Application Research of Computer Artificial Intelligence Technology in Urban Smart Logistics System

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Abstract. This paper proposes the application objective and path of intelligent logistics. Urban smart logistics system is constructed by digitization of underlying elements, modeling of intermediate operations and intelligent management decision-making system. The system in the standardized logistics mode to promote the supply side and the demand side of the maximum degree of fit. Then this paper takes e-commerce platform, e-logistics platform and e-government platform as the basic framework to build an intelligent logistics system composed of supply subsystem, demand subsystem and supervision subsystem. Finally, the system realizes the effective integration of information flow, business flow, logistics and capital flow in the operation process of intelligent logistics mode based on big data cloud computing. Finally, this paper analyzes the practical application of intelligent logistics in the field of intelligent management and decision making. Experimental simulation shows that the logistics system can improve the efficiency of scheduling, transportation and other processes.

Keywords: computer; artificial intelligence; urban logistics; intelligent logistics system.

1. Introduction

As a fundamental, guiding and strategic industry of China's national economy, logistics plays a strong role in promoting industrial restructuring, economic growth and consumption upgrading. With the continuous penetration of the application of new generation of information technologies such as big data, cloud computing, Internet of Things, mobile Internet, artificial intelligence, blockchain and 5G, the smart logistics based on big data will realize the comprehensive interconnection of logistics facilities, goods and information, and promote the visualization, automation and intelligent development of logistics. Driven by new demands such as intelligent manufacturing, new retail, integration of advanced manufacturing and modern service industries, intelligent logistics will achieve flexible, agile, green and full-chain service upgrading [1]. The traditional logistics management and decision-making methods have been unable to adapt to the new needs. The intelligent development of management and decision-making driven by intelligent logistics is the only way for the high-quality development of logistics industry. Based on artificial intelligence technology, this paper proposes the application target and path of intelligent logistics. Urban smart logistics system is constructed by digitization of underlying elements, modeling of intermediate operations and intelligent management decision-making system.

2. Overview of intelligent logistics

The concept of intelligent logistics was extended from the "Intelligent Future Supply Chain" research report released by International Business Machines Corporation (IBM) in 2010. In the era of Internet of Things, new technologies improve the comprehensiveness of information collection, increase resource management and control, and optimize the operation process. From this perspective, smart logistics is defined as creating more value by relying on information resources, so as to realize the transformation of development mode. Some scholars propose that smart logistics is based on logistics Internet and logistics big data, through collaborative sharing innovation mode and advanced artificial intelligence technology, reshaping industrial division of labor, reengineering industrial

structure and transforming the new ecology of industrial development mode [2]. Intelligent logistics can be simply understood as the use of advanced technologies such as the Internet of Things, big data, cloud computing and artificial intelligence in the logistics system, so that the entire logistics system is as intelligent as the human brain, real-time collection and processing of information, to achieve the optimal layout, and ultimately the coordination of all participants in the logistics system with high quality, high efficiency and low cost. According to the connotation of smart logistics, smart logistics has three main characteristics: first, realize information interaction and sharing, effectively reduce logistics costs and improve logistics efficiency; Second, intelligent decision and execution, to the direction of automation and programming; Third, deep coordination and integration, with intelligent management as the core to optimize the management model, to achieve the lowest cost to provide customers with high quality logistics services.

3. Design of urban smart logistics system

3.1 System Architecture

"Wisdom + sharing" logistics means that the two concepts of wisdom and sharing are integrated into the modern logistics operation system. Under the coupled dynamic mechanism such as cost reduction and efficiency increase, the associated elements of intelligent logistics intelligent technology system and shared logistics sharing interactive mechanism are coupled together [3]. Promote the main functional links of the logistics system to adapt to each other, coupled coordination, complement each other and finally achieve a new logistics operation mode of efficient intelligent logistics operation process, highly shared logistics resources, comprehensive transformation and upgrading of logistics system functions. Based on this, this study draws the basic theoretical framework of "wisdom + sharing" logistics mode, as shown in Figure 1.

