COMPUTER INFORMATION TECHNOLOGY APPLIED TO THE DESIGN OF DIGITAL LIBRARY INFORMATION INTEGRATION SERVICE SYSTEM

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ABSTRACT

*Based on computer information technology, this paper constructs a digital library information integration system. Firstly, the system is divided into information retrieval module and personalized service module according to the user's demand, and then the WebServices service is used to realize data integration and the library information obtained. And according to the principle of Fourier transform can be known to realize the conversion of information and knowledge. Finally, according to the movement state of knowledge expression, the formation of the wizard information base thus realizing information rectification. The structure shows that the digital library information integration system can provide 24h*14 hours of service, and the average response time of each operation is within 1s. It shows that the application of computer information technology in digital libraries can provide users with personalized services and perfect their interests.*

KEYWORDS

Computer information technology; digital library; personalized service; WebServices service; Fourier Transform

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1. INTRODUCTION

With the development of computer technology and network technology, digital libraries are gradually emerging [1]. However, because most of these digital libraries rely on their own strength to build, the cycle is long and costly, so that many units with such a need have encountered a lot of difficulties in the process of building digital libraries [2]. This has seriously hindered the process of building some digital libraries, so that the process of informationization construction is also constrained [3]. A more ideal solution to this problem is to implement the outsourcing of digital library construction projects, where professional system integrators provide digital library system solutions and carry out professional construction [4]. In this way, libraries can reduce investment by purchasing mature digital library integration system, and the integrator can make profits through multiple sales of integrated solutions [5-6].

Bramantoro, A. Creation of services with the ability to read all the required data from the library management system using full state technology to improve service quality. A technology acceptance model was used to measure organizational and user acceptance of the full state service system to provide some predictive basis for decision support for senior library management [7]. Sholeh, M. B. Automated Library Door Lock Control System using Arduino Uno and QR-Code. In designing the tool, Arduino Uno and QR-Code were integrated with library database application. Testing and analysis resulted in a 100% success rate of reading QR-Codes by the tested tool [8]. Shvartsman, M. pointed out new directions in e-library activities researching the storage of data, emphasizing the continuing interest in the subject of digital humanities and the fact that research in this field tends to focus on the problems of the modern society [9]. Bwalya, T. Through a descriptive survey, due to the fact that library administrators cannot effectively use all the modules of Koha due to lack of skills. Thus the main modules used are circulation module and cataloging module to enhance internet connectivity [10].

Lacuata, A identified the extent of implementation of guidelines for digitization of library resources in higher education institutions in terms of selection, technical requirements and implementation, legal aspects, budget, human resource planning, development and maintenance, preservation of digital content and project management. It will be used as a framework to provide effective and efficient digitization [11]. Afar, M. E. et al. used cultural institutions to develop new types of services under the influence of global information changes that determine new ways of knowledge mediation and management [12]. Lade, M randomly selected special libraries based on the descriptive statistics, mean scores, and standard deviation analysis of information on the attitude of professional librarians towards the attitudes of professional librarians towards digitization of professional library materials [13]. Babatope, I aimed to reveal the state of digital library education in higher education institutions and the preparation for the development of future digital librarians. The inclusion of digital library courses in order to prepare future digital librarians in this digital era, thus overcoming the often mentioned challenge of lack of ICT staff to manage digital libraries [14].

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Based on computer information technology, this paper constructs an information integration service system for digital libraries. It is divided into information retrieval module and personalized service module from the user demand. And based on WebServices service to realize the data integration needs to forward the service request to the corresponding subsystem through the service bus, combined with the Brookes equation gives the framework of the transformation relationship between information and knowledge, points out the transformation relationship between information and knowledge. The effectiveness of the system in this paper is verified through performance testing, digital resource integration, integration service and update efficiency and integration system accuracy comparison, which proves that computer information technology improves the indexing efficiency of digital libraries, and the integration system is less time-consuming.

2. ANALYSIS OF DIGITAL LIBRARY INFORMATION INTEGRATION SYSTEM

2.1. SYSTEM USER REQUIREMENTS

Digital library information integration system to solve the problem of data source distribution and heterogeneity in the process of using library digital resources, it can be concluded from the requirements analysis that the roles interacting with the system can be mainly abstracted as users, administrators and system administrators [15-16]. The target user retrieval subsystem requirements are shown in Figure 1, and the user use function use cases include user login, user information, literature search, favorites, history storage, primary search, secondary search, subject search, classification search and result display customization. The specific contents are:

1. The retrieval system should have simple retrieval, natural language, phrase retrieval, etc., advanced retrieval, categorized retrieval functions, and primary and secondary retrieval.

2. The output of retrieval results should have sorting functions, such as sorting by date, title, author, relevance and so on. Users can select the source range of retrieval results, data types, etc.

3. Retrieval results collection, the user needs to personalize the collection of retrieval results and retrieval formulas and other information. Fourth, retrieval history preservation. In order to improve the retrieval efficiency, the system should provide a retrieval track saving function to provide reference for the user's next retrieval.

