

Retraction

Retracted: Visualization of Information Retrieval in Smart Library Based on Virtual Reality Technology

Complexity

Received 23 January 2024; Accepted 23 January 2024; Published 24 January 2024

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] S. Fang, "Visualization of Information Retrieval in Smart Library Based on Virtual Reality Technology," *Complexity*, vol. 2020, Article ID 6646673, 18 pages, 2020.

Research Article

Visualization of Information Retrieval in Smart Library Based on Virtual Reality Technology

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Received 23 October 2020; Revised 16 November 2020; Accepted 18 November 2020; Published 29 November 2020

Academic Editor: Zhihan Lv

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Starting from the virtual reality technology, the characteristics of its most suitable combination with the library are explored, so as to lay a foundation in theory and practice to promote the development of virtual reality in the library. In the concentration camp of the latest advanced technology, the relevant technologies used in the various levels of models in the smart library are extracted, and their functional principles and applications are systematically introduced; Chapter 4 builds the level of the smart library information retrieval technology model. The structure diagram, various levels of functions, and related smart service models are discussed. Research is on context construction of extended resources of knowledge service in smart libraries. The elements and content of the resource context are introduced, and the strategy of constructing the resource context for the extension of the knowledge service of the smart library is proposed. Research is on the construction of the context of the extension and interconnection of knowledge services in smart libraries. The relevant elements and contents of the technical context and the spatial context are introduced, and a strategy for constructing a connected context for the extension of the knowledge service of a smart library is proposed. Research is on the context construction of knowledge service extension of smart library. The elements and contents of the service context are introduced, and the strategy of constructing the service context of the knowledge service extension of the smart library is proposed. A visual model of information retrieval is constructed. The model integrates the core steps of the information visualization process and introduces the information space and functional system (navigation, organization, indexing, and retrieval) in the information construction theory into it and through five mapping layers (functional space mapping, visualization space mapping, visualization mapping, view mapping, and interactive mapping) and six spatial layers (role space, information space, functional space, visualized information space, visualized object space, and visualized view space), which describe visualization applications that target the user experience model in information construction build process.

1. Introduction

With the advent of the big data era, a large amount of data continues to emerge, and there is a phenomenon of abundant information but there is a lack of useful information. Information overload has caused problems such as lack of information and a significant reduction in user information utilization. As an indispensable part of society, libraries should bring forth the new and avoid working behind closed doors. They need to adapt to the development of the times and integrate the latest technology into the library to achieve personalized services for users. But no matter how the library changes and how the technology is updated alternately, its core value of “people-oriented” has

not changed. How can the library realize the transformation from the passive and stereotyped model to the intelligent service model in the new intelligent environment and realize the transformation from single-library service to cross-library service? The construction of the technical model of China's smart library studied in this paper provides technical support for the above problems. Relying on the construction of this model, the library can realize transparent management of user services, mine users' useful information needs, and intelligently predict user personalized services trend, accurately integrating the value density of library management, scientific services, and librarian decision-making.

Research on smart libraries can suggest that it is a difficult and tedious task for readers to accurately find the

books and materials they need in the library environment, but location-aware technology can help readers solve such problems and achieve the purpose of accurate search [1, 2]; it is proposed that a smart library is a mobile library that can transcend space limitations and can be noticed by people [3, 4]. The fact that a smart library uses a large number of software quality projects to reduce users and libraries is emphasized. The goal of error is in the process of use, classification, configuration, installation, or processing by technical personnel [5]. Research is on the application of data mining technology in smart libraries. Through this interactive platform system, the library uses EAI technology to construct the underlying architecture, exchange heterogeneous systems, data, and platforms, realize seamless integration within the system and between multiple systems, and then uses scene graph, data mining, and data analysis technology which intelligently perceives, mines, captures, analyzes, and integrates information to achieve collaboration and sharing of data processing [6, 7]. In the era of big data, data mining technology is of great significance to the development of libraries. It not only can extract hidden and potentially valuable knowledge information from a large amount of disordered and vague practical application data but also can be used to support a wide range of business smart applications, such as directional marketing [8, 9]. Smart library mobile visual search service architecture diagram, and display mobile visual search services, visualization services, knowledge services, social services, social recommendations, one-stop navigation services, and other service functions in the smart service module [10, 11]. Innovative service models have distinctive features, and these accompanying features have evolved based on new technologies and intelligent facilities. Research is on location-based information push services and private customization and other service models, and the research and innovative development of smart libraries by expanding social networks and expanding publicity camps have increased [12]. Guided by relevance learning theory, service models of context-aware services, social services, cloud services, and mobile information services are constructed [13]. The deep integration of "Internet +" and the library has realized the interconnection between the physical world and the virtual world, making the library rich and diverse, and the library community is also actively studying this direction [14]. Under the background of the deep integration of traditional industries and the Internet, it is proposed that libraries should establish user thinking and Internet thinking to build a smart library. Internet thinking is the technical basis of user thinking, and user thinking is the manifestation of Internet thinking, include two complement segmentation [15, 16]. In the "Internet +" environment, the service content of the smart library is introduced in detail [17]. Information technology plays an important role in the transformation and upgrading of the library. The use of Internet of Things, cloud computing, wearable technology, virtual reality technology, artificial intelligence, and other technologies can realize the optimization of the library's literature, equipment, personnel, and buildings [18, 19]. Based on the problems in the application of the Internet of Things

identification technology in the smart library, the improvement measures for the construction of the smart library are proposed [20, 21]. The three relationships between wearable technology and smart library, the specific application of wearable technology in reader navigation, and help for disadvantaged groups and personalized services are analyzed [22, 23]. Using the effect of virtual reality to present pictures, models, or videos in the book, the reading method and interest are increased [24, 25]. A three-dimensional book of virtual reality is made, and the pictures in the book are carried out by using mobile devices. The scanning function can present the actual scene of the corresponding 3D model, change the interactive way of parent-child reading, and promote the establishment of the reading sharing relationship between parent and child [26]. Mobile learning is most effective only when it connects the real environment with related resources [27, 28]. Mobile AR technology provides a channel for the establishment of this connection, and library resources make the connection possible. In the research of the library personalized service system based on virtual reality, there is a detailed introduction to the realization of personalized service related functions, including the following: real-time scanning of QR codes, real-time calculation of projection matrix, projection of three-dimensional objects and location-based book retrieval and book recommendation functions of [29, 30]. In the research on the application of virtual reality technology in the library personalized service platform, it is found that the library information browsing system based on QR code and virtual reality can present different information interfaces to different users according to the information displayed by scanning the QR code. It guides readers to browse the information of books on the bookshelf in an intuitive way and at the same time recommends various resources of interest to readers [31]. The Android-based virtual reality library service platform is a platform that combines new technologies such as the mobile Internet and data mining technology to provide users with personalized services such as book query, book recommendation, and book location navigation [32]. The impact of various frontier technology developments is on libraries, including virtual reality technology. The ideas and countermeasures to innovate the library service model for reference from the Internet are put forward [33]. In the exploration of the application of virtual reality technology in the library, starting from the practical application direction of the library, the foundation of virtual reality is introduced in detail, the important role of this technology in the library business is explored, and the effect of virtual reality in the library is initially explored [34]. The application status of mobile virtual reality technology in the library, combined with the characteristics of various services of the library, is analyzed and the application prospects of mobile virtual reality technology in the library are also explored in order to further utilize the mobile virtual reality technology in the library. The application value in the library provides reference [35]. From the perspective of bookshelf and resource integration, virtual reality multimedia books, virtual reality library navigation, virtual reality optical character recognition, and virtual reality personalized

services, the application of mobile virtual reality technology in modern libraries is discussed [36, 37]. Through research and analysis, the necessity of using virtual reality technology in smart libraries is analyzed, and the application form, workflow, and image recognition mechanism of virtual reality in smart libraries are pointed out, and the innovative service mode of smart libraries based on virtual reality technology is explored [38]. The current situation of library business at this stage is analyzed, and, according to the characteristics of virtual reality, the application of virtual reality technology in intelligent libraries from three aspects is discussed: library personalized intelligent navigation service, resource integration service, and personalized recommendation push service [39, 40].

