

# Parcel Rack System of Express Station Based on RFID

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**Abstract:** *This paper puts forward a parcel shelf system of express station which is based on the RFID (Radio Frequency Identification) technology, substituting the traditional barcode technology. The storage rack adopts slides. This design has the advantages of high accuracy of information recognition, reliable performance and large amount of storage information, and it also provides express station with a more efficient solution for automatic identification, information protection, package in-out warehouse and package placement. This paper points out the shortcomings of parcel shelf, and carries on the discussion based on the RFID (Radio Frequency Identification) technology. Finally, the essay analyzes the efficiency of this system.*

**Keywords:** *RFID, Express station, Parcel shelf, Recognition, Incoming and outgoing storage*

## 1. Introduction

China's express delivery industry has developed rapidly in recent years. It is now the world's largest postal and express delivery network, covering the whole country, reaching rural areas and reaching the whole world. The volume of express delivery business exceeded 100 billion yuan, and the revenue exceeded one trillion yuan, playing an important role in serving the country's major strategies, fighting the epidemic, ensuring supply, and serving the people's livelihood. With the rapid development of online shopping and express delivery, express delivery list has become "disclosure list" repeatedly, and the problem of personal privacy disclosure has become increasingly prominent. As a result, telecom network fraud and other cases are common, bringing hidden dangers to people's life and property safety. In view of the problems such as easy damage, lack of environmental protection, information may be hidden and leaked in the express industry, this paper puts forward the design of RFID express station parcel shelf system, in order to improve the efficiency of the post station and adapt to the development trend of The Times.

From 1941 to 1950, improvements and applications of radar resulted in RFID technology. In addition, during the period from 1951 to 2001, RFID technology has been greatly developed both in theory and product research, and has begun to be applied in various fields. At present, RFID technology has developed into automatic identification and data acquisition technology (AIDC)[1].

The rapid development of RFID technology is closely related to its advantages. RFID tags have the characteristics of small size, large capacity, long life and reusable, which can support fast reading and writing, non-visual identification, mobile identification, multi-target identification, positioning and long-term tracking management. Cost saving and efficiency improvement make RFID technology become an important entry point for all industries to realize informatization. So far, RFID technology has been widely used at home and abroad. In China, RFID technology is mainly used in the early stage of the highway automatic toll collection, bus electronic monthly ticket system, personnel identification and other workplaces. With the development of RFID, various parking charging methods such as manual charging and IC card charging will be gradually replaced by automatic charging system based on RFID technology. For example, Beijing Airport Expressway and Shenzhen Huanggang Port have adopted RFID systems. In foreign countries, RFID technology is used in industrial automation, business automation, traffic control management and many other fields, such as goods management, assembly line automation.

## 2. System hardware

The RFID express rack hardware system designed in this paper is composed of RC522 module, STM32 MCU, FLASH memory and OLED module.

### 2.1 RC522 module

RC522 radio frequency module is a communication radio frequency software used in 13.56MHz non-contact smart card. It has the characteristics of small size, low cost and low voltage. It is a short distance wireless support technology based on NFC/RFID.

Radio frequency module RC522 is the core of the whole card reader, it is the radio frequency card and the MCU communication bridge. Many functions of the card reader will be performed by the RC522, such as receiving signals, demodulation and transmitting signals. RC522 and MIFARE1 cards are used for data exchange and connection through RF fields. The RC522 and the non-contact card reader are read and write through radio waves, and the process of data transmission and energy transfer between the IC card and the MFRC522 is essentially coupling between the two coils, so it has great convenience.

The Courier rack designed in this paper uses RFID technology instead of the original bar code scanning identification, and uses pasted electronic labels and sticks them outside the package. When the package enters the site, it prepares for storage. The PC writes the name, telephone number, storage time and other information of the package recipient in the label. After the package is taken out, the storage information is updated in time. At the same time, the data in the electronic tag can be collected after the RC522 module is driven. Compared with paper bills, electronic labels guarantee consumer privacy to a great extent[2].

This is because once the RFID tag leaves the place of sale, the tag cannot be read in other places, which means that the RFID electronic tag will not disclose the privacy of consumers in other places, but the information on the paper tag is always displayed on the paper, and the risk of disclosure is great. And if the RFID tag is needed, it can be reactivated when it returns to the place of sale.

