

Applied Research on Internet of Things Technology Enabling Intelligent Logistics

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Abstract: The breakthrough progress of the Internet of Things (IoT) technology provides a new impetus for the digital transformation of intelligent logistics. This paper analyzes the current status of the application of IoT in the field of intelligent logistics, discusses its specific application in the three links of warehousing, transportation and distribution, and puts forward feasible suggestions and prospects: Promote the greening of smart logistics; strengthen IoT infrastructure; prioritize data security and privacy protection; and cultivate high-end IoT talents. In the future, the level of automation and intelligence in logistics will continue to improve, further releasing the value of logistics data. The green development of logistics is the general trend, and intelligent logistics will realize high-quality development in the direction of automation, intelligence and green.

Keywords: Internet of Things (IoT) Technology; Intelligent Logistics; IoT Applications; Green Logistics.

1. Introduction

As a significant part of the digital economy and strategic emerging industries, the Internet of Things (IoT) has a strong leading role in the overall social and economic situation and long-term development.[1] The digitalization of logistics technology empowerment has become the strategic direction of intelligent logistics development. With the economic development and social progress, the traditional logistics is constantly subject to the impact of information technology, smart logistics will become a key force to promote the innovative development of the logistics industry, to push the traditional logistics in the direction of intelligence, automation, informationization transformation, providing sustained impetus for the development of modern logistics and innovation. In this paper, we will discuss how IoT technology empowers smart logistics, analyze the current status of the application of IoT technology in the field of smart logistics, specifically analyze the application of IoT technology in each link from the three dimensions of warehousing, transportation and distribution, and put forward the development proposals and future outlook, with a view to providing theoretical support and practical guidance for the digital transformation of the logistics industry, providing theoretical support and practical guidance for the digital transformation of the logistics industry, and promoting the logistics industry to a more intelligent, efficient and sustainable direction.

2. Overview of Internet of Things and Smart Logistics

2.1. Overview of the Internet of Things

The Internet of Things (IoT) relies on advances in semiconductors and information and communication technologies.[2] It is a kind of information sensing equipment such as radio frequency identification (RFID) devices, infrared sensors, global positioning systems, laser scanners, etc., which, according to the agreed protocols, connects the items with the Internet, exchanges information and communicates in order to realize the network of intelligent

identification, positioning, tracking, monitoring and management, with the characteristics of comprehensive sensing, reliable transmission, intelligent processing, etc., and at the core of which is the interconnectedness between the devices. Internet of Things technology is another global information industry change after the Internet technology. According to related scholars speculate that in the next 10 years, the user coverage of Internet of Things will greatly exceed the Internet, and leap into a new trillion high-tech industry.[2]

2.2. Overview of Intelligent Logistics

Intelligent logistics is the use of integrated intelligent technology, so that the logistics system can mimic human intelligence, with thinking, perception, reasoning judgment and self-solution of certain issues in logistics modern logistics model.[3] The modernized logistics model can realize fine, dynamic and visual management in all aspects of logistics, and improve the ability of intelligent analysis and decision-making of logistics system and automatic operation and execution.[4]

With the economic development and social progress, traditional logistics is constantly being impacted by informationization, and smart logistics will become a key force to promote the innovation and development of the logistics industry, and promote the transformation of traditional logistics in the direction of intelligence, automation and informationization, providing continuous power and innovation for the development of modern logistics.[5]

3. IoT Key Technologies

3.1. RFID Technology

RFID (Radio Frequency Identification) is a technology that automatically identifies target objects and obtains relevant data through radio waves. The principle is non-contact data communication between the reader and the tag, thus achieving the purpose of identifying the target. Its main application in the field of logistics is commodity labeling[5], which enables the efficient operation of goods receiving,

storage monitoring, picking efficiency and full tracking, and is of great significance for improving the overall operational efficiency and service quality of the logistics industry.

