RFID- based Distributed Information System of Aircraft Supply Chain Management

ZHANG Chuanchao[1, 2a], CHEN Li[3,b]

[1]School of Information Engineering，Wuhan University of Technology，No.122,Luoshi Road,Wuhan，PR.China,430070

[2]China Aviation Publishing & Media CO.,LTD., Office Building, No. 2, Beiyuan, Chaoyang District, Beijing,PR.China,100012

[3]Beijing Aeronautical Science & Technology Research Institute，Future Science and Technology City,Xiaotangshan,Changping District，Beijing，PR.China,102211

[A]cczhang_2008@163.com, [b]mig2131@163.com

Keywords: aircraft; RFID; supply chain management; distributed information systems; solution

Abstract. Visualization, accuracy and timeliness are the main trends of the supply chain. How combine the information technology and radio frequency identification technology is the next one of the difficulties of aircraft supply chain development in the world. In view of those problems such as geographical dispersion of the current aircraft manufacturing enterprises, and their supply chain too long and difficult to visualization,based on radio frequency identification(RFID) technology and information technology, a solution of distributed information systems for aircraft supply chain management is proposed, the system architecture and function modules are designed, the key problems for the system development are pointed out.

Introduction

RFID is a non-contact automatic identification technology achieved using RF communication. RFID can collect and exchange data by high speed between the reader and electronic tags, has intelligent read and highly encrypted communication ability. For accurate, fast, safe and controllable requirements of aircraft supply logistics, RFID provides a practical technical way. Whether the aircraft supplies are in any link which maybe the procurement, transportation, storage, use, and maintenance, RFID technology can achieve real-time information and status. RFID tag has many advantages such as small size, large capacity, long life, reusable, high accuracy, strong adaptability to the environment , strong anti-jamming, and quick operation, it can flow fast and accurately manage aircraft supply. Therefore, RFID will be used more and more widely in the aircraft supply chain.

Application Review

U.S. military paid a great regard to the application of RFID in logistics support. Starting from the early 1990s, U.S. military has begun to use RFID technology to help solve the visualization problems of transported supplies in Desert Storm. The application of RFID technology make U.S. military logistical supplies transparency possible, and provide a effective solution for automatically obtaining asset visibility information in storage, transit and use.

Visualization, accuracy and timeliness is the key to supply chain management, and this is precisely the most prominent advantages of RFID technology[1]. Thus, two of the world's leading aerospace manufacturing giant Boeing and Airbus are working on the RFID technology is applied to the tracking of components in the aircraft supply chain and manufacturing processes. Boeing announced in 2005 the use of RFID tags in the 787, but then RFID technology is not mature enough, and eventually canceled the program. Airbus paid a great regard to visibility and automatic identification of the value chain with RFID technology. Airbus A320 forward fuselage parts had shipped to the final assembly line process using RFID technology. On A380 final assembly line in Hamburg,RFID tags were installed on the container for transporting A380 cabin parts , its logistics providers could track

4800 container through those tags. In November 2008, the Airbus began to consider the installation of RFID tags on A350 aircraft components to help airlines and maintenance service providers to take configuration management and maintenance management within the entire life cycle[2-3].

It can be see,as an emerging automatic identification technology, RFID has more applications in the aircraft industry, and it has broad requirements[4]. RFID has more applications in the supply chain management[5-6].Currently supply,monitoring and management for aircraft materials develop toward increasingly precise direction, whereas the traditional manual ways are both time-consuming and error-prone. Supply of aircraft products and supplies shifts from small quantity, single variety mode to the large quantity and variety modes. The traditional manual ways can not meet the requirements for the aircraft diversification product and types. Wide-used RFID technology has become an inevitable trend of aircraft products supply chain development which is accurate, fast, safe, controllable.

In order to maximize the role of RFID and solve geographical dispersion problem, RFID must be combined with information technology to develop a distributed information system based on RFID technology for the aircraft supply chain management[1,7-8]. This is the next problem to solve for development of aircraft supply chain.These information systems will bring revolutionary changes to aircraft supply chain management.

