RFID'S Applications and Future Prospects

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Abstract. Radio Frequency Identification (RFID) technology comes from radar technology. It is a fusion of radio technology and radar technology. This paper expounds the basic principles of RFID technology development based on the research of related literature, and emphatically analyzes the actual application of this technology in modern society and the forecast of its future development trend. Radio Frequency Identification (RFID) is a wireless communication technology that can identify specific targets through radio signals and read and write related data without the need to establish mechanical or optical contact between the identification system and the specific target. The research results show that at present, RFID technology is mainly used in the three major fields of payment, supply chain, and anti-counterfeiting. Due to its advantages of fast broadcast rate, high stability, and strong repeatability, it will be widely used in the field of the Internet of Things in the future.

Keywords: RFID · electronic tags · readers · supply chain · anti-counterfeiting · payment

1 Introduction

Radar was invented to detect aircraft during World War II, but the fatal disadvantage of radar is that it cannot distinguish between the identity of the enemy and the enemy, so RFID technology was born. RFID is a short-range wireless communication technology, and the biggest difference between RFID and other short-range wireless communication technologies is that the RFID system works passively. RFID technology can not only realize wireless identification and data exchange, but also has the advantages of long life, fast speed, and the label can be changed. In recent years, the development momentum has been very strong.

The first application of RFID was during World War II, but the foundation of the theory was formed in 1948, when Harry Stockman published the paper "Communication Using Reflected Power" in the Academic Journal of the International Union of Radio Engineers. It systematically expounds the definition and principles of RFID technology [1]. From the 1950s to the 1980s, people continued to discuss and test RFID technology. Finally, in the early 1980s, the first commercial application of RFID technology—a commercial electronic anti-theft management system was born.

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In the 21st century, in order to ensure the development of RFID technology and improve the inclusiveness between different RFID devices and systems, the Electronic Commodity Coding Consortium (EPC global) was established in 2003. As the technology becomes more stable, the production costs will fall, and the application prospects will become clearer. On November 4, 2003, the world's largest retail giant, Wal-Mart Group, stated that it would trace all products in its major supplier system through RFID technology, and require its top 100 major suppliers to report all products that have been shipped since January 2005. RFID tags are affixed to pallets and outer drums delivered to Walmart [2]. This move by Walmart marks the arrival of the era of large-scale use of RFID. According to the patent application report, RFID technology entered a period of rapid growth from 2003 to 2012. This stage is the growth period of technology. The application of RFID technology in major fields continues to increase, which is mainly reflected in the supply chain, payment, and anti-counterfeiting fields. By 2016, almost no new RFID technology patents had been filed, and the technology had reached the stage of mature application.

This paper will analyze the basic principle of RFID technology development on the basis of relevant literature research, and study the possible development direction of RFID in the future in practical application. This is helpful for relevant personnel in the field of RFID application to grasp the existing technology and develop future applications.

2 Definition and Principle of RFID

2.1 Definition

RFID is an acronym for Radio Frequency Identification. Often it is called inductive electronic chips or proximity cards, contactless cards, electronic labels, electronic barcodes, etc.

2.2 Technical Principle

Usually, the RFID system consists of three units: an RFID tag, a reader and application control system [3]. The three-frequency tag management system is composed of dual-polarized antennas and chips. Each device has a corresponding identification code on it. The indicator is usually attached to the item to be marked. The electronic label management system is divided into low frequency bands, high frequency bands, ultra-high frequency bands and microwave bands according to the frequency band. Different frequencies determine parameters such as the reading distance and reading speed of the system. The reader is a device that completes the reading and writing of tag signals, and completes the collection, encoding, identification, and management of electronic tag signals. The application system is mainly responsible for the read-write management, storage, and management of tag information.

When the marked object is close to the magnetic field formed by the reader, the reader generates radio frequency technical information. After the reaction voltage is formed in the tag, the information stored in the chip (passive tag) is emitted. Active marking is the act of actively sending out a message (active marking). After the reader receives the information, it is sent to the application system to complete the information processing.

3 Application of RFID Technology

This paper summarizes the main application fields of RFID, which can be summarized into three application fields: electronic payment, supply chain and anti-counterfeiting. But with the popularization of RFID technology, the technology is also widely used in medical, library management and other fields. Because payment is closer to consumers and has more applications, this article mainly discusses the application in the field of payment.

3.1 Payment Field

The application of RFID in the payment field is quite extensive such as bank cards, bus cards and ETC cards. The previous generation of bank cards in China were magnetic stripe bank cards, which were not only easily demagnetized but also easy to steal information from. Therefore, China has gradually stopped issuing magnetic stripe bank cards since 2015. In 2017, the magnetic stripe bank card was completely abolished, and the bank card was completely replaced by an IC card.

