Modeling Analysis of Intelligent Logistics Distribution Path of Agricultural Products Under Internet of Things Environment

Xiaoyan Ai(✉) and Yongheng Zhang

Yulin University, Yulin 719000, China
zcmddnl111@163.com

Abstract. Aiming at the insufficiency of the logistics distribution model of traditional agricultural products, this paper puts forward the optimization modeling analysis of the intelligent logistics distribution route of agricultural products under the Internet of Things. According to the logistics distribution model of agricultural products under the Internet of Things environment, the intelligent logistics distribution path of agricultural products is optimized and modeled and analyzed. The objective function of the shortest path of the model is calculated, and constraint conditions are set, thereby completing the intelligent logistics distribution path optimization modeling of agricultural products. Experimental parameters are set and traditional methods with path optimization modeling analysis methods are compared. From the comparison results, When the time is 10:00, the difference between the accuracy of the traditional method and the accuracy of the intelligent logistics distribution route optimization model is the largest, with a difference of 80%. It can be seen that the use of intelligent logistics distribution route optimization modeling and analysis has higher accuracy. It can be seen that the path optimization modeling and analysis method has higher precision in the analysis of agricultural products intelligent logistics distribution route, and provides an effective solution to ensure freshness of agricultural products.

Keywords: Internet of Things · Agricultural products · Logistics distribution · Path optimization

1 Introduction

The Internet of Things is the convergence and integration of various perceptual technologies, modern communication technologies, artificial intelligence, and automation technologies to create an intelligent network that can sense the real world. In the future, with the advent of the 5G era, new applications for the Internet of Things will emerge in an endless stream, and 4G obviously cannot meet the requirements. 5G has obvious advantages in terms of bandwidth speed and energy efficiency, and the end-to-end delay will be reduced. These characteristics are particularly important for the application of the Internet of Things. At present, the application of the Internet of Things is limited to some independent small systems. When we talk about big blueprints such as

S. Liu and G. Yang (Eds.): ADHIP 2018, LNICST 279, pp. 322–329, 2019.
https://doi.org/10.1007/978-3-030-19086-6_36

"Smart City" and "Smart Earth", we need a unified framework that seamlessly connects, and 5G is just a good opportunity to provide a unified framework. According to data from the Internet Data Center, the global Internet of Things market will exceed US $3 trillion by 2020. Under the background of China's "Internet Plus" strategy, the scale of the Internet of Things industry has been met with unprecedented development conditions. It is now entering a stage of rapid development from the stage of overall distribution, and it is playing the role of "core productivity" to promote the rapid development of the world economy. Agricultural products are difficult to distribute because of their characteristics of perishability [1]. The combination of the Internet of Things and the circulation of agricultural products simply means the use of technologies such as RFID radio frequency identification. Through the information network, real-time monitoring and sharing of information on the state of agricultural products and the status of vehicle transportation in the distribution process are realized, and according to this, intelligent operations are carried out.

The problem of multi-objective path optimization research can be analyzed from two aspects. It can be generally divided into single-factor single-object path optimization and multi-factor multi-objective path optimization. Among them, the multi-objective path optimization problem is mainly based on the optimization study that considers the minimum cost, the highest customer satisfaction, or the shortest delivery distance, and is more comprehensive, scientific, and reasonable than the single-objective optimization problem. Literature [2] proposed that the agricultural Internet of Things is an emerging technology that exploits agricultural productivity, improves the level of precision of agricultural equipment, and realizes intelligent agricultural production. It integrates agricultural information perception, data transmission, and intelligent information processing technology, and is based on field planting. Significant demand for facilities in horticulture, livestock and poultry farming, aquaculture and agricultural product logistics, and planning of distribution routes, but the method is less accurate. Therefore, the main issue of the study is how to solve the problems of low efficiency and information lag in the distribution of agricultural products through the Internet of Things technology, to plan distribution routes scientifically and rationally, while improving distribution efficiency and ensuring the quality of agricultural products, improve customer satisfaction and reducing distribution costs. Thus, to achieve a balance between the economic efficiency of agricultural products enterprises and customer satisfaction.

2 Analysis of Logistics Distribution Model of Agricultural Products Under Internet of Things

Aiming at the insufficiency of the logistics distribution model of traditional agricultural products, combined with features of Internet of Things and agricultural products, the model of agricultural products distribution under the environment of Internet of Things was proposed. As shown in Fig. 1.

