Intelligent Management of Unmanned Library Based on RFID Technology Application

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Abstract: With the continuous development of information technology and the increasing demand of people's reading, the traditional library management mode gradually exposes its limitations. Therefore, it is particularly important to explore a more efficient and intelligent library management model. As a non-contact automatic identification technology, Radio Frequency Identification (RFID) technology has the advantages of fast identification speed and large data storage capacity, and its application potential in library management has been gradually explored. The purpose of this study is to explore the intelligent management mode of unmanned library based on RFID technology. By introducing RFID technology, the functions of automatic borrowing and returning of books, real-time inventory monitoring and intelligent navigation and query can be realized, so as to improve the management efficiency of the library. This paper first introduces the research background and significance, and then expounds the design of intelligent management system of unmanned library based on RFID in detail. Then, the challenges of implementing RFID technology are analyzed, and the corresponding solutions are put forward. Finally, the main achievements and contributions of the research are summarized.

1. Introduction

As an important place for knowledge dissemination and cultural inheritance, the management mode and service mode of the library are constantly changing. The traditional library management model has gradually exposed its limitations in terms of labor cost, management efficiency and reader experience, and it is difficult to meet the needs of modern society [1]. As a non-contact automatic identification technology, radio frequency identification (RFID) technology can automatically identify the target object and obtain relevant data through radio frequency signals, which has the advantages of fast identification speed, large data storage capacity, reusability and strong durability [2]. The intelligent management mode of unmanned library based on RFID technology is put forward to meet the challenge of traditional library management mode and improve library management efficiency and service quality [3]. By introducing RFID technology, the intelligent management of unmanned library realizes the functions of automatic borrowing and returning books, real-time inventory monitoring and intelligent navigation and query [4]. The unmanned and intelligent service mode also reduces the labor cost of the library and improves the reading experience of readers.

It is not only of theoretical significance but also of practical value to study the intelligent management of unmanned library based on the application of RFID technology. Theoretically, this study is helpful to enrich and improve the theory of library management and provide theoretical support for the innovation of library management mode. On the practical level, this study provides a feasible solution for library management practice by exploring the application of RFID technology in intelligent management of unmanned libraries. By systematically analyzing the basic principles and advantages of RFID technology and the requirements of intelligent management of unmanned libraries, this study will design a set of intelligent management system of unmanned libraries based on RFID, and elaborate its specific applications in self-service book borrowing and returning, real-time inventory monitoring, intelligent navigation and query. Through this study, I hope to provide useful guidance and support for library management practice and promote the development of library cause in a more intelligent and efficient direction. Furthermore, it is hoped that more

scholars and practitioners will pay attention to and discuss the intelligent management of unmanned libraries through this study, and jointly promote the in-depth research and development in this field. In the future research, we can further explore the integrated application of RFID technology and other advanced technologies, such as artificial intelligence and big data, so as to realize more intelligent and personalized service of library management.

2. Overview of RFID technology

As an advanced non-contact automatic identification technology, RFID technology has been widely used in various fields in recent years. The basic principle of RFID technology is to realize the automatic identification of static or moving objects by using radio frequency signals and their spatial coupling and transmission characteristics [5]. Its core is to identify a specific target and read relevant data through radio signals without establishing mechanical or optical contact between the identification system and the specific target. This non-contact identification method makes RFID technology have great flexibility in application.

A typical RFID system is mainly composed of Tag, Reader and data processing system. Tag is the data carrier of RFID system, which usually consists of coupling elements and chips. Each tag has a unique electronic code and is attached to an object to identify the target object [6]. The reader is the device responsible for reading (and sometimes writing) the tag information. It uses radio frequency technology to read the tag information, decodes it and sends it to the data processing system for relevant processing. The data processing system judges the legality of the tag according to the logical operation, and makes corresponding processing and control according to different settings, and finally sends out an instruction signal to control the action of the actuator.