4. Registration and login. Users can apply for an account and use the user name and password to log in the system.

5. Users can change the personal information of the account.

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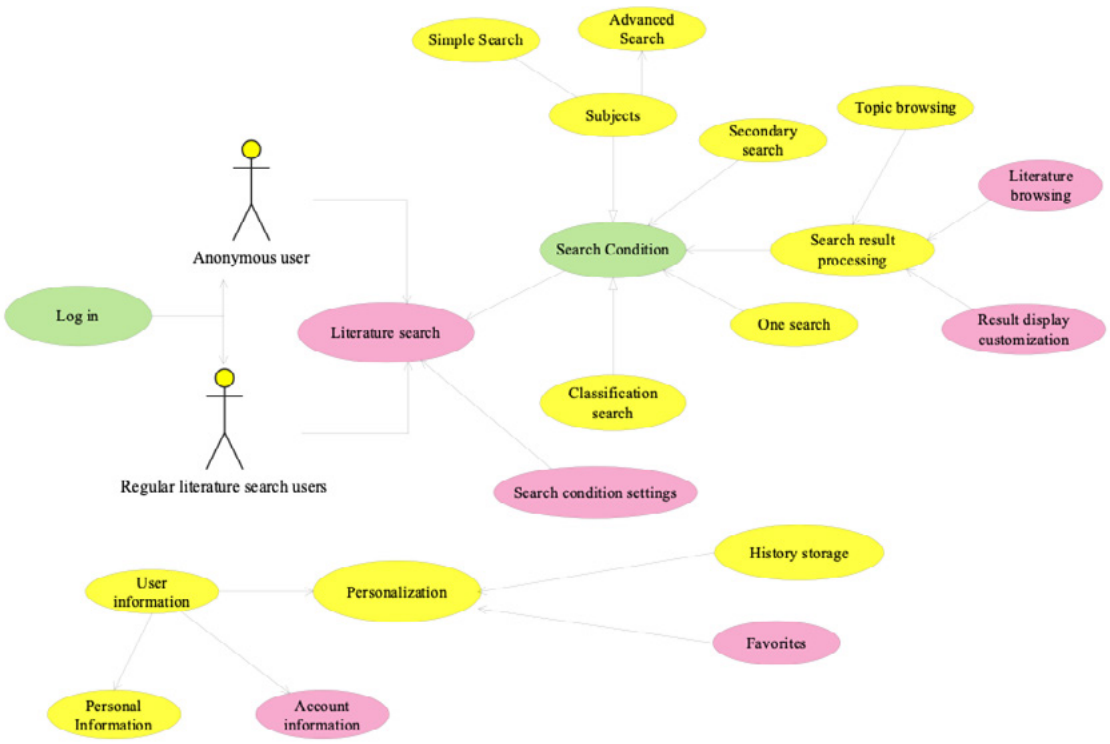

Figure 1 User example

2.2. SYSTEM ARCHITECTURE

The FDL integrated information retrieval system is divided into two main parts, the information retrieval module and the personalized service module. The main function of the user interface component is to intelligently assist the user in clarifying and refining the query request according to the user interest model. The refined query request is then submitted to the intermediary, waiting for the intermediary to return the query result and display it to the user. In addition, the UI also logs the user's basic actions while using the system. These operation logs will show the user's interest in certain information resources for the personalized service module to automatically summarize and learn the user's hobbies and improve the user's interest model. The UI resides on the user's terminal browser and provides the user and Web interaction interface.

The UI resides on the user's terminal browser and provides an interactive interface between the user and the Web. The user hobby learning machine selects training positive and negative examples according to the operation log, and updates the user interest model with user examples. Fig. 2 shows the library integrated information retrieval, where the mediator is activated upon receiving a query request from the UI, converts the query request submitted by the UI into an RDF statement to be submitted to the wrapper generation module, and then waits for the return result. When multiple wrappers respectively return the results of their respective queries in the form of RDF

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documents, the intermediary summarizes the query results and combines them into a complete RDF result document in accordance with the relevance ordering.

Because each data source adopts different metadata representation standards, the intermediary needs to convert the metadata information describing the object data in the process of merging the results. The mediator queries the pre-defined metadata mapping table, and converts other metadata formats to Dublin Core-based metadata. This ensures the consistency of the RDF result document and facilitates the display and processing. As most user browsers do not support the display of RDF documents, in order to ensure that the RDF result document can be displayed in the client in a clearer and more friendly way, the intermediary also needs to be based on the pre-defined display format Schema will be converted to HTML pages, returned to the UL through the modification of the display format Schema can be changed by the display of the results of the query, which also increases the flexibility of the system. This also increases the flexibility of the system. The query of heterogeneous data sources is completed by the wrapper, FDL integrated information retrieval system adopts the mechanism of automatic generation of the wrapper, to ensure the scalability of the system [17].

