# Research on Adaptive Design Methods of Intelligent Systems for Different User Groups

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## Abstract

With the rapid proliferation of intelligent technologies, the application scenarios of intelligent systems are increasingly diversified, and differences among user groups in age, cognitive ability, usage needs, and other aspects are becoming increasingly pronounced. The traditional design mode is difficult to meet the personalized needs of different users. Therefore, the research focuses on the adaptive design methods of intelligent systems with different user groups. The theoretical basis of user group division and adaptive design is sorted out, and a design method system including user group fine division, multi-dimensional adaptive design module and dynamic adaptation mechanism is constructed; The advantages of this method and the traditional method are analyzed from the theoretical level; The rationality of the design method is verified with typical application scenarios, which provides theoretical support for enhancing the adaptability of intelligent systems to different user groups.

**Keywords** Intelligent System; Different User Groups; Adaptive Design; User Division; Theoretical Comparison

## 1 Introduction

With the popularity of artificial intelligence technology, intelligent systems have widely penetrated into many fields, and become an important support to improve production efficiency and optimize the quality of life. However, different user groups have significant differences in physiological characteristics, cognitive ability, usage habits and core needs. At present, most intelligent systems adopt the idea of universal design, which is developed only for the needs of mainstream user groups, ignoring the difficulties of special groups, leading to some users' difficulties in use, poor experience and even giving up use, which limits the universality and value of intelligent systems [1-3]. Therefore, carrying out the research on the adaptive design method of intelligent system for different user groups and realizing the accurate adaptation of the system to different usage needs can not only improve the user experience, expand the application coverage of intelligent system, but also promote the development of intelligent technology in a more inclusive direction, which has important theoretical significance and practical value. Adaptive designing of an intell. sys was researched very early, in the late 20th c. people began looking at the effect different kinds of users had on how the design got made [4-5]. The earlier studies were about the help from another part of a smart things and those who have something special but made the things simpler. With new intelligent technologies, study started researching more on the Dynamic Adaptive based upon User Data. Build accurate user model and let system function and the mode of interaction changed by itself, we will arrange all these function of our system in sequence as per the user's habit while using the application. Currently, there are some targeted researches conducted in areas like education intelligence system, medical intelligent device etc., they mainly focus on analyzing the needs of certain types of users, optimize designs. But the existing user groups are roughly classified, and mostly based on one single aspect. This makes it difficult to truly understand a user's unique preferences [6]. Adaptive design is not systematic. It focuses just on single dimension interface or function and does not create a full system for requirements, creation and dynamical adjustment. The comparison of the existing design methods depends on experiment data verification, and lack of deep analysis from theory point of view [7].

Therefore, the research reviews the relevant theories of user group division and adaptive design, clarifies the core connotation and key elements of adaptive design of intelligent systems for different user groups, and constructs the adaptive design method system of intelligent systems for different user groups, covering the refined user group division method, multi-dimensional adaptive design module and dynamic adaptation mechanism. The advantages and disadvantages of the design method proposed in this paper and the existing mainstream design methods are compared and analyzed from the theoretical level, and the rationality of the design method is verified with typical application scenarios.

The overall logic of the study is as follows: first, through literature research, sort out the relevant theoretical basis and research status, and clarify the research gap; Secondly, based on the results of theoretical combing, the adaptive design method system is constructed; Thirdly, carry out the theoretical comparative analysis of design methods; Finally, the feasibility and superiority of the design method are verified by case analysis combined with specific application scenarios.

## 2    Relevant Theoretical Basis

### 2.1    User Group Division Theory

Dividing user groups is a condition for designing in response, the central idea here is taking all those persons who have same needs,characters or behavioral characteristics under common category which gives you a place on earth for your particular adaptation. User group division theory comes from market segment theory, in the late period is being used for the human computer interactive environment and systems designs as well. According to different partitions, there's single dimension partition and also has multiple dimensional comprehensive partitions.As shown in Table 1.