The workflow of RFID technology is relatively simple and efficient. When an article with an RFID tag enters the identification range of the reader, the reader will send out a radio frequency signal to activate the tag, and the tag will send information such as its own code back to the reader through the radio frequency signal [7]. After receiving these messages, the reader decodes them and sends them to the data processing system for further processing. The whole recognition process does not need manual intervention, and the real automatic recognition is realized.

RFID technology has many advantages over other identification technologies. First of all, its recognition speed is fast, and it can complete the recognition of a large number of tags in a very short time. Secondly, RFID tags have large data storage capacity, which can store more item information and meet the needs of various complex applications. In addition, RFID tags are reusable and durable, and can work normally in various harsh environments. Most importantly, RFID technology can realize non-contact identification, which greatly improves the efficiency of identification.

In the field of library management, these advantages of RFID technology have been fully exerted. By introducing RFID technology, the library can realize the functions of automatic borrowing and returning books, real-time inventory monitoring and intelligent navigation and query [8]. Readers only need to put books with RFID tags on the reader/writer, and they can complete the borrowing and returning operation without manual operation by staff. Furthermore, librarians can check the inventory of books in real time through RFID system, and supplement or adjust the book resources in time. In addition, RFID technology can also be applied to the intelligent navigation and query system of the library to provide readers with a more convenient and efficient reading experience.

3. The demand for intelligent management of unmanned libraries

With the continuous development of information technology and the increasing diversification of readers' needs, the traditional library management model gradually exposes many limitations and is difficult to meet the needs of modern society. Therefore, it is particularly important to deeply analyze the demand of intelligent management in unmanned libraries. This section will elaborate from two aspects: the problems of traditional library management and the needs of intelligent management of unmanned libraries.

There are many problems in the traditional library management mode. First of all, the high labor cost is a big challenge faced by traditional libraries. The library needs to hire a large number of staff to borrow and return books, put them on shelves, take stock, etc., which increases the operating cost of the library and makes it difficult to guarantee the service quality [9]. Secondly, the management efficiency of traditional libraries is low. Due to the huge number of books, it is difficult for librarians to grasp the inventory of books in real time, which often leads to delays or mistakes in borrowing and returning books and putting them on shelves. In addition, the reader experience of traditional libraries also needs to be improved. Readers often need to wait in line when borrowing and returning books, and the navigation and query system of the library is not intelligent enough, which brings inconvenience to readers.

Aiming at the problems of traditional library management mode, the demand for intelligent management of unmanned library arises at the historic moment. First of all, the intelligent management of unmanned library needs to realize automatic book borrowing and returning service. By introducing RFID technology, readers can borrow and return books by themselves, without manual handling by staff, which greatly improves the efficiency of borrowing and returning books. Secondly, the intelligent management of unmanned library needs to realize real-time inventory monitoring. Through RFID system, librarians can check the inventory of books in real time, supplement or adjust book resources in time, and ensure that the library's collection can meet the needs of readers. In addition, the intelligent management of unmanned library also needs to build an intelligent navigation and query system. By introducing artificial intelligence and big data technology, libraries can provide readers with more convenient and efficient navigation and query services.

4. RFID based intelligent management system for unmanned libraries

In order to realize the intelligent management of unmanned library, this study designed a set of intelligent management system of unmanned library based on RFID. The system makes full use of the advantages of RFID technology to improve the management efficiency of the library through automation and intelligence.

4.1. System architecture

This system is mainly composed of hardware and software. The hardware part includes RFID tag, RFID reader, server, self-service book borrowing and returning machine and other equipment. The software part includes database management system, user interface and background processing system. Table 1 shows the main components of the system hardware and their functions.

Table 1 Main components and functions of system hardware

Hardware Component	Function Description
RFID Tag	Attached to books, stores book information, and is recognized by RFID readers
RFID Reader	Reads RFID tag information for automated book identification and management
Server	Stores book information, user data, and provides backend support
Self-Service Machine	Allows users to borrow and return books independently, communicates with the server for information processing

4.2. Functional module

This system mainly includes the following functional modules: self-help book borrowing and returning module, real-time inventory monitoring module, intelligent navigation and query module and safety management module. Table 2 shows the main functional modules of the system software and their functional descriptions.

