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Research Article

A Research on Library Space Layout and Intelligent Optimization Oriented to Readers' Needs

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With the rapid development of the Internet age, all walks of life have been affected to a certain extent. The layout of a traditional library is an extremely important part of the library. A good layout can make full use of the space in the library to maximize the use of space and give readers a better sense of experience. It is better to study or work in the library. At the same time, with the rapid development of the Internet, all walks of life have been affected to a certain extent. For the library, the intelligent library based on GA-RFID technology can improve both the readers and the staff in the library. Reading books can improve the efficiency of study or work. In this article, some comparisons are made between the intelligent library based on GA-RFID technology and various types of libraries, and the technology is compared from many aspects, thus reflecting that this technology is beneficial to readers.

1. Introduction

The library is an institution that specializes in the collection, sorting, preservation, and dissemination of documents and the use of science, culture, education, and science. It is the material basis for the library to carry out all work. In terms of design concepts, the traditional library space is a "book" space, while for the intelligent library [1], it is a "human" space in my opinion. For these two spaces, the layout of the library is extremely important. The layout of the library that makes readers feel comfortable will directly increase the reader's sense of experience and interest in coming to the library. The layout generally refers to the overall layout of the building [2] and overall design [3]. With the rapid development of the Internet, the library is no longer a rigid building. It is an intelligent library with vitality. For readers, the more important thing about the spatial layout in the library is whether it allows them to find the books they want more easily and quickly. At this time, we can introduce more intelligent content to achieve high efficiency [4] to meet the readers' desires. This kind of intelligent library based on RFID technology [5] can better improve the efficiency of readers in finding, borrowing, and returning books. If the RFID capture effect [6] probability value [7] is higher, the capture speed will be faster; at the same time, RFID-based book carts can be set up, which can better help readers complete the functions they want to achieve and can help working people with similar tasks such as putting new books on the shelves. Finally, the comparison of the average time spent by readers in traditional libraries and RFID-based intelligent libraries [8] and the comparison of related indicators [9] are carried out. From the comparison, it can be concluded that the RFID-based intelligent libraries are used by readers, the operation efficiency will be higher, and the reader's sense of experience will be better [10].

So far, nearly 100 institutions in Singapore, Australia, India, and other countries have adopted RFID technology in their library automatic management systems [11]. The National Library of Singapore is the first library to implement an RFID system. Every book in the library has an RFID tag [12]. In this library, borrowing and returning books are self-service [13]. At the same time, the staff can quickly understand the type and location of books through the scanning device [14]. In China, on February 20, 2006, the Chengyi College Library of Xiamen Jimei University was officially opened to the public. The supporting "RFID Smart

Collection Management System" was also announced to be completed and put into trial operation, becoming the first domestic library with complete functional modules [15] and entering the practical stage.

2. Library Layout Requirements

The library is composed of reading rooms, book stacks, computer equipment rooms, etc., but when arranging the entire library, these should not only be considered but also the aisles, stairs, lighting, ventilation, and other aspects should be affected by each other. The layout of the rooms should be combined, the specific role of each section should be considered, and the overall planning should be carried out to achieve the optimal layout result.

2.1. Requirements for the Layout of Reading Rooms and Library. For readers, the reading room is the most important part of the entire library. It should have basic requirements such as quietness, good light, and fresh air. The second is to consider the size of the tables and chairs in the reading room and calculate the optimal arrangement distance and the number of tables and chairs in the reading room. For these data, it is necessary to have a certain understanding of the reading room area and the number of people that may be accommodated. The most important thing in the reading room is the bookshelf, so the layout of the bookshelf is a problem we must consider. After establishing the length, width, and height of the bookshelf, we can know how many books can be accommodated in the current library and can be able to know the usage area of the library. Generally speaking, if there are many people in the reading room and the number of tables and chairs in the reading room, the area invested must be large. At the same time, the requirements for lighting and ventilation are relatively high, and the height of the floor must be increased. At the same time, if there are relatively few people using the library, the position of the bookshelves remains unchanged, and the floor height of the room is reduced accordingly. For general reference, the following standards are used: the floor height of the reading room is 3.6 m~4.8 m; the floor height of the bookshelves is 2.4 m~3.6 m. For readers, setting the height of the bookshelf to a height that makes them comfortable will allow readers to get a better experience when choosing books in the library.

2.2. Requirements for the Layout of Computer Equipment Rooms. With the rapid development of electronic information technology, libraries should also follow the footsteps of and incorporate computer equipment into the library, so as to provide users with a better sense of use. Just like the layout of the library, it is necessary to set up computer rooms, databases, multimedia reading rooms, and so on. For these rooms, it needs to have the basic requirements of quietness, good light, and fresh air and also strictly manage the use of these devices, such as timely updating the system and software, to provide readers with a better sense of use.

2.3. Requirements for Aisles and Stairs. For the library, whether it is to buy or borrow books or read books in the library, there will always be an endless stream of people. Therefore, the layout of the corridors and stairs of the library is also very important because of its traffic. The connection layout is very frequent, so the width of the stairs and aisles can be slightly wider; generally, the approved width is 1.4 m~2.2 m. This width is also a suitable length for the reader, and it is not too spacious and appears to be open. For the setting of the safety exit, it is necessary to be clear, so that readers can know where it is for the first time.

2.4. Lighting and Ventilation Requirements. For a library, good lighting conditions are also very important. It is necessary to ensure that every place in the library is well-lit, but at the same time, it should not be dazzling; second, there should be good ventilation conditions to ensure the entire indoor air. At the same time, some green plants can be set up in the library. Green plants will not only make the entire library more dynamic but also allow readers to relax when they are tired.