**Table 1.** User group division method

| Comparison Dimension | Single-dimensional Segmentation Method | Multi-dimensional Comprehensive Segmentation Method |
|---|---|---|
| Segmentation Basis | Single user characteristic | Static characteristics such as physiology, cognition, and society - dynamic characteristics such as usage habits and scenarios |
| Segmentation Comprehensiveness | Only covering a single characteristic, making it difficult to fully reflect demand differences | Covering user characteristics in multiple dimensions, enabling comprehensive capture of personalized needs |
| Operation Difficulty | Simple and easy to implement | Relatively complex, requiring multi-dimensional data support |
| Adaptation Value | Only meeting the basic needs of single-characteristic groups | Providing a comprehensive basis for precise adaptation |

### 2.2    Adaptive Design Theory

Adaptive design theory is an important theoretical branch in the field of human-computer interaction. The core idea is that the system actively adjusts its functions, interfaces, interaction modes, etc. according to the changes of user characteristics, use scenarios and other factors, so as to improve the user experience. According to different adaptation subjects, adaptive design can be divided into system oriented adaptation and user oriented adaptation. As shown in Table 2 .

**Table 2.** Comparison of characteristics between system-led adaptation and user-led adaptation

| Comparison Dimension | System-led Adaptation | User-led Adaptation |
|---|---|---|
| Adaptation Subject | The intelligent system itself | User's independent operation |
| Core Logic | Collect user data → automatically analyze needs → adaptive adjustment | Provide setting options → user's independent selection → manual adjustment of adaptation status |
| Advantages | High degree of automation, no need for user intervention, more precise adaptation | Strong user control, can accurately match personal subjective needs |
| Disadvantages | Relies on data quality, may have adaptation deviations | High operation cost, unfriendly to low-cognition users |
| Applicable Scenarios | Most general intelligent systems, such as e-commerce recommendations and information APP | Professional systems or scenarios with strong personalized needs, such as professional design software |

The core elements of adaptive design include adaptation object, adaptation dimension and adaptation mechanism. Good adaptive design needs to accurately grasp the demand differences of the adaptation object, reasonably select the adaptation dimension, and build an efficient and flexible adaptation mechanism.

### 2.3　Human Computer Interaction Theory

Human computer interaction theory is the most basic theory of intelligent system design. Information transmission and the exchange process from humans to systems, and it also focuses on how systems can conform to the physical and mental traits of users [8-9]. The user centred design principle and cognitive load theory from the field of Human-Computer interaction both offer some useful ideas around what an adaptive thing should be. User-centered design means that we make the system for use based on what people need us to do it as well as making everything that's within the system easier for people who will use it; Cognitive load theory states that the system is meant to lessen the minds strain for those using it so no information is too large and can be grasped by the user who uses this system.In the application of human-computer interaction theory, according to the cognitive level and operation habits of different user groups, the interaction process and information presentation mode of the system are optimized to reduce the learning cost and operation difficulty of users; Improve the efficiency and accuracy of interaction between users and the system through reasonable interface layout and feedback mechanism.

## 3　Construction of Adaptive Design Method System of Intelligent System for Different User Groups

### 3.1　Design Goals and Core Principles

Design Goals
In order to achieve the precise adaptation of the intelligent system to the needs of different user groups, and improve the user experience and operation efficiency of user groups; Expand the application coverage of the intelligent system so that users of different ages, cognitive levels and usage habits can easily use the intelligent system; Enhance the flexibility and expansibility of the intelligent system, and be able to adapt to the dynamic changes of usage needs.

Core Principles
Through the refined division of user groups, accurately grasp the differences in the needs of different user groups, and ensure that the design scheme can accurately match the needs of users. The adaptation dimension should fully cover the interface, function, interaction and other aspects, avoid the experience weakness caused by a single dimension adaptation, build a dynamic adaptation mechanism, and adjust the adaptation status of the system in real time according to the changes of user behavior; The fourth is the principle of ease of use. The design scheme simplifies the operation process, reduces the cognitive

burden and learning cost of users, fully considers the needs of special user groups, and has good inclusiveness and accessibility.

