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RFID Technology Applied in Warehouse Management System

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Abstract

Having taken into account the features of modern warehouse management, we put forward a warehouse management system (WMS) based on Radio Frequency Identification (RFID), and probe into the structure and operation flow of the system. The WMS will adopt RFID middleware as the support platform, cover goods entry, picking, checking, delivery and many other operation flows, and can collect, deliver, check, and update mass data on the frequent warehouse entry and delivery, so as to decrease the labor intensity, avoid fault scanning, miss scanning, re-scanning and other artificial errors, and improve the efficiency and accuracy. The WMS based on RFID will help to improve the efficiency of warehouse management, and make rapid self-recording of receiving and delivery.

1. Introduction

The main functions of modern warehouse management include: traditional warehouse management, intersected transportation or combination on the way, value-added service flow, goods returned, quality guarantee and dynamic customer service [1]. In the supply chain, the warehouse is always at the joint of the processes, like between purchasing and manufacturing, between pretreating and finishing processing, between manufacturing and selling, between wholesale and retailing, and among the switch of transportations [2]. With the development of concepts of the global operation strategy and the supply chain management, the warehouse management becomes more and more important in the supply chain. Computerization and automatization have been introduced and applied more and more in the warehouse management to support all processes of the supply chain. As a modern data-collection tool, RFID will be applied widely in the warehouse management system with its remarkable advantage.

The WMS in this paper aims at establishing an express lane in the warehouse system based on RFID to realize high efficient warehouse management and high speed self recording of goods entry and delivery. The WMS will adopt the RFID middleware system as the support platform, including goods receiving, warehousing, picking, matching, stock taking, withdrawing, forklifts locating and dispatching and many other flow packages, which can be assembled flexibly, and customized to new function packages that can be operated independently, or connected smoothly.

2. The structure of the WMS based on RFID

2.1. The front-end system

The front-end system consists of RFID tags, hand-held units, fixed antenna, vehicle units, etc.

1) RFID tags. According to different application requirements, high frequency (HF) or ultra-high frequency (UHF) RFID tags will be adopted, which can be divided into pallet tags, warehouse position tags, goods tags, etc.

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2) Hand-held units, including integrated mobile hand-held devices, hand-held electronic tags with the electronic identification codes for the hand-held devices, can send data or information to the bank-end system through the wireless network.

3) Fixed antennas, including UHF omni-directional, vertical and horizontal plane antennas, can adjust in the multiplex and highly scattering environment, magnify the receiving signal, and constitute a LAN without blind areas while small in size.

4) Vehicle units, including vehicle-controlled computers, displays, readers, identifying antennas, vehicle electronic tags with truck identification electronic codes, etc., can adapt for many kinds of complex bad working environment, integrate with wireless network communication function, and send data or information to the back-end system.

2.2. The back-end system (the WMS system)

The back-end system is the operation support system of the WMS, can collect, filter, collate, encapsulate and retransmit data. Integrated with all function packages seamlessly, the system makes data in different function or flow packages run smoothly on the whole platform. The back-end system can be the data collection support platform operated independently, or the support platform for the simultaneous operation of different function packages, also the connecting and data exchange platform with the emulation system, the management information system, the ERP system and other external systems.

2.3. The warehousing facilities

The warehouse will be divided into several different goods locations with correspondent electronic codes, including the name of the warehouse, goods area, rack and independent goods storage area. The electronic codes of the goods locations will be input into the goods location identification electronic tags, which will be packed in the correspondent goods location navigation indicator. The whole warehouse will be covered by the wireless LAN for the sharing and rapid delivery of information [3].

3. The flow of warehousing operation

3.1. The flow of warehousing entry

1) After receiving the delivery order from the sender, the back-end system will dispatch an electronic code for each individual goods according to the goods attributes, write in the chipset of the electronic tags, then appoint correspondent position for each goods, and generate receiving order according to the operation requirements.

2) The back-end system will generate the warehousing entry, search idle forklifts through the wireless network, then write the correspondent identification electronic codes in the warehousing entry, and send to the front-end system.

3) When the front-end system receives the warehousing entry, the driver will drive the forklift to transport the goods to the waiting area. When the forklift passes the antenna area, the fixed reader will read the goods tags in batch and send to the back-end system, which will check the goods information with the warehousing entry, then send the detailed statement of the goods to the control computer on the vehicle units through the wireless network according to the goods storage position pre-set in the system, and open the navigation light on all appointed goods locations.

4) The driver will reach the appointed position according to the indication of the navigation light and the detailed statement of the goods displayed on the vehicle display, read the goods tags of the waiting area through mobile devices, and send data to the front-end system, which will check the data collected with the system order, then instruct the driver to transport the goods to the appointed waiting area.

5) The front-end system will send the confirmed data to

the back-end system. After obtaining the data, the back-end system will update the correspondent system data, indicate the current position of goods, and close the correspondent navigation light.