In view of the research on the information retrieval technology model of the smart library, a detailed analysis is made on the specific construction content of the smart perception layer, network transmission layer, data resource layer, and smart application layer. This article mainly focuses on personalized and scenario-based recommendation, and virtual research is carried out on six service dimensions of reality, multimedia, smart space, and visualization. From a new perspective, virtual reality technology has been widely popularized in certain fields and has brought about certain benefits to those fields. One of the evaluation criteria for the effect of the integration of new technology is whether it has improved the industry, and the application of virtual reality in the library is consolidated through various practical improvement effects, so as to lay the foundation for the popularization of the library industry, as well as theory and practice to be prepared for in-depth research. It also proposes a strategy for constructing a resource context for the extension of knowledge services in a smart library to introduce the elements and content of a resource context, a strategy for constructing a context for the extension of knowledge services in a smart library, and a strategy for constructing a context for extension services of a smart library. The application of augmented reality, virtual reality, and integrated reality provides a new way for libraries to carry out innovative services and a new perspective for libraries to better serve readers. With the passage of time, the technologies of virtual reality, augmented reality, and integrated reality will continue to develop, and the applications full of surprises will continue to change the way readers work, communicate, and entertain themselves and further expand the functions of libraries, so as to promote the construction and development of smart libraries.

2. Information Retrieval Model of Smart Library Based on Virtual Reality

With the current rapid development of intelligence and Internet of Things technology, a technical platform has been created for the bold use of virtual reality technology in libraries, and it has also provided technical innovation and service concept transformation for the diversified transformation of library services. Virtual reality technology is to reflect virtual information into the real world with the help of computer processing technology to realize the integration

of virtual objects, scenes, actions, and other objects and apply them to real scenes. The introduction of virtual reality technology in the smart library creates a comfortable smart virtual space for readers, allowing readers to enhance their desire to enjoy library services in the context of services. Virtual reality technology is a special form of reality technology. It has the characteristics of strong interaction, integration of virtuality and reality, and three-dimensional positioning. It introduces three-dimensional registration and virtual compatibility. At present, if libraries want to efficiently broaden the scope of public cultural services, they should introduce AR virtual reality technology as soon as possible, show the service model to readers in a brand new form, and use high-quality resource construction to burst out the library's own advantages.

2.1. Construction of the Technical Hierarchical Model of Smart Library. The library uses its own obvious resource advantages and integrates the advanced service performance of smart libraries, combines the library models built by predecessors, and introduces smart modern technology based on the theory of integration and collaboration to build a technical-level technical-service model that meets user needs. As shown in Figure 1, the current situation that libraries use a general service mode to meet user needs is broken, and the stable development of the library's service concept of "serving users and satisfying users" is promoted.

The architecture shown in Figure 1 is mainly composed of four parts: smart perception layer, network transmission layer, data resource layer, and smart application layer. The smart perception layer in the smart library is mainly composed of wearable devices, sensors, storage devices, RFID, and video. It consists of monitoring equipment and network monitoring equipment. Users visit the library under the information demand target. The intelligent equipment in the intelligent perception layer perceives, screens, and extracts the data traces generated during the reader's enjoyment of the library's application mode and services. Through the network transmission layer, according to the distance between the geographic location of the sensing device and the library collection data, the large amount of data collected by the intelligent sensing layer can be safely, efficiently, and quickly transmitted through the wireless network, triple play technology, and computer communication network.

The data resource layer is at the center of the technical model. It consists of data warehousing, data mining, cloud computing, information push, and semantic analysis technologies. It is mainly responsible for user data storage and format conversion, user data resource mining and calculation, and user personalized information needs. Task functions include prediction, recommendation, and management. The smart application layer relies on the data analysis provided by the data resource layer and is mainly constructed by virtual reality technology, multimedia, data visualization, and other technologies to realize library scene-based recommendation services, user personalized services, virtual reality services, and multimedia services. The improvement of smart space services and visualization services

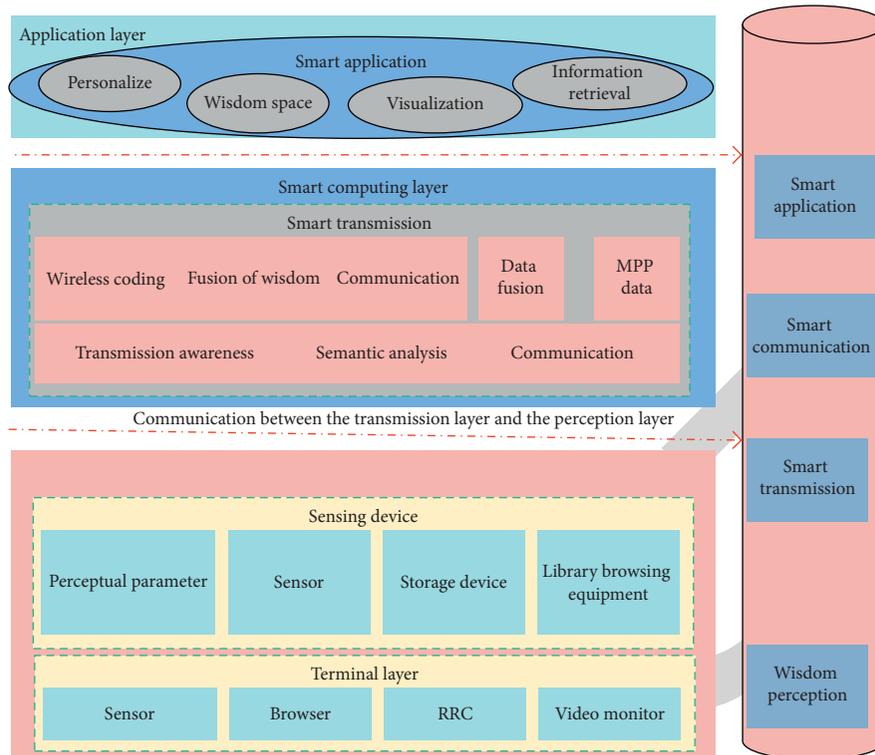


FIGURE 1: Architecture of the intelligent library information retrieval technology model construction system.

and the innovative development of smart libraries have realized the service process from sensing information to digging information, processing information, and finally discovering wisdom.

Virtual reality technology has computer-generated three-dimensional effects that integrate visual, tactile, and olfactory functions, allowing users to enjoy interactive services immersively with realistic and visual scenes. The multiple senses, visibility, permeability, and immersion characteristics of virtual reality technology make it popular in the library field. At present, virtual reality technology is mainly used in the virtual official buildings of libraries, allowing users to “walk” among them, freely associate with the virtual space, and obtain a three-dimensional and realistic user experience. When users “walk into” the virtual space of the library, they can understand the overall layout of the library and can also obtain information consulting services and browse the operation mode of the library in the most direct way of expression, allowing them to understand at a glance and fully embody the superiority of the smart library. It also appropriately compensates for the one-sided and localized information obtained on the library website and increases the user’s affinity for the virtual reality of the smart library. The application of visualization technology in smart libraries can realize the service functions of explicit tacit knowledge, clarification of fuzzy knowledge, and concrete abstract knowledge. In the process of smart library services, the collection of knowledge and the organization of knowledge are inseparable from the service criteria of “knowledge visualization.” Therefore, the smart library must achieve the visual effect of vivid knowledge services. Data

visualization technology is conducive to processing intricate data relationships, transforming data dimensions into visual dimensions, and then mining the knowledge structure and development trends hidden in the data.

2.2. Application of Virtual Reality Technology in Smart Library. In the actual application process, the manifestation of virtual reality technology can be divided into three types according to the user’s “immersion” and “interaction.”

2.2.1. Virtual Reality Technology Display Mode Based on Computer Screen Display. The real-world image or video captured by the camera equipment is input to the computer, synthesized with the virtual scene generated by the computer graphics system, and output to the screen display. The user sees the final enhanced scene picture or video on the screen. This form of expression is simple, in the enlightenment stage of the concept of virtual reality technology, and most of the things shown to users are display attributes, unable to operate and interact, and cannot bring much immersion to users. The implementation scheme of the virtual reality technology system based on computer screen display is shown in Figure 2.