IC cards also use RFID technology in a broad sense, and IC bank cards are also divided into contact types and non-contact types or both coexist. Contact chip cards need to be inserted and traded at the POS machine. The contactless chip can perform QuickPass transactions on POS machines that support QuickPass. In addition to bank cards, today's campus cards also basically use RFID technology. Each campus card has an electronic tag, and the electronic tag stores the personal information (id) of each student. After the electronic tag is close to the credit card machine (reader), the credit card machine uploads the students' information and the amount to be deducted to the database. If the balance of this identity in the database is greater than the amount to be deducted, the corresponding amount will be deducted, and if the balance is less than the amount to be deducted, it will feedback "Insufficient balance".

China's Electronic Toll Collection (ETC) uses RFID technology in its management system. The RFID tag with the user's identity is pasted on the front windshield of the vehicle, RFID readers are installed on the high-speed outbound and inbound ETC exclusive channels. The information on the tag is read, and the transaction can be completed after the verification is completed.

Due to the wide application of RFID technology in the consumer field, its security issues have also received considerable attention. For example, a "man-in-the-middle" attack means that when the electronic tag and the reader interact with each other, a device sends a radio frequency signal to block or even modify the wireless signal between the reader and the tag. Therefore, different companies use different technical means to improve the security of commodity transactions through RFID [4]. Therefore, the RFID system used for payment often sets up many verification links. Caution is required when applying.

3.2 Supply Chain Field

In the field of supply chain, it is also a place where RFID technology can show its talents. The supply chain refers to the process from raw materials to product production, and then

to the whole process of logistics and sales. Massachusetts Institute of Technology is the first to study the application of RFID technology in the supply chain. At the end of the twentieth century, the Auto-ID Center at the Massachusetts Institute of Technology used a certain link in the enterprise supply chain as an experimental object. An in-depth study of the application of RFID technology in production quality management and monitoring, improvement of business performance, capital use management and control, etc. [5]. With the rapid development of modern society, the supply chain structure is becoming more and more complex, products are becoming more and more diverse, and often have long transportation distances. Although traditional bar code technology can accurately distinguish items, the labor cost and identification time are much higher than with RFID technology.

The benefits brought by the application of RFID can be studied from the most important part of supply chain logistics. Massachusetts Institute of Technology research shows that the staff of a logistics station spend an average of 11,000 h counting the number of goods and scanning barcodes. Applying RFID technology to modern logistics systems not only realizes the daily information management of materials, it can also supervise all the valid information of the material. It also overcomes the drawbacks that barcode technology cannot be automated. The introduction of RFID technology into modern supply chain systems can also save labor costs, and improve management accuracy and processing speed.

Analysts at the Sanford Bernstein Group retail industry data, believe that, after the introduction of RFID technology, Wal-Mart will be able to save 8.35 billion yuan a year. This is mainly due to the reduced cost of labor for scanning barcodes. It also mitigates the huge losses caused by out-of-stock retail, theft, and disrupted suppliers. Just because of theft, Wal Mart lost about 2 billion yuan a year. This shows that, RFID technology can indeed play an important role in the logistics activities of the entire enterprise itself [6].

In the food and catering industry, if the food is damaged during transportation, it will shorten its service life. The U.S. Food and Drug Administration has determined that “up to 20 percent of food discarded is due to damage in the supply chain” [7]. The introduction of RFID systems can reduce this damage. The RFID system can track these foods in real time without human participation and food movement and scanning, while active RFID electronic tags can dynamically update food information.

3.3 Anti-counterfeiting Field

Using RFID technology to prevent counterfeiting. Its essence is to use a unique RFID tag number to identify items. Each item has a globally unique id code. This id code is stored in the chip rom from the beginning of the manufacture of the chip. Therefore it cannot be copied or altered. By comparing the unique ID code with the stored information of the commodity itself, the authenticity of the commodity can be checked, and the tracking and tracing can be realized by recording the information of the commodity sales area, passing place, person in charge and so on.

Compared with traditional technical means such as laser anti-counterfeiting and digital anti-counterfeiting, RFID anti-counterfeiting technology also achieves the advantages of no wear, anti-stain, low damage, and high efficiency. With the diversification

of pharmaceutical sales channels, higher requirements have been placed on the anti-counterfeiting of pharmaceutical packaging. If the medicines purchased by consumers are counterfeit and shoddy products, it will seriously affect the health of consumers and even endanger their lives. The existing anti-counterfeiting methods of barcode or inquiry are very easily forged, and the use of RFID anti-counterfeiting technology can effectively prevent medicines from being counterfeited and shoddy. The application prospect of RFID anti-counterfeiting technology in the field of medicine is considerable.