### 2.2 STM32 MCU

STM32 is a high performance, low cost and low power microcontroller (MCU) based on ARM CortexM architecture launched by stmicroelectronics Group (ST). It is an embedded chip with excellent performance and occupies a mainstream position in embedded system design. STM32 is based on the ARM Cortex-M3 kernel. The Cortex-M3 processor is the latest generation of ARM embedded processors. It not only reduces the power consumption of the system, reduces the number of pins, but also reduces the cost to meet the needs of MCU functions, making excellent computing performance and advanced interrupt system response.

#### 2.2.1 Operation design

In this paper, the experimental design of the express rack using STM32 minimum system, the single chip has the characteristics of high performance, low cost, low power consumption, on the basis of writing code can also realize the data collection, display and processing. Interface converter is used when STM32 connects with PC, so that the two can communicate normally, and the package data can be obtained and processed by STM32 drive RC522 module.

The overall flow chart of software operation of the card reader system is shown in Figure 1 below. After the system is started, the system initializes STM32 MCU peripheral and RC522 module first. After the initialization, the system starts to wait for receiving. Upper computer instruction. When the system receives a valid instruction, the system will immediately start to determine whether it is a card seeking instruction. If it is a card seeking instruction, then STM32 will drive RC522 to find the tag. If not, then the system continues to determine whether it is a read card instruction, if it is a read card instruction, then STM32 will drive RC522 to read the label specified sector, the specified block of data, and then determine whether it is a write card instruction, if the write card instruction, then STM32 drive RC522 to write the label specified sector, the specified block of data. If none of the above occurs, the system goes back and waits to receive instructions. If the system has completed the instructions of card searching, card reading or card writing, the system will package the data and send it to the upper computer, and then enter the state of waiting for instructions [3].

### 2.3 OLED module

Using OLED module, we can have a more intuitive understanding of package information, which is convenient for timely error correction when inputting label information.

### 2.4 W25Q32 module

The W25Q32 chip is a flash memory that can be operated by SPI. The W25Q32 module is programmed to work in the corresponding mode when the package is in and out of the library.

### 2.5 Setting button

The setting button is used by the administrator to distinguish between package entry, information entry and outgoing, so that the system works in the corresponding working mode [4].

This paper aims at the low efficiency of express delivery, warehousing, inventory and package finding, and integrates the current package management with RFID technology to improve work efficiency and service quality. The system uses the reader to identify labels and collect label data. The data is processed by STM32 microcontroller and stored in W25Q32 module after processing. The hardware architecture of this system is shown in Figure 2.