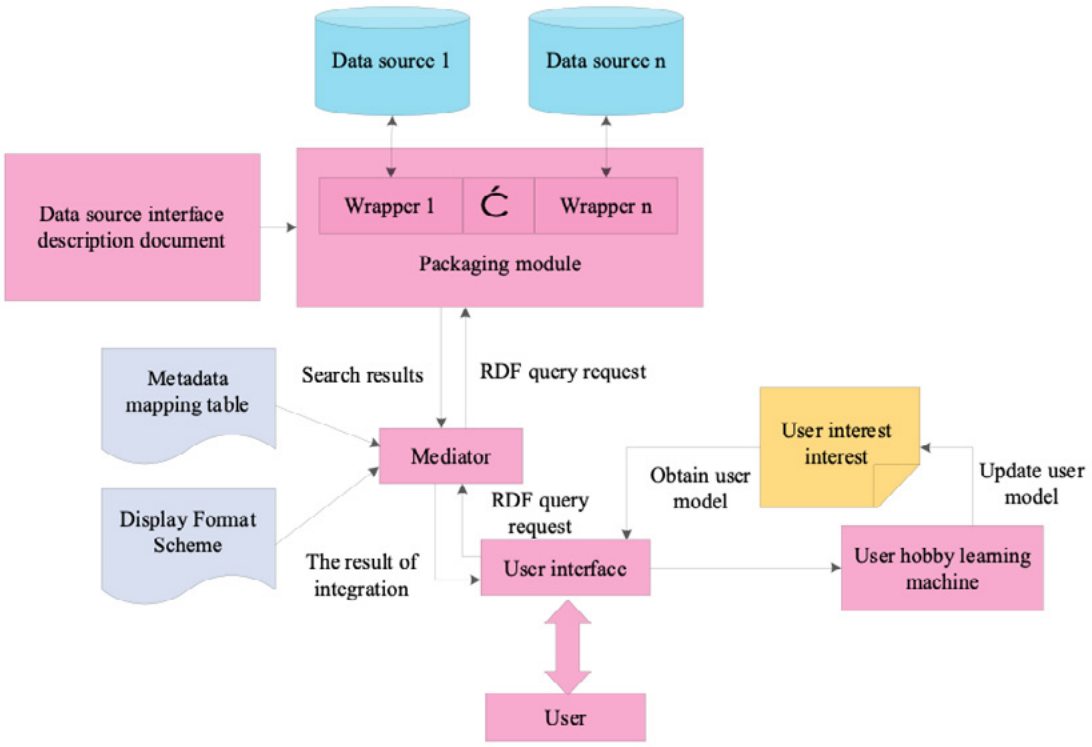

Figure 2 Library integrated information retrieval

Subsequently, based on the information obtained from the search, learning and information recommendation are based on user interests. It includes several components, including user personalized characteristic information base, user interest learning, information search, and information filtering. User interest learning and information recommendation is shown in Figure 3, including:

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1. User personalized characteristics information base, or user personalized information table mainly includes information about the user's personalized characteristics. Such as the user's name, unit, address, specialty, occupation. User's previous request tasks such as classification, subject line, query range, etc. IP address, title, time of browsing, frequency of keywords and user's evaluation value, request time, URL of the requested file > HTTP version number, etc.

2. In order to provide personalized services to the user to recommend different information for different users, it is necessary to analyze the user's present or future interest preferences from the user's historical records in order to provide information services to the user actively [18]. Obtaining user needs through user-initiated descriptions. Embedded intelligent Agent, active tracking to collect the user's usual interest in information, from which to analyze the user's preference characteristics and background knowledge, the establishment of user personalized characteristics and stored in the user database.

3. Information search function through keyword matching, to the local or network resource database query, return the corresponding query results.

4. Information filtering function adopts content-based filtering method, extracts information content features from the query content, and matches them with the user personalized feature library to filter out the information related to the user's interest and recommend it to the user. Collaborative filtering technology is used to establish a user classification and recommendation mechanism to recommend information based on the same or similarity between users. Synthesize the strengths of content-based filtering and collaborative filtering to improve the accuracy of recommendation.

2.3. CHINESE WORD CLASSIFICATION MODULE

Chinese word classification module is closely related to the information query module and information indexing module in the system. The Chinese word classification model is shown in Figure 3, before indexing the crawled local web resources, the information indexing module will call the Chinese word classification module to perform word classification, and the indexed fields after word classification will be written into the Lucene library. After the user sends a query request, the information query module will also call the Chinese lexicon module to parse and slice the request submitted by the user. Then it is transformed into a query field that meets the standard of Lucene retrieval interface, and the query is compared in the index database to return the corresponding document collection. The Chinese word segmentation module mechanically slices and matches the input according to the words present in the dictionary. If a string is found in the dictionary, the match is successful, i.e., a word is recognized. Record the location of the word and return the dictionary index of the word. Dictionary management module mainly realizes the

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statistics of the number of entries in the dictionary, dynamic addition and deletion of entries.