6) After all goods loaded, the driver will push the "Affirmation" button, indicating all goods have been received. The back-end system will obtain the identification electronic codes of the forklift, check whether all goods are loaded or not, whether the forklift is idle or not. After confirmation, the system will dispatch the forklift into the "idle forklift", and wait for the next order. The warehouse entry flow is shown in Figure 1.

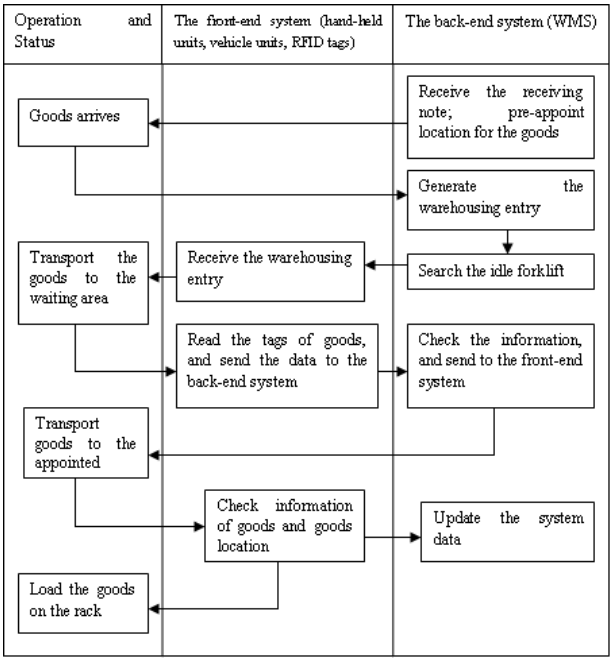

Figure 1 Flow of warehousing entry

3.2. The flow of picking operation

RFID can also facilitate the picking process, particularly for pallet picking area with forklifts, as Figure 2 shows.

1) The back-end system will generate picking orders according to business requirements.

2) The back-end system will search idle forklifts through the wireless network, and send picking operation order to the forklifts.

3) The front-end system will receive the picking order. The driver reads the tags and codes of the goods location through the mobile devices, and sends to the front-end system.

4) The front-end system checks whether the data collected are matched with the system order or not. If confirmed, the system will send order to the driver to transport the goods out of the warehousing area.

5) The RFID system will update the data in the tags of goods location in the warehousing area. The front-end system will send the results to the back-end system through the wireless network, and the back-end system will update the correspondent data in the system.

6) After completing the operation, the driver will push the "Affirmation" button. The back-end system will attribute the forklift into "idle forklifts", and wait for the next order.

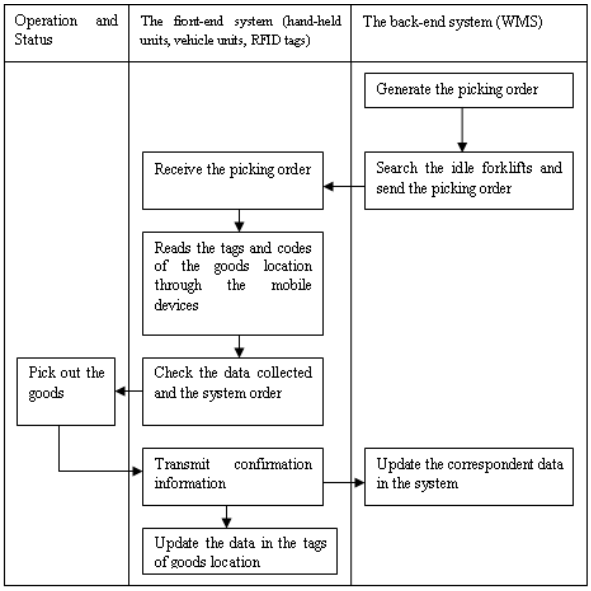

Figure 2 Operation flow of picking goods

3.3. The flow of stack taking

Different devices and operation flow will be adopted according to the difference in the types of the warehouse, and the way and requirements of stack taking. This paper will just probe into the manual stack taking of plane warehouses and the automatic stack taking of tired warehouses, especially the latter.

3.3.1. The manual stack taking of plane warehouses

After receiving the checking order from the back-end system, the warehouse administrator will assign workers to enter into the warehouses with hand-held and vehicle devices to check all goods locations and send all information collected to the back-end system through the wireless network, while the back-end system will check information of the goods location with the content of inventory sheet, and update the data, then output the result.

3.3.2. The automatic stack taking of tired warehouses

Antennas will be installed on both sides of the stacker, and linked with a fixed reader, which will communicate with the background management system through the wireless network, and read the data in the pallet tags wirelessly. Thus the real-time, zonal and automatic stack taking with no manual intervention can be realized with automatic gathering method of RFID, while the speed of stack taking operation and the accuracy of stack taking data can be guaranteed. The operation flow of automatic stack taking is shown in Figure 3.

1) The back-end system will generate stack taking orders according to the business requirements, and send the inventory order to the front-end system to conduct stack taking on some part or the whole warehouse.

