The State of Art and Future Development of Internet of Things Warehousing Technology

Yizhong Sun[*, a, †], Yao Tong[b, †]

[a] Beijing Institute of Technology, 5 Zhongguancun South Ave., Haidian, Beijing, China 100081

[b] Henan Polytechnic University, 2001 Shiji Road, Jiaozuo, Henan, China 454003

* Corresponding Author Email: 1120201111@bit.edu.cn

[†]These authors contributed equally.

Abstract. The Internet of Things (IoT) has received a lot of attention from the government, academia, and enterprise enterprises for its amazing software prospects, and the IoT warehousing technology has received vast attention. In this paper, primarily based on the study of the concept, workflow, and system components of the IoT storage system, we propose how to optimize the present IoT storage system scheme. The evaluation focuses on two aspects: the records transmission science of the system, and the enchantment area of the system algorithm. This paper gives the improvement technique of logistics information transfer in the common warehouse management process and additionally proposes the use of edge computing most desirable for optimization. This system has the advantages of being fast, convenient, accurate, efficient, and rather automatic in access, monitoring, inventory, and picking.

Keywords: IoT warehousing technology, logistics information transfer, Edge computing.

1. Introduction

A large community known as the "Internet of Things" is created by fusing a number of data sensing devices with the Internet, including radio frequency identification (RFID) devices, infrared sensors, global positioning systems, laser scanners, and other devices [1-3]. Its goal is to link all items to the network so that the device can recognise, track, and monitor objects automatically in real time and trigger appropriate actions. In order to detect smart identification and administration, the Internet of Things connects all objects with the Internet using records sensing devices like radio frequency identification (RFID). The term "Internet of Things" describes cutting-edge technology advancements that link various types of sensors with the current Internet. After computers, the Internet, and cellular communication networks, it is the third wave of the global facts industry.

The ITU Internet Report 2005: Internet of Things was published in 2005 by the International Telecommunication Union (ITU) [1]. The research made note of the impending ubiquity of the "Internet of things" verbal exchange generation, which would allow for the active exchange of all items online, including paper towels, toothbrushes, and tyres. Nanotechnology, sensor technology, radio frequency identification (RFID), and intelligent embedding technology will be employed more widely.

The development of warehousing has experienced three development stages: manual and mechanized warehousing, automated warehousing, and intelligent warehousing. Information technology has become an important pillar of storage technology. The combination of automatic storage and information collection and decision system and the application of radio frequency technology make storage develop towards the intelligent direction. The Internet of Things (IoT) has pointed out the direction for the development of intelligent warehousing systems. It links goods with the Internet so that all items can be remotely sensed and controlled. Therefore, it is of great significance to study the intelligent storage system of the Internet of Things [4].

In the application of the Internet of Things, information processing technology can organize and analyze the whole process of information data of warehousing and logistics, data processing, and data mining, to provide a reliable basis for intelligent decision-making and realize the intelligent management of warehousing and logistics. At present, most of the algorithms and models are univariate time series, so they can only use the point variable time series information of a certain kind of information personnel, and cannot realize the effective application of the existing multivariate information. However, in the actual application process, affected by the attributes of the object itself and various external factors, the presentation state of the object often has spatial complexity and time difference.

2. IoT WAREHOUSING SYSTEM

2.1. System process

Storage, inventory, determination, and distribution make up the workflow of the warehouse management system. The desktop makes use of the most advanced radio frequency identification (RFID) technology available, provides an individual identifier code (EPC code) for each item, and stores the necessary attribute records of the items in the server, allowing the device to automatically locate, tune, and reveal the items. The warehouse also installed additional many kinds of sensors to create a wireless sensor network that covers all blind spots, allowing the staff to understand the condition of the warehouse store and timely processing at any time from the monitoring center. On the basis of high efficiency, accuracy, and speed, storage administration security is expedited in this way as well.

2.2. System composition

Intelligent storage IoT is mainly composed of six modules: warehouse goods identification, information collection and processing, warehouse goods monitoring, background information server, local database server, and business system [5].

In the storage goods identification module, the system uses the EPC code as the unique identifier code of the item and attaches an RFID tag with EPC to each item. The tag IS composed of a silicon chip and antenna stored in the EPC and attached to the marked item. The EPC code contains a string of numbers representing the item ID, category, name, supplier, production date, place of origin, warehousing time, shelf number, and other information, which IS stored in the database of the EPC-IS server. At the same time, these data can be updated in real-time as the items are transferred or changed inside and outside the warehouse.