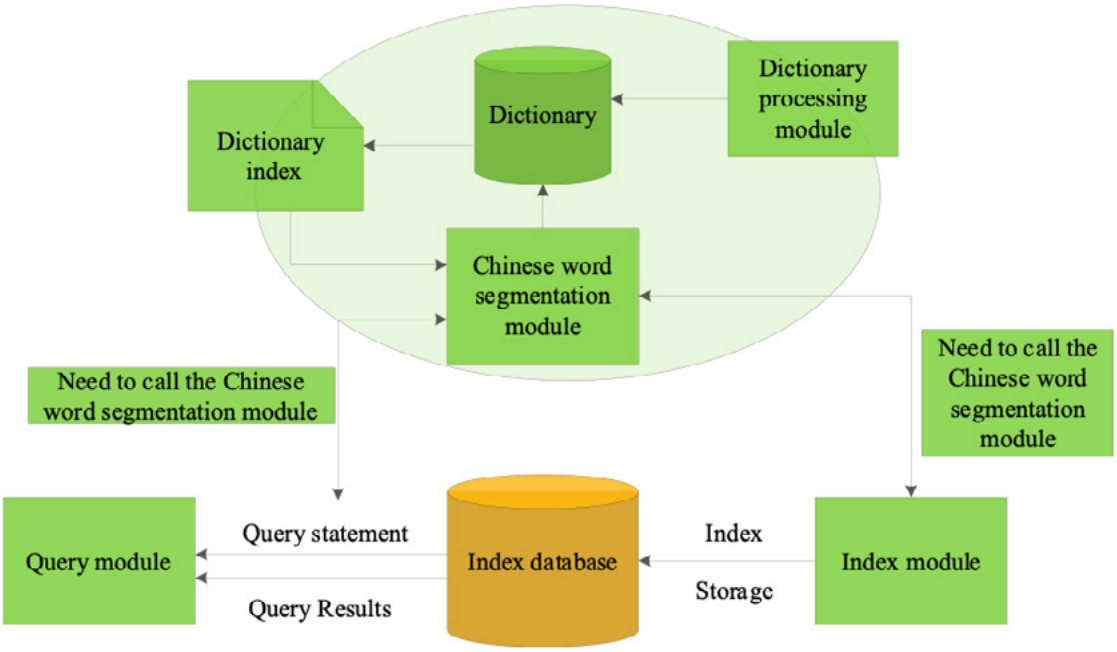

Figure 3 Chinese word classification module

2.4. IMPLEMENTATION OF DATA INTEGRATION

WebServices-based services to achieve data integration needs to be forwarded through the service bus service requests to the appropriate subsystems, based on the Web Services data integration process shown in Figure 4, the use of Web Services approach to data integration process is: first of all, the user issued a query command, analyze the query is a comprehensive query on which service or which services, and then through the unified Web Services interface to issue access orders, the Web Services interface to query the list of service buses to find the application system to access and forward services, and finally the application system will query the query to find the application system and forward services. If it is a comprehensive access to several services is decomposed into several services, and then through the unified Web Services interface to issue access commands, the Web Services interface in the service bus list query, find the application system to access and forward the service, and finally the application system will be queried by the return of the data to integrate the multi-table joint query data that is to get the desired information.

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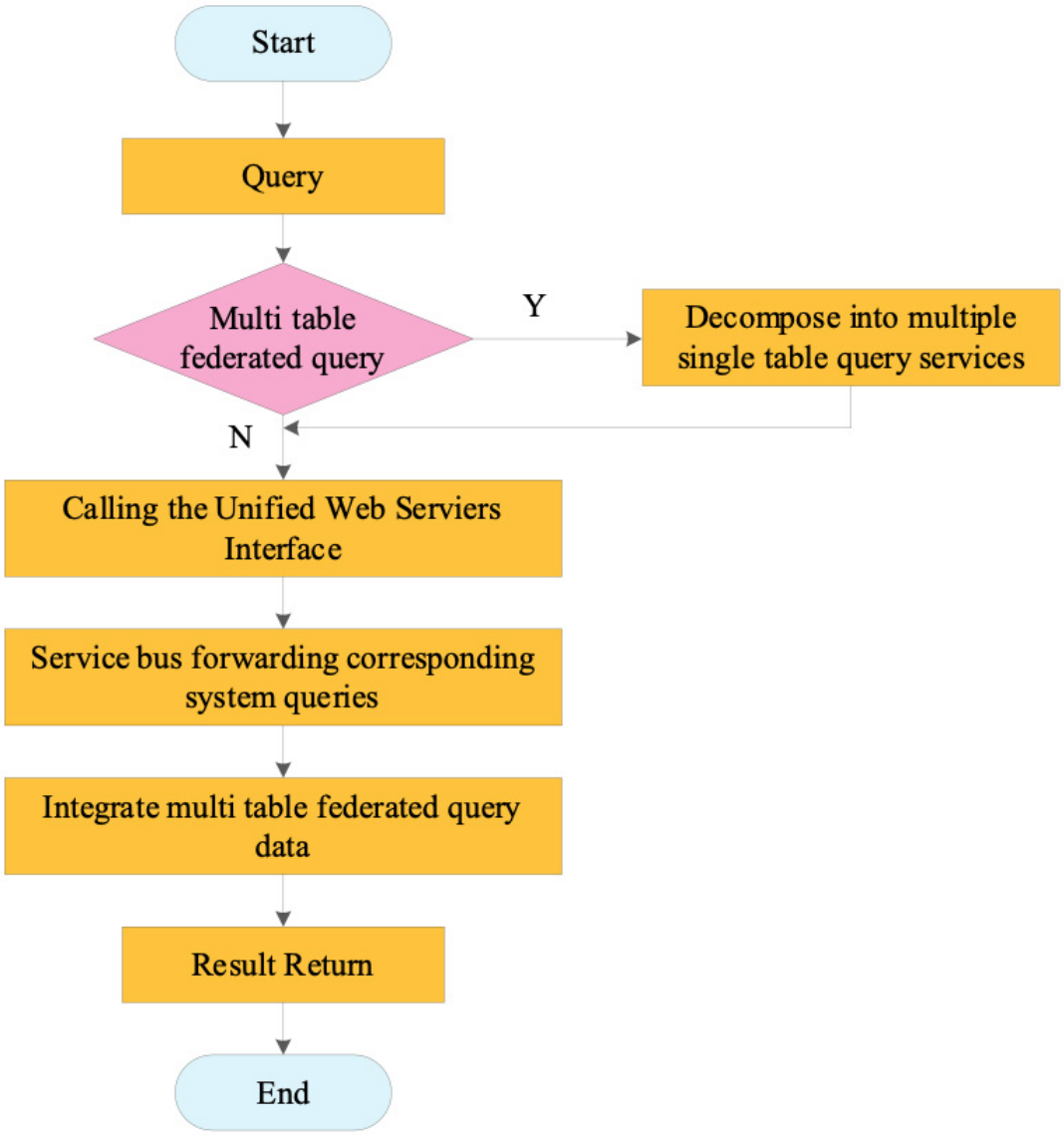