The technical features of RFID

The basic principle of RFID is shown in the reference [9].Relative to the two-dimensional bar code, RFID technology has the following distinctive characteristics[3]:

(1) large memory capacity: the storage capacity of RFID is 2^{94}.It abandoned the limitations of the bar code, so that each object in the world can have a unique identifier.

(2) rapid speed to read and write: when the electronic tags enter into the magnetic field, the reader can read the information of those tags in real-time.The recognition rate is up to 50 per second.

(3) high data security: RFID is coded in accordance with the international unified electronic product code, the code is curing the chip at the factory, and it is an 40 bits unique identification which is not duplicate and can not be copied and changed. The data can be encrypted, the sector can independently once locked. The technology is difficult to counterfeit, invasive and high safe.

(4) The superior physical properties: RFID can be stored the permanent and non-permanent data, the information in the chip memory can be updated dynamically, and can be used repeatedly, and long service life.

(5) conveniently read and write: RFID is a non-contact way, and has non-directional requirements. Tag data can be read through packaging, and passively remote read and write, and the distance for reading and writing is up to 1.5m.

(6) Anti-collision: the electronic tags had fast anti-collision mechanism, and can prevent data interference between cards. So the reader can handle more than one non-contact electronic tags, and realize batch identification.

The Solution Based on RFID for Distributed Information System

To achieve full link control of the aircraft supply chain, it must play the role of RFID and build distributed information systems based on RFID technology for aircraft supply chain management. Electronic tags are affixed to aircraft products and supplies, and the read points for the RF information are set up along the road, and installed RFID readers, and the readers are networking with the supply chain management system database. When aircraft products and supplies are through these information read point, fixed readers of RFID collect data from the electronic tags, and real-time transmit the data to the supply chain management system database to share. All personnels can obtain the correct and real-time information of supply resources, and track,record and position aircraft products and supplies throughout the supply chain, and realize the visualization management for aircraft products and supplies.

Overall framework. The solution uses RFID technology and are established for collecting and track the logistics information in supply chain. By that, it can meet aircraft manufacturers and users' the information management requirements for products and materials,which cover all links including the storage, inventory, sort and transportation. The system has a high degree of integration, and data traceability, query and powerful reporting capabilities, and it can meet the changing requirements. Personnels in the office will know the supply situation as well as the flow of aircraft products and supplies, realize supply chain visualization. The overall framework is shown in Fig. 1.
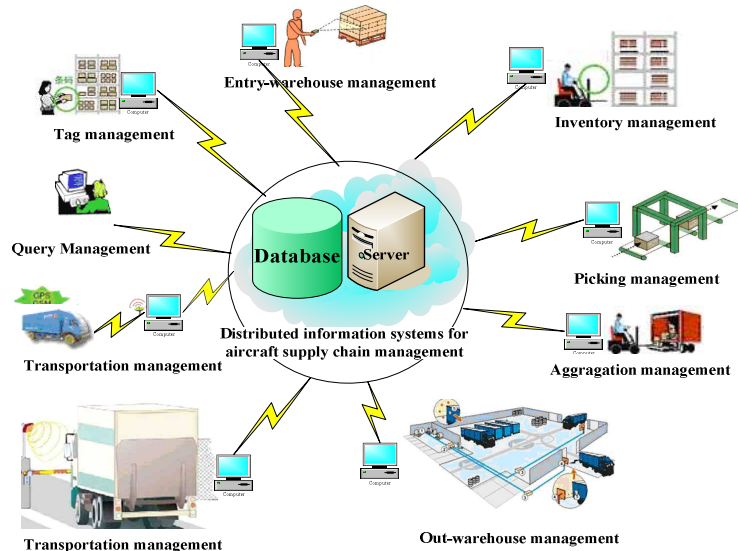

Fig.1 RFID-based supply chain management of distributed information systems

System components. A complete distributed information system based on RFID for aircraft supply chain management is composed of three parts, which are data acquisition system, software management systems and communication networks.

