Intelligent Storage System Architecture Research Based on the Internet of Things

Li Liu(✉) and Kaifeng Geng

Nanyang Institute of Technology, Nanyang 473000, Henan, China
liuli861202@126.com

Abstract. With the development of e-commerce, Internet of things (IOT) and computer network technology, logistics has an increasingly important status is daily life. However, at the same time of providing people with convenience, e-commerce puts forward higher challenge to the storage link [1]. Proceeding from the problems such as the lagging logistics work caused by uneven flow of information, this paper investigated the impact of IOT on the warehousing industry, proposed the IOT based intelligent warehouse system model, which can promote the business flow by warehouse information flow and achieve the purpose of improving the upper layer business operation.

Keywords: Internet of Things · RFID · Intelligent storage · Sensing technology

1 Introduction

In recent years, the explosive development of e-commerce has promoted the rapid rise of the logistics industry. However, the surge of online shopping orders also exposed the weaknesses of the industry. As a result, the original storage and preservation function has been far from satisfying the needs of the industry. The prominent blasting warehouse, delayed orders, goods out of stock, damaged goods and other phenomenon, does not only bring a lot of inconvenience to customers, but also cause huge negative impact on suppliers and e-commerce platform service providers. Thus, the importance of storage in logistics is increasingly prominent. As the link connecting manufacturers, platform service providers and consumers, it can help overcome the spatial and temporal differences between the two parties, support the enterprise logistics decision, while it can also achieve the purpose of improving customer service level and reducing logistics cost.

The warehousing link has a lot of work including loading and unloading, handling, stacking, statistics and information transfer, which is mostly done by manual operation at present. China's warehousing industry features large holdings, relatively low management level, and imbalanced warehousing internal technical development. In spite of the substantial improvement of the storage infrastructure and the emergence of many stereoscopic warehouses, the warehousing technology application level has made some progress, but still cannot meet the need.

Relying on the promotion of national policy and considering the restriction and impact brought by the low warehousing efficiency, the development of IOT technology based intelligent warehouse system will better solve the current warehouse inventory,

J. Wan et al. (Eds.): Industrial IoT 2016, LNICST 173, pp. 247–256, 2016.
DOI: 10.1007/978-3-319-44350-8_25

meet the needs of warehousing business in e-commerce environment to significantly improve the service level of the stock sectors [2].

2 The Impact of IOT Technology on Warehouse Management

2.1 Optimize Warehouse Operation Process and Improve the Level of Warehousing Services

The study of IOT technology based intelligent storage system is conductive to improve the low efficiency in storage, inventory, environmental monitoring and other links, improve the information transmission efficiency and realize the real-time share in the inventory, environment, output and input of warehouse [3]. IOT technology has optimized the traditional storage process, achieve real-time, accuracy and high efficiency from information acquisition, processing to the application of the upper business information, give full play to the role of warehousing link deployment and improve the level of storage service.

2.2 Improve the Level of Warehousing Intellectualization and Informationization

The transformation from manual operation, mechanization operation to intellectualization reflects the accelerating rotation speed of the storage corporate entity flow. In the e-commerce environment, the promotion of website operation, goods launching and shopping settlement become extraordinarily directly and efficiency; the integration and distribution of cross-enterprise and cross-regional goods is more prosperous, which continues to drive the development of virtual economy and real economy and promotes the seamless delivery of business flow and logistics [4]. Urged by the powerful impetus of economic interests, warehouse management will develop towards the direction of being more intelligent to achieve the purpose of on-demand integration and distribution, handle the processing and information management tens of thousands of orders every day, so as to complete the docking of business flow and logistics. Under the environment of IOT technology, to provide every customer with the best quality service, warehousing enterprises continues to improve the information-based degree to implement the intelligent level of warehouse management.

2.3 Realize the Information Synchronization and Sharing Between Enterprises in the Supply Chain

To warehousing sector, the geographic separation has become an important part of supply chain business management. The centralized management mode exists in name only under the environment of the current land policy [5]. Each enterprise should consider its own operating costs, especially in the electronic commerce environment. In the operation process of small profit mode, scattered remote management will better continue the integration thinking of supply chain management to achieve the

supervision, management and control of remote warehouse sector. The strengthening of the information sharing between the warehousing link and upstream and downstream link in the supply chain is conductive to the mutual support and convergence between the businesses in the whole supply chain, also effectively solves the problem of information asymmetry in the supply chain management integration, successfully alleviates the difficult problems in land requisition, improve the overall efficiency of supply chain management and the informatization level of warehouse sector management.