2.2.2. Display Mode Based on Optical Perspective. This type of virtual reality technology needs to use display devices that emphasize the user’s vision and tactility, mainly helmet and glasses-type displays, to enhance the visual immersion by being close to the user’s body. Early AR products produced

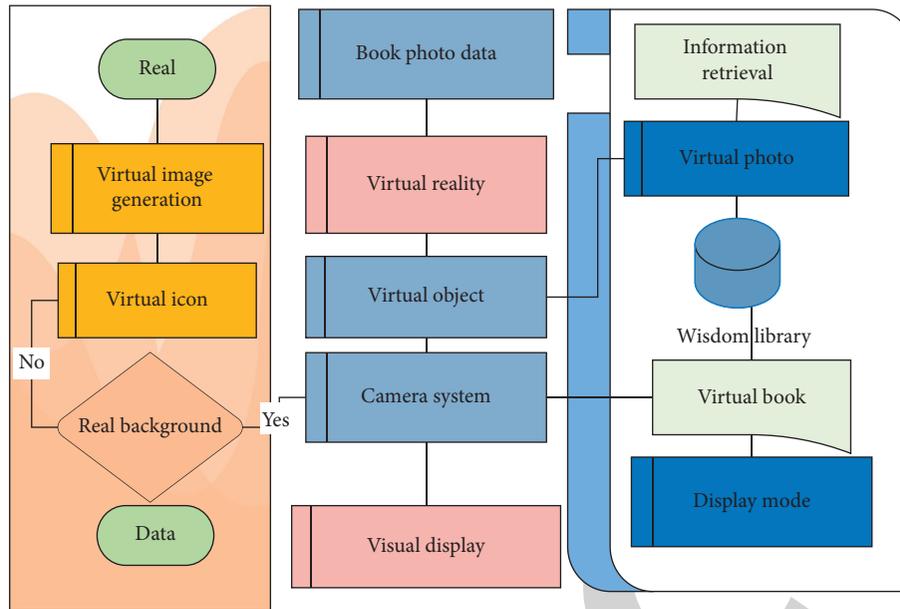


FIGURE 2: Operating principle model of virtual reality technology display mode based on computer screen display.

by electronic product companies such as Sony and Google are geared towards users in the form of helmets and glasses. Different from the computer screen display, the user can directly see the external real world. In fact, it uses a transparent optical synthesizer to project the signal of this virtual image to the eyes, and then because the real world is clearly visible, there is no way through shooting processing and artificial display. Its operating system is shown in Figure 3.

User experience design includes information construction, user interface design, human factor configuration design, and user experience evaluation. In order to complete these designs, they must be carried out in stages according to the requirements of user experience design, namely, the discovery of information needs based on user experience, the construction of user-oriented services based on resource integration, and feedback control based on information integration and service integration. These three aspects can be subdivided, as shown in Table 1.

The integration of information resources based on user experience directly faces users, highlights needs and services, and allocates limited resources to the service businesses that users care about most to ensure the efficiency of resource utilization. To do this, you need to analyze the information needs of users. The discovery process is to understand and analyze users' information needs from multiple angles. The measures taken include analyzing the current environment, understanding the real needs of users through surveys or interviews, deep mining and using the acquired user information, and coordinating user needs with the service organization's strategy and environmental requirements and then enter the design phase of user experience construction.

Construction design is the main part of user experience design, including information architecture, user interface design, human factor research, and user experience evaluation. Information architecture is a high-level information

design that focuses on the organization and presentation of information, and its purpose is to provide users with clear and understandable information. User interface design requires reasonable arrangement of interface elements on the basis of information construction, distinguishing the importance of information, expressing information in an easy-to-understand manner, and enabling users to interact with system functions. Human factor research and user experience evaluation are generally combined. Their responsibilities include user experience testing, researching user development, communicating with users, and passing these results to designers. The feedback control design requires the specification and description of the design process and user-oriented business, listening to opinions in many aspects, and designing a user-oriented integrated service feedback control system to ultimately improve the user experience design.

2.3. Virtual Reality Technology Improves the Effectiveness of Information Retrieval Services and Management of Smart Libraries. As the current popularity of virtual reality technology is not very high and it is not currently included in the development plan of the library business, the survey of this technology in the questionnaire must first start with the cognitive level of the surveyed, and it is easy to be surveyed. The questionnaire was designed based on the expression of the reader's understanding, and the cognitive results are shown in Table 2.

The survey results showed that 35 people did not understand the concept of virtual reality technology at all, accounting for 36.55% of the total number of people in the survey. Because the cognitive problem of the survey is also an important reference data, I do not think that choosing this option will lead to a whole answer. This questionnaire is invalid, which also reflects the current state of understanding of this technology in the industry to a certain

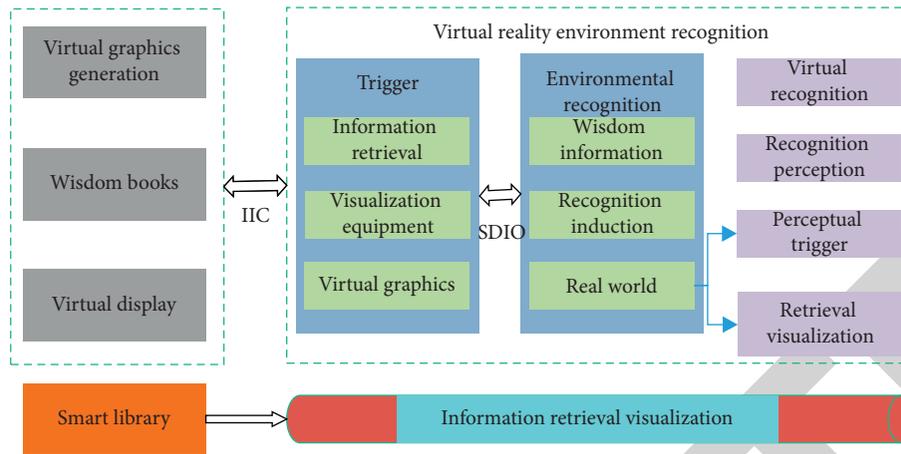


FIGURE 3: Display mode based on optical perspective.

TABLE 1: User experience design process.

User needs	Experience building	Feedback control
Background analysis	Concept + first prototype	Design description
User interview	Site map	Process feedback
User role and plot setting	Interactive model	Performance control
Brainstorming	Idea refinement	
Group design practice	User interface + visual design	
	User experience evaluation	

TABLE 2: User perception statistics.

Variable	Types of	Quantity	Percentage
Awareness	Don't understand	35	36.55
	Scan the QR code	34	38.71
	Sweep the reality object	34	35.47
	Electronic games	28	31.17
	For life	35	36.58

extent, and even if you do not understand the concept of virtual reality technology, you can express the expectations of the surveyed in the subsequent survey options. At the same time, I set the option of “scan QR code” in the research options. In fact, although the method of using QR code is similar to virtual reality technology, the two are not in a mutually compatible relationship. Codes do not belong to virtual reality technology. In the survey results, 14 people chose the QR code option alone, accounting for 14% of the total number of people. It can be understood that these users do use QR codes but they are still familiar with virtual reality technology. If combined with users who do not know anything about it, the proportion of respondents who have a weak awareness of virtual reality technology reaches 50.6%, which accounts for about half. This ratio reflects the current use of virtual reality technology in books. Among the remaining options, “scanning reality” is one of the main features of virtual reality technology, “electronic games” is a hot development field of current virtual reality technology, and “available for life services” means that all types of technologies including virtual reality technology are available. The selected development goals and those that

chose these options also accounted for the other half of all surveyed objects, reflecting the controversy of virtual reality technology in libraries.

The combination of virtual reality technology and library management and services has not only obtained theoretical support in the previous chapters but also should find the advantages of the combination of the two in real applications to enrich theoretical research and lay a foundation for popularization of practice. This section summarizes specific advantages by combining the results of the questionnaire survey and the author’s reasonable assumptions. The survey results are shown in Table 3.

In the questionnaire survey on the advantages of virtual reality technology in library applications, 83 people think that virtual reality technology can provide more comprehensive services for library readers, accounting for 90.31%, and 73 people think it will enhance the interaction between the library and readers’ sex, accounting for 77.43%, 57 people think that this will make paper books break the limit of paper media, accounting for 60.23%, 50 people think that virtual reality technology in the library will help library management, accounting for 55.9%, and 5 people think the advantage is not obvious, accounting for 4.4%. From the analysis of the above survey results, it can be seen that service is the primary consideration in the application of virtual reality technology in smart libraries, and its advantages can be better reflected in services. There is a certain gap between the research objects in management and the selection of services. This also shows that the proportion of virtual reality technology in the development of smart library services and management may also fit the selection of this survey.

TABLE 3: User advantage selection.