Generally speaking, the internal space of a library building consists of several use spaces and connecting spaces. The layout must be based on the functional characteristics and needs of the library, and the various parts of the space must be organized rationally.

2.5. Basic Facilities Required by the Library. The basic facilities required by the library and the main functions of the functional areas are shown in the following Table 1.

3. Layout Optimization

When conducting related research on the layout of the library, we can regard the library as a system. The various spaces of the library will cause the movement of people. The connection between the book stocks and people forms a spatial connection, and the result is to form a layout with multiple styles. Topological analysis of the library is performed to obtain the degree of travel and integration to reflect the basic variables of library accessibility.

The degree of traversal is the number of times the shortest distance traversed within any two spaces in the space system in the entire space of the library. The more the number of times, the more convenient and quicker the readers will move in the various spaces in the library, that is, the room. The specific expression is as follows:

$$NAchoic_i = \frac{\log\left(ACH_r + 1\right)}{\log\left(ATD_r + 3\right)}. \tag{1}$$

In the above formula, NAchoici is expressed as the standard degree of travel, r is expressed as the standard topological structure, ACHr is expressed as the selectivity under the radius r, and ATDr is expressed as the depth value under r.

The degree of integration li indicates the degree of agglomeration or dispersion of a space unit and other space units. When the value of the integration degree is greater, the

Table 1: Names and functions of library functional areas and service facilities.

Serial number	Function area and service facility name	Main functions of functional areas and service facilities
1	Query machine	Assist in querying the specific location of books and newspapers
2	Reading room	Provide a place to read all kinds of books
3	Computer equipment room	Provide computer equipment to help readers reach a project
4	Newspaper reading room	Provide access to various periodicals and magazines
5	Learning commons	Provide one or more integrated common spaces for various informal learning behaviors, including solitary and collaborative
6	Locker	Provide a location for storing personal belongings
7	Lounge	Provide a place to read and rest
8	Fire room	Store firefighting equipment and emergency supplies
9	Bathroom	Provide a place to solve personal physiological needs
10	Waterhouse	Provide drinking water
11	Library	Where to store books

space, that is, the room, is in a more convenient position in the system (library).

$$\mathrm{I_i} = \mathrm{RA_i} = \frac{2\left(\mathrm{MD_i} - 1\right)}{\mathrm{n} - 2}. \tag{2}$$

where MDi is the average depth, and n is the number of spatial nodes. Based on the above, it is possible to calculate which room in the library will be more integrated, so that the room is located in a more convenient location for readers.

From the reader's point of view, this article considers the spatial layout of the library and asks to bring the best sense of experience to the readers. Therefore, the problem of optimizing the spatial layout of the library is transformed into how to achieve the results they want faster (including reading, borrowing, returning) after the readers come to the library and how to use the advantages of the layout to improve the reader's the question of experience.

For example, there are n libraries with demand points $P_i(x_i, y_i)$ $(i = 1, 2, ..., n)$, and $b_i(i = 1, 2, ..., n)$ is the demand for each reader. Also, suppose that there are m library candidate points $Q_i\,(u_j, v_j)$ $(j = 1, 2, ..., m)$. g bookshelves are selected from the m candidate points to serve the n readers' demand points in the library so that the distance between the n demand points and the place they want to reach is the shortest. *Tij* and *dij* (i=1, 2 ..., n; j=1, 2, ..., m) are, respectively, the books provided by the library candidate point *Qi* (*uj*, *vj*) to the demand point Pi (xi, yi) and the distance between the two points. If wi is recorded as the demand at the demand point Pi, and aij is the weight coefficient, then the target equation is

$$\min\left(\sum_{\mathrm{i}=1}^{\mathrm{n}}\sum_{\mathrm{j}=1}^{\mathrm{m}} \mathrm{a_{ij}w_id_{ij}}\right). \tag{3}$$

The corresponding constraints are

$$\begin{gathered}\sum_{i=1}^{n} a_{ij} = 1,\ i = 1, 2, ...n,\\ \sum_{j=1}^{n}\left(\prod_{i=1}^{n} a_{ij}\right) = g, g \le m \le n.\end{gathered} \tag{4}$$

The above two constraints are to ensure that each reader's demand point can be searched on a certain bookshelf, and there are at least g bookshelves.

3.1. Buffer Model. From a mathematical point of view, buffer analysis is a distance analysis based on the topological relationship between spatial objects (this article refers to libraries and readers), and its basic model is a given set of spatial objects $O = \{O_i/i = 1, 2, ..., n\}$, where Oi is a target of the space, and the buffer of Oi is defined as

$$B_i = \left\{d\left(x, O_i\right) \le d_i\right\}. \tag{5}$$

where d(x, Oi) is the distance between x and Oi; di is the radius of the field, or called buffer analysis, and sometimes, di is a constant.

For the spatial target set $O = \{\mathrm{Oi}/i = 1, 2, ..., \mathrm{n}\}$, the buffer is usually defined as

$$\mathrm{B} = \bigcup_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{B_i}. \tag{6}$$

3.2. Find the Mathematical Model of the Nearest Bookshelf. After optimizing the spatial layout of the library, it is necessary to check the rationality of the optimized library spatial layout. The mathematical model of finding the nearest facility (referring to a certain bookshelf in this article) can enable readers at the demand point to find the nearest bookshelf. The mathematical model of the shortest path is as follows.