3 Study of Key IOT Technology

The application of key IOT technology provides a good technical foundation for building an intelligent warehouse. The integrated application of IOT technology in the warehouse industry ensures the transfer efficiency and accuracy of key data information flow in the intelligent warehousing, making a great contribution on solving the problem studied by this paper.

3.1 RFID Technology

RFID is the abbreviation of radio frequency identification, which is a non-contact automatic identification technology. It can automatically identify the target via radiofrequency signal and obtain the related data in the object. By transmitting into the computer system, these data can complete the track, identification, storage, sensing and other processes [6]. The working principle of RFID system is shown in Fig. 1. When the label enters the magnetic field induction area and emits the carried information to the reader, the reader will obtain the information through sending a certain radio frequency via antenna and transmit the information to host computer for processing.

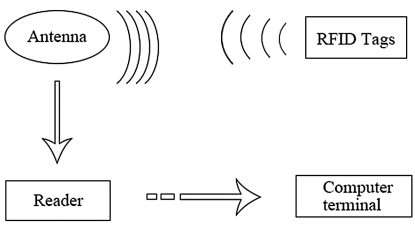

Fig. 1. RFID working principle diagram

The efficiency comparison of three input mode such as RFID, bar code technology and artificial entry is shown in Table 1 [7].

As the above characteristics of RFID, It can provide the most direct individual recognition to realize the link of everything in the world, which is seen as the most important one of the key technologies of Internet of things. The same technology can be used in modern logistics system, which can not only improve the ability of warehouse loading and unloading, inventory, product tracking in logistics enterprise, but also can

Table 1. Entry rate comparison

Entry requirements	1 piece	10 pieces	100 pieces	1000 pieces
Artificial entry	10 s	100 s	1000 s	2 h 47 min
Bar code technology	2 s	20 s	200 s	33 min
RFID	0.1 s	1 s	10 s	1 min 40 s

provide better service for the customer, and lay the foundation for realizing automatic and intelligent logistics system [8].

3.2 ZigBee Technology

ZigBee technology is a two-way wireless communication technology featuring close range, low power consumption, low rate and low cost, which is mainly used in the data transmission between various electronic devices characterized by close range, low power consumption, low transmission rate and typical periodic data, intermittent data and low response time data transmission [9]. Except the above characteristics, ZigBee technology can implement object positioning indirectly, which make it rapidly applied to storage environment management field of logistics management link.

The data frame is fully reflected in ZigBee, each wireless data frame includes a large number of wireless packages, including the information of a lot of time, address, order and synchronization. The real data information only accounts for a small part, becoming the key for ZigBee to realize network organization, high reliability and lower power transmission.

3.3 Sensor and Detection Technology

In the national standard GB/T 7665-2005, the sensor is defined as follows: devices can feel being measures and convert into the available output signal according to certain rules, usually consisting of sensitive components and conversion components [10]. Sensor is a kind of testing device, which can feel the measured information and convert the information into electrical signal or other information outputs by certain rules to meet the requirements of information transmission, processing, display and control, and is the first step to achieve automatic monitoring and automatic control. With the development of technology, the sensor is gradually realizing miniaturization, intelligentization and networking.

4 IOT Technology Based Intelligent Storage System Model Architecture

Storage system is a very complicated system, requiring unified management of the hardware, software and goods in the warehouse to achieve the intelligentization of warehouse management. In order to realize the synchronization of data information flow and the real flow in warehouse management process in time and space, intelligent storage

system architecture needs to pay attention to the various aspects of the operation information such as upload, processing, parsing and encapsulation and so on, so as to maintain the integrity of information and speed up upload and processing capacity of data, so that the data can quickly build associated with the upper business information, and provide effective data to support the upper business, which will speed up the efficiency of upper business. Intelligent warehouse system prototype is extracted according to the research of typical business function and carry out the study of information flow in the late intelligent warehousing based on the prototype architecture, so as to improve the level of information technology and accelerate the warehouse operation efficiency [11]. The intelligent storage system model is as shown in Fig. 2.