Variable	Types	Quantity	Percentage
Advantage type	Full service	83	90.31
	Improve interactivity	73	77.43
	Breakthrough paper media	57	60.23
	Improve management effectiveness	50	55.9
	The advantage is not obvious	5	4.4

The number of users of smart libraries is large, and the level of information retrieval service is at the forefront of the times. It is the basis for smart libraries to adopt and popularize new technologies, and it is the main advantage. Compared with the more expensive and fixed-location navigation machine in the library, the virtual reality technology can be realized on the user's mobile phone, and the service can be provided through the design of the program, and the user's use method is flexible, easy to learn, and fast. As far as the development of smart libraries is concerned, the introduction of intelligent information services such as virtual reality technology improves service efficiency and implements the reader-centered concept. In the questionnaire survey, more than 75% of the respondents believe that virtual reality technology has improved the interaction between the library and the reader, and the smart library has the interaction between the reader and the smart library in each part. The application of virtual reality technology will make the way of interaction more intelligent. In terms of social value, if the use of virtual reality technology is promoted by the smart library of colleges and universities and the concept of new technology is popularized among young users, it will make college students who are good at using computers and mobile phones take advantage of this technology. The strong impression will also affect their future scientific and technological concepts and thus they will have a sense of dependence on the smart library and become loyal users. The group of young people is a group with a rapid popularity and a large number. It can also achieve certain effects in public libraries with evenly distributed age groups. Providing virtual reality technology services for older and traditional library user groups can achieve the effect of narrowing the social technological gap and completing large-scale technical literacy.

Any new technology may be a double-edged sword in the initial stage of application. Through the understanding of the functional characteristics of virtual reality technology, combined with the learning and understanding of the library, and the questionnaire survey and analysis, it is also found that the following points may limit its development, and user survey results are shown in Table 4.

In the questionnaire survey on the limitations of the application of virtual reality technology in libraries, 61 people think that the equipment of virtual reality technology is more expensive, accounting for 64.53%, 44 people think that the utilization rate of virtual reality technology in libraries is low, accounting for 48.38%, 28 people think that virtual reality technology is difficult to popularize as a new thing, accounting for 31.17%, 25 people think that virtual reality technology is complicated and difficult to use,

accounting for 25.82%, and 5 people think there are other reasons, accounting for 4.5%. Therefore, it can be seen from the survey results that the cost issue is the main issue in the application of virtual reality technology in the library. This is not only in the aspect of virtual reality technology. The library's funding is based on the overall consideration of each part of the library, so virtual reality of the cost of technical equipment should be carefully considered. Without experiments, the utilization rate is also worthy of attention. The low utilization rate of advanced and expensive equipment after the introduction will cause great losses to the library. The limitations are discussed in detail below.

3. Knowledge Service Extension and Information Retrieval Visualization of Smart Library

As a valuable and high-quality high-level knowledge service product, smart service is a perceptible, calculable, and visualized creative service, which will drive the technological upgrading, conceptual innovation, management reform, and service transformation of smart libraries. The library becomes an incubator for technological innovation and creativity and promotes the burst of imagination and creativity of users.

3.1. Characteristics of Knowledge Service Extension of Smart Library. The ultimate goal of the extension of the knowledge service of the smart library is to improve the knowledge service capability and level of the smart library and meet the increasingly diverse and individual needs of users. Specifically, the extension of the knowledge service of the smart library is to use the Internet of Things technology to realize the digitization of resources, the application of metadata harvesting, and the establishment of a data warehouse; as well as the storage and calculation of big data on the basis of data interconnection, forming a first-hand reliable information resources; on the basis of information collection, resources are reorganized, a knowledge base system through resource reengineering is built, and the knowledge of information is realized; a precise service platform based on situational awareness is built, and personalized knowledge service products is provided; the intelligence of knowledge is realized, and finally big data analysis tools are used to perform machine learning, mine user preferences, recommend personalized knowledge products, and achieve precise services. The goal of the extension of the knowledge service of the smart library is shown in Figure 4.

TABLE 4: Users' views on limitations.

Variable	Types	Quantity	Percentage (%)
Types of limitations	Expensive	61	64.53
	Low utilization	44	48.38
	New things are difficult to popularize	28	31.17
	Complex operation	25	25.82
	Other reasons	5	4.5

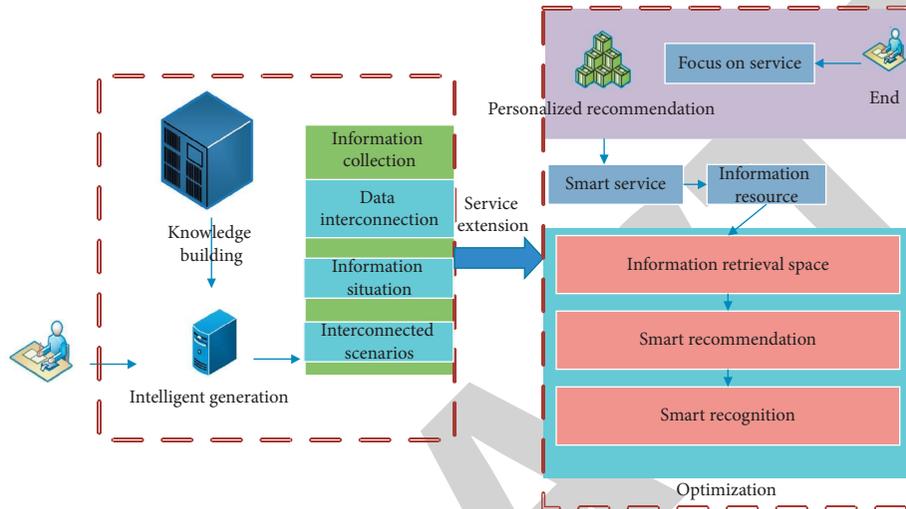


FIGURE 4: Goal-oriented diagram of the knowledge service extension of the smart library.

As shown in Figure 4, the interconnected context is the technical guarantee for the knowledge service context function of the smart library. The accessibility and popularization of the interconnected context depend on the supportive context technology of the Internet of Things and the ease of use and audience perception of the knowledge service platform. Resource context is the material basis of knowledge services in smart libraries. Resource reorganization and resource reengineering to improve the quality of resource content are related to the smooth development of user knowledge mining, knowledge association, knowledge utilization, and knowledge creation. In particular, human resources have become the first resource for the extension of knowledge services in smart libraries. It is the key to applying emerging technologies in the process of knowledge services and carrying out resource reengineering, knowledge creation, and smart services. The service context is the integration of the elements of the knowledge service field of Unicom's smart library under the combined effect of the technology interconnection context and the resource context. The personalized service and precise adaptation incentive function reflect the final performance of the knowledge service of the smart library. The interconnected context, resource context, and service context are cross-integrated and interacted in the knowledge service extension mechanism of the smart library, which together influence and determine the knowledge service level and users' perceived experience and satisfaction.

3.2. Endogenous Power Mechanism Model of Knowledge Service Extension of Smart Library. Based on the mechanism of interaction between the user and the smart library knowledge service system and the influence of the interaction function of the smart library knowledge service system on user behavior, this model is constructed from the different context dimensions of the interaction process between the user and the smart library knowledge service system. Users are the most basic and active force in the extension of knowledge services. The function of the knowledge service system of the smart library and the influence mechanism of user behavior are the user context, which mainly includes user needs and user experience. The three knowledge service context factors of the smart library are interconnection context, resource context, and service context. The corresponding ones are the ease of use, usefulness, and motivation of the correlation between the knowledge service function of the smart library and the user information interaction behavior. They include the ease of use of the space-time system, the ease of use of the supporting system, the usefulness of the resource construction system, the usefulness of the resource reengineering system, the standardized incentives of the service system, and the personalized incentives of the service system. The extension of the knowledge service function of the smart library and the construction of the mechanism model of user behavior are shown in Figure 5.