Let $G = <\mathrm{V}, E>$ be a nonempty simple finite graph, V is the set point, and E is the edge set. For any $e = (v_i, v_j) \in \mathrm{E}$, $\mathrm{w}(e) = \mathrm{aij}$ is the weight of edge (v_i, v_j). P is a directed path between two points in G and defines the weight of P.

$$\mathrm{W(P)} = \sum_{\mathrm{e}\in\mathrm{E(P)}} \mathrm{w(e)}. \tag{7}$$

Then, the directional path with the smallest weight between two points in G is called the best path of these two points, that is, the best path for readers to complete the service they want based on the library after the optimized spatial layout. The shortest path model is

$$\min \sum_{\left(\mathrm{v_j},\mathrm{v_i}\right)\in\mathrm{E}} \mathrm{a_{ij}x_{ij}}. \tag{8}$$

The constraints of the above formula are

$$x_{ij} \geq 0,$$
$$\sum_{(v_j,v_i)\in E} a_{ij}x_{ij} - \sum_{(v_j,v_i)\in E} a_{ij}x_{ij} = \begin{cases} 0, & i = 1 \\ 0, & 2 \leq i \leq n-1 \\ -1, & i = n \end{cases}. \quad (9)$$

Among them, x_{ij} is the number of occurrences of (vi, ji) in a limited path.

Through this model, we can randomly select multiple demand points, calculate the total distance from the demand point to the optimized bookshelf, and compare the total distance from the demand point to the bookshelf before optimization. In order to verify the rationality of the optimized spatial layout of the library, readers need to reach the required location in a relatively short time.

3.3. Objective Function and Constraints. There are many layout planning goals that need to be followed for the spatial layout of the library, such as making the best use of the area of each space, facilitating readers to achieve the desired purpose in the library, providing good infrastructure services, and providing good books. But in order to simplify the processing and the efficiency in data acquisition, only the following goals are considered, that is, to make the best use of the area of each space to facilitate readers to achieve the desired purpose in the library. Making the best use of the area of each space is to understand and plan the functionality of each space in the library. For example, a room is used as a reading room or an electronic equipment reading room, and how many bookshelves, tables, and chairs are more appropriate in a room. Therefore, the objective function of the problem can be expressed as

$$\begin{aligned} &\mathrm{Min}\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=1}^{K} C_{ijk}X_{ijk}, \\ &\mathrm{Max}\sum_{i=1}^{N}\sum_{j=1}^{M}\sum_{k=1}^{K}\sum_{i'=1}^{N}\sum_{j'=1}^{M}\sum_{k'=1}^{K} L_{ij,i'j'}H_{k,k'}. \end{aligned} \quad (10)$$

Similarly, the problem also needs to meet the following constraints.

The number of space utilization types for each unit must meet the predefined structural ratio.

$$\sum_{i=1}^{N}\sum_{j=1}^{M} X_{ijk} = X_k, \forall k. \quad (11)$$

There must be a sufficient area in each space unit.

$$\sum_{k=1}^{K} X_{ijk} = 1, \forall ij. \quad (12)$$

A production unit is adjacent to at least another unit.

$$S_{Lij,i'j'} \geq 1, \forall (ij, i'j'). \quad (13)$$

The spatial adjacency constraints of the production units of the same type are relative. It is better to generate a completed area with the same type of production units. This is the need for planning the library and to make the distribution of each type of space more complete. If mi1j1k, i2j2k represent the Manhattan distance of 2 units (i1j2) and (i2j2) of space utilization type k, there are certain requirements.

$$m_{i_1j_1k,i_2j_2k} = 1. \quad (14)$$

Distance constraint: It is necessary to maintain a certain distance between different types of production units. For example, a certain distance must be maintained between the reading room and the bookshelves and tables and chairs. It is not easy to satisfy the distance constraint between space objects of arbitrary shape in vector space, but it is relatively easy to deal with the distance between two space objects of different shapes in grid space. If di1j1k1, i2j2k2 is used to represent the Euclidean distance between a unit of space use type k1 (i1j1) and a unit of land use type k2 (i2j2), and it is required to be greater than D, the distance constraint can be expressed as follows:

$$d_{i_1j_1k_1,i_2j_2k_2} > D. \quad (15)$$

Convenience constraints. For example, the emergency exit in the library should be set up at the most convenient location. Bij represents the most convenient unit set for a certain spatial unit (i,j), as shown in Equation 19:

$$\mathrm{i} \notin \mathrm{B_{ij}} \& \mathrm{j} \notin \mathrm{B_{ij}}. \quad (16)$$

In addition to this, there may be other corresponding constraints in a specific practical problem.

In the above expression, the objective function and constraint conditions are nonlinear and multidimensional, which is a combined problem, while the size of the problem increases exponentially with the increase in the number of spatial planning units, and many spatial constraints and spatial objectives are more important. The objective function and constraints increase the complexity and size of the problem. Conventional accurate algorithms are difficult or even impossible to solve, and the above method is another way to solve the problem.

4. Intelligent Library

So far, the traditional library business model familiar to readers has been relatively mature, but for most people, including staff, the overall impression of a traditional library is still the oldest and relatively traditional one. He believes that a library is still just a place for reading and borrowing books, a "book collection center" in the traditional sense. But in fact, the basic functions of traditional libraries have not changed. For this kind of service concept, in today's relatively advanced science and technology, it must be developed in the direction of multifunctionality and omnipotence, so as to expand the functions of today's traditional libraries.

