

The Application Of RFID in Automatic Warehouse Management System

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Abstract: The impact of global financial crisis has appeared and now influence in logistic industry. Under this flinty situation, how to improve the productivity and reduce the operating costs are very important issues for enterprises. Radio frequency identification (RFID) used in automatic warehouse management system can make the management of storage, transportation and distribution more efficient, accurate and logical, it can helps the enterprises to reduce the operation costs, and put itself in a dominate position in the competition. Establish the warehouse management information system based on RFID technology, can make the distribution of information more smoothly, which is beneficial to control and reduce inventory, improve the turnover and reduce the costs (including the human resource costs). It's an important segment for the enterprise to facing the financial crisis and improving the productivity.

Keywords: RFID; automatic warehouse; information system

I. Introduction

At present, warehouse management system usually uses the bar-code tags or the artificial warehouse management methods (such as bill) in order to support self warehouse management. But the bar-code tag's has weak points such as easy to make duplicate, can be damaged by moisture and bad antifouling performance, combine with the complexity of artificial bill control it is easy to cause man-made loss. The domestic loss of warehouse management has always happened. As the world's most important retailers, Wal-mart, metro, Tesco are all begin to focus on RFID technology, and become an engine of global RFID revolution. By using RFID technology, the defects of the bar code were fixed in warehouse management. Wal-mart's stock dropped by 16%, the products which using RFID tags are 3 times more than the products which didn't. Now, Wal-mart has 130 major suppliers sending the products with RFID to its distribution center, and 50 for Metro. Last year, Wal-mart distribution centre has received 540 million pieces of products with RFID tags; it greatly reduces the cost of inventory. For Metro, the German headquarters distribution center can save 850 million Euros each year by using the RFID application. From the perspective of the current application progress of RFID, it has become irresistible to promote more of one-dimensional barcode identify technology innovation revolution. This document is based on RFID technology

design of the automatic warehouse management system framework and system composition, analyzing and find the advantage of the RFID technology when it be used in warehouse management. Warehouse management system with RFID can do automatic identification and also has strong background check and supervision function. It can operate on site supervision and guidance by doing real-time error correction.

II. RFID System Components and Technical Features

The RFID System Components

RIFD is the abbreviation of Radio Frequency Identification, It is a technology which can do identify work without manual intervention, and it can be used in various environments. RFID technology can identify high-speed moving objects and can identify multiple tags; the operation is fast and convenient.

A typical RFID (RFID technology) system is composed with the electronic tags, the general reader and the computer system, as shown in figure 1.

Electronic Tag (RF card): composed with coupling components and chips, tags, built-in antenna which is used for communication with RF antenna.

Reader: read (Also can write in the card) label information of the equipment.

Antenna: Transmit the signal between tags and reader. Some systems can make the connection through the reader's RS232 or RS485 interface with other computer or external supervisory system, in order to operate the data exchange.

Computer systems: estimate the tags validity by Boolean calculation. These processes will be done automatically.

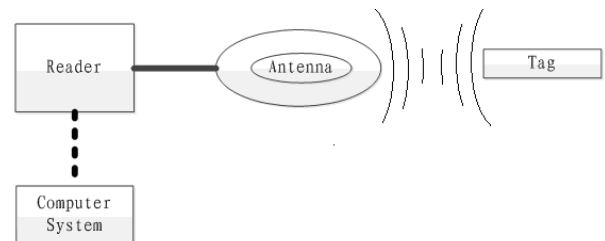


Figure 1 The RFID system components

RFID Technology Characteristics

1) Read and write function: By using RFID reader, the data can be read and transferred to the database without any

physical touch. It can handle multiple tags, and write the logistic processing status information into the tags in order to operate the next operation stage.

2) Easy for miniaturization and compatible for diverse shapes: When RFID system doing the label scanning, the scanning quality will not be affected by the label's size and shape. The Label can be designed smaller and compatible with more different products, so the RFID can control the production smartly especially in the product line.

3) Environmental adaptability: It is very difficult to read a paper label with dirt on it, but the RFID can adapt in such situation, for water, oil and drugs RFID has strong resistant. In the dark or dirty environment, the RFID also can read and write data.

4) Reusable: Because the RFID use electronic data card which support multiple read and write, the label can be used for many times.

5) Penetrability: If the RFID is covered by paper, wood and plastic which are nonmetal or opaque materials it also can undertake penetrating communication. But if it is metal, it will not work.

6) Large memory capacity of the data: The capacity of the memory will developing as the technology update, the information volume needed for a product in the future will getting larger, but RFID will not be affected.

7) System security: Transfer the product's data from the core computer system to product's components provide good system security. It will improve the system security very much.

8) Data security: By verify or cyclic redundancy check method to ensure the accuracy of data stored in RF label.

