як піктограми та колірні характеристики, типи дизайну інтерфейсу, і наданні рекомендацій для подальшої оптимізації дизайну інтерфейсу систем моніторингу.*

Методологія. *У рамках дослідження проведено огляд літератури для вивчення принципів дизайну інтерфейсів систем моніторингу. Окрім того, було здійснено систематичний аналіз 70 зразків інтерфейсів систем моніторингу. Аналіз охоплював дослідження типів піктограм, розташування елементів на екрані, а також колірних схем, застосованих у цих інтерфейсах.*

Результати. *Узагальнено типи піктограм інтерфейсу системи моніторингу та схарактеризовано 10 загальних стилів дизайну піктограм інтерфейсу систем моніторингу, включаючи лінійний прямокутний, лінійний, із закругленими кутами, відкритий, багатоколірний, градієнтний, накладений, лінійної поверхні, плоский, скевоморфний і світлий скевоморфний. Виявлено, що стиль оформлення піктограм системи моніторингу змінюється з оновленням версій комп'ютерної системи та має певні характеристики безперервності. З аналізу дизайну макета інтерфейсу моніторингу підсумовано 9 стилів дизайну інтерфейсу з різними макетами, які поєднуються з типами китайських ієрогліфів для образної обробки, що робить стиль більш впізнаваним. Виділено 90 кольорів HSB інтерфейсу. Виявлено, що найбільш широко використовуваний і високочастотний діапазон кольорів інтерфейсу HSB становить 180° < H ≤ 240°, 0% ≤ S ≤ 20% і 20% < B ≤ 40%, представлений темно-синім кольором. інтерфейс, який може забезпечити теоретичну основу та підтримку для оптимізації дизайну для розробників, пов'язаних з інтерфейсами моніторингу.*

Наукова новизна. *Вперше виокремлено типи піктограм, виявлено оптимальні колірні рішення інтерфейсу системи моніторингу. Отримали подальшого розвитку принципи дизайну інтерфейсів.*

Практична значущість. *Завдяки аналізу прикладів системи моніторингу елементи дизайну інтерфейсу, таких як піктограма, макет, загальні типи стилю*

дизайну кольору та особливості кольору моніторів з високою частотою, розроблені елементи інформаційного забезпечення дизайну інтерфейсу системи моніторингу.

Ключові слова: система моніторингу, графічний дизайн, піктограма, колір, стиль, розташування, дизайн інтерфейсу, типологія, тенденції дизайну, взаємодія «людина-комп'ютер».

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