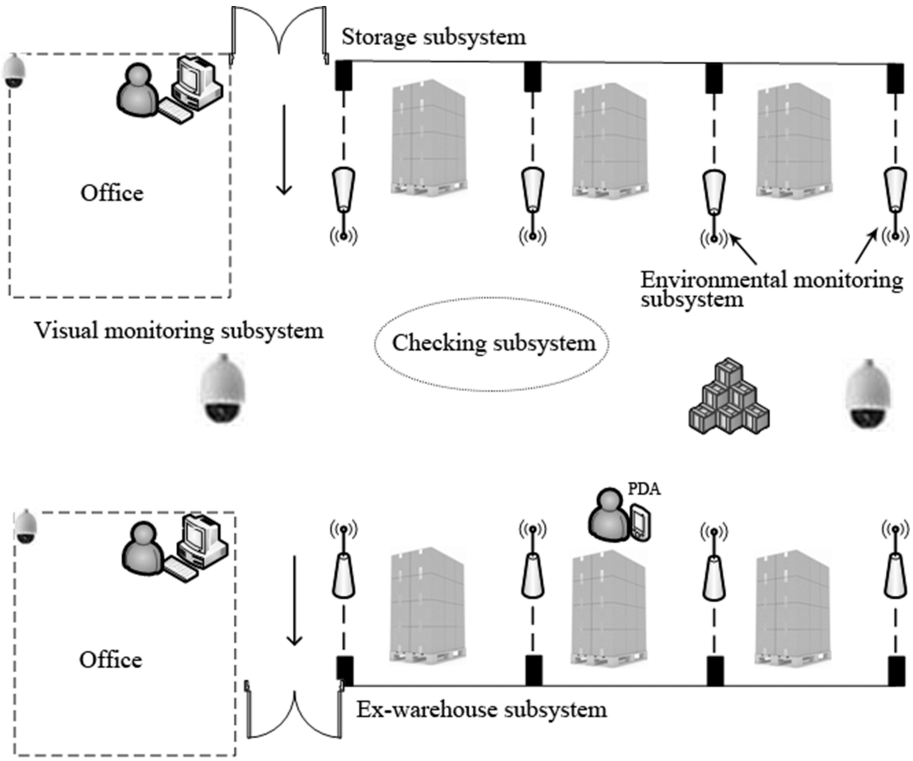

Fig. 2. The intelligent storage system model based on IOT technology

It can be seen from the picture above, the intelligent storage prototype system mainly includes the in-out stock subsystem, Checking system, environment monitoring subsystem and visual monitoring subsystem; orderly connection between systems is indispensable from the fast processing and transfer of information flow to support and meet the demand of warehouse system.

4.1 Storage Subsystem

Storage subsystem is mainly realized by RFID and serial communication technology. Hardware facilities mainly include RFID tag, RFID antenna, upper computer, portal access to ensure the goods data access and rapid transfer of information. In the goods circulation process, other information achieved real-time transmission via RFID tag, reader and main control system, so as to complete the transparent management of goods in the warehouse.

In the process of goods warehousing, goods and circulation unit is granted a sole ID respectively to complete the binding of goods and circulation unit with RFID tag [12]. It is used as the information carrier of goods and the circulation unit in the entire circulation to ensure the goods information track throughout the warehouse management. When the warehouse administrator uses PDA devices to complete the goods shelves scanning, PDA will transmit the scanning information to the upper machine for saving. Business function flow chart is shown in Fig. 3:

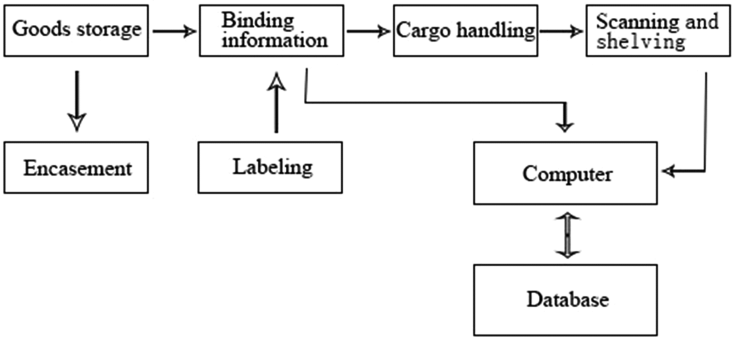

Fig. 3. Storage subsystem business flow diagram

4.2 Checking Subsystem

Checking subsystem refers to that when goods arrive at the designated position, bind the goods with the corresponding position information. In the process of goods storage management, each move and position change requires to bind the goods and position and rapidly get the goods RFID tag information via smart shelves, PDA scanner, etc. In this way, the accurate control of goods position can be achieved. At the same time, by the scanning of RFID, you can achieve real-time grasp of goods quantity information and dynamic changes by the scanning of RFID antenna and avoid the economic loss caused by inadequate inventory or excessive inventory. It cannot only achieve the accurate positioning and rapid goods inventory [13].

The entire flow of information transfer achieved the purpose of real-time, efficient, accurate, smooth and automatic data update, meet the needs of high-level vertical shelves, realized the consistency of physical flow and information flow, solved the synchronization problem of goods flow and information flow on shelves in time, improved the operational efficiency of the whole process.

4.3 Environmental Monitoring Subsystem

In warehouse storage, the goods environmental information collection is extremely important. The change of goods external environment will affect the changes of the good itself, sometimes will even lead to the reduction or scrapping of goods service life. Environmental monitoring subsystem is to use WSN/ZigBee technology to deploy each terminal node in every shelf of the warehouse, and collect the current shelf environment information (including temperature, humidity, smoke, etc.), and get the terminal node information to upload to the upper machine. Then the upper machine will judge whether the monitored shelves are in a secure environment according to the upper and lower threshold value. In the case of above or below the threshold, the system will automatically trigger a warning system to remind warehouse management personnel for inspection, realizing the intelligent management of warehouse goods external environment. The environment node deployment diagram is as shown in Fig. 4:

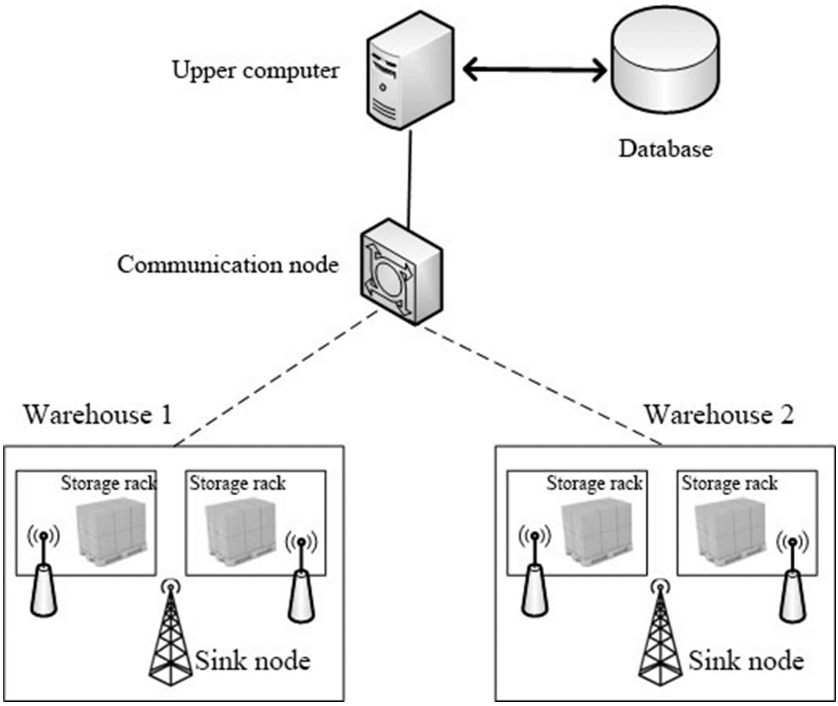

Fig. 4. Environment node deployment diagram

4.4 Visual Monitoring Subsystem

Visual monitoring subsystem aims to achieve simplified, intellectualized and visualized warehouse internal management. Its hardware facilities mainly include a webcam, LED display, speech broadcast audio equipment, etc. By deploying the web camera in the warehouse, the entire warehouse operation can be accurately monitored to achieve sound