2) After the front-end system receives the inventory order, the stacker will be located on the goods location to be checked, and the back-end management system will control the reader to begin its operation through the wireless network, and read the data in the pallet tags wirelessly.

3) The readers will read the tags of the goods locations in the warehousing area, obtain the book quantity of goods in the current goods location, and send to the front-end system. The front-end system will check whether the data collected is matched with the system orders. If confirmed, the system will continue to send orders to read the bar codes of goods in the goods location.

4) The real quantity of goods and other information will be sent to the back-end system through the wireless network.

5) The front-end system will send operation completion signals to the back-end system after operations are finished according to the stack taking operation order.

6) After receiving the signals, the back-end system will process the data collected, and check with the original storage record, then generate the inventory result.

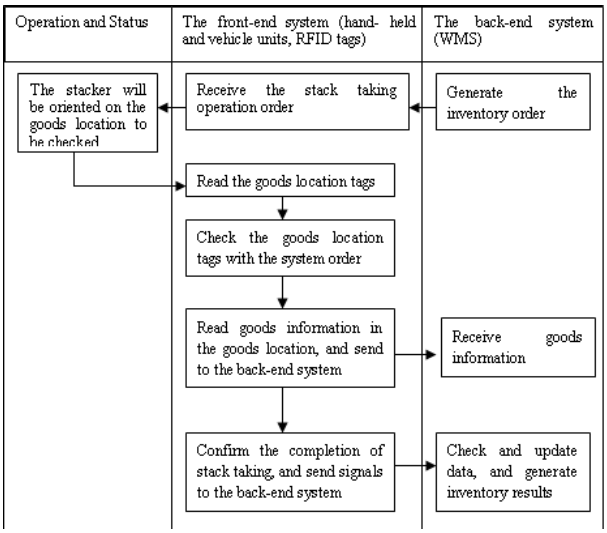

Figure 3 Operation flow of automatic stack taking

3.4. The operation flow of goods delivery

1) The back-end system will generate the withdrawing order based on business requirements, search idle forklifts through the wireless network, and then assign the withdrawing operation order.

2) After the front-end system receives the withdrawing order, the back-end system will obtain the identification

electronic codes when idle forklifts are driven through the warehouse entry gate with readers, send the detailed list of goods to be delivered to the vehicle computer, displaying to the driver on the vehicle screen, and open the goods location navigation light.

3) The vehicle antenna will identify the goods location navigation indicator on each rack, and the display will display the detailed list of goods to be unloaded when reaching the right position.

4) The vehicle units will read the tag information of goods in the goods location according to the direction of the display, and send to the front-end system. The front-end system will check whether the data collected are matched with the system order. If confirmed, the system will direct the driver to transport the goods to the appointed delivery area.

5) The front-end system will send the data confirmed to the back-end system, and then the latter will update the system data, and close the navigation light on the goods location that goods have been delivered.

6) The flow of goods delivery is shown in Figure 4.

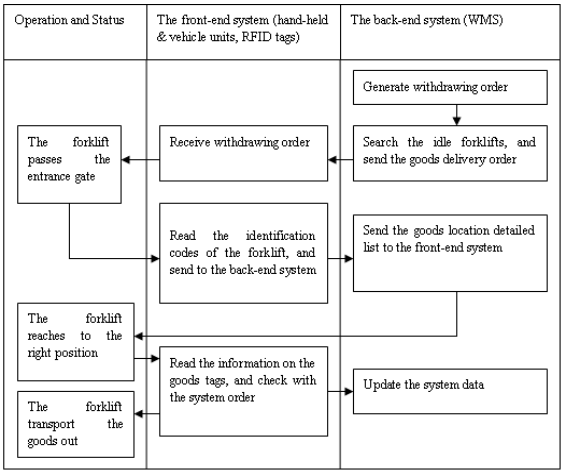

Figure 4 Flow of goods delivery

After all assigned goods have been delivered, the driver will push the "Affirmation" button, which means the goods delivery operation has been completed. The back-end system will obtain the identification electronic codes of the truck, check whether all assigned goods are delivered or not, whether the truck is idle or not, and then attribute the forklift to the "idle forklifts" to wait for the next order [4-6].

4. Conclusion

The RFID technology has a lot of advantage, such as simultaneous collection of large quantities of data, without any requirement on accurate counter-position, which makes the enterprise free of daily mass repeating operations. The warehouse management system (WMS) based on RFID can collect, transfer, check, and update mass data on daily frequent goods entry and delivery, thus the labor intensity will be decreased, errors like fault scanning, miss scanning, re-scanning in the repeating manual operations can also be avoided, while the efficiency and accuracy will be improved a lot. With development of the RFID technology, reduction of costs, gradual unification of the standards, decrease of the error rate, the effective combination of WMS and RFID will become one of the key factors to improve the competitive power of enterprises and the efficiency of the supply chain.

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