For example, with the fierce growth of the Internet, libraries should also integrate with it to achieve more intelligent services, so as to provide more readers with a better sense of experience and more convenient use for readers.

The accelerated development of the new generation of information technology is related to my country's ability to seize the opportunities of the new cycle of technological revolution and industrial transformation. At present, with the rapid development of Internet-related information technologies such as big data, cloud computing, and the Internet of Things, the application of artificial intelligence in different industries and fields will become more and more extensive and in-depth. As a collector, inheritor of human culture, and a promoter of social civilization, libraries must also seize the opportunity to combine intelligence with the improvement of service functions, the optimization of the hardware environment, and the targeted implementation of data. New state and function design are carried out, the renovation and upgrade are completed, and an intelligent library that meets the requirements of the new era is built. For readers, by optimizing the use environment of the library, allowing readers to enjoy reading more effectively, based on this expectation, library intelligence can achieve this.

The intelligence of the library is reflected in the hardware, such as smart technology, data resources; at the same time, it can also be well reflected in the management, service, and other software parts. The conclusion is that the two-way co-construction of technology and services must be linked to the intelligent construction of the library to truly narrow the gap between readers and the library, and let artificial intelligence become an intermediary between people and the library. With the continuous innovation of intelligent wearable devices, RFID tags, chips, and other technologies, artificial intelligence-related products such as shelf sorting robots and reading service robots are applied to the work of libraries to serve readers to the greatest extent. In the improvement of service and management level, the library site is transformed into a comfortable, tidy and bright space, so that readers have a better reading environment, enjoy the reading environment better, and greatly improve their spiritual life. The main modules of library intelligence are as follows in Figure 1.

With the intelligent analysis of relevant information, intelligent information transmission, and intelligent human-computer interaction, the big data of book information resources and readers' reading behavior can be better integrated, analyzed, and applied. At the same time, relying on big data of information resources, big data of reader behavior, etc., readers' knowledge portraits and charts are constructed, and the law of interaction between book information resources and readers are analyzed and understand not only carry out customized, segmented, and accurate library resource recommendation but also can focus on single-point information. Providing diversified and comprehensive relevant information greatly improves the efficiency of readers' information capture and meets the needs of readers to the greatest extent. An intelligent security-related system can also be built. The library is a public place with intensive personnel and knowledge. To ensure safety, artificial intelligence technology can be used to build an intelligent security system, which can effectively improve the safety factor in all aspects and protect the library's safety. Safe operation: In terms of data management, intelligent security is strengthened, library network confidentiality is improved, and network attacks, virus transmission, intrusion, and other issues are effectively prevented. In terms of circuit management, through the intelligent security system, intelligent diagnosis, analysis, and processing of faults in the library operation process are carried out, and the temperature of various electronic components is controlled around the clock to reduce the overload of electronic circuits. In terms of facility management, intelligent monitoring collects data such as the flow of people and logistics. Real-time fire safety monitoring ensures the safety of the central area.

4.1. RFID Technology Introduction. The emergence of RFID technology and its application in libraries have enabled libraries to take a step toward an intelligent library, but, at the same time, they have also brought challenges.

RFID technology is a radio frequency technology and a noncontact automatic identification technology. At the same time, this technology can also be called an electronic tag. To put it simply, when we are shopping in the supermarket, we scan the QR code of the product and show the payment code. The clerk uses the machine to scan it using this technology.

Applying this technology to the library can be used when readers borrow and return books. When the reader needs to scan the barcode, it will show which bookshelf the book belongs to and all related information. This kind of operation can realize the self-service borrowing and returning of readers to improve efficiency. At the same time, we can also configure RFID tags as a management method, through document recognition and portable scanning, to change the traditional library's contribution to only relying on manpower to locate bookshelves and count books. This technology can realize the real time and accuracy of book storage in various tasks such as new book storage, book location changes, and book inventory.

For the logistics classification in RFID technology, we can also use this concept to develop smart book carts, which are in line with the smart transmission equipment of smart libraries. In view of the limited static physical location of the smartbook cart, it is expected that the correspondence between the wireless dynamic document address data and the classification principle can be used to provide on-board computers and multiunit document classification for the book cart. RFID readers and computers can better and faster determine the specific location of books that the reader wants by identifying books and bookshelves. In this way, the query and delivery process of books in a certain area can be realized. This RFID-based technology enables this book cart to have functions such as document shelving and arranging at the same time as shown in Figure 2.

We can compare the high efficiency that this technology brings to libraries. The results of libraries that use this technology with the results of libraries that have not applied this technology are compared, so as to understand intelligence more intuitively.