In the information acquisition and processing module, the detailed information of items is obtained through the RFID data acquisition interface for processing. When the item passes through the warehouse entrance, the item label reader set at the warehouse entrance reads the item EPC code, and then accesses the background EPC-IS server according to the item EPC code to obtain the item details, and saves the relevant information to the local database, and finally passes the information processing module for processing. Multiple readers can be installed at the warehouse entrance for classification and processing, and a manual coding area should be provided for unreadable labels.

In the warehouse goods monitoring module, a series of sensors, including video sensors, temperature sensors, humidity sensors, and smoke sensors, are arranged inside and outside the warehouse shop to cover all the blind areas. A wireless sensor network is self-organized to connect with the Internet and business system through the network. So that the staff can know all kinds of situations inside and outside the warehouse shop at any time in the monitoring center, to deal with them in time.

The background information server is used to store the detailed information of items, such as item ID, category, name, warehousing time, etc., and can respond to the request of a remote application in real-time, allowing the item information to be queried through the EPC code of the item.

The local database server is used to store the item information obtained by the information collection and processing module, to query and maintain in the business system. Warehouse staff can query the current status of items anytime and anywhere through wireless devices or Web clients.

The function of the business system is mainly in the warehouse management in addition to the warehouse management, in warehouse management includes the storage of items in the warehouse, the warehouse item query, inventory, and other operations. RFID technology is used in the process of warehouse item inquiry and inventory operation.

3. INFORMATION TRANSMISSION TECHNOLOGY

Storage logistics Internet of Things information transmission can be carried out through wireless communication and wired communication. In the process of rapid development of modern communication technology, there will be more new communication technologies and networking modes in the future, which will be applied in the scenarios of warehousing logistics Internet of things, and gradually achieve breakthroughs in communication broadband, rate, and networking efficiency, and promote the rapid development of warehousing logistics Internet of things information transmission.

3.1. 5G communication technology

Compared with the 4G network, 5G network performance has achieved a significant improvement, its data traffic has increased rapidly, the data of connected devices has been expanded by more than 100 times, the peak network speed can reach 10GB/s, and the user usage rate can reach 10Mb/s.5G network has a shorter delay, higher reliability, and spectrum utilization, and lower energy consumption. The application of a 5G network in the storage and logistics Internet of Things can achieve real-time acquisition of large capacity data information, guarantee the data transmission of scenario modeling, and provide important technical support for the application of artificial intelligence equipment in storage and logistics management.

3.2. LoRa technology

LoRa technology is a kind of special radio modulation and demodulation technology. In the Internet of Things, the emergence of LPWAN technology provides technical support for remote device access. Through the coverage of the star network, it can correct the error code of data input at the data receiver, avoid node data concurrency or packet loss through channel conflict detection, and effectively enhance the robustness of the network. The main advantages of LoRa technology lie in low energy consumption, low cost, and wide area network transmission. This technology can be applied in warehouse logistics for logistics tracking. By installing the LoRa network management system in warehouses, logistics network coverage areas, transport vehicles, etc., the tracker on the material can be connected to the network. Managers can use it to improve management efficiency and avoid problems such as cargo loss. At the same time, cargo owners can also timely grasp the flow of materials and timely processes.

3.3. Nb-IoT technology

Nb-IoT technology has significant advantages such as low cost, low power consumption, stable connection, and optimized architecture. The NB-IoT network is composed of terminals, base stations, core networks, M2M platforms, operation support systems, etc., and it is mainly applied in the Internet of Things market with wide coverage. Nb-IoT occupies 180KHz broadband and has three modes of independent deployment, guard band deployment, and in-band deployment. In warehousing and logistics, NB-IoT technology is mainly applied in container tracking, storage management, fleet management and tracking, cold chain logistics (status and tracking) management, and other aspects, which is an important means of IoT information transmission in warehousing and logistics in the future.

4. artificial intelligence algorithm in heterogeneous IoT

Nowadays, the number of heterogeneous IoT devices' functions has increased a lot. For example, Smartphones can connect with more than just computers and TVs and realize more functions than they used to. This leads to cloud computing further being approached by users [6]. However, because of the heterogeneity of the IoT, the IoT's incredibly high delay to the cloud, and a large amount of data, the conflict between a scarcity of spectrum resources and high bandwidth needs is made more severe by simultaneous access to IoT devices. The quality of experience (QoE) can't be satisfied by the traditional single cloud access mode. Therefore, with the development of cloud computing, it has extended to edge computing of IoT [7]. But there are still many challenges for current edge computing in security, caching, and so on. For the services in heterogeneous IoT, the characteristics of it are intensive and high concurrency, which are most obvious in dealing with delay-sensitive applications.