Figure 4 Web Services data integration process

3. CONDITIONS AND MECHANISMS OF COMPUTERIZED INFORMATION GENERATION

Based on the above acquired library information, this paper gives a framework of the transformation relationship between information and knowledge in conjunction with Brookes' equation, which points out the direction for research on the utilization of information. This section analyzes and discusses the equation from physical and cognitive perspectives, pointing out that there exists a transformation between information and knowledge, but the transformation from information to knowledge is the most important as far as knowledge construction is concerned.

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3.1. CONDITIONS FOR INFORMATION GENERATION

According to the principle of Fourier transform, it is known that in order to realize the transformation of two different domains of information and knowledge, the transformation process must have the following transformation functions:

$$Is(t) = I(t)S(t) = I(t)\delta_{Ts}(t) \quad (1)$$

$$I(S) * S(S) = Is(S) \quad (2)$$

$$Is(S) * P(S) = K^*(s) \quad (3)$$

Reduce it to:

$$I(S) * K(S) = K(S + \Delta S) \quad (4)$$

The above equation illustrates that the knowledge system *K (S)* is convolved with the knowledge spectrum *I (S)* of the information to produce a new knowledge system $K(S + \Delta S)$, i.e., the realization of the transformation of information and knowledge to require three different stages of conditions:

1. The first stage is the perceptual cognitive process of knowledge formation, which requires that the knowledge system must be selective, i.e., sampling the attributes of information $= I(t)$ to form a sample sequence of information $I_s(t)$.

2. The second stage is the rational cognitive process of knowledge, and then the sample sequence of $I_s(t)$ is abstractly categorized to form the transformation of the knowledge spectrum sequence Is (S).

3. The third stage is the process of utility formation of knowledge, i.e., Is (S) is convolved with the original knowledge spectrum K(S) of the knowledge system to produce a new knowledge spectrum, i.e., a new knowledge increment is introduced, thus realizing the rectification of information. ΔS represents the utility of the information to generate knowledge, there may be three cases, when $\Delta s > 0$ indicates that the information generates new useful knowledge. When $\Delta s = 0$ indicates that the information does not generate new useful knowledge, and when $\Delta s < 0$ indicates that instead of generating new useful knowledge, the information increases ambiguity.

3.2. INFORMATION GENERATION MECHANISMS

Information expresses the states of things in motion and the ways in which the states change, and knowledge expresses the states of things in motion and the laws of state change.4 For some random piece of information *X*, if there are *N* possible states of motion, i.e., if its state space is $X_1, X_2, \ldots\ldots, Xn$, and if the ways in which these states change are distributed according to some probability $P1, P2, \ldots\ldots, Pn$, then the probability space, which is a combination of the state space and probability distribution, is inscribes this information.

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According to the law of movement state and state change of knowledge expression has a certain external form, has a certain logical content, presents a certain value to the cognitive subject, and the corresponding knowledge is called morphological knowledge, content knowledge, utility knowledge, respectively [19-20]. From the point of view of the information recognition process, both morphological knowledge and utility knowledge can be directly perceived from external information. The mechanism of generating morphological knowledge is a form comparison process, which starts with sampling information to establish information samples and extracting the external formal characteristics of the motion state [21]. Such as size, height, weight form, color, etc., and formal features of the way the state changes, such as randomness, episodicity, and ambiguity. Observing multiple information samples and identifying a set of information features with common meaning constitutes a feature information base, which in turn is further formed into a wizard information base through the computation of the feature information base by the information architect. The utility of a piece of information for a certain subject not only depends on the subject's goal, but also relates to the amount of knowledge of the subject. The generation mechanism of utility knowledge is a process of comparing the distance between the state of reality reflected by the state of information and the state of the subject's goal, because from the viewpoint of the most basic method of knowledge induction, only such and such a state of things in motion as well as the way of change of state will reflect such and such information, and only such and such information can be obtained by the state of motion of the thing as well as the state of change of the law of such and such knowledge. The content knowledge, on the other hand, can only be obtained through the understanding of the way things move and change. Content knowledge can only be realized through the mapping of morphological knowledge and utility knowledge. Let the information generated by the morphological knowledge for , from the information generated by the utility knowledge for , content knowledge is the simplest mechanism to generate the information categorization division, through the wizard information base navigation links, the knowledge spectrum convolution results into the knowledge base, so as to realize the information rectification and effective conversion, performance in the morphological knowledge and utility knowledge between the establishment of a mapping relationship .

Figure 5 shows the mechanism of information generation, through the above analysis of the mechanism of information generation of morphological knowledge, utility knowledge and content knowledge, it can be concluded that the realization of information and knowledge transformation must have three conditions, the selectivity of the knowledge system, the transformability of the knowledge system, and the utility of the knowledge system.