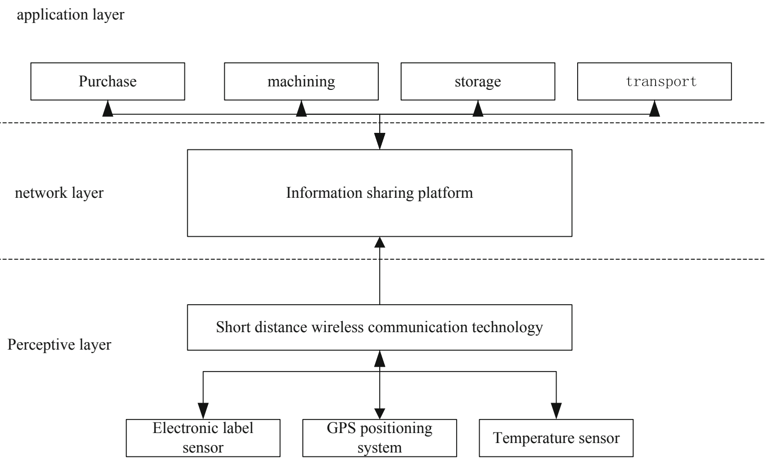

Fig. 1. Agricultural product logistics distribution model in the Internet of Things environment

Through Fig. 1, the intelligent operation of agricultural products such as procurement, distribution processing, transportation and warehousing, transportation, quality traceability, etc. It is implemented to promote the transition from agriculture to intensive production, and improve the utilization ratio of agricultural resources and the level of information. The pattern of agricultural product distribution under the Internet of Things environment can be divided into three basic levels: the perception layer, the network layer, and the application layer. The sensory layer transmits the collected information to the information sharing platform through various sensing technologies. The network layer allows various agricultural product information to be transmitted to the application layer through the underlying bearer network, supports the transmission, routing, and control of the agricultural product information of the sensing layer, and ensures the exchange of data in the network transmission; The application layer is the use of Internet of Things technology, through the unified management of various types of sensing data, to achieve a direct experience of agricultural products in the distribution process of intelligent [3].

3 The Construction of Intelligent Logistics Distribution Route Optimization Model

3.1 Problem Description

According to the logistics distribution model of agricultural products under the Internet of Things environment, the intelligent logistics distribution path of agricultural products is modeled and analyzed. The problem can be described as: There are n vehicles in m distribution centers, which provide i kinds of material distribution services for k locations. The load capacity of each vehicle is not the same, and some of the materials must be used together. The goal is to optimize the vehicle's driving path so as to shorten the distance traveled by the vehicle on the premise of meeting the freight requirements. At the same time, through the Internet of things technology to optimize the waiting time between different types of materials, in order to minimize the distribution costs of power supplies [4].

3.2 Model Basic Assumptions

(1) Consider only one logistics center, that is, the distribution center. According to the customer's order demand, the vehicle needs to start from the distribution center and return to the distribution center after completing the distribution service.
(2) Each customer's demand for agricultural products can not exceed the maximum carrying capacity of the delivery vehicle. Using a single vehicle distribution can make the vehicle load, speed, driving costs and other conditions are fixed;
(3) Each customer has one and only one vehicle for distribution, but each vehicle can provide distribution services to multiple customers;
(4) The customer's demand for agricultural products, expected delivery time period, tolerable delivery time period, distribution center and customer's specific geographic location are all known;
(5) The demand for agricultural products by customers within the delivery service time is constant [5].

3.3 Model Construction

Assuming that $S_1, S_2, \ldots, S_n$ species are needed, which are provided by p distribution centers $m_1, m_2, \ldots, m_n$, providing delivery services for $m_{\mathrm{p}+1}, m_{\mathrm{p}+2}, \ldots, m_{p+n}$ demand sites [6]. The demand for each of these materials is $q_1, q_2, \ldots, q_n$. $\{\mathrm{n}_i | 1 \leq i \leq \mathrm{n}\}$ represents a collection of parking lots; $m_1, m_2, \ldots, m_n$ represents the number of vehicles owned by the depot; $\left\{Z_i^m | 1 \leq \mathrm{m} \leq \mathrm{m}_i\right\}$ represents the load capacity of vehicles in each depot; $\{\mathrm{d}_{ab} | 1 \leq \mathrm{a} \leq i+n, 1 \leq \mathrm{b} \leq i+n\}$ represents distances from each point [7]. The elements satisfy the following relationship:

(1) $\mathrm{d}_{ab} = 0$ indicates the distance between the supply points themselves is 0;
(2) $\mathrm{d}_{ab} = \mathrm{d}_{b\mathrm{a}}$ indicates that there is no direction between the two points;

λ_{ab}^n represents the stability factor of the path taken by vehicle n; t_{ab}^n indicates the safety factor of the time required for the vehicle n to travel; C_1^n represents the material loss cost of the path taken by the vehicle n; C_2^n represents the supply delay cost of the path taken by vehicle [8]. Among them, several coefficients of λ_{ab}^n and t_{ab}^n are obtained through the data collection of path information using RFID and GPS and other Internet of Things technologies in material distribution [9]. According to the fluctuations in the overall transportation process, find the mean and variance. If the variance is smaller, the higher the stability of the road, the lower the cost of material loss [10]. t_{ab}^n is determined by the real-time status and path information of all vehicles collected by the information system. Through information sharing, collaborative operations between suppliers and enterprises can be realized, delays in delivery or early arrival risks can be reduced, and waiting time between each other can be reduced, thereby saving a lot of time costs.