III. System Design of Automatic Warehouse Management System Based RFID

The General Structure of System

RFID automatic warehouse system structure is shown in Fig. 2.

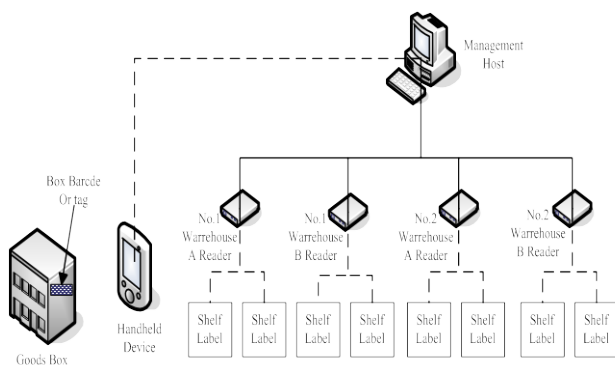


Figure 2 RFID automatic warehouse system structure

RFID inventory management system is made of the business management software; RFID tags release system and RFID tags recognition and acquisition system. These systems are connected with each other, and finish the item management in various processes. Backend database management system is the core of the whole system, RFID identification management is the fundamental method for implement the management functions. Background management software is made of central data servers and management terminal; it is the core system of data center. It is responsible to communication with hand-held reader, converting the data uploaded from hand-held reader, and transfers the data into the database of background warehouse management system, implementing the store and processing the tag management, tag release and captured tag information. RFID tags release system is made of electronic label printer and label generating application, and responsible for completely writing information of status labels, tags, box labels, and printing label surface information. Electronic label printer uses embedded, non-contact reading, industry-specific thermal printer, can write the information in the label's chip, at the same time print the contents of predefined information on the tag surface. Tag generation function dynamic-link libraries is the core of tag production management software, it is embedded in the background system, provide the label printer interface functions for the label generation in the background warehouse management system, based on this dynamic libraries, it also provides an independent software for label generation, this software support manual input tag data, in order to produce the temporary tags. RFID tags recognition and acquisition system can collect label information from hand-held reader and fixed position terminal, finish store tags data, exchange the data with the management center through the RFID middleware.

System Hardware Design

The hardware involve in this system mainly are the fixed reader at the top of warehouse and the hand-held bar-code reader tag. Combining with the market, we choose the method that linking self-development with integration. For the part of fixed reader, we choose ForeID_TAM_6102-type high-frequency-range Reader which is relatively mature in market, produced by the Shenlian Technology Company. For the hand-held bar-code tag reader which is the handheld terminal that used to manage warehouse and inventory one's stock, we develop it in ourselves according to our own needs and the feature of this system. Hand-held device hardware structure is shown in Fig.3.

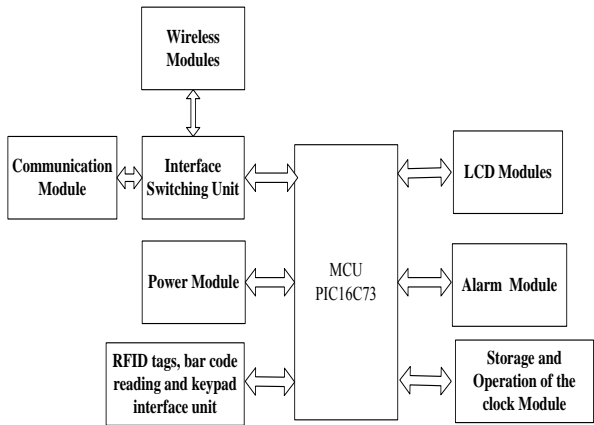


Figure 3 Hand-held device hardware structure

As can be seen from the figure, the entire hardware system mainly formed by the MCU master control module, electronic tag reader module, memory and operating clock module, LCD module, alarm module, keyboard module, power module, communication module and wireless module. The whole system is mainly to achieve two functions of reading and writing electronic tag. When the whole system is in reading label state and the label goes into an effective work area, the label is activated. The electronic tag reader module reads tags valid data through the RF antenna and data is transmitted to the main control module. The data that is processed by control module is displayed in the display module and be saved to the memory module at the same time. When the system is in writing tag state, the control module will save the date that is input by keyboard module into memory module. In the same time, the date is displayed and written to the tag through the electronic tag writing module. Of course, all of the above operation is provided a unified operation date and time by the clock module. Here RFID reading and writing module circuit connection diagram is shown in Fig.4.