## 3.2 Refined User Group Segmentation Method

The refined division method of user groups proposed in this paper adopts the idea of multi-dimensional comprehensive division, and combines the static and dynamic characteristics of users to build the division index system. The specific steps are as follows:

Step1: clearly divide the index system. The division indicators include static indicators and dynamic indicators. Static indicators cover users' physiological characteristics, cognitive characteristics and social characteristics; Dynamic indicators cover users' usage habits, usage scenarios, and core requirements.

Step2: Determination of indicator weight. As different indicators have different impact on usage needs, AHP is used to determine the weight of each indicator. Through the construction of judgment matrix, the weight value of each index is calculated to ensure the rationality of weight distribution.

Step3: user group clustering. According to the partition index system and the weighting allocation, we use K-means clustering algorithms for the user information's grouping; similarly-natured individuals and similar requirement people will be put in one category. When it comes to doing clustering we have to modify our number of clusters such that every single kind of user category we see will be recognized clearly as well as have proper recognition with how demanding things would go. Like split by clusters, we make it low cognitive elders group, high cognitive elders group, young student, professional worker and so on.

Step4: user group demand modeling. For each cluster of user groups, through user interviews, questionnaires and other means to further clarify their core needs, potential needs and use difficulties, build a user demand model, and provide a clear basis for the subsequent adaptive design.

## 3.3 Multi-dimensional Adaptive Design Modules

Based on the refined division results and demand model of user groups, this paper constructs a multi-dimensional adaptive design module, including interface adaptation module, function adaptation module, interactive adaptation module and information presentation adaptation module. Each module cooperates with each other to realize the comprehensive adaptation of the system to different user groups, as shown in Table 3.

**Table 3.** Core characteristics and adaptation goals of each module

| Adaptation Module | Core Characteristics | Adaptation Goals | Typical Adaptation Strategies |
|---|---|---|---|
| Interface Adaptation Module | Focus on visual presentation and layout optimization to match user physiological and cognitive characteristics | Improve interface readability and recognition, and reduce visual cognitive burden | Large fonts/high contrast, personalized skins , efficient layout |
| Function Adaptation Module | Realize functional modularization and personalized combination based on demand differences | Accurately match core functional needs and eliminate redundant functions | Basic functions are enabled by default , professional functions are integrated , interesting functions are embedded |
| Interaction Adaptation Module | Provide diversified interaction methods to adapt to operating habits and physiological capabilities | Improve operational convenience and accuracy, and reduce operational difficulty | Voice interaction , gesture touch , shortcut keys |
| Information Presentation Adaptation Module | Optimize the form and detail level of information to match cognitive level and information needs | Improve information transmission efficiency and ensure that information is easy to understand and obtain | Step-by-step graphics and text , animations and comics , professional reports |

Interface Adaptation Module

The Interface Adapting module focuses on improving how it looks in terms of its interface like where everything lays out or colors and text sizes and other such things for various user types with varying physiological traits and cognitive stages. Elderly people with low cognition, adopt simple and clear interface layout to reduce redundancy, increase the font size and icon size, so as to enhance the readability, choose high-contrast color matching to help those with poor eyesight identify easily, remove complicated animations to avoid distractions from user's attention. Teenagers can use colorful and lively interfaces, and there should also be some different skins, which can also satisfy the students' own interests. The Professional Workgroup can use more organized interface layouts that makes the most important elements easy to use.

Function Adaptation Module

The function adaptation module realizes the personalized customization and modular combination of system functions according to the core needs of different user groups. By building a function module library, it includes basic function modules and personalized function modules. The system can automatically match the core function modules for different user groups according to the demand model of user groups, and allow users to manually add or remove function modules according to their own needs, so as to realize the flexible adaptation of functions.

Interaction Adaptation Module

According to different users' operational habits and their own bodily conditions, the interactive adaptation module gives various kinds of interactive model selections, it can make the interactive model automatically adapt. Touch Interactoin Voice Inteaction Gesture Interacting Keyboards Mouses Interacting. And as well as all teenagers, make it better for fun and easier using your hands too. For professionals in our workplace we will be allowing you key board mouse as well as short cut keys so that everything goes faster. Meanwhile, the system also learns what kind of interactions people like best and figures out how to change its interaction method according to the way a person acts.