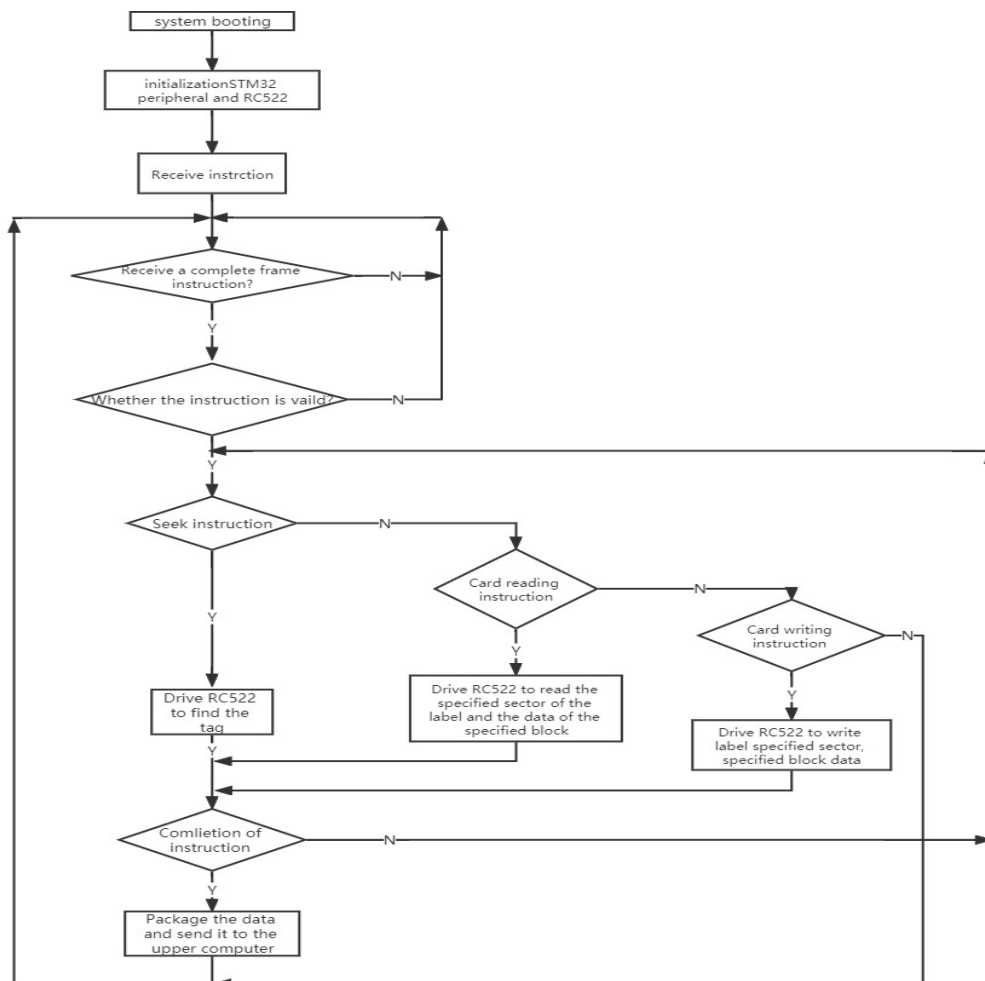


Figure 1: The overall flow chart of software operation of the card reader system

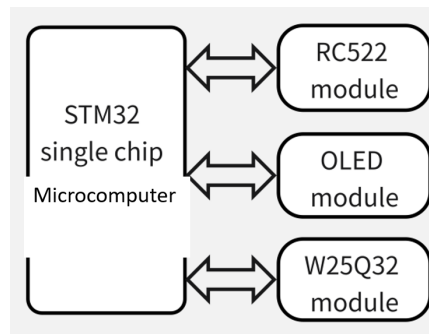


Figure 2: System hardware architecture diagram

### 3. Characteristic

The original traditional express rack only plays a basic function of placing parcels. The Courier rack designed in this paper combines the two processes of warehousing sorting and parcel placement into one, and is a Courier rack that can realize parcel identification, storage and management. Traditional express racks need manual intervention throughout the whole process from parcel sorting to storage. Manual sorting is often affected by practitioners, and fatigue will often reduce the sorting accuracy, which is feasible for short-term development, but not conducive to long-term development. From the current point of view, the market commonly used paper sheet also has certain drawbacks. For example, the use of paper bills is costly and susceptible to bad weather. Since the real-name express delivery system, users' information security can not be guaranteed. This design aims at improving the disadvantages of traditional express delivery, and maintains the privacy of users to a large extent by using electronic labels. At the same time, in order to reduce labor costs, we use RFID technology combined with STM32 to realize automatic parcel sorting, and when the parcel is stored, we use guideway pulley to transfer the parcel, realizing the liberation of hands.

### 4. Express rack system design

#### 4.1 Parcel data design

In the experiment, the express rack part uses RC522 radio frequency module, whose main function is to read the data in the package label. Through the CH340 serial port, you can input and modify the data of the label in and out of the storage time, storage classification etc. and collect and process the parcel data through the RC522 module and STM32 microcontroller.

Figure 3 is a simplified block diagram of the RC522 structure. In the figure, the analog signals are modulated and demodulated through the analog interface, while the role of the contactless UART is to handle the protocol requirements when communicating with the host. Data transmission between the host and the contactless UART is achieved through the FIFO buffer. Different host interface functions meet different user requirements.