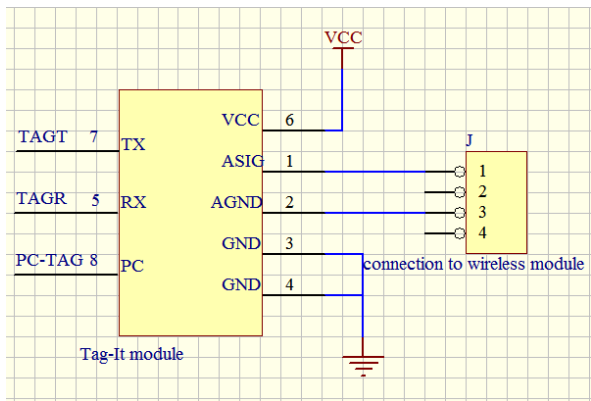


Figure 4 RFID reading and writing module circuit connection diagram

The module is connected with the main control module circuit shown in Figure 4 above. RX is data input pin of RFID reader module. When the control module sends data to this module, PIC16C73 microcontroller sends serial data and the command word to the module through RX pin; TX is data output pin of electronic tag reader module. When the electronic tag sends response data, the module sends output data to main control module through TX pin. PC is enable pin that is responsible for the module chip-select. While, The ASIG and the AGND pins are connected with the RF antenna module (J in Fig.4).

The following shows the procedure to write tag control fragment.

```
void send_com(uchar*Data) // sends data to tag module
{
    Int sent_cont=0,sent_len;
    Uchar tmpD;
    PC_Tag=0; // enable RFID reader module

    Delay(10);
    tmpD=Data[1];
    if(tmpD=='R'tmpD=='L'tmpD=='B')
        //determine the length of Transmitted data
        send_len=3;
    else if(tmpD=='W')
        send_len=7;
    else if(tmpD=='r'tmpD=='l')
        send_len=11;
    else if(tmpD=='w')
        send_len=15;
    else if(tmpD=='M'tmpD=='I')
        send_len=2;
    else // Indicating system error
        "Error"
        {
            send_len=0;

            bankdata[0]=0x1B;
            bankdata[1]=5;
            bankdata[2]='E';
            bankdata[3]='r';
            bankdata[4]='r';
            bankdata[5]='o';
            bankdata[6]='r';
            lencnt=7;
        }
    For (sent cont=0;sent_cont<send_len; sent cont++)
        //Transfer complete
        {
            SBUF=Data[sent cont];
            While(TI==0);
            TI=0;
        }
}
```

System Software Design

System management software which is warehouse operation and management platform primarily consists of eight modules. Namely, basic information management module, a storage operation management module, handheld device management module, equipment and label detection module, stock alarm module, inventory information Query Module. System software flow chart is shown in Fig.5.

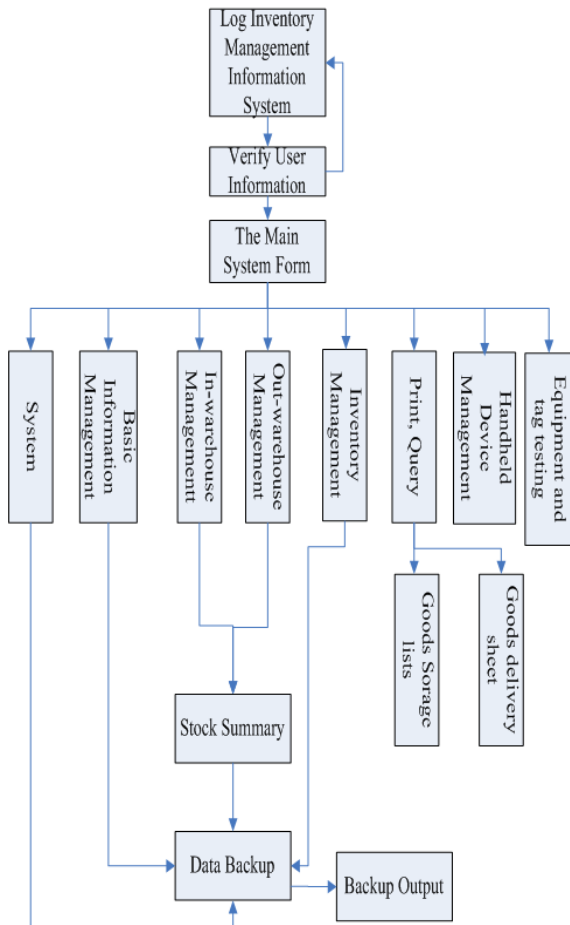


Figure 5 System software flow chart

IV System Functions Introduction

Vehicles, Pallet and Goods Identification

Install the card reader in the channels between Warehouse to warehouse and each entrance. By this way, the pallet, forklift, goods which installed the tag, will be automatically identified and be recorded when they enter these area; all the information data are saved in the system database; and in the background, when goods leave the distribution center, card reader will send the label information to the operation system, and automatically generate shipping list; after the trucks arrive the destination, the reader automatic scan the

label, then quickly complete the inspection and verification. Management system can track the position of the forklift, pallets which have installed the tags, Readers was installed above the warehouse entrance for the truck and pallets, each pallet is installed RFID tags, when a truck carrying a tray of goods goes through, the reader will inform the computer about which pallets with the goods have already gone through. This system handles a large amount of pallets per day, and improves the efficiency very much; furthermore, it ensures the accuracy and the reliability of information relating to the goods. After install tags on goods and packages, management system can track each link in the logistics process conveniently for inventory search and matching. As shown in Fig.6.