Table 2 Main functional modules and their descriptions of the system software

Functional Module	Description
Self-Service Borrowing/Returning Module	Enables users to borrow and return books independently, communicates with the server for information processing
Real-Time Inventory Monitoring Module	Uses RFID readers to read book information in real-time for inventory monitoring and report generation
Smart Navigation and Query Module	Provides real-time book location information, navigation paths, and supports detailed book information queries
Security Management Module	Protects user information and book data security, sets access control permissions

4.3. System flow

The overall workflow of the system is as follows: First, the librarian sticks the RFID tag on the book and enters the book information into the system database. Then, users borrow and return books through self-service book borrowing and returning machines or mobile devices. In the process of borrowing and returning, the RFID reader will read the RFID tag information on the book and communicate with the server to complete the processing of the borrowing and returning information. Intelligent navigation and query module provides users with real-time location information and navigation path of books, as well as detailed information query function of books. Table 3 shows the main workflow of the system and its description.

Table 3 The main workflow of the system and its description

Workflow	Description
Book Information Entry	Managers attach RFID tags to books and enter book information into the system database
User Borrowing/Returning	Users borrow and return books using self-service machines or mobile devices
RFID Tag Recognition & Processing	RFID readers read book tag information and communicate with the server for information processing
Inventory Monitoring & Report Generation	The real-time inventory monitoring module updates book inventory information and generates reports
Navigation & Query Services	The smart navigation and query module provides book location information, navigation paths, and book query functions to users
Data Security & Access Control	The security management module protects system data security and sets access control permissions

5. Challenges and solutions of implementing RFID technology

5.1. Technical challenge

First of all, the identification accuracy of RFID tags is an important technical challenge. Due to the complex library environment and dense books, RFID tags may be blocked or interfered, which leads to the decline of recognition accuracy. In addition, data security and privacy protection are also important issues that need to be paid attention to when implementing RFID technology. As a public place, how to ensure the safety of users' information and book data and prevent data leakage and illegal access is an urgent problem.

5.2. Solution

To address the issue of accuracy in RFID tag recognition, it is possible to optimize the placement and orientation of RFID tags, reduce occlusion and interference, and improve recognition accuracy. Meanwhile, using high-performance RFID readers and antennas can also enhance the stability and accuracy of signal transmission. In addition, advanced signal processing techniques can be introduced to filter and correct the read data, further improving recognition accuracy.

In terms of data security and privacy protection, encryption technology can be used to encrypt user information and book data for storage and transmission, to prevent data leakage. Furthermore,

strict access control permissions should be set up so that only authorized personnel can access the system backend and sensitive data. In addition, regular security audits and vulnerability scans can be conducted on the system to promptly identify and fix potential security risks.

In addition to the technical challenges and solutions mentioned above, implementing RFID technology also requires consideration of cost-effectiveness issues. Although RFID technology can improve the management efficiency and service quality of libraries, it also requires investment in equipment procurement and system construction. Therefore, before implementing RFID technology, it is necessary to fully evaluate the cost-effectiveness to ensure that the invested costs can receive a reasonable return.

6. Conclusions

This study discusses the design and implementation of intelligent management system of unmanned library based on RFID technology. By analyzing the basic principle and advantages of RFID technology and the requirements of intelligent management of unmanned library in detail, this study designs a complete intelligent management system of unmanned library, and expounds in detail its specific applications in self-service book borrowing and returning, real-time inventory monitoring, intelligent navigation and query. Furthermore, this study also deeply analyzes the challenges that may be faced in the process of implementing RFID technology, and puts forward corresponding solutions.

The research results show that the intelligent management system of unmanned library based on RFID technology can significantly improve the management efficiency and service quality of the library. Through automation and intelligence, the system has realized the functions of automatic book identification, borrowing and returning, inventory monitoring, navigation and query, and provided users with a more convenient and efficient reading experience. Furthermore, the system also effectively protects the security of user information and book data through security measures such as encryption technology and access control authority.

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