It can be seen from Figure 5 that user experience interaction and user demand promotion are accompanied by

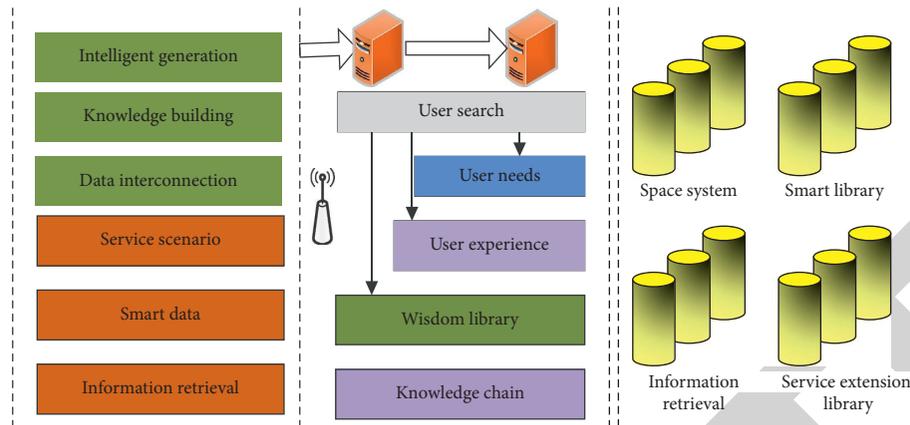


FIGURE 5: Mechanism model of endogenous power and user behavior of the extension of knowledge service in smart libraries.

both service experience characteristics and demand promotion functions. The interactive function of the knowledge service system of the smart library and the user's information interactive behavior work are through the following mechanism: the information of the knowledge service is presented to the user, and the user confirms the occurrence of the interactive behavior through self-perception. The psychological feelings of cognition, emotion, value, and so forth obtained by users through interactive behaviors are the result of comparison between user interaction perception and expectations, which directly affect the evaluation of knowledge service system functions and service incentive levels. In the process of information interaction, the user's impressive experience is accompanied by use and operation behavior, including the mastery of the knowledge service context function and the realization of needs; the user will always be based on the interactive experience and perception of the received customized information feedback and adjust their information interaction behavior. The functional elements of the knowledge service interconnection context, resource context, and service context of the smart library enhance and promote the data interconnection, knowledge construction, and wisdom generation of users, which have an impact on users' information interaction behavior, stimulate users' interactive interest at any time, and induce users' information interaction. The result of its interactive experience is changed. Users' knowledge needs to have new characteristics such as interconnection, sharing, knowledge integration, ubiquity, intelligence, and innovation. The user's interactive behavior in the knowledge service coincides with the ease of use of the knowledge service interconnection context, the usefulness of the resource context, and the motivation of the service context; that is, the user's psychological feelings and satisfaction with the knowledge service and reflecting a good experience of knowledge service quality is the whole process of the effect of the endogenous power of the knowledge service extension of the smart library.

The application of virtual reality technology in smart libraries has certain feasibility. First, the integration of the "three networks" and the construction of the Internet of Things provide networks and traditional equipment and

provide hardware support for the use of virtual technology. The integration of the "three networks" has achieved a high level of resource sharing, with higher communication speed, higher communication quality, and stronger communication security. As an important part of the new generation of information technology, the Internet of Things has realized the real connection of things with the help of the Internet. The development of the Internet of Things will greatly promote the development of smart libraries and VR technology. Second, the development of libraries requires the integration of virtual reality technology. Smart library is a new type of library facing the future and facing science and technology. It is an extension and expansion of traditional libraries. With the development of smart libraries, more and more information technology will be widely used in its function realization and service improvement. When VR technology has shown great advantages and potentials, its integration has improved the way of information services and enhanced the visibility and influence of smart libraries. Third, the characteristics of virtual reality technology are applicable to smart libraries. The immersion of virtual reality technology enables participants to exist in the virtual environment as subjects. The sense of interaction allows participants to get feedback from the virtual environment and realize interaction. Imagination will enable participants to expand more knowledge content through logical judgment, reasoning, and association based on the information they have obtained. It can be analyzed from the above three points that the application of virtual reality technology in smart libraries is very feasible.

3.3. Visualization of Information Retrieval in Smart Library.

For the design of the information visualization model of the smart library, it must not only conform to the basic system structure of the smart library but also fully meet the various requirements of information visualization. Therefore, for the design of the model, the following principles must be met:

- (1) Meeting the individual needs of users. The design of the model should be able to meet the needs of various users of the smart library, and different users have different preferences for the choice of visualization

methods. The personalization of user preferences is mainly in the results, that is, the way to provide personalized visualization results through the icon library.

- (2) Universality. The information resources contained in a smart library are massive, and there are many types of these information resources, including text, graphics, images, sounds, and videos. In the process of model design, it should be classified according to the information resources contained in the smart library to avoid the phenomenon that only information in a specific field is effective, so that the model can be used in a wider range of fields.
- (3) Convenience. Convenience here means that when the user visits the smart library, its visual interface is friendly and there is good interaction between the user and the system.
- (4) Interoperability. Information visualization technology faces the massive collection of information in smart libraries. This information is stored in various databases in different formats. The visualization system should be able to achieve undifferentiated access to information. In addition, the information contained in the smart library comes from different application fields, and the system should also implement interoperability between them.
- (5) The flexibility of the structure. The development prospects of visualization technology are unpredictable. Both information technology and computer technology are developing rapidly, and it is impossible for any technician to fully predict the future development.

Fuzzy C-means clustering algorithm is a typical information retrieval partitioning algorithm; its idea is to make the similarity between objects classified into the same category is the largest, and the similarity between different objects is the smallest. In the iterative optimization process, the FCM algorithm continuously updates the values of the various centers and the elements of the membership matrix until it approaches the minimum value of the following criterion function:

$$T_n(O, P) = \sum_{j=1}^N \sum_{i=1}^c o_{ij} w_{ij}^2 \quad (1)$$

Regarding feature extraction, in the test sample data set, there are a total of 988 keywords, and the number of keywords that are different from each other reaches 628. w is the weight of the number of keywords. After the data dimensionality reduction process, the remaining unique keywords are 113, which greatly reduces the aggregation. The data dimension of the class algorithm in the document space vector matrix R is stored in a text file as the data source of the FCM algorithm in Matlab. The number of iterations of running the FCM algorithm is 100, and the clustering result when the clustering objective function value is the smallest is taken out as the final result output. The results of the five experiments are shown in Table 5.

The clustering results of the third run in Table 5 are the best, and only 2 documents are misclassified in each of the three categories. In general, when the number of FCM documents is small, the clustering quality is better, with an average correct rate of 97.4%. But sometimes the result is not very stable, mainly due to the limitations of the FCM algorithm itself; that is, the random initialization of the center point has a greater impact on FCM.

Since keywords can directly indicate the subject of the literature and the characteristics of the subject, the similarity of the literature can be directly reflected by the similarity of the keywords. In order to cluster the documents, the document similarity matrix is first defined, and the similarity is expressed by Euclidean distance. The following definition is based on the following assumptions: suppose that the total number of documents to be clustered is n , the total number of different keywords in all documents is m , the keyword set is S , and the number of categories is k . The document similarity matrix ($n * n$) is defined as

$$\begin{bmatrix} W_{11}, W_{12}, \dots, W_{1n} \\ W_{21}, W_{22}, \dots, W_{2n} \\ \dots \\ W_{n1}, W_{n2}, \dots, W_{nm} \end{bmatrix} \quad (2)$$

The similarity of two keywords is defined as

$$W(\lambda_i, \lambda_j) = \begin{cases} \frac{\kappa}{\kappa_i + \kappa_j - \kappa}, & \kappa \geq 4, \\ 0, & \kappa < 4. \end{cases} \quad (3)$$

The components of the literature keyword matrix are defined as

$$Q_{ij} = \max(W(\lambda_i, \lambda_j)). \quad (4)$$

The clustering objective function is defined as follows:

$$E = \frac{\sum_{j=1}^k \sum_{i=1}^m (y_i - y_j)^2}{m_j} \quad (5)$$

The selection operation is adopted to select good individuals from the current group and decide which individuals can enter the next generation. First, the individuals are sorted according to the fitness function from large to small, and the first h individuals are copied as new individuals directly into the next generation, and the fitness of the remaining individuals is calculated as follows:

$$P(D) = \left[c + (d - c) \frac{M - \text{rand}(D)/M - d}{(M - c)} \right]. \quad (6)$$

In order to test the feasibility and effectiveness of the information retrieval of the smart library, the value of 207 documents in the life is taken as the test data set. The genetic algorithm parameter is 50, the probability of mutation is represented by P , the value is 0.15, and the intersection value is 0.0002. The value is 0.76, and the maximum number of iterations is represented by T , with a value of 100. After 50

TABLE 5: FCM clustering results.

Number of experiments	Information science (52)		Philology (71)		Library science (87)		Objective function
	Correct	Error	Correct	Error	Correct	Error	
1	47	2	68	1	84	2	101.2245
2	48	4	71	2	83	3	100.4342
3	51	2	69	2	84	2	98.9119
4	48	3	67	2	83	3	102.5346
5	51	2	67	3	84	2	99.2325

experiments, the result of the average objective function is shown in Figure 6.

It can be seen from Figure 6 that, in the iterative process of the FCM algorithm, the objective function can converge quickly, and the value of the objective function is greater than that of the GA algorithm, indicating that the convergence accuracy of the FCM algorithm is inferior to the GA algorithm. GA algorithm converges slowly, but the average accuracy of classification can reach more than 99%, which is better than FCM algorithm. As the GA algorithm draws on the idea of genetics in biology, it searches for the optimal solution through repeated iterations of “survival of the fittest.” Therefore, the optimization ability of GA is better than the FCM clustering algorithm, but the disadvantage is that the GA calculation speed is slow and many parameters need manual intervention.