However, since the communication between the RFID tag and the reader is realized by using wireless radio frequency signals, the transmitted signals are exposed to the surrounding environment. This creates a certain level of insecurity. Therefore, some enterprises combine RFID technology with digital anti-counterfeiting technology, encryption, and decryption technology in actual use. For example, the private key system is added to the RFID reading and writing. For example, a private key system is added to RFID reading and writing. The private key is used to write the tag information to the tag memory through encryption. After identifying the tag, the fixed information is written in the tag or the tag is directly destroyed.

4 The Future Prospect of RFID Technology and the Problems to Be Solved

4.1 RFID Technology Outlook

Before the advent of the RFID network, the society had been looking for a more advanced information label system [8]. With the explosion of IoT technology in recent years, as the foundation of IoT perception layer technology, RFID technology is also at the center of research and application. Because RFID technology has the advantages of fast propagation rate, high stability, strong repeatability, strong adaptability to the natural environment, and longer life, the technology has been widely used in medical, transportation, payment, retail, and other fields. The Internet of Things is in its heyday, various developments are still gradually deepening, coupled with the incomparable advantages of RFID technology. In the future, the development space for RFID technology will be huge. Recently, some scientists even expressed that RFID technology should be used in environmental monitoring [9], such as monitoring the atmospheric environment, water environment, and agricultural soil environment.

The author believes that there are two points for the future development of RFID technology. One is public administration, such as library administration. Currently limited by the cost of electronic tags, most libraries still scan barcodes for storage, classification, and borrowing, because the cost of using electronic tags for every book in the library is much higher than scanning barcodes. With the development of technology, the cost problem will eventually be solved, so the outbreak of RFID technology in the field of public management can be foreseen in the future. The second is the application of UHF RFID technology. At present, the application of RFID technology in my country is still concentrated in the low-frequency field, and the application of UHF RFID technology is far lower than that in the West. UHF electronic tags have the advantages of being able to identify multiple objects, strong penetrability, and large memory capacity. Farm management is the largest application of UHF RFID technology. Each poultry, cattle, sheep,

and pig is outfitted with an electronic label, allowing for traceability management from seedling to quarantine, slaughter, processing, and sales, as well as effectively addressing food safety issues.

4.2 Problems to Be Solved

4.2.1 RFID Technology Cost Problem

RFID technology also has its limitations. If these problems are not addressed, then the development of RFID technology will be greatly hindered. Previously, security was also one of the urgent problems to be solved by RFID technology. However, because it is not directly oriented to production and consumers, and major companies combine RFID technology with traditional encryption technology in practical application, the author believes that this problem can not be regarded as a serious problem hindering the development of RFID technology.

Although the cost of RFID technology is already very low, an electronic label with a unit price of 0.3–0.5 yuan is still difficult to accept for the retail industry with low profit margins. Therefore, RFID technology has not been widely used in Chinese supermarkets until now, and most supermarkets still choose lower-cost barcodes to distinguish products. For example, Wal Mart group, the world's largest retail enterprise giant that first used RFID technology, originally planned to post RFID marks on all commodity distribution boxes and pallets in the enterprise by January 2005. However, due to the high cost of electronic labels and the consideration of confidentiality, Wal Mart chose to use rfid10 only within the enterprise, including logistics distribution centers and warehouses [10].

4.2.2 RFID Technology Standardization

Although RFID technology has been developed for decades, until now, the world has not yet established an international common specification for RFID in different frequency bands. The United States, the European Union, Japan, etc. all have their own technical standards. The inconsistency of standards makes the current sales of RFID products produced by different manufacturers incompatible, which will inevitably limit the use and development of RFID technology. Then, how to integrate these technical standards with each other or establish a unified standard system so that the sales of RFID products in various countries can be universal all over the world is an urgent problem to be solved.

5 Conclusion

From World War II to modern times, the history of RFID technology is not short. With the large-scale application of the Internet of Things in recent years, RFID technology is developing rapidly in our country, especially in the civilian field. Nowadays, the application of this technology is inseparable from the clothing, food, housing, and transportation needs of life. However, there is still a certain gap between my country's RFID technology and international technology in terms of standardization, cost, and security. The further application of RFID technology still has a long way to go. This paper discusses

the relatively successful application cases of RFID technology in the civilian field, and also discusses the cost and standard problems that need to be solved urgently for this technology based on the current state of the technology. Looking forward to the future of RFID technology, on the basis of continuing to deepen its application in the supply chain, payment, and anti-counterfeiting fields, it will be extended to the Internet of Things, public management, environmental monitoring, and even military fields. The application of RFID technology in daily life has just begun.

Due to the limited space and application examples, this paper may not represent the current situation of all the research and application of RFID technology. The author is very interested in the modernization of the breeding industry and saving the human cost of the breeding industry. In the future, the author will continue to study the relevant applications of RFID technology in the breeding farm, such as the unmanned management of poultry farms, the identification of each poultry with RFID technology, and the traceability of problem meat.

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