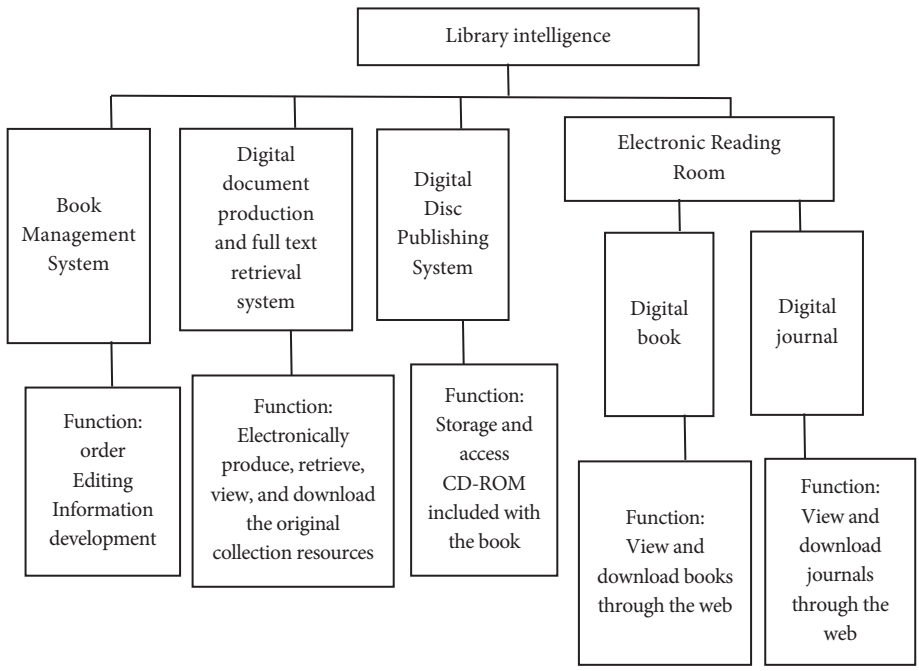

Figure 1: Main functional modules of library intelligence.

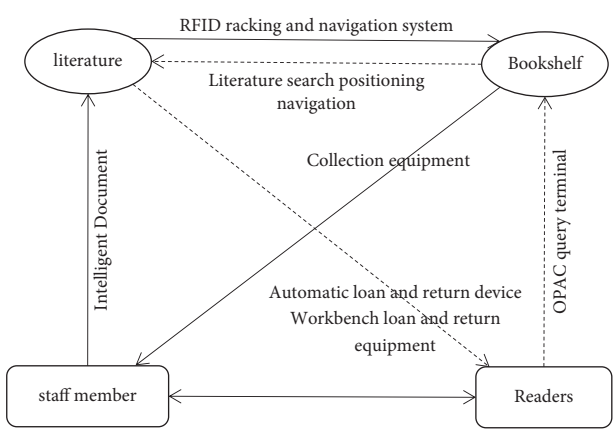

Figure 2: Functions that can be realized by the smartbook cart.

4.2. GA Genetic Algorithm. The genetic algorithm (GA) was first proposed by John Holland in the United States in the 1970s. The algorithm was designed and proposed according to the evolutionary laws of natural organisms. It is a computational model that simulates the biological evolution process of natural selection and the genetic mechanism of Darwin's biological evolution theory. It is a method to find the optimal solution by simulating the natural evolution process. The algorithm uses computer simulation to transform the problem-solving process into a process similar to the hybridization and mutation of chromosomal genes in biological evolution. When solving more complex combinatorial optimization problems, it is usually faster to obtain better optimization results than some conventional optimization algorithms. Genetic algorithms have been widely used in fields such as combinatorial optimization, machine learning signal processing, adaptive control, and artificial life.

In the process of researching genetic algorithm, genetic operations such as selection, crossover, and mutation are random, but the genetic algorithm is not a blind search. It can select relatively better individuals from the previous generation group according to its own reproductive ability. Therefore, each generation of the population can continue to evolve and eventually converge to the individual with the highest fitness function level in the coding space. Since the standard genetic algorithm has a relatively fixed algorithm execution process, only a few important factors need to be defined when using the genetic algorithm. These important factors include parameter coding, initial population selection, adaptive function design, genetic manipulation design, control parameter settings.

4.2.1. Genetic Manipulation Design. Choose: The choice to adopt an adaptive ratio will be implemented in the form of a roulette wheel. The specific operation is as follows: for a given population X = {x1, x2, X3, ..., x4} with population size n, calculate the fitness value of individual xi (xi ∈ X) as f (x), then the selected concept size is

$$P_i(x_i) = \frac{f(x_i)}{\sum_{j=1}^{n} f(x_j)}. \tag{17}$$

The above formula determines the survival probability of each individual in the offspring population. After the selection operation, the expected number of parent individuals in the next generation population is

$$\mathrm{N}(\mathrm{x_i}) = \mathrm{n} \cdot \mathrm{p_i}(\mathrm{x_i}). \tag{18}$$

Mutations: The mutation operation is implemented according to the mutation operator used in the genetic algorithm using binary coding. For a given random individual

$S = a1a2a3...aL$ and the new individual after mutation $S' = a'1a'2a'3...a'L$, the specific operation is as follows:

$$O(P_m, S): ai' = \begin{cases} 1 - a_i\, x \le P_m \\ a_i\, x > P_m \end{cases}. \quad (19)$$

In the above formula, the termination condition of 2 adopts the maximum algebra method, and the maximum iteration algebra is set to 100, and then, the calculation is performed according to the genetic algorithm process, and the obtained coordinates (x, y, z) are the preliminary position estimates of the tags to be located, plus the correction factor to get the final positioning result. For this technology, we can apply it to the library to locate books when searching and, at the same time, combine RFID technology with it to achieve better results.

4.3. GA-RFID Technology Realization. A static RFID system consists of identification devices, namely readers, databases, and a large number of passive tags. The identification device and all tags share all wireless channels, and the identification device does not have any specific quantity and prior information about the tags before identification. The interrogation response is used for communication between the identification device and the tag. The tag can only perform simple calculations, storage, and communication capabilities, and the tags do not communicate with each other. Based on the above information, we can obtain the probability of capturing effects under the influence of different channel environments, so that the application of GA-RFID technology in the library can be easily accepted by readers.