   Data acquisition system. The system is composed of a reader, an antenna, and RFID electronic tags mounted on readers. The system can use fixed installation readers and handheld readers. The reader can sense electronic label via antenna and read the data in electronic tags. The distance that the fixed installation reader can read data in electronic tags can reach ten meters.

   Software management system. The system is mainly responsible for storing the data collected by the data acquisition system into the database, and updated in real time. After achieving the data,the readers can directly access the computer's ports, instantly and automatically entered the data into the system database. The system is a network-version, the administrators or users can query and manage supplies in real-time, and real-time monitor the location of supplies.

   The communication network. The network is the bridge between the data acquisition system and the software management system. Via the network, the data collected by the acquisition system can be stored into the database of the software management system. The users can access to database through the network. The network can realize the visualization for end-to-end and real-time movement management for the supplies.

Functional Description. The key functions of the software management system include:

   Tag management. The supplied products and materials are established unified identification codes in accordance to the same rules, and the tags are printed and embedded chips. The chip contains the information such as name, type, size, origin, batch and production date. By tag management, the complete archives of aircraft products and supplies are established, and this not only facilitates the tracking management for production materials, finished products, the parts and attachments, but also helps to achieve a reasonable inventory preparation. Product identification tag records the state of the product in order to achieve the tracking and management of products and materials.

Entry-warehouse management. When aircraft products and supplies reach their destination, the staffs can hold a handheld reader to quickly check the reached aircraft products and materials. Via electronic tag identification, their information is collected and processed and passed into the database to distribute a location and to update the location information. RFID technology makes no wrongly record and erroneously charge like the traditional record ways. Meanwhile, because of remote sensing and accurately processing multiple electronic tags at the same time, the efficiency and accuracy of the entry-warehouse management are greatly improved.

Inventory management. By inventory management, the current inventory information is collected to facilitate the procurement, picking, goods collection management. Compared with the previous stock inventory, it will facilitate to know the current supply and demand situation, and do good resources planning well. Staff can collect and query the information on the products and materials within the warehouse through handheld reader, and the efficiency and accuracy of the inventory management will be improved. Inventory management is another challenge that many manufacturing companies are striving to optimize[11]. To trim these inventories for both manufacturing companies and airlines will be a significant benefit, while ensuring that parts are always where they need to keep the aircraft flying.To implement RFID in inventory management, tags should generally be attached on each item,and readers are placed at entrance and exit, or on the ceiling and walls distributed in an array in order to cover the range of the goods to be traced.

Picking management. In the transportation or packaging process,aircraft products and supplies, especially parts, are mixed in package under normal circumstances. How to pick out different aircraft products and supplies is a very important and tedious work. Therefore, RFID is used to identify the type and information of aircraft products and supplies, and helps to do ancillary products and materials picking work.

Aggregation management. In the warehouse storage, aircraft products and materials are stored in the subregional. Before they are out-warehouse, firstly the staff could pick the products and materials according to users' requirements list. The products and materials on the same list may be in a region of memory , may also be in a different zone stowage. Therefore, when the staff collects supplies according to the user list, aircraft products and supplies will respectively to be picked from the warehouse location, and then aggregate. With RFID technology, the information of chosen aircraft products and supplies is collected into the software management system. By comparison with the list, they will be checked whether they meet user's requirements.

Out-warehouse management. According to the results of aggregation management, the information of supplies which have been completed aggregated is collected to establish an out-warehouse data, the system is updated the out-warehouse time, location, delivery time, destination and other information. Before leaving the warehouse, trucks will be read and identified by reader automatically, the information obtained is automatically importing software management system. The system instantly compared with the list of user's requirements. If it finds the wrong and leakage, the system will automatically alarm to stop the truck out of the warehouse.