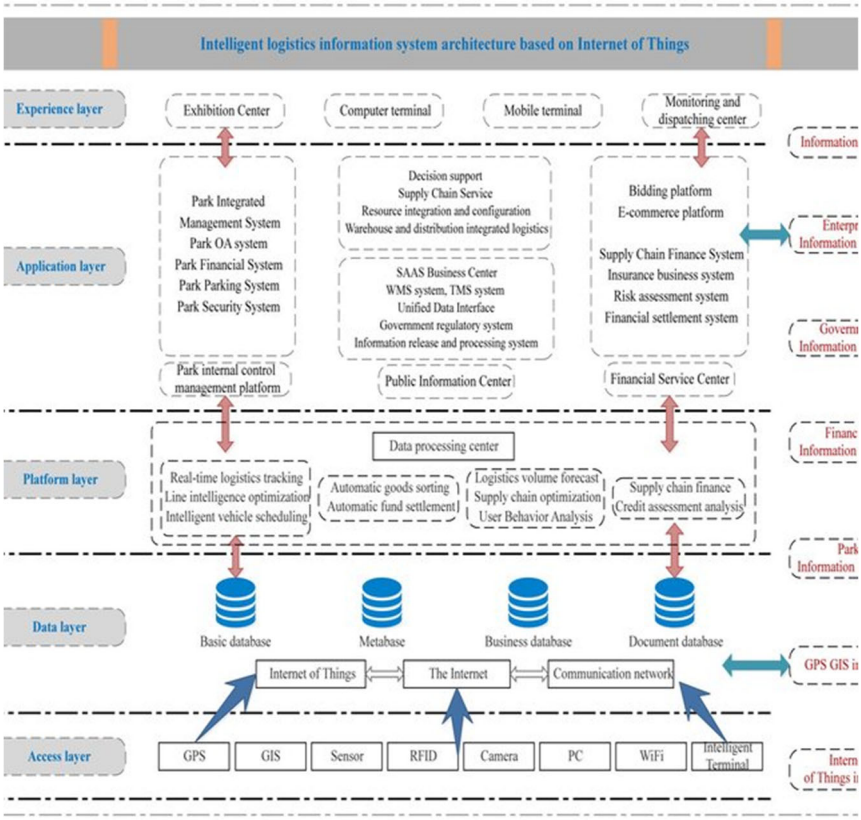


Figure 1. Intelligent logistics system architecture

3.2 System Level module design

1) Perceptual interaction layer

The perceptual interaction layer is composed of radio frequency identification technology, global positioning system and wireless sensor network [4]. It can obtain comprehensive and accurate logistics information with the help of various sensing equipment and sensing technology, which is helpful to realize the identification, positioning, tracking and management of logistics operation process. Radio frequency identification (RFID) technology is a non-contact two-way communication technology, which can automatically perceive and identify goods to obtain the corresponding logistics information, effectively identify the authenticity of goods, and help logistics enterprises realize the intelligent operation of warehousing and transportation process and visual management of logistics operation. The use of global positioning system can realize the logistics process of real-time tracking, positioning, timely and accurate understanding of the status of goods, and can be combined with real-time traffic conditions to make the transport route more reasonable; Wireless sensor network is a kind of network formed through wireless communication, which can obtain logistics information in real time, and test the accuracy and reliability of the obtained information, so as to realize the function of intelligent regulation and automatic decision-making. Figure 2 shows the perceptual hierarchy model of intelligent logistics.