For the communication line in the GA-RFID system in this article, including the forward channel and the reverse channel, the identification device sends query commands through the forward channel and provides a continuous carrier signal, while the tag will communicate in the reverse direction. The scattering method obtains the ability from the carrier signal of the identification device and responds with certain information to the reader. The identification device needs to comprehensively consider the forward and reverse link loss in the cascaded channel when receiving the power of the label reply signal. Let Ptx be the transmission power of the identification device, and the power Pr,T of the identification device signal received by the tag is as follows:

$$P_{r,T} = \rho L P_{tx} G_T G_R L(d_f) |h_f|^2. \quad (20)$$

Here, PL is the polarization loss factor (PLF) matching the identification device and the transition, and GR and GT are the antenna gains of the identification device and the tag, respectively. The tag obtains the information through backscattering and gives a reply, so the information power Pr,R of a tag that the identification device can receive is

$$P_{r,R} = \tau v_T \rho L P_{tx} |G_T|^2 G_R^f G_R^b. \quad (21)$$

In the above information, T is the normalization coefficient, which represents the difference in the received power of the identification device caused by the encoding and modulation methods; vT is the power transmission efficiency between the tag chip and the identification device; f and b, respectively, represent the forward link and the reverse link; R and T represent identification devices and tags, respectively.

The effect of tag capture in the GA-RFID system is defined according to the power model as follows. When n tags send signals at the same time, if the signal strength of a certain tag is much greater than the sum of the information strengths of all other tags, the identification device will have a capture effect, as shown in the following:

$$P_{r,R\_i} \ge Z \left\{ \sum_{i \ne j} P_{r,R\_i} + N \right\}. \quad (22)$$

In the above information, it is the power ratio threshold, which is the minimum interference ratio required after the identification device successfully receives the signal from the book. For a general narrowband system, 1<<10. At this time, "_i" in the formula represents the received power of tag i, and N is additive noise, which is a negligible value. Therefore, when there are n tags transmitting information in the same time period, the probability of a capture effect is

$$q_n = \text{prob} \left\{ \frac{P_{r,R\_i}}{\sum_{j \ne i}^{k} P_{r,R\_j} + N} \right\} n. \quad (23)$$

Among the above information, if there are n tags sending information at the same time, the probability that the capture effect occurs is qn. When the value of qn is larger, that is, the information on the book, such as the two-dimensional code and the like, is more likely to be captured. For readers, they can get it on the library smart device based on GA-RFID. A better sense of experience can be completed with higher efficiency in order to meet certain needs.

5. Intelligent Distribution of Books

In the process of borrowing and returning books, we can understand which books are more popular at the moment, so that we can better plan them, just like placing the hottest books in the most conspicuous way. Readers can see these books intuitively. Of course, the realization of this idea is also combined with intelligence and realized by using certain formulas, which fundamentally saves time and costs and achieves the effect of enhancing the reader's sense of experience.

We can use the book trolley mentioned in the previous article to know which bookshelf or which bookshelves have the most readers and use the kernel density estimation method to perform a calculation. We can move the book trolley to a certain bookshelf. The position is the center, and the books in a certain range of radius h are set with the bookshelf as the center. The closer the center point is, the maximum attribute value decreases as the distance increases. The formula is as follows:

$$F(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right), \tag{24}$$

where $F(x)$ is the kernel density function at position x, h is the threshold radius (>0), and K is the kernel density equation. $x-x_i$ is the distance from the element point x to x_i.

A relevant data set is established based on the book cart data and grid the data, and the grid center is used as the demand point to reduce data errors caused by data errors. The specific steps are as follows.

In the first step, for each supply point, that is, bookshelf j,

$$R_j = \frac{S_j}{\sum i \in \left\{d_{ij} \le d_n\right\}^{P_i \times g\left(d_{ij}\right)}}. \tag{25}$$

In the second step, for each demand point i,

$$A_i = \sum j \in \left\{d_{ij} \le d_n\right\}^{R_i \times g\left(d_{ij}\right)}. \tag{26}$$

$g(d_{ij})$ is the Gaussian equation considering the distance attenuation, and the calculation formula is as follows:

$$g\left(d_{ij}\right) = \begin{cases} e^{-1/2 \times \left(d_{ij}/d_n\right)^2} - e^{-1/2}, & d_{ij} \le d_n. \\ 0, & d_{ij} > d_n \end{cases} \tag{27}$$

In the above formula, R_j is the supply ratio of the library's supply to the total number of people demanded within the supply radius of the supply point bookshelf j, Sj is the area of the supply point bookshelf j, k is the space function of the supply point j, and the internal demand point D_{ij} is the representation of the distance between demand point i and supply point j; dn is the service radius of a book cart; Pi is the number of library people at demand point i; Ai is the final process matching index of each demand point, that is, taking the demand point i as the center, sum up all R_j within the service radius of a specific bookshelf in the library.

6. Experiment Comparison

According to the information mentioned in the above article, we can compare the average duration of GA-RFID-based library intelligent equipment with that of traditional libraries, that is, using manual registration. Of course, under the same environment and conditions for comparison, this comparison can better highlight the advantages and disadvantages of different algorithms. At the same time, we can carry out a simulation of borrowing, returning, and finding books in the library environment and check the average market performance required for each operation, as shown in Figure 3.

For readers, there are several indicators in the reading library that can be used as evaluation indicators for the overall evaluation of the library. At the same time, we can also integrate and optimize the overall layout and various aspects of the library based on these indicators, as shown in Figure 4.