3.4. Information Retrieval Visualization Construction. For the design of the information visualization model of the smart library, it must not only conform to the basic system structure of the smart library but also fully meet the various requirements of information visualization. Therefore, for the design of the model, the following principles must be met:

- (1) Meeting the individual needs of users. The design of the model should be able to meet the needs of various users of the smart library, and different users have different preferences for the choice of visualization methods. The personalization of user preferences is mainly in the results, that is, the way to provide personalized visualization results through the icon library.
- (2) Universality. The information resources contained in a smart library are massive, and there are many types of these information resources, including text, graphics, images, sounds, and videos. In the process of model design, it should be classified according to the information resources contained in the smart library to avoid the phenomenon that only information in a specific field is effective, so that the model can be used in a wider range of fields.
- (3) Convenience. Convenience here means that when the user visits the smart library, its visual interface is friendly and there is good interaction between the user and the system.
- (4) Interoperability. Information visualization technology faces the massive collection of information in

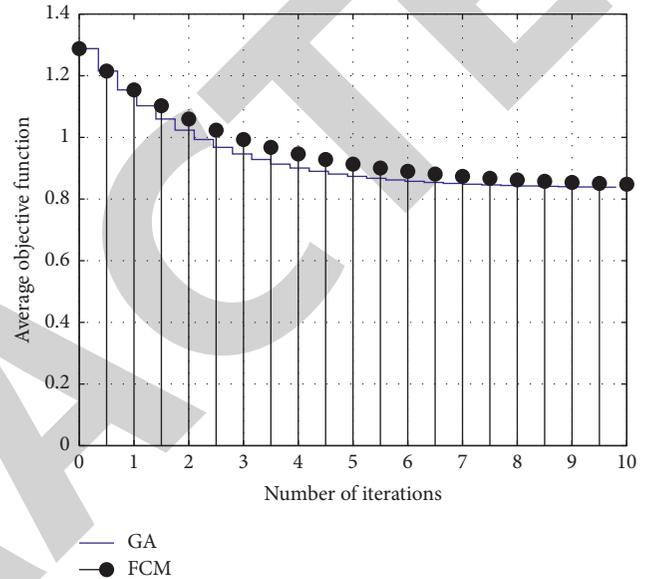


FIGURE 6: Comparison of the relationship between objective function and evolutionary algebra.

smart libraries. This information is stored in various databases in different formats. The visualization system should be able to achieve undifferentiated access to information. In addition, the information contained in the smart library comes from different application fields, and the system should also implement interoperability between them.

- (5) The flexibility of the structure. The development prospects of visualization technology are unpredictable. Both information technology and computer technology are developing rapidly, and it is impossible for any technician to fully predict the future development. Therefore, when designing a visualization system, full consideration should be given to the standardization of the database and the expansion of the system.

The information visualization model of the smart library designed in this paper is shown in Figure 7, which is based on the combination of the basic architecture of the smart library and the reference model of information visualization. As shown in Figure 7, the proposed smart library information visualization model includes a total of six modules: source data module, original database module, feature

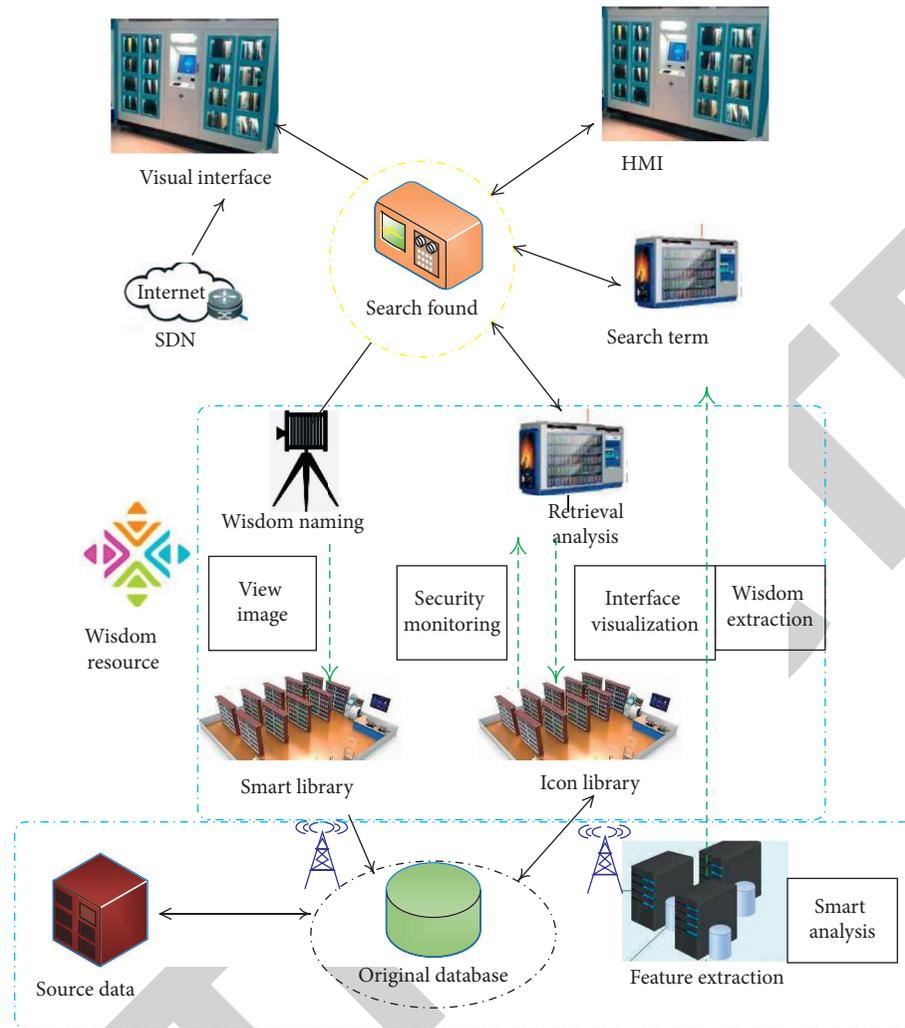


FIGURE 7: Information visualization model of smart library.

database module, view object module, visualization interface module, and extended function slot module.

Based on the above considerations, the L-Apriori algorithm is described as follows:

- (1) Classify the collection of books, combine the book classification method, and divide the collections into professional books and cross-professional books according to their professional background. Professional books for each profession are definitely different.
- (2) Preprocess the historical borrowing data, and set up subdatabases according to profession and year. Each subdatabase only contains the historical borrowing data of previous students in the major, which relates to the borrowing information of professional books and cross-professional books.
- (3) Data association rule mining of professional books: data mining is performed on subdatabases through Apriori algorithm; then the frequent item set A of each subdatabase must be the borrowing information of this professional book, and association rules

can be extracted for recommendation; at the same time, get the frequent item set B of cross-professional books.

- (4) Prune the frequent itemsets obtained by Apriori algorithm mining, delete the frequent itemsets of professional books, and keep only the frequent itemsets of cross-specialties.
- (5) Compare the frequent itemsets A of the first subdatabase a and the frequent itemsets B of the second subdatabase b, find out the same parts, and put the same parts into the frequent itemsets C of the merged new data category c.
- (6) For frequent itemsets, scan b to obtain the support degree sup_x in b and sup_x plus the support degree sup in A; if the sum of the two is greater than or equal to the minimum support degree, put them in C. Similarly, for frequent itemsets, scan a and recalculate its support; and if it is greater than or equal to the minimum support, put it in C.
- (7) Repeat steps 5 and 6 until all the subdatabases are merged to form a new frequent itemset and

association rules, and the extracted association rules are recommended to users in a visual way.

4. Experimental Verification

In order to verify the efficiency of the L-Apriori algorithm, a comparative test was conducted with the Apriori algorithm. The test data is the student borrowing data of a smart library from 2011 to 2012 in the last semester. The test results and the required time are observed through different mining algorithms. The required software and hardware environments are the same. The performance comparison of the two algorithms is shown in Figure 8.

Through the comparison and analysis of the test results and the required time, L-Apriori is more effective than April in the frequent itemset mining of library borrowing data, and the result is simpler, mainly because the L-Apriori algorithm pruned some of the frequent items of professional books in the process of subdatabase frequent itemset integration, and the pruned frequent items of professional books directly extracted the association rules and recommended them to users in the form of knowledge. The frequent items of cross-professional books are integrated one by one to form a frequent itemset of cross-professional books, which is much less than the frequent itemset obtained by April and naturally requires less time. Both the cross-professional book association rules obtained by the L-Apriori algorithm and the professional book association rules obtained by the Apriori algorithm can be recommended to users.