3.2. Geographic Information System

Geographic Information System (GIS) is a spatial information system for capturing, storing, analyzing and displaying geospatial data. GIS is mainly used in the field of logistics for traffic planning, vehicle tracking, etc., with the characteristics of data analysis, visualization, decision support, etc. The application of GIS improves the efficiency and accuracy of logistics operations. With the continuous progress of technology, its application will be more in-depth and extensive, providing strong support for the intelligentization, automation and sustainable development of the logistics industry.

3.3. Sensor Technology

Sensor technology refers to the use of a variety of sensors to detect and measure physical, chemical or biological quantities (such as temperature, pressure, humidity, light intensity, etc.) and convert them into readable signals or data, with high precision, real-time, multi-parameter monitoring, intelligent characteristics. By deploying a variety of sensors in goods, transportation vehicles and storage facilities, it is possible to monitor the status of goods in real time, optimize transportation routes, improve the efficiency of warehouse management, enhance the ability to track goods, and support data-based decision-making.

4. Application of Internet of Things Enabling Intelligent Logistics

4.1. Intelligent Warehousing

With the rapid development of the e-commerce industry, express warehouse has become a major problem plaguing warehousing logistics. A large number of fragmented orders make the traditional warehousing management and operation lag behind the times, accelerating the intelligence of warehousing and logistics management, automation upgrades to become the trend of the logistics industry.

The application of Internet of Things (IoT) technology in the warehousing link is becoming more and more widespread, providing strong technical support for the intelligent transformation of the logistics industry. In the warehousing link, wireless sensors can accurately recognize the RFID of materials to obtain data information. In the inventory link, the focus is on regular inventory and management of inventory. In the inventory check, with the use of radio frequency identification technology, the staff can manage the storage items through intelligent equipment, and accurately control the dynamic changes of the inventory materials,[6] effectively reducing the cost of human resources and improves operational efficiency; in warehouse management, the use of RFID devices to read the electronic tags of the goods and cargo space, real-time positioning of the goods, and then through the Internet and the warehouse management system to carry out information interaction, uploading the electronic tags of the goods and cargo space information to the warehouse system, thus improving the accuracy of the reading of the information of the goods and cargo space.[7] . Wu Jianfeng et al. in their research constructed the core architecture of material perception based on RFID-AP technology, realizing the real-time perception and

management of materials.[8]. The application of IoT technology in smart warehousing improves the efficiency and accuracy of warehousing operations and brings innovative solutions to the logistics and warehousing industry.

4.2. Intelligent Transportation

In the modern logistics and transportation system, Internet of Things (IoT) technology plays an important role, and this paper focuses on the practical application of sensor technology and GIS technology empowering logistics and transportation.

In environmental monitoring, temperature and humidity sensors can be utilized to assess the environmental conditions of goods undergoing transportation in real time. This enables the verification of their storage environment, which is of particular importance for temperature-sensitive goods, such as food and flowers. In terms of cargo condition monitoring, by installing sensors for vibration, tilt, etc., we can monitor the condition of the cargo during transportation and prevent cargo damage.

In terms of vehicle positioning, GIS technology, through the integration of GPS data, enables precise positioning of transportation vehicles and tracking of their movement trajectories, which is crucial for ensuring on-time delivery of goods, optimizing distribution routes and improving customer satisfaction. In transportation resource planning, GIS technology assists decision-making by analyzing geographic data, helping planners assess the geographic characteristics of different routes, including road networks, traffic conditions, terrain and topography, etc., and then optimize vehicle allocation and transportation routes, assisting in the design of the transportation network, and improving the overall transportation efficiency. In terms of trip monitoring, through GIS, managers are able to monitor the driving status and trip progress of vehicles in real time, detect and deal with deviations from scheduled routes or situations that may lead to delays in a timely manner, and enhance the control of potential risks in the transportation process. In the face of traffic congestion, bad weather or other unforeseen events, GIS can maintain tracking and accurate positioning of logistics delivery vehicles, through spatial analysis, based on linear programming models, to find the optimal driving route and solutions[9] that reduces disruptions to operations.