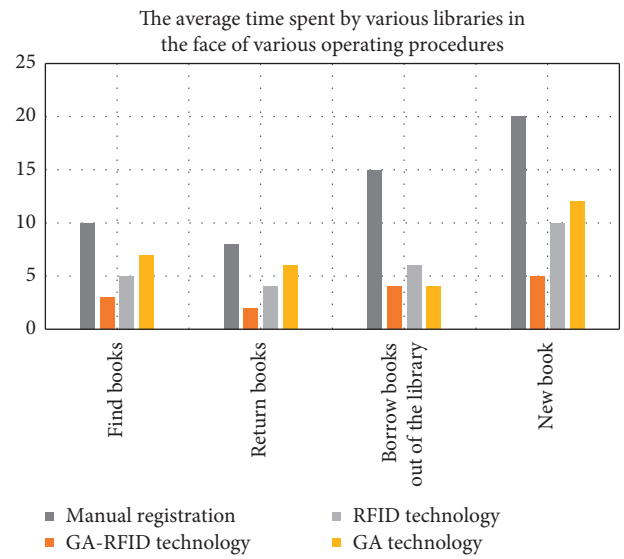

Figure 3: The average time spent by various libraries in the face of various operating procedures.

People who come to the library at different ages will have different acceptance of intelligent equipment. For older people, they will actually be more inclined to the traditional form of library, which is to use manual registration; for middle-aged people, if they are relatively familiar with GA-RFID technology, they will choose to use this technology, so it is necessary for us to design this technology more simply and clearly, and for young people, young people are more receptive, and they will be more inclined to intelligent equipment; for younger children, they will be novel about intelligent equipment (especially robots), and they need to work at this time The staff gave a guide to the children, as shown in Figure 5.

The frequency of use of various functions of intelligent equipment by visitors to the library is integrated in various time periods, so as to use this as a data source for planning or upgrading the library, as shown in Figure 6.

Based on this comparison, we can understand which function readers are more inclined to in each time period, so as to specifically improve the role of related functions in a certain time period.

In order to better compare these three methods, we can extract some books in the library to observe the results expressed by readers based on these three technologies, so as to compare the required efficiency and correct rate of these three methods. The reader's satisfaction and other factors are compared, as shown in Figure 7.

In the above chart, the efficiency is the length of time it takes to find a book based on this technology, and the correct rate is whether the book found is what the current reader wants. When optimizing the layout of the library space, different spaces need to be paid differently. For example, the proportion of the reading room must be more important. From this, you can compare each space to understand each space. Therefore, detailed

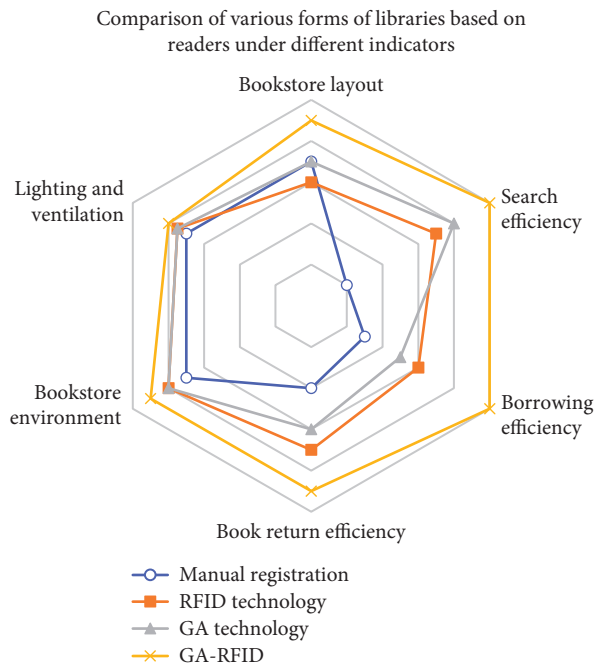

Figure 4: Comparison of various forms of libraries based on readers under different indicators.

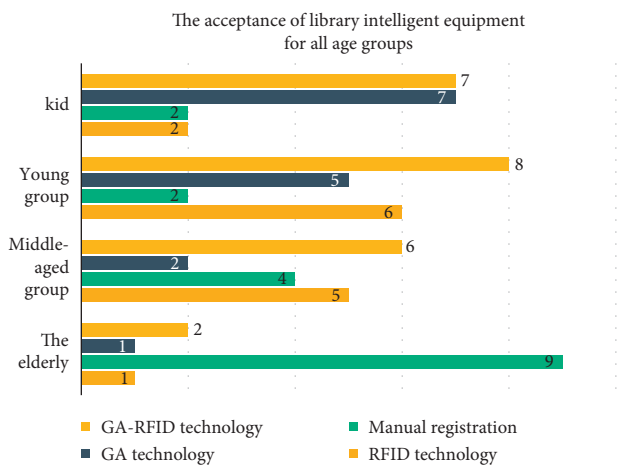

Figure 5: The acceptance of library intelligent equipment for all age groups.

