

Research on the application and prospect of RFID technology

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Abstract. As Radio Frequency Identification (RFID) has the advantages of fast scanning speed, small size, large data storage, high security, and other technologies, it is widely used in various fields to upgrade working efficiency. Meanwhile, as one of the research topics of the Internet of Things (IoT), Radio Frequency Identification also provides the possibility for the development and application scope of IoT. Based on the application principle of Radio Frequency Identification technology, this paper discusses the application of Radio Frequency Identification in the two fields of intelligent libraries and intelligent logistics through literature review and theoretical analysis. Through the analysis of the current situation of RFID application in the library management and logistics industry, this paper discusses the advantages and shortcomings of radio frequency identification technology, and according to the existing problems the future direction of development of the corresponding improvement proposals to promote the further improvement of the application of radio frequency identification technology.

Keywords: RFID radio frequency identification technology, Intelligent library, Intelligent logistics, Application

1. Introduction

Nowadays, the Internet of Things technology has become a hot spot of technological innovation, and RFID technology is the basis of the perception layer technology of the Internet of Things, and is also the hot spot of the current Internet of Things technology research. RFID is a kind of automatic identification technology, non-contact two-way data communication through radio frequency, the use of radio frequency to record media (electronic tag or radio frequency card) to read and write, so as to achieve the purpose of identification and data exchange [1]. RFID technology has been widely used in logistics and transportation, intelligent book management, medical care, transportation and other fields, superior to its excellent performance, the future has a broad application market. An in-depth understanding of the application methods of RFID technology in the field will help support the further development of the industry.

The antenna, chip and reader are the main components of the RFID system, and the radio frequency signal is transmitted between the tag and the reader through the antenna (Figure 1). The electronic tag consists of a chip and an antenna, which is attached to the object to identify the target, and each tag has a unique electronic code to store information related to the identification of the object [2]. The reader is a device that uses radio frequency technology to read and write electronic labels, and transmits the information contained in the front-end electronic label to the back-end computer network, so as to complete the storage, management and control of data information. The operating frequency of the

reader is mainly in the range of 125.00, 134.20, 135.60 kHz, etc., and the distance of the radio frequency identification is affected by the power of the reader. In addition, the application system is used to integrate and upload the data obtained by multiple readers effectively, and complete the functions of data query, management and exchange. Based on the above principles, RFID technology has been fully and widely used in various fields and has played a greater role [3].

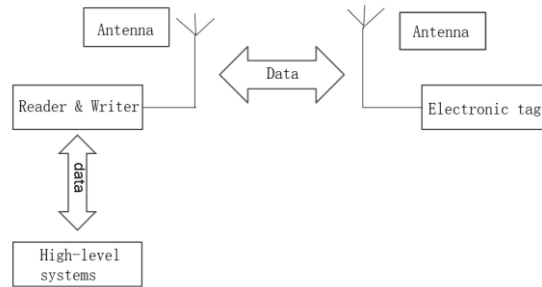


Figure 1. Components of RFID

This paper analyses the application of RFID by means of qualitative analysis, focusing on two major fields: intelligent library and intelligent logistics. In addition, the development direction and development trend of RFID technology are discussed according to the application of RFID in intelligent libraries and intelligent logistics, in order to promote the further enhancement of the effectiveness of the application of RFID technology.

2. Application advantages of RFID

RFID has the advantages of fast scanning speed, small size, large data storage, high security and long life [4].

Because RFID readers accept signals quickly and scan fast, they can meet the needs of reading multiple electronic tags at the same time. In addition, RFID is not limited by size and shape in reading, and can be developed into more miniaturized and diversified forms according to needs. And RFID overall memory storage capacity is large, the capacity can be several megabytes or even hundreds of megabytes. Moreover, because RFID carries electronic information, the code of each electronic tag can be a unique code, and the data information content saved by it is protected by password, so that it is not easy to be forged and copied. Meanwhile, RFID stores data in chips that are highly resistant to water, oil and chemicals, so that the chip and data are not contaminated, and ultimately the design life of RFID can reach 15 years.

3. Application of RFID in the construction of smart library

The application of RFID technology in libraries has greatly enhanced the level of automation of books, liberated librarians from the work of book sorting and so on, and realized the active connection between readers and libraries, providing personalized information resource services.

3.1. Overall structure design of the system

RFID based university library uses RFID tags to realize intelligent management of books. The system is divided into two types of users: administrators and readers. For administrators, it is necessary to meet their requirements on functions such as intelligent inventory and bookshelf arrangement. The needs of readers and users are mainly self-service borrowing and returning, intelligent access control, visual query of books and other functions (Figure 2).