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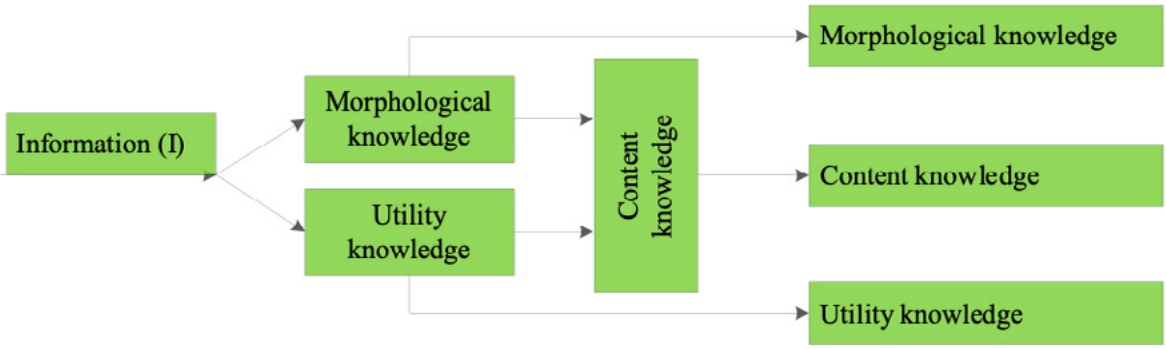

Figure 5. Information generation mechanism

4. SYSTEM PERFORMANCE TESTING

4.1. TEST METHODS

In this paper, from the user's point of view, the system function test, the test includes the performance of the system as well as the function, the performance test is from the perspective of the system's non-functional design, test the system's final results whether to meet the non-functional needs of the previous; functional test, on the other hand, is to test the system's functional modules to test the system whether it is capable of completing the various business.

4.2. ANALYSIS OF TEST RESULTS

4.2.1. PERFORMANCE TESTING

This paper samples the data of the system running for a week to test the performance of the system, and the results of the system performance test are shown in Table 1. After the system is online, it can ensure that the system can provide 24h*14 hours of service, the average corresponding time of the system function is less than 0.2s, the slowest corresponding time on the system line is less than 1.2s, and the system data analysis is done in the background. Considering the performance of the server, the time for system data analysis is less than 1h, the average trouble-free time is less than 0.3 times per month, and the system performance is excellent.

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Table 1 System performance test results

The Project	Specific Projects	Indicators
Robustness	Availability	14*24 hours normal operation
	Average Failure Frequency	<0.3 times/month
	Average Repair Time	<1h
Real-Time System	Average Response Time	<0.2s
	Slowest Response Time	<1.2s
	Statistical Time	<30min
	Average download speed	<1M/s

4.2.2. FUNCTIONAL TESTING

Functional testing is to test the various functions of the system, specifically manifested in the functional interface for data input, test the system whether it can return the expected results. Table 2 shows the navigation function test, 100 times the test results of a row to reach 100%, no error.

Table 2 Functional navigation tests

No.	Content	Number of tests	Consistency of test results/%	
			Normal test	Error test
Query_001	Navigation Functions	100	100	100
Query_100	Search by Title	100	100	100

In addition, various performance indicators of specific business operations such as system insertion, deletion and modification are also analyzed and summarized. The results of the categorized operating system test are shown in Table 3, and the average response time of each operation is within 1 s. The CPU occupancy rate is also controlled within 19%. Because now the computer memory is generally above 2G, and because of the small amount of data accumulated in 10 days, DB can be loaded into memory at one time, the number of memory exchanges and the number of hard disk reads and writes are generally low. And the computer information technology has a good control of the disk write operation, the modified data can be temporarily saved in the memory and written to the disk at one time when the CPU is idle, so the impact on the corresponding time has been controlled, and the exception rate is 0 in both entry and modification.

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Table 3 Classification operating system test results

	Corresponding time/ms	CPU usage/%	Memory usage/M	Memory swaps/session	Disk reads/writes	Abnormal/%
Search	580	18.45	274.6	0.02	0.08	0.04
Record	121	11.22	233.9	0.11	0.26	0
Modify	548	17.69	254.7	0.06	0.23	0
Delete	728	16.88	253.1	0.09	0.16	0.1

4.3. INTEGRATION OF DIGITAL RESOURCES

In order to prove the practicability of the proposed method, a general-purpose computer is set up in the experimental platform, the CPU of which is intrlCor 3110M, the memory is proposed to be 4G, and the operating system is Win-dows10. 120GB of resources are to be integrated in a library service platform, which contains domestic and foreign newspapers, drawings, scientific research results, books, and other attributes, and the integration planning of these resources is carried out in this paper. The integration planning is carried out. Figure 6 shows the results of resource storage space integration under the system, the proposed system after integration, there will be no problem of resource loss, the book category of digital resources for the 60/GB. This is because the proposed method will be converted to digital resources into associated data, relying on the existence of the correlation between the data to classify the different types of digital resources, so as to enhance the integrity of the digital resources in the integration process.