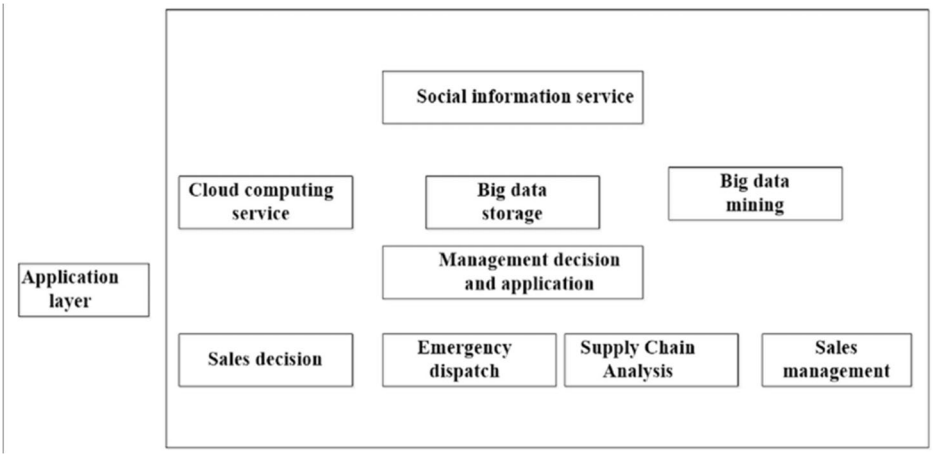


Figure 2. Perceptual hierarchy model of intelligent logistics

2) Network Transport Layer

Network transport layer mainly includes cloud computing technology, M2M technology and digital trunking communication technology, which can integrate, process and transmit logistics information and data, and provide scientific decision-making basis for subsequent logistics operation management [5]. Cloud computing technology is fully combined with mobile communication, Internet, artificial intelligence and other technologies, which can carry out intelligent analysis and processing of a large number of logistics information and data, extract effective information from it, and provide the necessary premise and basis for the logistics system to make intelligent decisions. M2M technology refers to the realization of intelligent communication between machines and goods by effectively embedding wireless communication inside machines and taking wireless communication as the main information receiving mode. Digital trunking communication technology, with strong anti-attenuation ability of signal and good information confidentiality, can realize the security and systematic transmission of data, pictures, information.

3) Intelligent processing of decision layer

In the construction of decision-making layer, it is necessary to pay attention to the correlation analysis and cluster analysis of massive logistics data, so as to realize intelligent decision-making and real-time processing of intelligent logistics. Big data processing technologies such as SPSS, data mining, data cleaning, data association analysis and data visualization are used to promote the

aggregation and integration of various elements of smart logistics and constantly release the value of logistics data. Utilizing simulation technologies such as digital twinning and digital simulation, logistics software technologies such as intelligent management system, intelligent optimization analysis system, intelligent scheduling analysis system and intelligent decision system, artificial intelligence technologies such as neural network, complex algorithm, machine learning, reasoning planning and intelligent prediction, as well as decentralized, traceable and fully transparent blockchain technology, Logistics data distributed processing and scientific decision [6]. This layer is directly connected with the cloud storage layer and the application decision layer, and is the system hub for the digital logistics brain to make judgment, decision and deployment. Figure 3 shows the flow of logistics transmission strategy algorithm.