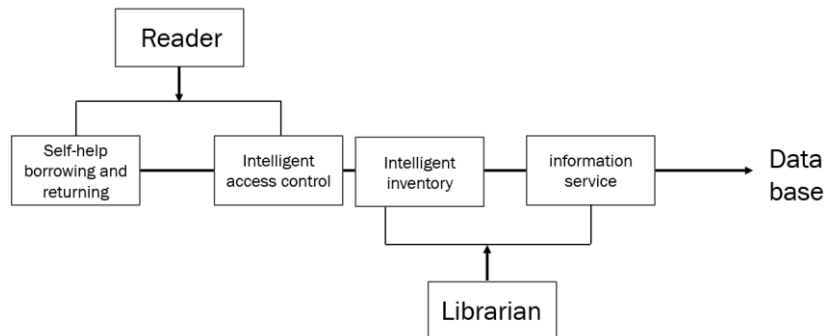


Figure 2. System structure

3.2. Function realization based on RFID technology

3.2.1. Smart bookshelf. In general, the library generally divides the library into several shelving units according to relevant standards, and establishes the layer on one side of the shelf as a basic area. According to the physical location of the space, the orientation of the code is set reasonably, and the scope of the book partition is divided scientifically. For the book classification code, many libraries have adopted the structure of "floor number + zone number + roadway number + shelf row number + orientation sign + shelf number" so as to clearly and intuitively display the location of the literature [5].

By cataloging, which means affixing an RFID code to the back cover of each book and to each bookshelf, smart bookshelves can help readers and librarians find the exact location of books. For the RFID identification of books, RFID is linked to the book bar code, and each bar code information is unique. According to the spatial positioning function of RFID, the location of the book can be determined in the first time. For the RFID identification of bookshelves, shelf labels and layer labels can be selected. Among them, the layer label is the most basic and smallest book classification code.

3.2.2. Self-service loan and return. The materials in the library can be borrowed and returned by the readers self-service through the RFID system (self-service loan and return system equipment), so as to achieve the circulation of loans and returns. This is an application system that can quickly scan, accurately identify and automatically process the borrowing and returning operation of the items affixed with RFID tags, including computer terminals, card reading equipment, scanning equipment and book monitors. It breaks the previous form of scanning code one by one and borrowing and returning books by reader's card, which makes the book borrowing process effectively optimized and effectively improves the efficiency of book borrowing and returning.

Self-help lending also includes two processes: borrowing books and returning books. When borrowing books, after the reader passes the identity authentication of the self-service loan and return book terminal device, the book is placed on the built-in RFID reader of the self-service terminal to read the bar code information of the book, and the book can be immediately completed. When returning the book, the reader will directly place the borrowed book on the RFID reader, and click on the automatic terminal device interface to confirm the book information, you can complete the return of the borrowed book.

In addition, the self-service loan and return machine can also realize batch loan and return, which greatly improves the efficiency of book loan and return.

3.2.3. Security and anti-theft. The advantage of the RFID security door detection system is that it can batch scan and accurately identify books containing RFID tags, which can play a role in preventing book theft.

This system has an early warning mechanism, which can judge whether the book is safe according to the borrowing state of the book, and then decide whether to start the alarm mechanism. When the reader returns the book using the self-service terminal, the RFID reader will change the borrowing and

returning status marked in the RFID tag in real time. If the information in the RFID tag is "loan", the reader will be allowed to pass through the access control system. On the contrary, if the information in the RFID tag is recorded as "return", that is, the book literature has not been lent, the book in the access control system will trigger the automatic alarm function, indicating that there is a problem with the book [4].

3.3. Advantages of introducing RFID into library construction

Because the RFID system supports the identification statistical function, the reader's reading preference can be analyzed according to the reader's book borrowing information. In this way, we can judge which kinds of books are popular with readers, and generate relevant reports in time to help the library timely supplement popular books and further promote the construction of the library.

In addition, compared with the traditional bar code recognition in Table 1 lists, RFID has the advantages of Multi-label collection, fast scanning speed, high security and strong repeatability.

Table 1. Traditional barcode recognition VS RFID

	Traditional barcode	RFID
Collection	Single label collection	Multi-label collection
Scanning speed	Slow	Fast
Scanning range	Small	Wide
Safety	Low	High
Waterproofness	not waterproof	waterproof
Contact	Requires light contact	No need for light contact
Repeatability	Weak	Strong

3.4. Improvement

In the process of positioning, there will be problems such as thermal noise at the receiving end of the reader, phase deflection of different RFID tags, and dynamic background environmental interference factors. In order to solve the above problems, the phase difference method is usually used to locate, which can meet most of the needs of book searching. The phase value data is collected by several antennas, and then the differential enhanced hologram is constructed to realize the accurate positioning label. If the positioning requirements need to be more precise, the power of the reader should be adjusted. Through the electromagnetic backscattering coupling process, the energy and transmission information are finally obtained, and the label reading work of accurate distance is completed [5]. The label's maximum readable distance R is calculated by the Frings transmission equation 1:

$$R = \frac{\lambda}{4\pi} \sqrt{\frac{P_t G_t G_r}{P_r}} \quad (1)$$

Where, R: the maximum readable distance of the label; λ : signal wavelength; P_r : transmitting power of reader antenna; G_t : reader transmit antenna gain; G_r :label receiving antenna gain; P_r : The minimum opening power of the tag.