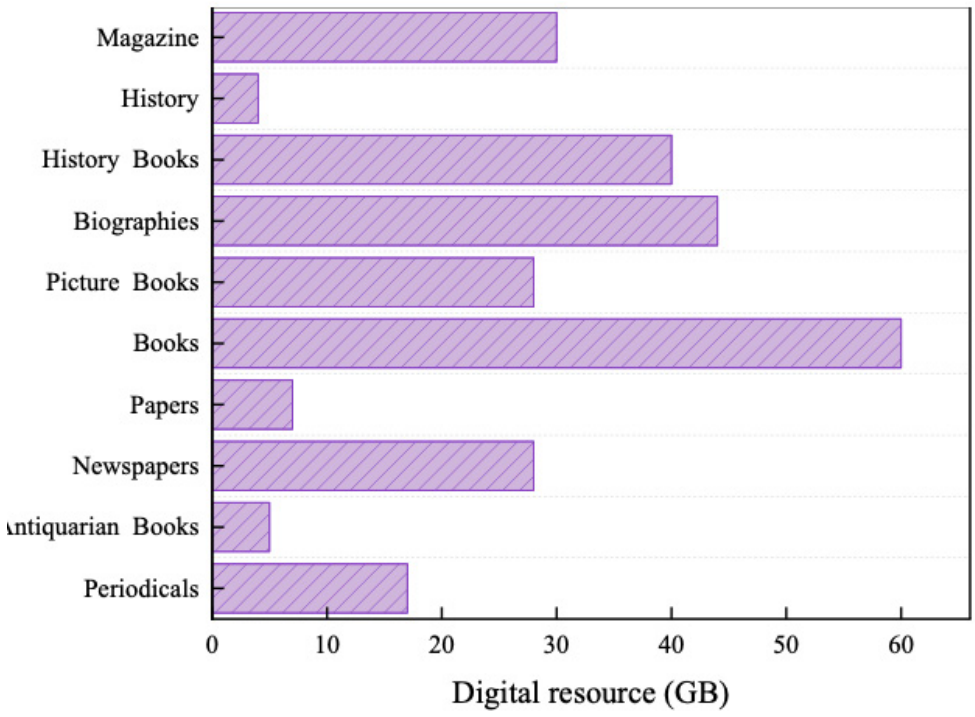

Figure 6 Results of digital resources integration

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4.4. INTEGRATION SERVICES AND UPDATING EFFICIENCY

To a certain extent, the efficiency of integrated literature retrieval depends on the construction efficiency of the index. Under the computer information technology, each working node has the same working performance with the master node, which improves the construction efficiency of integrated index. The experimental system tested the traditional centralized structure, the WES retrieval method as an example with computer information technology, under the conditions of different document set size index construction efficiency, the document size of the specific 150M, 500M, 1G, 2 G, 5G, 1T, index construction efficiency results shown in Table 4. Compared with the traditional centralized structure of the retrieval method, the computer information-based retrieval method has a huge advantage in the index construction efficiency. This is mainly due to the computer information structure gives each independent node more computing power, when the size of the file to be queried is large, the advantage of the distributed structure is more obvious, in 1.25M/s-1.61M/s.

Table 4 Comparison of index building efficiency

Serial number	Literature size	Index construction efficiency M/s	
		WES search	Computer information technology
1	150M	6.68	1.25
2	500M	6.69	1.27
3	1G	13.25	1.36
4	2G	32.44	1.49
5	5G	58.57	1.52
6	1T	88.64	1.61

As the digital library resources are in a state of constant updating, the index that has been established needs to be updated in real time, the update efficiency of the document index under the same data size, the index update efficiency is shown in Table 5. When the size of the document is 150M, the index update efficiency of computer information technology is less different from the traditional method, and the computer information technology is 0.66M/s. When the size of the document continues to increase to 1T, the index update efficiency of computer information technology is much higher than the traditional method, and the computer information technology is 1.54M/s, and the WES retrieval is 2.78M/s. It shows that the computer information technology-based integrated document retrieval method is more suitable for the integrated service design of digital libraries.

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Table 5 Index update efficiency

Serial number	Literature size	Index construction efficiency M/s	
		WES search	Computer information technology
1	150M	0.78	0.66
2	500M	1.15	0.97
3	1G	2.32	1.25
4	2G	2.64	1.41
5	5G	2.78	1.54
6	1T	2.82	1.68

4.5. INTEGRATED SYSTEM ACCURACY COMPARISON

Four different fields, namely, economy, empirical evidence, sports and education, were selected and a total of 10,000 text records were collected. Under the same data size and hardware and software conditions, the proposed computer information technology-based ISS in the paper is compared and validated with the WES-based and metadata-based ISS using retrieval time and correctness of retrieval results as the comparison indexes. The results of the retrieval training time comparison are shown in Fig. 7.

When the size of literature is less than 2000 items, the training time of metadata-based integrated service system is more than 180ms, and the training time continues to improve with the expansion of literature size, and serious fluctuations occur in the middle. The smoothness of the WSE service system is better than that of the metadata method, but the efficiency of the integration continues to decline with the expansion of the size of the literature, and the time consumed is the highest. The advantage of computer information technology (CIT) in large-scale literature integration is gradually highlighted with the increase of literature dataset size, and when the literature size is more than 3000, the training time tends to stabilize, which fully explains that the integration system based on CIT is less time-consuming.