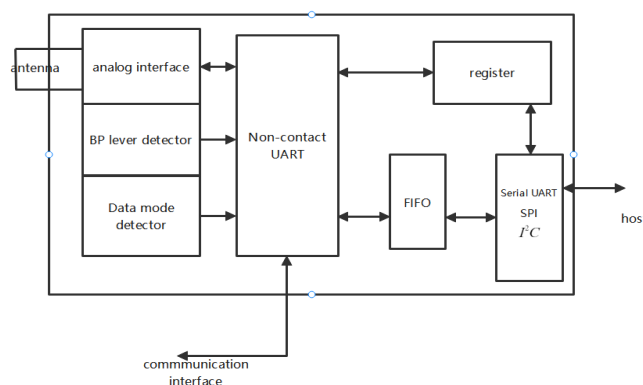


Figure 3: Simplified block diagram of RC522 structure

#### 4.2 In and out storage design

The express rack system takes STM32 as the core, because the working mode is divided into four kinds: identification label, input information, storage and storage, so at least three keys are set to distinguish. For the working mode in and out of the warehouse, set the specified time format to display the year, month and day, to achieve the purpose of recording the time when entering and leaving the warehouse and displaying the time when label recognition.

#### 4.3 Parcel shelf section

We use sliding rails for the shelves where packages are placed, and set certain height and Angle for the dividing area, so that the packages have initial speed before entering the shelves. By installing sliding rails on both sides of each floor of the shelf, the packages can reach the front end of the shelf with the help of the sliding rails. In order to make full use of the resources of the shelf, each package is close to each other [5].

The express rack system designed in this paper combines RFID technology with the barcode identification technology commonly used today. When the express package arrives at the express station, the staff can manually sort the large package first, and for other packages, the electronic label can be affixed outside the package. When the package is stored, the recipient's name, contact information and other information can be written into the label. If the information in the label shows that the package is in Library A, install sliding rails that can move freely on both sides of each shelf layer. After assembling packages in each warehouse, set and adjust the hardware architecture to have a certain Angle with the parcel entrance of the express shelf, so that the package has a certain initial speed before entering the shelf layer. Then with the help of the slide rail to the front end of each layer, the working flow chart is shown in Figure 4.

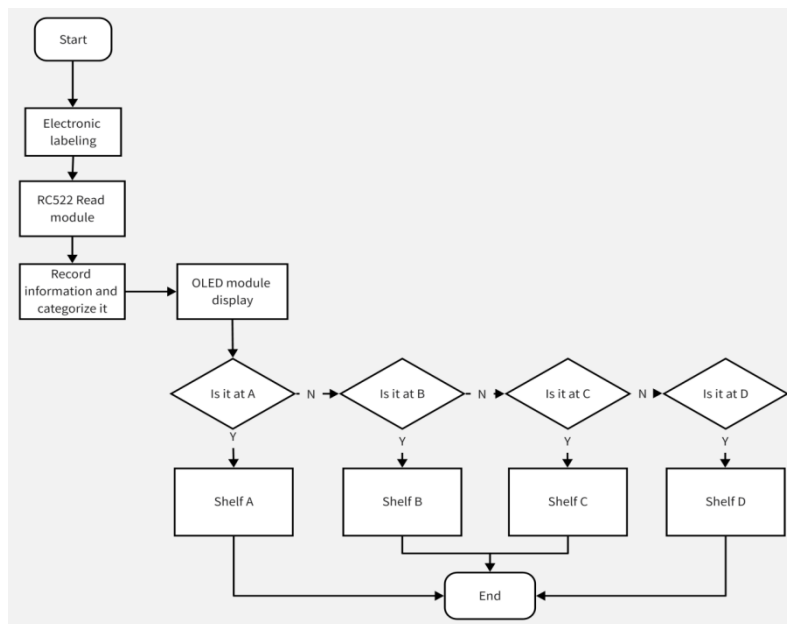


Figure 4: Working flow chart

#### 5. Conclusions

In this paper, RFID technology is used to replace the traditional paper form, and STM32 microcontroller, RFID radio frequency module, FLASH memory and OLED module are used to scan and read the package information and write it into the electronic label, so as to complete the update of incoming and outgoing information. The position of packages is designed through the PC end. After the packages of each warehouse are collected by the free moving slide rails installed on both sides of each shelf, the Angle between the hardware architecture and the parcel entrance of the express shelf is set and adjusted, so that the packages can reach the top of each layer at an appropriate initial speed before entering the shelf layer. RFID technology will continue to be deeply applied in all walks of life, life needs and other aspects, we believe that with the progress of science and technology and the

development of The Times, RFID technology will have a brighter development prospect.

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