Information Presentation Adaptation Module

The Information Presentation Adaptaion Module, it will change how we show the info we give people according to what their brain is able to do and what they actually need to see based on themself. Old guys with lower mind, ordinary word choice that isn't technical jargon is done to give out data; break down the hard stuff into smaller, easier steps to get more understanding from people; important stuff shown by mixing texts and making the transmission quick. For professional workplace groups, professional and detailed information presentations were used to create full data reports as well as professional analyses reports for them. We can support the user's definition of filter/sort so as to be able to meet the user's own need for information. And in case of the youth group we go about using bright and colorful ways to display information to increase the attraction.

## 3.4    Dynamic Adaptation Mechanism

In order to adapt the system to the dynamic changes of usage needs, a dynamic adaptation mechanism based on user behavior analysis is constructed. The mechanism mainly includes three core links: user behavior data collection, demand change identification, and adaptation strategy adjustment. As shown in Figure 1.
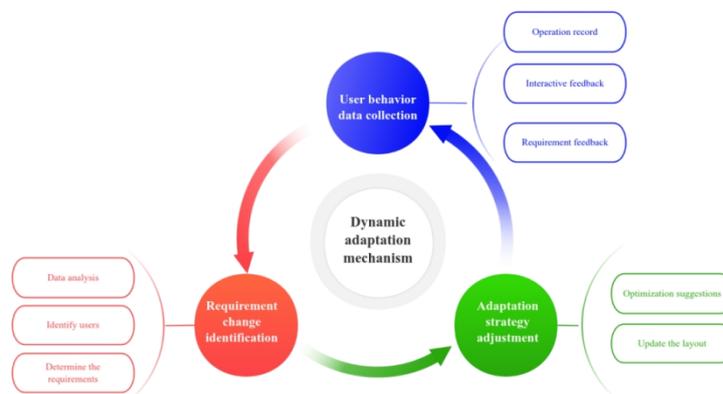


**Fig. 1.** Core links of dynamic adaptation mechanism

User behavior date, The system is recording all the things that users do like when they open their phone with the real time data and also it's through this point tech embedded, For demand changes we analyze all those users' behavioral dates using machine learning algorithms so that we could find a change trend for what kind of demands these users have. Adaptation strategy adjustment: Automatically adjust adaptation strategy, update interface layout, functional modules, interaction methods or information display forms according to the recognition results of demand changes. When a great change in need has been made, and no change had occurred as an effect of auto adjustment for the system, it would display suggestions for improvements to adapt and make necessary changes under user confirmations. At the same time send the user's demand change data to the user grouping division component as a basis for dynamically updating user groups.

In order to verify the superiority of the adaptive design method of intelligent system for different user groups proposed in this paper, this section selects three current mainstream design methods as the comparison object, and makes a comparative analysis on the five core indicators of user group division accuracy, adaptation dimension integrity, adaptation flexibility, user experience optimization effect and system scalability from the theoretical level. The comparison objects are: the traditional general design method, recorded as method a, the adaptive design method based on single dimension, recorded as method B, the adaptive design method based on user portrait, recorded as method C, and the design method proposed in this paper, recorded as method D. The comparison results are shown in table 4.

**Table 4.** Comparison results

| Design Method | Comprehensiveness of User Group Segmentation | Completeness of Adaptation Dimensions | Adaptation Flexibility | User Experience Optimization Effect | System Scalability |
|---|---|---|---|---|---|
| Method A | Low | Incomplete | Low | Poor | Low |
| Method B | Medium | Relatively Complete | Medium | General | Medium |
| Method C | High | Relatively Complete | Medium | Good | Medium |
| Method D | High | Complete | High | Good | High |

The results show that the design method proposed in this paper is superior to the existing mainstream design methods in many core indicators, can more accurately capture the demand differences of different user groups, achieve more comprehensive and flexible adaptive design, significantly improve the user experience, and has stronger system scalability, which is more in line with the diversified and personalized development needs of the current intelligent system.