Figure 6 Vehicles, pallet and goods identification

Inventory Management

When the goods entering the warehouse, warehouse administrator check each piece of goods according to the order list, after that, he or she will hand over the goods to the warehouse keeper, and then store them in the warehouse. The warehouse keeper use hand-held reader scan the label which located on the shelf and stocks, register all the item information. The data is recorded in the treasury operation data table in the hand-held reader, and then place the goods on the designated location. If the goods need to store in the box, the warehouse keeper needs to scan the box labels in order to update the information in the hand-held reader. After all goods entering the warehouse, the warehouse keeper will return the hand held reader to the warehouse administrator. The administrator will import the income date into the database, and finish the income stocks operation. By doing this process, we can easily find the location, quantity, specifications of each items. By the warehouse management software, it realizes the visualization of the storage statistics.

Outbound Management

When the goods going out of the warehouse, warehouse administrator verify warehouse status according to the stock application, then make the advance outbound order list; warehouse keeper move the specified goods which are

requested in the advance outbound order list, use the hand-held reader to scan location labels and items tags, check In the outbound messages, record the data into the hand-held reader outbound data tables; after all the goods are moved out, send the record data to the mainframe, and verify the data with the record in the outbound order list, in the end, register the actual amount of the goods.

Inventory Tracing Management

Staff or forklift driver can use hand-held reader to collect data, such as Item's tag information, quantity and shelf number as shown in Fig.7 below. System can automatically generated or artificially generate the selected counting task list according to the stock classification document to implement inventory counting operations. During the operation, we scan the product label and collect the corresponding location information. After the data uploaded, the system will automatically list the products we have counted and which haven't. Depend on the requirements to operate inventory overage and shortages.



Fig. 7 Use hand-held reader to collect data

Management of Exchange or Refunding

When customers request to exchange the Item due to the defection, by scanning the product label, we can verify whether the item is belong to the customer or not, selling time information, and conveniently inquire the other sales information related to make efficient supervision and management. For the items which need to confirm for exchanged operation, when hand-held reader scan the labels, the time will fill into the corresponding field in the label information table.

Staff Management

A tag will assign to each staff, when the staff move in and out of the warehouse the tracing device installed above each entrance will trace the staff's working time and track, it

makes the supervision of the staff work status and efficiency easier.

Goods Allocations Management and Report Analysis

When doing the goods allocation, according to the allocation situation to select the proper process; meanwhile the system can do the analysis and generate the reports, in order to provide decision making support for enterprise to establish the development strategy.

Cargo Transportation Tracking

Install the label on the vehicle's windscreen and the container, for the bulk cargo containers and package, tag on the vehicle's windscreen, system can use the exclusive internal code or vehicle information (plates, the cargo) to identify and automatically load the goods. Tag will transfer the data in the memory into the microwave signal to the antennas. When the trucks go through each site, the scanner installed in each site will identify the trucks go through and record the information which include the time of the truck arrived, the information of pallet and cargo in the trucks, then automatically connect to database to verify the information, and upload the data to Internet system to realize the real-time tracking. Finally, through the computer LAN, send the data to the relevant person's terminals. This procedure realizes the remote control of transportation management. When container and bulk cargo go through the port within the network coverage, RFID readers will verify the information of the container and the goods then transfer the data to a computer.

System Characteristics

Through the above analysis and system structure introduction, we can see this system has the following features:

- 1) Combined the whole warehouse management process with the RFID technology, Can efficiently improve and finish all kinds of business operation in warehouse management. It improves the efficiency and value;
- 2) It improves the recognition rate of items in and out of the warehouse, even without open-package inspection, it also can identify multiple items, improve the efficiency of loading and unloading;
- 3) Reduce the inventory counting cycle, increase the data real-timing, control the inventory information dynamically, and realize the inventory item's visual management;
- 4) By using RFID technology, enterprise can greatly increase the efficiency and accuracy in distribution and selection process, reduce the time for delivery, decrease the artificial and the distribution cost;
- 5) Master the stock status, optimize reasonable inventory.

V Conclusion

By using the RFID technology in the intelligent automatic warehouse management system, it completely and effectively solved the management of warehouse related information, it increases the amount of goods transferring within one day and also tracing the entire data related to them. RFID inventory management system has strong automatic identification, verify and backstage supervision function, can do the real-time guidance, supervision and correction. It will help enterprises to control and reduce inventory and operation cost (including the human cost), improve the turnover rate, It is an Important segment for enterprise to face the financial tsunami, and improve the productivity.

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