When the minimum opening power of the tag P_r , the gain of the tag receiving antenna G_r and the gain of the reader transmitting antenna G_t cannot be changed, the transmitting power P_t of the reader antenna should be adjusted to achieve accurate adjustment of the RFID tag reading distance.

4. Application of RFID in smart logistics construction

With the rapid development of modern logistics technology, RFID technology as one of the technical support has also been rapid development, it plays an important role in logistics warehousing and logistics distribution, and promotes the further efficient development of the logistics industry. The intelligent logistics system based on RFID technology can be roughly divided into two links: logistics warehousing and logistics distribution.

4.1. Intelligent logistics warehousing based on RFID technology

4.1.1. Preparation for storage. The emergence of intelligent logistics has replaced manual inspection and greatly improved the efficiency of goods storage. Through the operation of the master control system, the system will produce an electronic code unique to each item, according to the properties of the item. The electronic code is filled into the RFID electronic tag, that is, the unique identification of such goods is obtained. Then, the specific location of the goods in the warehouse is also entered into the RFID electronic watch label. When picking up goods, only the use of RFID technology to identify the electronic tag, you can obtain accurate positioning, accurate completion of the warehousing of goods [6].

4.1.2. Storage. After receiving the order information, pick up and select the currently available vehicle to arrange the delivery of the goods. The electronic code of the selected vehicle will be marked on the corresponding cargo receipt to complete the binding of the vehicle and the goods. Before the delivery vehicle enters the warehouse, the reader in the RFID system will be connected with the main control system to obtain the electronic code of the vehicle, so as to check the information of the entering vehicle and the goods it carries. At the same time, the administrator needs to compare it with the storage order, if the information is consistent, it means that the goods and vehicles are correct and can enter the warehouse. At the end of warehousing, when the vehicle leaves the warehouse and passes through the door, the main control system will identify its electronic code. The electronic code reflects the information of the goods in the car. When all the goods have been unloaded, that is, the system displays the "no-load" state, the vehicle can be released.

4.1.3. Goods inventory and changes. After the goods are stored, the quantity of the goods, the date of storage, and the attribute information of the goods should be checked from time to time. The cargo is scanned using RFID technology, the computer compares the information received with the information stored in the database, and the electronic results are fed back to the administrator. This is convenient for the manager to understand and deal with the abnormal situation of the goods in time.

When the goods change in the warehouse, the warehouse manager needs to issue the goods location change instruction through the main control system of RFID technology. The on-board unit changes at the same time as the indicator and assists in updating the position of the cargo according to the instructions it receives.

4.2. Intelligent logistics distribution based on RFID technology

Using RFID technology, goods can be inventoried, logistics tracking and goods distribution.

4.2.1. Logistics tracking. The principle of RFID technology to realize logistics tracking is related to the role of communication satellites. In the process of transportation of goods, the goods themselves and logistics vehicles will carry RFID tags. After receiving the information in the label, the receiving device contacts the communication satellite and transmits the information to the logistics dispatching center. The dispatching center can store the information in the database for information update and subsequent logistics needs.

4.2.2. Goods distribution. After the goods reach the distribution center, RFID is used to read the information in the label of the goods, and according to the reading results, the goods are checked to avoid errors in the distribution process. After the destination of the goods is identified, the distribution is carried out according to the different destinations. This greatly improves the efficiency of the distribution of goods, but also reduces the distribution cost [7].

4.3. Problems and improvement measures

4.3.1. Logistics warehousing standardization system. At present, because China has not yet formed a perfect logistics warehousing standardization system, the logistics industry intelligent application scope is small. Therefore, the establishment of RFID technology-based logistics warehousing standardization system, including warehousing label data coding standards, air interface protocols, warehousing middleware standards and other design standards, is conducive to improving the efficiency of the logistics industry. Through the design and improvement of logistics warehousing standardization system, we can promote the sustainable development of enterprises and the improvement of China's logistics industry.

4.3.2. Security of technical application. Because the RFID system is a passive system, that is, there is no reading and writing ability, it is difficult to use the key for authentication. This will lead to a series of security problems such as data leakage, and increase the risk of technology application to a certain extent. In order to solve this problem, it is necessary to consider the high cost of active tags, and it is suggested that the research direction of relevant fields should be shifted to one-time password question answering in the future. While ensuring that the cost is not high, improve the security of the application of intelligent logistics technology [7].

5. Conclusion

RFID with its fast scanning speed, strong repeatability, high security advantages are more and more used in various industries, especially in the library and logistics applications are relatively wide. In order to meet more and larger market demand, it is necessary to continuously improve its performance and correct the shortcomings in the application of the industry. In the library application, it is necessary to solve the positioning problem, usually by using the phase difference method. In addition, the accuracy of tag positioning can be improved by constructing differential enhancement holograms. For the security problems of RFID systems in the logistics industry, the future can be combined with a one-time password question answering to enhance the security of intelligent logistics while reducing costs.

However, the optimization of RFID application proposed in this paper has not been verified and tried through experiments, and the scope of reference literature is limited, mainly referring to the application of RFID in China. In the future, the application of RFID can be further explored by referring to the development background and application scenarios of different countries.

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