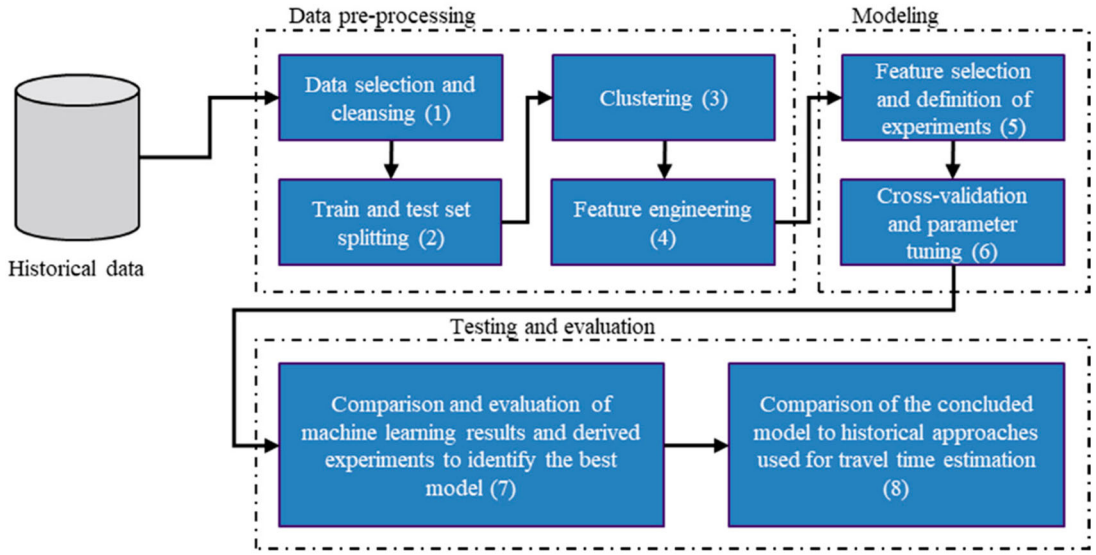


Figure 3. Flow of logistics transmission strategy algorithm

4) Application Service Layer

Application execution layer is the last layer of intelligent logistics system, which determines the effectiveness of the whole life cycle of logistics. The application of scientific and reasonable automation technology and equipment to the whole process of intelligent logistics is conducive to the efficient operation of the system [7]. Using electronic label picking, automatic conveying and sorting, intelligent robot sorting and other automatic sorting technology, unmanned forklift, palletizing robot, AGV car and other intelligent handling technology and equipment, distribution robot system, intelligent vehicle networking system, unmanned aerial vehicle system and other intelligent freight technology and equipment, integrate order, query, sorting, transportation, distribution and other operating models. To realize automatic access, selection, handling and other application implementation of logistics products automation, in order to improve the dynamic expansion and flexibility of the intelligent logistics system.

4. Intelligent logistics scheduling data processing method

Suppose that there are H distribution centers in a city, and M customers need to be delivered. The customers served by each distribution center constitute a distribution zone. The h distribution center is set to deliver goods to L_h (h= 1,2, ⋯, H) customers. The h distribution center has K_h distribution vehicles, the carrying weight of each vehicle is Q_{hk} (k= 1,2, ⋯, K_h), and the maximum driving distance of one distribution is D_{hk}. The goods demand of the ith customer served by the h distribution center is q_{hi} (i= 1,2, ⋯,), the transport distance from customer i to j is d_{ij} (i, j= 1,2, ⋯,), and the distance between the distribution center and the JTH customer is d_{hj} (h= 1,2, ⋯, H; j= 1,2, ⋯,), and

then set n_{hk} as the number of customers distributed by the K vehicle in the h-th distribution center (n_{hk}=0 means that the K vehicle is not used), and set R_{hk} to represent the K path in the H region. The i element rhki represents the sequence of route k of the customer r_{hki} in the h region as i (excluding distribution center), so r_{hk0}=0 represents the distribution center. If the shortest total distribution mileage is taken as the objective function, the following mathematical model of vehicle scheduling problem in multiple distribution centers can be established:

$$\min Z = \sum_{h=1}^{H}\left\{\sum_{k=1}^{K_h}\left[\sum_{i=1}^{n_{hk}} d_{r_{hk(i-1)}r_{hki}} + d_{r_{hkn_{hk}}r_{hk0}} \cdot sign(n_{hk})\right]\right\} \tag{1}$$

$$\text{s.t.} \sum_{i=1}^{n_{hi}} q_{hr_{hki}} \le Q_{hk} \tag{2}$$

$$d_{r_{hk(i-1)}r_{hki}} + d_{r_{hkn_{hk}}r_{hk0}} \cdot sign(n_{hk}) \le D_{hk} \tag{3}$$

$$0 \le n_{hk} \le L_h \tag{4}$$

$$\sum_{k=1}^{K_h} n_{hk} = L_h \tag{5}$$

$$\sum_{h=1}^{H} L_h = M \tag{6}$$

$$R_{nk} = \{r_{nki} \mid r_{nki} \in \{1,2,...,L_h\}, i = 1,2,...,n_{hk}\} \tag{7}$$

$$R_{hk_1} \bigcap R_{hk_2} = \phi \ \forall hk_1 \ne hk_2 \tag{8}$$

$$sign(n_{hk}) = \begin{cases} 1 & n_{hk} \ge 1 \\ 0 & \text{other} \end{cases} \tag{9}$$