# 4    Application Case Analysis

In order to further verify the rationality and feasibility of the adaptive design method proposed in this paper, this section takes the design of intelligent health management system for multi-user groups as an example to carry out application case analysis.

## 4.1    Case Background

The user group of the intelligent health care system is old people, middle-aged people at work, young people and so on. There is quite an amount of difference between what each one is after when going through their health. Elderly folks mostly focus on watching some simple stuff about our body along with an emergency medical thingy that's all pretty simple and straight forward, middle-aged employees will look more into stress from work as well as sports & exercises suggestion kind of things and they would also require quick & easy info searching, data analyzing sorts, young people mainly consider growing up, development, forming habits related things which involve some level of engagement & enjoyment. Traditional way is not able to suit everyone, thus in this paper an adaptive way is used in system building.

**4.2     System Design and Implementation Based on the Proposed Method**

With the multidimensional partitioning index system we introduce here we have taken up age and thinking level as well as medical demands and usage routines to create key elements. Weights for each indicator are obtained via analytic hierarchy process. Then the user data are clustered based on kmeans cluster algorithm. Finally we have the groups of low cognitive elderly, high cognitive elderly, middle age workplace, young people. For each group we build the demand model from interviews done with the users. Interface adaptation module is improved for different groups: simple arrangement, large font and obvious color difference for people who do not have good mental condition, use vivid and cartoon style for teenagers. Function adapting part builds a set of function modules that matches the general functions like taking a look at someone's BP, giving them an emergency call if they are old and don't think quite well; it could also be linked up to special job-oriented ones such as keeping track of someone's anxiety levels or looking out how much motion has been made; we can connect their growth and maturation chart monitoring services along with the kind of stuff they like to eat as well as any other related activities to do with the teenager part of society. The interactive adaptation module makes adjustments to the voice interaction function for the senior citizens and it has support for dialects too. The Keyboard shortcut can be supported by the middle–aged work place groups. Touch gestures is improved by youth groups. Information presentation adaptation module uses step-by-step graphic information for elderly users. It provides detailed data analysis report for the middle-aged group. The teenage users receive animation containing health information. We get the data by putting an embed point and when the need change we learn by machine learning algorithms. For instance, if I see a diabetic asking questions on my page on diabetes, I'm going to automatically put a module in there for health managment around diabetics, so it changes the way things get presented and gives me some very easy diabetes self-care information.

# 5     Conclusion

Relevatant theoryical basis for categorizing the users into group, adaptative designing and interactive designing etc. and also define their main features and direction of the work. And complete designing means, dividing user, making a few adaptive modules like many other things, and creating dynamic adaption. The system is able to take note of how much each sort of person need things in different ways so that they would have an entire, changeable plan for what to do. By way of theoretical comparative analyses, we validate the current design technique, which is deemed to be a better approach than traditional general design or adaptive designs centered around only one factor. After analyzing some actual cases of smart health care system, then we would confirm the rightness of using the above mentioned methodology.

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# Conflicts of Interest

The authors declare no conflicts of interest.

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# 面向不同用戶羣的智能系統自適應設計方法研究

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摘要：隨着智能技術的迅速普及，智能系統的應用場景日益多樣化，用戶羣體在年齡、認知能力、使用需求等方面的差異日益明顯，傳統的設計模式難以滿足不同用戶的個性化需求。因此，本文研究具有不同用戶羣的智能系統的自適應設計方法，梳理了用戶羣劃分和自適應設計的理論基礎，構建了包括用戶羣精細劃分、多維自適應設計模塊和動態自適應機制的設計方法體系；從理論層面分析了該方法與傳統方法的優劣；通過典型應用場景驗證了設計方法的合理性，爲提高智能系統對不同用戶羣體的適應性提供了理論支持。

關鍵詞：智能系統；不同用戶組；適應性設計；用戶部門；理論比較

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