The recommendation service methods of the interviewed smart libraries that provide recommendation services can be divided into two types: personalized recommendation and nonpersonalized recommendation. As shown in Figure 9, about 56% of the interviewed smart libraries provide nonpersonalized recommendation services, such as “new book recommendation,” “borrowing ranking,” “hot review books,” “librarian recommendation,” and “reader recommendation.” Only about 23.5% of the provincial smart libraries have achieved personalized recommendations, but about 72% of them need to rely on third-party search systems to complete personalized search recommendations. Personalized search recommendations mainly rely on user search content to make recommendations, with similar recommendation forms and relatively single content, such as “Guess you like,” “Related Borrowing,” “Related Collection,” “Other Works by Authors of the Same Name,” and “Borrowing Relationship Diagram.” The survey found that the third-party systems that provide personalized search recommendations are mainly the ILAIII knowledge portal search system and the Interlib system. The smart library has completed personalized recommendation under its own recommendation system. When a user logs in to the service platform of the smart library, the recommendation system can analyze the user’s interest and preferences based on the user’s historical data, provide personalized recommendations of “Guess you like” on the homepage, and provide nonpersonalized recommendations of “everyone cares” or dynamic recommendation.

Using the information retrieval visualization API, event processing of the visualization interface can be performed, and interactive control can be added. This means that multiple visualization views can be coordinated, and data flow and control flow can be managed with the server through event processing. Information retrieval visualization provides more than 20 chart types, including the chart type that comes with the API and many visualization chart types developed by third parties, such as tag clouds. Therefore, with the increase of the API applications, the optional visualization types will gradually increase. As shown in Figure 10, the view elements are manipulated by responding to mouse click events. The information retrieval visualization API can also call the information retrieval visualization API to update the visualization view through asynchronous interaction with the server without updating the entire page.

However, from the perspective of the types of visualization, there is a lack of many classic views in the field of information visualization, such as graph-based visualization types and many tree-based visualization views (e.g., hyperbolic trees, radial trees, etc.). It lacks focus + context and overview + detail visualization.

The implementation of questionnaire survey mainly includes two parts: questionnaire survey and individual interview. All the users who participated in the questionnaires selected in this article are those who have used mobile virtual reality technology and are between 20 and 40 years of age. The author first explained the basic concepts of mobile virtual reality technology and then briefly introduced the mobile virtual reality technology prototype system and its functions designed and implemented. Finally, the software was installed on the mobile phone with the Android operating system and the subjects personnel conduct operation and experience. A total of 55 questionnaires were distributed in the survey and 55 were returned, of which 48 were valid questionnaires, with an effective rate of 95%. After collecting the questionnaires, the author randomly selected several questionnaires and conducted individual interviews with the corresponding subjects to discuss related issues that need to be understood.

It can be seen from Figures 11 and 12 that the four categories of user experience scores are not high, the highest score is behavioral experience, with 55 points, and users are basically satisfied. Since the designed mobile virtual reality technology prototype does not involve a social module, users will basically not have a social experience, so the social experience score is low and users are very dissatisfied.

In order to verify the clustering performance of the information retrieval visualization algorithm, the International Standard (IRIS) classification data is used for testing. The data set uses the characteristics of the Orioles as the data source. The data set contains 150 data sets, divided into 3 categories, each with 50 data, and each data contains 4 attributes. It is very commonly used in data mining and data classification for test set and training set. In the PSO algorithm, the inertia weight and learning coefficient adopt linear change strategy. In the information retrieval visualization algorithm, the number of IS-PSO iterations is 20, and

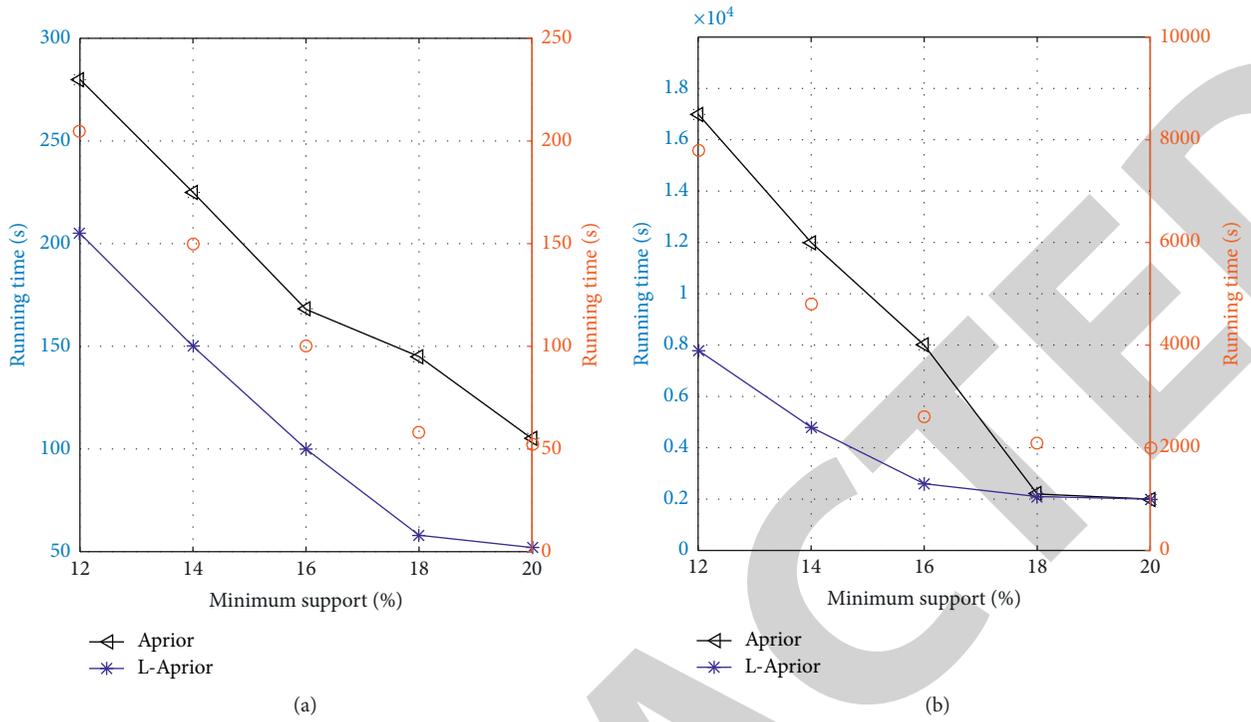


FIGURE 8: Performance analysis of L-Aprior algorithm.

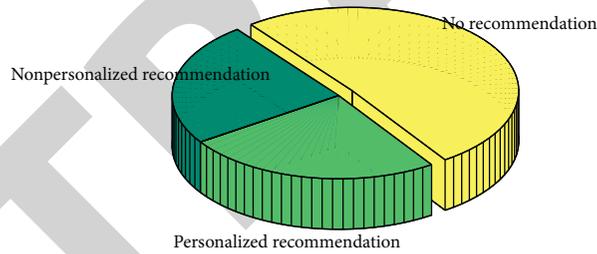


FIGURE 9: Specific content of the recommendation service provided by the smart library.

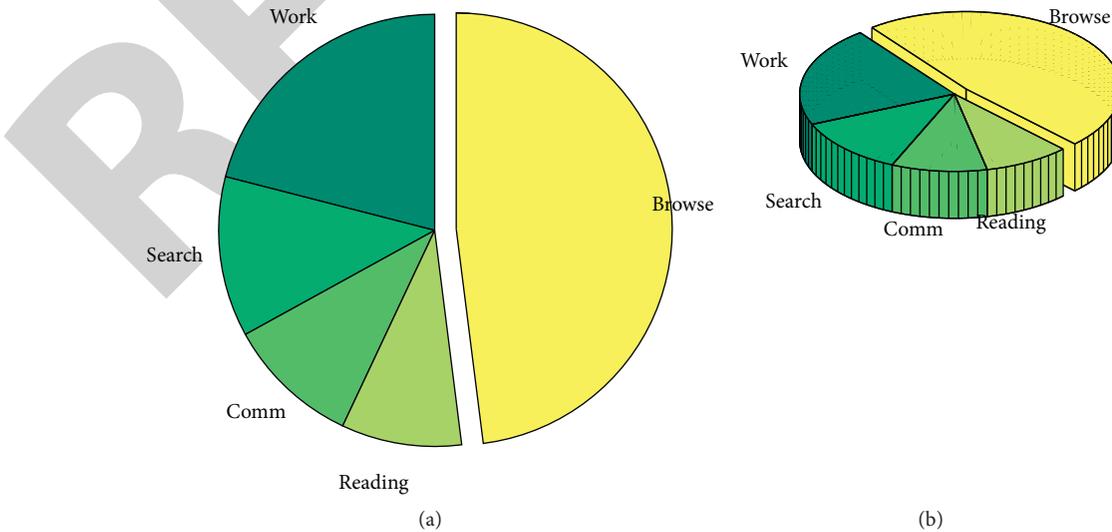


FIGURE 10: Pie chart (view events responding to mouse click).