In the above model, formula (1) is the objective function, which requires the shortest total distribution mileage (the sum of length of each distribution path). (2) To ensure that the sum of the goods demand of each customer on each route does not exceed the load of the vehicle; (3) The formula ensures that the length of each distribution path does not exceed the maximum driving distance of a vehicle distribution; (4) Formula indicates that the number of customers in each path of a distribution zone does not exceed the total number of customers in the zone; Formula (5) indicates that the sum of the number of customers in each distribution path in a distribution zone is equal to the total number of customers in the zone; Formula (6) indicates that every customer gets delivery service; Formula (7) represents the composition of customers of each path; (8) limit each customer can only be delivered by one vehicle; Formula (9) indicates that when the number of customers served by the KTH vehicle in region h is greater than or equal to 1, it means that this vehicle has participated in distribution, and sign(n_{hk})=1 is taken; when the number of customers served by the KTH vehicle is less than 1, it means that this vehicle has not been used, so sign(n_{hk})=0 is taken.

Compared with the model based on network graph in related literature, the mathematical model of multi-distribution center vehicle scheduling problem based on intuitive description has the following characteristics: (1) the objective function and constraint conditions considered are more comprehensive and close to the reality; (2) The expression of decision variables, objective functions and constraints is natural, intuitive and easy to understand. It is convenient to design solving algorithm and use computer programming to solve.

5. Scheduling simulation of intelligent logistics system

A multi-distribution center vehicle scheduling problem generated randomly by computer is experimentally calculated by C language program [8]. Based on the nearest distance allocation method, the following partition results are obtained through the program calculation: (1) Distribution center Ⅰ has 6 customer services, whose customer numbers are 3, 5, 11, 18, 25, 26; (2) Distribution Center II is for 10 customer service, customer numbers are: 1, 4, 6, 7, 9, 10, 12, 15, 28, 29; (3)

Distribution center Ⅲ has 14 customer services, whose customer numbers are: 2, 8, 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 27, 30. The solution of the multi-distribution center vehicle scheduling problem can be obtained by combining the solutions with the highest quality of the above three distribution zones. The corresponding distribution scheme of this solution uses a total of 5 vehicles, and the total length of the 5 distribution routes is 177.5km. It can be seen that the algorithm designed in this paper can be used to solve the multi-distribution center vehicle scheduling problem, and good calculation results can be obtained (Table 1).

Table 1. Known conditions of Case 1

Customer number	1	2	3	4	5	6	7	8	9	10
x(km)	3.1	20.6	6.8	7.6	15.5	7.3	6.4	0.6	15.1	1.3
The y-coordinate y(km)	13.9	15.0	19.6	5.5	17.1	14.8	5.2	15.5	12.6	1.5
Quantity demanded for goods q(t)	1.9	0.4	2.1	0.5	0.2	0.8	1.6	2.0	1.0	1.8
Customer number	11.5	12.5	13.5	14.6	15.6	16.7	17.7	18.8	19.8	20.8
x(km)	4.1	15.7	0.3	12.8	2.4	12.4	10.9	10.4	14.2	19.9
The y-coordinate y(km)	9.5	18.6	11.9	0.4	16.5	13.6	11.2	20.1	8.3	8.9
Quantity demanded for goods q(t)	0.8	1.4	0.9	2.0	2.0	0.7	1.9	2.1	0.6	0.2
Customer number	21.9	22.9	24.0	25.0	26.0	27.1	28.1	29.2	30.2	31.3
x(km)	12.2	12.1	18.8	20.0	12.2	12.3	13.3	0.5	3.7	18.3
The y-coordinate y(km)	8.8	2.8	11.0	12.9	17.6	20.7	12.7	11.6	8.6	1.1
Quantity demanded for goods q(t)	1.9	1.0	1.1	1.7	1.7	1.0	0.2	0.4	1.4	0.6

6. Conclusion

Combined with practical cases, this paper establishes the application model and basic path of intelligent logistics by digitization of underlying elements, modeling of intermediate operations and intelligent management decisions. Applying smart logistics to make management decisions helps build a perceptive and traceable Internet of everything ecology. On the basis of describing the multi-distribution center vehicle scheduling problem, a mathematical model based on intuitive description is established. The model takes into account the constraints close to the actual conditions, and has the advantages of simple, intuitive, easy to understand and easy to design algorithms to solve.

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