supervision and regulation of internal warehouse personnel operation flow (such as unsafe operation habit, goods lost verification, etc.) [14]. LED display can make real-time display of environmental monitoring information for internal staff viewing. At the same time, it can be used as the board of internal warehouse operation flow to display the next operation task, improve the execution efficiency of operators, making it become the carrier of warehouse internal information to efficiently accelerate the transfer speed. Voice broadcast can remind the warehouse management personnel of the internal warehouse monitoring information in the form of voice to complete the automatic push function of environmental information. This information can be transmitted to the local monitoring end via cable network and can also be transmitted to the remote monitoring terminal via wireless network to facilitate the remote monitoring of management sector. Remote monitoring subsystem equipment deployment diagram is as shown in Fig. 5:

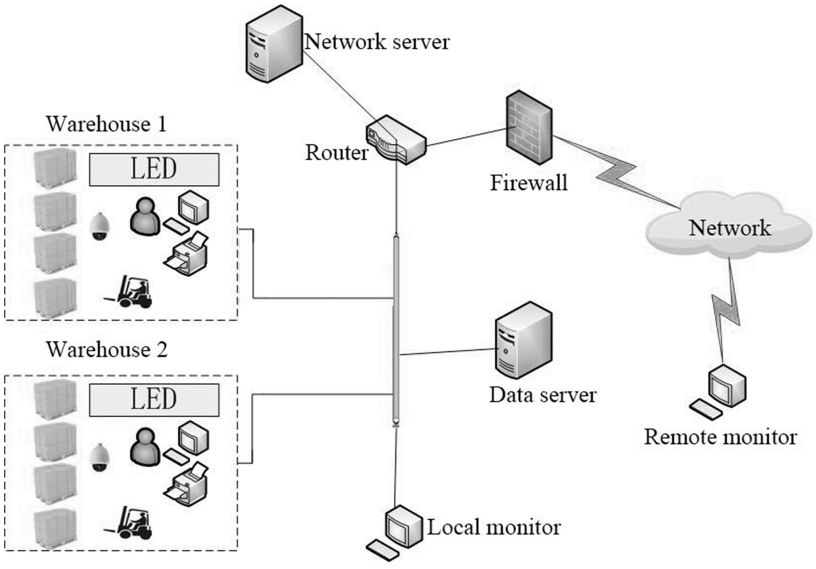

Fig. 5. Remote monitoring subsystem equipment deployment diagram

4.5 Ex-warehouse Subsystem

Ex-warehouse subsystem greatly improves the efficiency and accuracy of goods ex-warehouse, which cannot only achieve the real-time sharing of ex-warehouse to facilitate real-time storage materials, alleviate the problem of excessive or insufficient inventory caused by lagging ex-warehouse information; at the same time, it also provides information security to the warehousing backend transportation monitoring in the supply chain integration.

Ex-warehouse subsystem hardware equipment includes entrance guard (RFID read-write antenna, upper computer and serial line), the portal channel makes the inventory of ex-warehouse goods via RFID reader-write device. During ex-warehouse, the forklift or other transport tools will transport the goods through the ex-warehouse channel.

Because of the different pallet code and goods code, you can access to the tag information by RFID antenna and upload to the workbench terminal by serial communication. And then make comparison between the acquired information with the ex-warehouse information in the upper machine. If no error is found, the goods will smoothly pass the portal guard and complete the ex-warehouse business.

There is a strong dependency between subsystems. The smooth link in business largely depends on the completion status of the upstream subsystem, of which the main cohesion is the transfer of information flow [15]. To a certain extent, the efficiency of information flow transfer determines the efficiency of related business of each functional modules; the subsystems complete the purpose of passive launching to active warehousing business of information flow, achieve the purpose of business information as the driving force to the physical movement of goods in the warehouse from the subsystem storage input to storage output.

5 Conclusion

The application of IOT technology is gradually popularized in various industries and the research on the warehousing link informationization in the logistics industry is the focus of future research. This paper focuses on the discussion of the related issues of lagging information flow in the warehouse, which is combined with the application of many hardware facilities and IOT related technologies such as RFID, ZigBee technology. It puts forward the IOT technology based intelligent warehouse system model, makes in-depth analysis of each module and function in the model, aiming to improve the informationization level of warehousing system and storage efficiency.

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