4.3. Intelligent Distribution

As the final link in the logistics supply chain that directly interfaces with customers, the efficiency and service quality of the distribution link will directly affect customer satisfaction and the market competitiveness of the enterprise. This paper discusses the application of Internet of Things (IoT) technology in the distribution link from three aspects, namely, real-time distribution monitoring, intelligent express cabinet management and customer interaction and service, to reduce costs, increase efficiency and optimize customer experience.[10]

Internet of Things (IoT) technology, through the integration of GPS tracking devices and sensor networks, realizes real-time monitoring of distribution vehicles and goods, and is able to provide the precise location, speed and instant information of the vehicles and goods, which makes the distribution management more transparent and responsive, and the distribution enterprises are able to optimize the distribution routes and adjust the plans in time to cope with emergencies.

As an effective solution for "last-mile" delivery, intelligent express lockers realize safe and efficient access to parcels by integrating Internet of Things (IoT) technologies such as RFID, QR code and NFC. The application of IoT technology enables the express locker to be remotely monitored and managed, providing 24-hour self-service and enhancing the flexibility of distribution and user convenience.

Through mobile applications and smart devices, customers can track the delivery status in real time, receive notification of expected arrival time, and perform self-service, such as booking delivery and pickup. IoT technology not only enhances the efficiency of logistics and distribution, but also reshapes the customer-enterprise interaction mode, improves the service experience and enhances customer loyalty.

5. Suggestions and Prospects for the Development of Intelligent Logistics

5.1. Greening of Intelligent Logistics

The integration of Internet of Things (IoT) technology into the development of green logistics can realize the intelligence, automation and greening of the logistics process, reduce logistics costs, reduce environmental pollution and promote the sustainable development of the logistics industry.

New energy means of transportation should be vigorously promoted, and logistics enterprises should be encouraged to use clean energy means of transportation such as electric vehicles and hydrogen fuel cell vehicles to reduce carbon emissions. The use of sensors to monitor the power, range, operating status and other information of new energy means of transport in real time, and data analysis and processing through the Internet of Things platform; based on vehicle status data and GIS technology, realize intelligent scheduling of vehicles, optimize route planning, reduce the rate of empty loads and meandering transportation, and reduce energy consumption; with the help of the Internet of Things technology, carry out remote monitoring and management of the operation of new energy means of transport. Timely detection and treatment of faults, improve vehicle operating efficiency and service life.

Realize the logistics and packaging cycle. Use RFID tags to uniquely identify recycled packages and carry out tracking management to realize the recovery and reuse of packages; establish an intelligent recycling system based on Internet of Things (IoT) technology to realize automatic identification, classification and recycling of packages, and improve the recycling efficiency; and analyze the data of package usage so as to optimize the design of the packages, reduce the use of materials, and reduce the generation of packaging waste.

Realize the energy-saving and emission reduction of intelligent warehouse. The use of environmental sensors real-time monitoring of the warehouse temperature, humidity, light and other information, and according to the monitoring results of the automatic adjustment of the warehouse environment, to achieve energy saving and emission reduction. Based on the Internet of Things technology to realize intelligent control of warehouse lighting, according to the warehouse personnel activities and light intensity automatically adjust the lighting intensity.

5.2. Strengthening IoT Infrastructure

Accelerate the construction of IoT network infrastructure, expand network coverage, improve network transmission speed and stability, and provide more reliable network

support for smart logistics. Build smarter warehousing facilities, equipped with automated equipment and robots, and improve the efficiency of warehousing operations and space utilization. Developing intelligent distribution systems, promoting the use of intelligent distribution vehicles, drones and other distribution tools, and improving distribution efficiency.