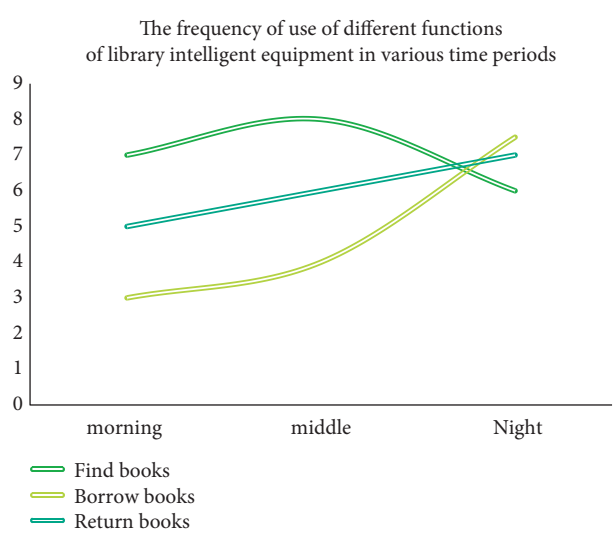

Figure 6: The frequency of use of different functions of library intelligent equipment in various time periods.

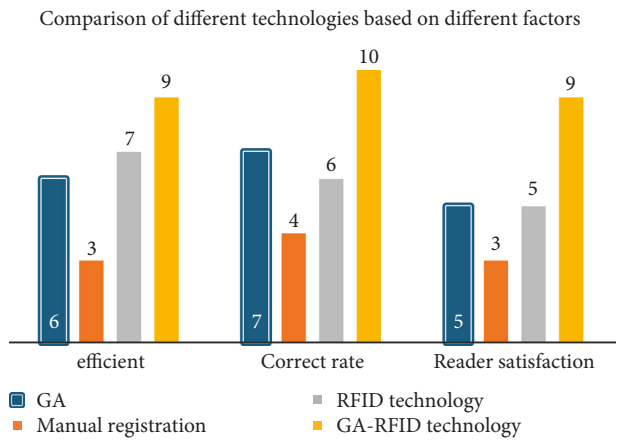

Figure 7: Comparison of different technologies based on different factors.

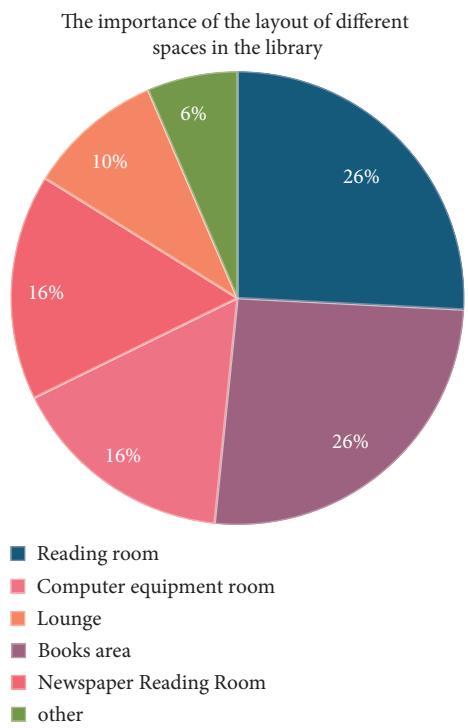

Figure 8: The importance of the layout of different spaces in the library.

planning of each space layout is carried out, as shown in Figure 8.

We can compare the time of these four technologies when looking for books with different numbers of books, so as to see the efficiency of searching books of different technologies, and choose a better technology for library intelligence, as shown in Figure 9.

Based on the above information, it is not difficult to see that the GA-RFID technology has considerable advantages when searching for books.

The processing time of this technology is shorter whether it is facing a large number of books or a small number of books. This high-efficiency result can bring a better sense of experience to readers, and books the staff in the museum can

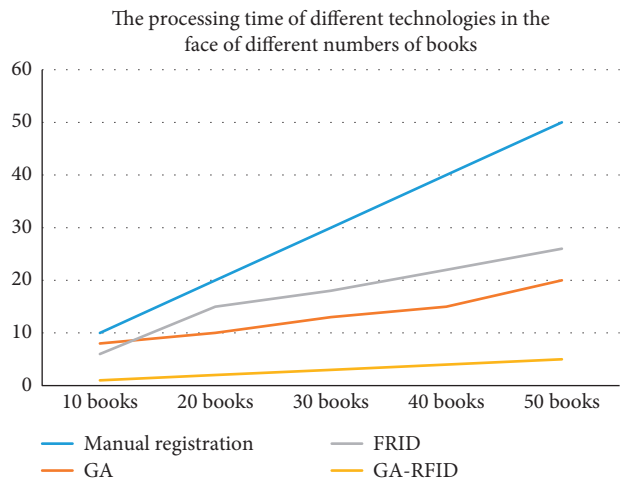

Figure 9: The processing time of different technologies in the face of different numbers of books.

also greatly improve the efficiency of the staff when they work again.

7. Conclusion

For a library, the layout of the library is a very important issue. A good layout, such as quiet, bright, transparent, is the most important indicator for readers to evaluate a library. If you want to bring readers to have a better experience, it is necessary to continuously optimize and upgrade the layout of each space in the library. With the development of the Internet, a faster and better bridge can be established between books and readers, just like the intelligent library based on GA-RFID technology in this article can help libraries save manpower and material resources to a certain extent, and at the same time, more importantly, it can give readers a better sense of experience and higher processing efficiency. This technology not only helps libraries upgrade their intelligence but can also apply this technology to other fields to achieve the purpose of improvement. The intelligent effect and operational efficiency of the library realized through GA-RFID technology will only be better. Furthermore, with the introduction of Learning Commons in library, this GA-RFID technology would be expected to be transplanted into the management of spatial units of Learning Commons, replacing the objects "books" with spatial units of Learning Commons, and it will be possibile to be utilize the efficient use and visual management of Learning Commons

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

Acknowledgments

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