With the development of artificial intelligence technology, intelligent algorithms can be deployed on the edge clouds or cloud to implement new smart IoT applications [8]. Here are two algorithms, Smart-Edge-CoCaCo and ACE^2 [9,10], which can improve the indicators of edge computing to meet the QoE.

Smart-Edge-CoCaCo: This algorithm is compared with the traditional cloud computing mode in computation offloading experiments, where the AIWAC emotion recognition system is used [11].

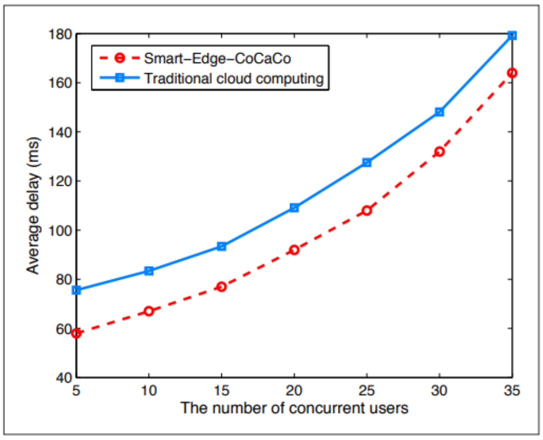

Figure 1. Comparison of concurrent computing between regular cloud computing and Smart-Edge-CoCaCo [9].

In Figure 1, the average latency of both regular cloud mode and Smart-Edge-CoCaCo is increasing with the number of concurrent users increasing. However, the Smart-Edge-CoCaCo algorithm always performs better than the regular mode. because of the computation offloading mechanism and the collaborative filtering. Due to the network congestion, the gap between these two modes is narrowed as the abscissa goes up.

In the simulation experiment, an edge-end collaborative multi-mode low-carbon PIoT network is established to test the ACE^2 against two other frontier algorithms. ACE2 lowers queuing latency by 57.96% and 61.81%, energy consumption by 14.96% and 18.66%, and secrecy capacity by 5.57% and 7.21% when compared to ACPA and WoLF-PHC [10,12,13]. The ACE^2 algorithm has an excellent performance in energy use, queuing latency, and secrecy capacity.

Compared with Smart-Edge-CoCaCo, ACE^2 not only pays attention to the delay but also considers energy consumption and secrecy. Edge computing and edge-cloud collaborative computing are both used in Smart-Edge-CoCaCo. In work, the algorithm will compare the total latency of the two calculation modes, and select the mode with the lowest delay for unloading. In ACE^2, the edge cooperative channel selection is carried out to eliminate the access conflict caused by the same multi-mode channel being contested by many devices, which contributes to decreasing the delay. Reducing latency is an important indicator to meet QoE and improve communication speed. These latency reduction strategies in two algorithms can be integrated. Based on channel selection and task offloading at the edge, the comparison with the cloud is added to select the best solution to decrease the delay.

In ACE^2, the device power is split into artificial noise (AN) transmission and data transmission. If more transmission power is provided for AN-based anti-eavesdropping, the original communication performance will be reduced and the delay will be increased. Due to device limitations, communication and security performance cannot be improved at the same time. In the future, through the algorithm, the limited power resources should be intelligently allocated to the two parts of AN transmission and data transmission, and on this basis, energy consumption can be saved.

Compared with ACE^2, Smart-Edge-CoCaCo confronts more and more concurrent users, and its role gradually decreases. Due to DRL, ACE^2 has strong adaptability and has greater advantages in dealing with multiple situations. In the future, with strengthening the application of deep learning in edge computing, more secure, more energy efficient, and more efficient IoT systems will be put into use.

5. CONCLUSION

With the fast update of IoT technology, its utility penetration in quite a number of industry fields has been strengthened to promote the expert improvement of industrial use management. The fee is continuously increasing. The Internet has a broader prospect in the present-day storage field, but in the authentic application, the corresponding IoT software technology is nonetheless at a quite low-end level, whether it is algorithm or system has room for additional improvement. Therefore, they want to further the corresponding software of the Internet of things for non-stop in-depth look up to make certain that the Internet of things technological know-how in the software of continuous deepening, the actual knowledge of the warehouse to the Internet of things point of view for high-quality construction, so that the warehouse industry innovation and the complete ability of the warehouse to be continuously improved. Future development of warehousing logistics, the addition of the Internet of things is certain to promote industry change, fortify the depth of integration with the Internet of things technology, and actively explore the development of warehousing logistics Internet of things, is a vital vogue in the development of the modern industry.

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