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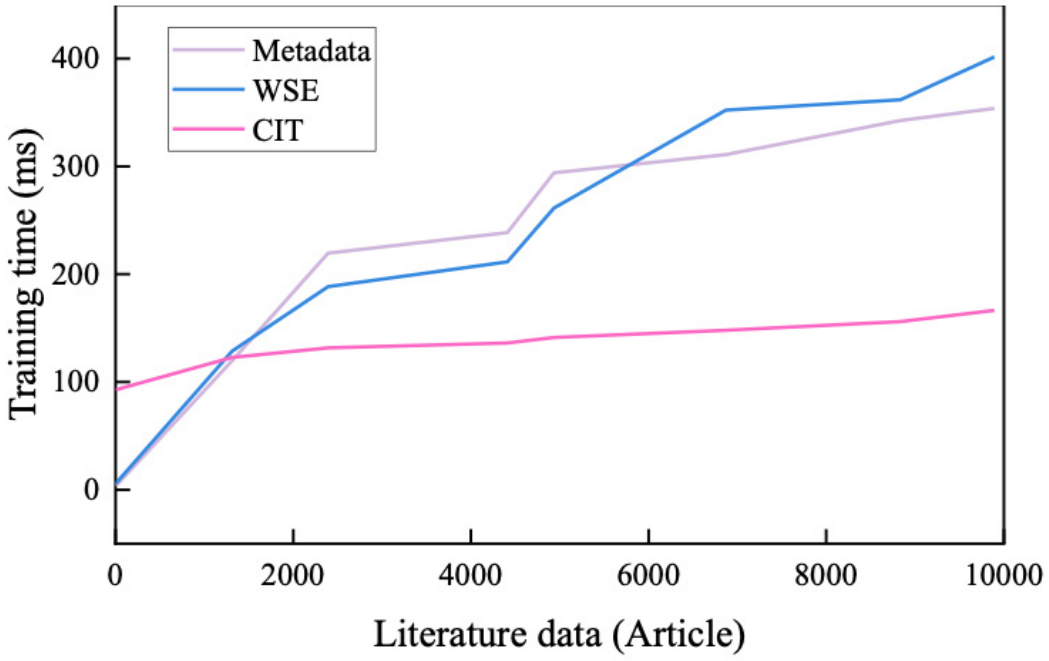

Figure 7 Integration time variation

The results of the integration correctness comparison are shown in Fig. 8, when the data size of the literature reaches 10,000 items, the correctness ratio of the integration method based on computer information technology can still exceed 85%, which is significantly better than the traditional integration method.

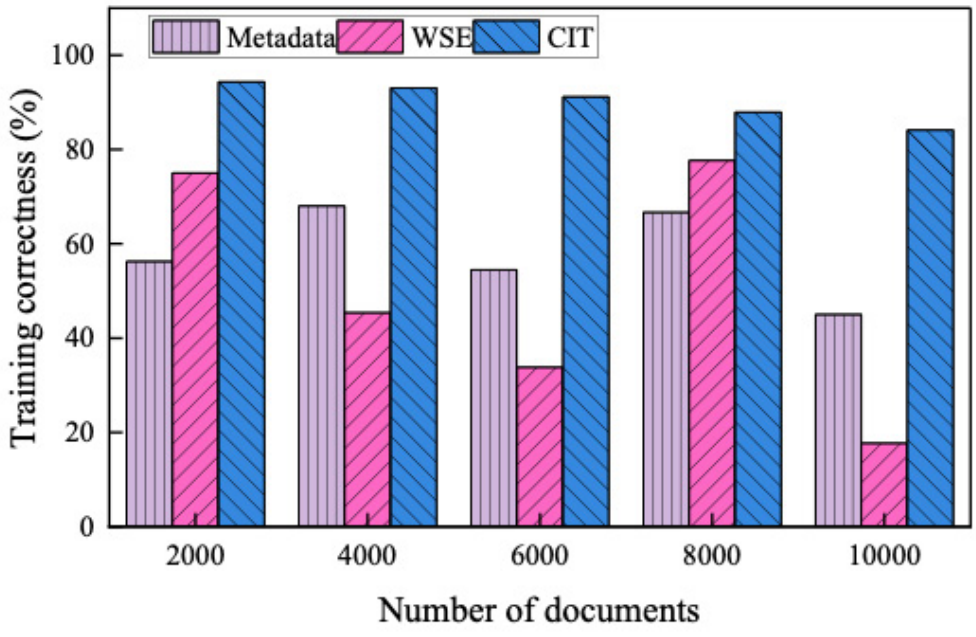

Figure 8 Comparison of correct rate of integrated system

5. CONCLUSION

This paper takes the design of digital library information integration service system as the research objective, designs it on the basis of computer information technology,

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and verifies the effectiveness of the system in practical analysis, and the conclusions are as follows:

1. In the performance test, the system can provide 24h*14 hours of service, the average corresponding time is less than 0.2s. And the test results of 100 times of one line reaches 100% without error.

2. In the integrated service and update efficiency test, when the size of the documents to be queried is large, the indexing time is in the range of 1.25M/s-1.61M/s. It shows that the integrated retrieval method of documents based on computer information technology is more suitable for the design of integrated services in digital libraries.

3. By comparing the accuracy rate of the integrated system, the machine information technology when the size of the document is more than 3000, the length of the training time tends to stabilize, which fully demonstrates that the integrated system based on computer information technology is less time-consuming.

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