5.3. Focus on Data Security and Privacy Protection

There are information security risks in the use of Internet of Things technology, and information on users, goods and other information is vulnerable to leakage and illegal theft. It is necessary to establish a sound data security management system, clarify data security responsibilities, strengthen data security protection and prevent data leakage and misuse. At the same time, data encryption and privacy protection technologies should be strengthened to safeguard privacy and prevent the illegal acquisition and utilization of user information.

5.4. Cultivating Top-level IoT Talents

At present, there is still a lack of high-end talents in the field of intelligent logistics, and the shortage of talents has gradually become a major problem hindering the sustained and rapid development of Internet of Things industry. Therefore, to improve the Internet of Things talent training system, to create a high-level Internet of Things talent team with relevant professional knowledge and skills and good at learning, innovation for Internet of Things technology innovation and industrial development are fundamental and decisive significance. At the same time, we should actively promote school-enterprise cooperation, carry out IoT technology training and talent exchanges to improve professional skills and practical experience, provide sufficient human capital supply for the industry promotion of IoT technology, and alleviate the contradiction between supply and demand in the IoT talent market.[1]

6. Concluding Remarks

Intelligent logistics, as an important field of IoT technology application, is leading the innovation and development of the logistics industry. Looking ahead, with the continuous progress and application of IoT technology, smart logistics will develop in the direction of automation, intelligence and greening, further releasing the value of logistics data and bringing more efficient, convenient and sustainable logistics services to enterprises and consumers. and greening, further releasing the value of logistics data, bringing more efficient, convenient and sustainable logistics service experience for enterprises and consumers, and realizing the high-quality development of the logistics industry.

References

- [1] Ren Baoping, Miao Xinyu. The Path and Support System of IOT Enabling High-Quality Economic Development in the New Development Stage [J]. Review of Economy and Management, 2022, 38 (03): 14-24.
- [2] Guo Yanguang. Measurement of Factors Influencing the Adoption of Internet of Things Technology in Retail Supply Chain [J]. Journal of Commercial Economics, 2023, (21): 89-92.

- [3] Ma Jiawei,Zhao Guopeng,Xie Xiaobin,et al. On the Application of Internet of Things Technology in Intelligent Logistics [J]. China Storage and Transportation, 2024, (01): 186-187.
- [4] Yang Xia,Tian Shen,Long Ting. Research on the Application of Internet of Things Technology in Intelligent Logistics[J]. Logistics Sci-Tech, 2024, 47 (08): 39-42.
- [5] Li Xiaorui,Xing Chunyu. Research on the Application of Internet of Things Technology in the Field of Smart Logistics [J]. Logistics Sci-Tech, 2023, 46 (14): 53-56.
- [6] Xie Yujian,Zhao Xiaomei. Analysis and Prospect of the Application of Internet of Things Technology in the Field of Warehousing and Logistics [J]. Software, 2022, 43 (12): 159-161.
- [7] Li Qiuling,Wang Jie. Warehouse Operation Method and Application Based on RFID Technology [J]. China Transportation Review, 2023, 45 (03): 152-156.
- [8] Wu Jianfeng,Liu Chang,Ding Honglin,et al. Research on Intelligent Logistics Management Based on Internet of Things Technology [J]. Logistics Engineering and Management, 2022, 44 (12): 29-31+38.
- [9] Zhao Aoquan,Zheng Huiyan,Wang Hui. Application of the GPS and GIS Technology in Logistics System [J]. China-Arab States Science and Technology Forum, 2021, (05): 26-28.
- [10] Zeng Jun,Yao Qingguo. Optimization of Last Kilometer Distribution Mode of New Logistics [J]. Logistics Engineering and Management, 2020, 42(03): 96-98.
- [11] Zhang Z ,Zongguo Z ,Yue L , et al. Research on the Influence of New Generation of Information Technology on Contemporary Enterprise Logistics Management Information System [J]. Journal of Physics: Conference Series, 2020, 1648 (4): 042039.