Transportation management. Transportation management manages the information of in-transit vehicles, products and supplies. RFID technology can achieve real-time tracking of in-transit vehicles, products and supplies. The tags on the truck use the internal written unique identifier or the information written directly to identify the transportation vehicles and supplies loaded. When leaving the warehouse, the vehicle will be automatically sensed and identified by the RFID reader installed in the exit. The leave time and other information are recorded and entered into the system. When the vehicle goes through the reader installed transport routes outlets, the location and time information are automatically recorded. When the vehicle arrives at the destination warehouse, the reader at the entrance will automatically identify, record the relative information and pass it into the system. The system database will be updated from time to time. So the in-transit vehicles, containers, products and materials are monitored real-time, the users can query the location of products and materials through the internet. At the same time, GPS transmitter and receiver device can be installed in distribution centers, warehouses and transportation carrier, location information of the in-transit products and materials is enter into the software management system to query.

Query Management. Query management modules will provide these functions such as in-warehouse query, in-transit query, user-tailor query, real-time tracking. The query result will be shown to the user in real time. In-warehouse query is to inquire about the inventory situation. In-transit query is to query the status of the in-transit aircraft products and goods. The user-tailor query is to select query content in accordance with the user's requirements. Real-time tracking is to query related location information of aircraft products and supplies.

Summary

This distributed information system for supply chain management based on RFID proposed by this paper not only can solve the problem of geographical dispersion, and supply chain too long, but also has the characteristics such as reliable communication, low cost, high efficiency, easy operation. It can shorten the operating time, improve the quality of inventory operations, increase the throughput of the distribution center, reduce operating costs, achieve visual management, make the information transfer more quickly and accurately. The system can achieve real-time monitoring of aircraft supply chain products and supplies from all aspects of the finished products, transportation, warehousing, distribution, use, and increase the automation degree, reduce error rate, improve supply chain visibility. However, the system still exist the problems such as data security, uniform standards, the reliability and reading accuracy, environment adaptability of tags.

References

[1] Graham Warwick:Auto-ID Gathering Momentum, submitted to Journal of International Aviation, Vol.9(2009),p.80-81

[2] Yoon S. Chang, Chang H. Oh, Yoon S. Whang, Jae J. Lee, JangA. Kwon, Min S, Kang, Jun.S.Park,Ung, Y Park:Development of RFID Enabled Aircraft Maintenance System,submitted to Proceedings of 2006 IEEE International Conference on Industrial Informatics(2006)

[3] Wei He, Chi Xu, Yintai Ao, Xuejian Xiao, Eng Wah Lee,Eng Leong Tan: RFID Enabled Handheld Solution for Aerospace MRO Operations Track and Trace, submitted to proceedings of IEEE ETFA(2011)

[4] K. Harun, K. Cheng and M. Wibbelmann. RFID-Enabled Aerospace Manufacturing: Theoretical Models, Simulation and Implementation Issues, submitted to proceedings of the 2008 IEEE IEEM(2008)

[5] Sujing, H. Hongmei, W. Lu, and Z. Zhou: The design and implementation of the warehouse system based on RFID and mobile devices, submitted to proceedings of the 2nd International Conference on Computer and Automation Engineering (2010)

[6] A. Melski, L. Thoroe, and M. Schumann:Managing RFID data in supply chains[J]. Int. J. Internet Protocol Technology, vol. 2(2007), p. 176-189

[7] C. S. Vishik and G. N. Kartha, U.S. Patent 7551082B2. (2009)

[8] A. Kumar, and B. Sriram, U.S. Patent 7557707B2. (2009)

[9] KANG Dong, SHI Xiqin, LI Yongpeng, in: The Core Technology and Typical Application and Development Case of Radio Frequency Identification(RFID),edited by Posts & Telecom Press,Beijing(2008),in press.

[10] GENG Guiping: Analysis of Two-dimensional Bar Code Standardization Work,submitted to Journal of Aeronautic Standardization & Quality，Vol.236(2010)，p.30-32

[11] B. Violino: RFID takes wings,submitted to Journal of RFID Journal, Vol.10(2004),p.13-17

Vehicle, Mechatronics and Information Technologies II

10.4028/www.scientific.net/AMM.543-547

RFID-Based Distributed Information System of Aircraft Supply Chain Management

10.4028/www.scientific.net/AMM.543-547.4548