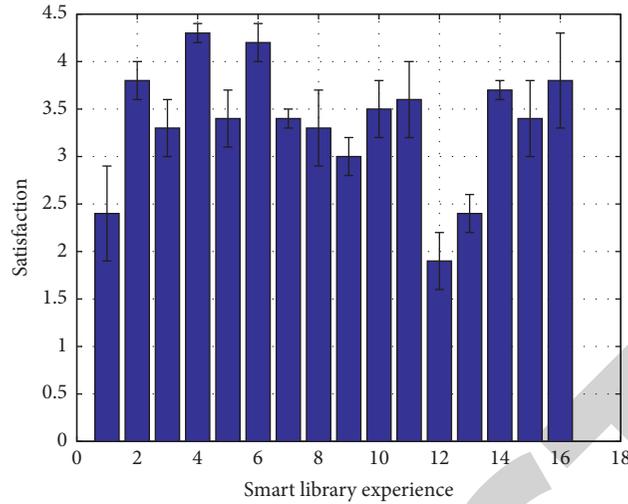


FIGURE 11: Histogram of satisfaction with various elements of user experience.

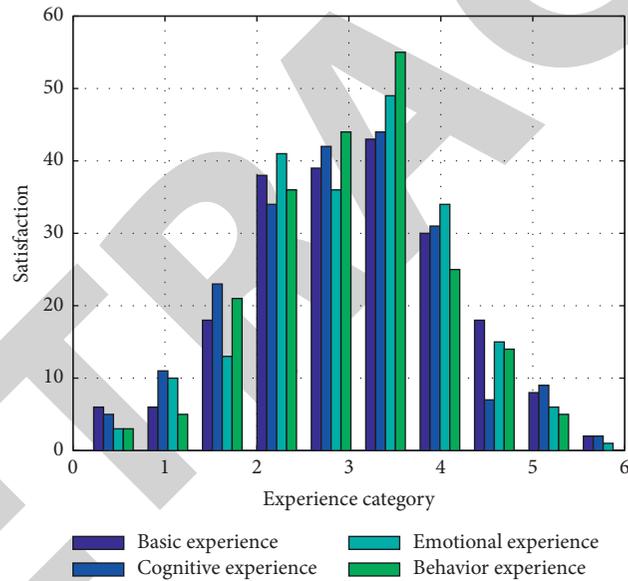


FIGURE 12: Histogram of user experience category satisfaction.

the number of FCM iterations is 80. The results are compared with the results of IS-PSO algorithm and FCM algorithm at 100 iterations. The results of multiple tests of the two algorithms on the same data set are relatively stable. Table 6 shows the comparison of the average performance of the three algorithms.

From the perspective of the correct rate of classification, the correct rate of FCM algorithm classification is only 88.68%, while IS-PSO and information retrieval visualization algorithms have reached a higher accuracy rate; from the perspective of running time, IS-PSO runs the most due to the complexity of the algorithm. The shortest running time of the FCM algorithm is more than 17 seconds, while the running time of the information retrieval visualization algorithm is in the middle. From the objective function, the

information retrieval visualization algorithm is the basis for finding a better center point in the PSO algorithm. On the other hand, with the advantage of fast convergence of FCM, the optimization accuracy is the best, while the IS-PSO algorithm could not exceed the information retrieval visualization algorithm in the optimization accuracy due to the limitation of running algebra.

Figure 13 shows a simulation diagram of the objective function optimization of the two algorithms. The FCM algorithm has the fastest convergence speed but is premature. The IS-PSO algorithm has the slowest convergence speed and the worst optimization performance within the range of 100 iterations. The information retrieval visualization algorithm is consistent with the IS-PSO algorithm in the first 20 generations, but in 20 after the first generation, due to the

TABLE 6: Comparison of average performance of algorithms.

Algorithm	Correct rate (%)	Operation hours	Objective function
FCM algorithm	88.68	0.138668	0.0515
IS-PSO	94.66	18.358748	0.0485
Information retrieval	96.2	3.964959	0.0384

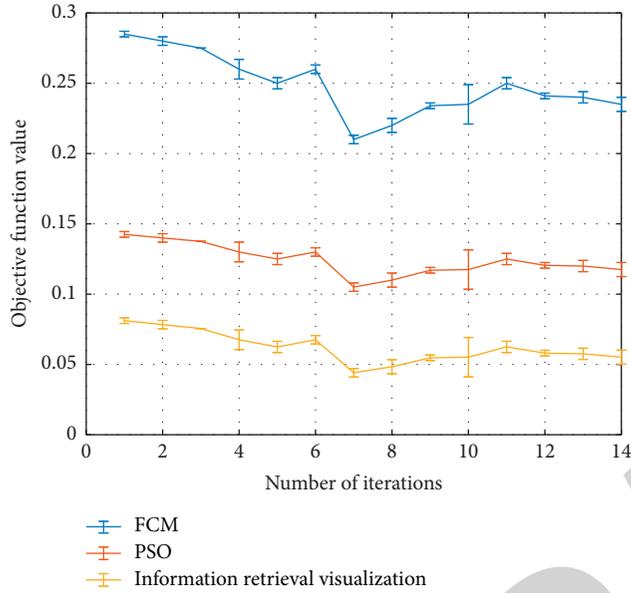


FIGURE 13: Simulation diagram of objective function.

FCM algorithm, the convergence speed is accelerated, and a better optimization effect can be quickly achieved.

As shown in Figure 13, although the efficiency of information retrieval visualization algorithm is slower than FCM, its optimization performance is better than FCM. The information retrieval visualization algorithm combines the advantages of higher optimization accuracy of PSO and the characteristics of fast convergence of FCM, so the information retrieval visualization algorithm can be better applied to document clustering in smart libraries.

5. Conclusion

Inner motivation is the decisive force to promote the increase of contextual functions of new knowledge services. The key to exploring the extension and sustainable development of knowledge services is to explore the intrinsic motivation of new knowledge service enhancements. Therefore, it is necessary to comprehensively consider the development and changes of user experience and perception in the knowledge service process, continuously improve the user's interactive experience and perception, continuously improve the new knowledge service context function of the smart library, and comprehensively and evenly improve the new knowledge service context function design and development to better meet the multidimensional applications and individual needs of users. External motivation is the driving force and supporting force to promote the contextual function of new knowledge

services, which mainly comes from the improvement of resource content quality and basic conditions. Resource context is an important force that determines the function of the new knowledge service, and the maximization of resource content attributes and value is the basic force to promote the interactive function of the new knowledge service context. According to the internal mechanism of knowledge service extension of smart library, the internal power and external power are actively and effectively used to form a dynamic and balanced situational state in order to promote the improvement of the overall function of the library's new knowledge service. By building a smart technology system of smart perception layer, network transmission layer, data resource layer, and smart application layer, with the help of various sensing devices in the perception layer, network technology in the network transmission layer, data mining and cloud computing in the data resource layer technology, virtual reality and augmented reality technology at the smart application layer complete the collection, distribution, and organization of user data and collection data and realize user personalized recommendation services, scene-based services, multimedia services, smart space services, visualization services, and virtual realistic service. However, smart libraries also need diversified smart countermeasures to solve various problems in the construction process and establish an interactive smart platform for the multifunctional smart library system to check for deficiencies and make up for the lack of public welfare services. Under the banner of advocacy, we can focus on user needs and implement the service standards of "precise demand and high-quality services" to create a smart space, to realize the interconnection of physical space, to increase the comfort and humanistic care of the space, and to embody the concept of a smart library for the convenience of readers and green development. In addition, the integration of online and offline libraries, libraries and bookstores, libraries and logistics companies, integrated service solutions, and other integrations are also being further explored, and integration is becoming the main form of the development of smart libraries.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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