It can be assumed that the decision variables are as follows:

$$x_{in}^{ab} = \begin{cases} 1, & \text{vehicles passing by distribution center} \\ 0, & \text{other conditions} \end{cases}$$
$$y_{in}^{ab} = \begin{cases} 1, & \text{there is vehicles} \\ 0, & \text{other conditions} \end{cases} \tag{1}$$

Build the model shortest distance objective function:

$$\min A = \sum_{a=1}^{p+k} \sum_{b=1}^{p+k} \sum_{i=1}^{p+k} \sum_{n=1}^{p+k} x_{in}^{ab} y_{in}^{ab} \tag{2}$$

The model needs to meet the following constraints:

① The total demand for each vehicle's distribution cannot exceed its carrying capacity, that is:

$$\sum_{a=1}^{p+k} \cdot q_a \cdot \sum_{b=1}^{p+k} \cdot x_{in}^{ab} y_n^i \le C_m^n \tag{3}$$

② The number of vehicles departing from each delivery is equal to the number of vehicles returning to the distribution center and does not exceed the number of vehicles it owns, that is:

$$\sum_{a=1}^{p+k} \sum_{a=p+1}^{p+k} \cdot x_{in}^{ab} y_n^i = \sum_{i=1}^{i} \sum_{a=p+1}^{p+k} \cdot x_{in}^{ab} y_n^i \le m_a \tag{4}$$

This can obtain the optimal model of logistics distribution.

4 Verification Analysis

In order to verify the accuracy of modeling and analysis of intelligent logistics distribution routes for agricultural products under the Internet of Things environment, the following experimental verification analysis was conducted.

4.1 Experimental Parameter Settings

Assuming that there are M_1, M_2, and M_3 three material reserve centers in a certain place. There are four kinds of power supplies N_1, N_2, N_3, and N_4, including switch contactors, towers, cables, and transformers, which are required to be distributed. Materials are distributed to the four construction sites and are represented as Z_1, Z_2, Z_3, and Z_4, respectively. There are 30 vehicles in total, which are randomly distributed at the B_1, B_2, B_3 parking lots. The parking lot parameter information is shown in Table 1.

Table 1. Yard parameter information

Vehicle number	The parking lot	Vehicle load (t)	Vehicle speed (km/h)
1	B_2	50	40
2	B_1	80	45
3	B_3	60	43
4	B_1	30	42
5	B_3	60	39
6	B_2	20	41

According to the parameters of the yard parameters shown in Table 1, the experiment was analyzed.

4.2 Experimental Results and Analysis

Weather Influence

Under the influence of weather, the accuracy of traditional method and intelligent logistics distribution route optimization modeling analysis method was compared and analyzed. Through the different kinds of weather, we can fully verify the advantages of this method. The results are shown in Fig. 2.

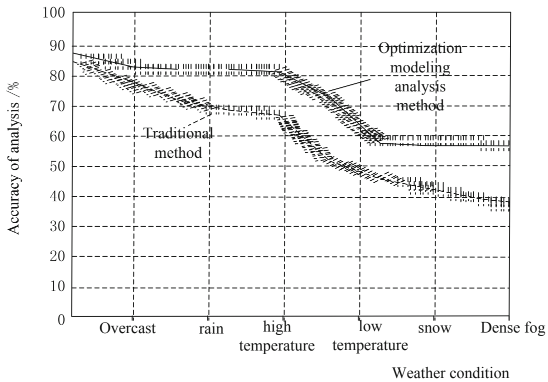

Fig. 2. Comparison of the accuracy of two methods under the influence of weather

From Fig. 2, we can see that when the weather is cloudy, the accuracy of traditional method analysis is 75%, and the accuracy of intelligent logistics distribution route optimization modeling is 81%; When the weather is raining, the accuracy of the traditional method analysis is 11% lower than the accuracy of the intelligent logistics distribution route optimization modeling analysis; When the weather is at a high temperature, the difference between the accuracy of the traditional method and the accuracy of the intelligent logistics distribution route optimization modeling model is the greatest; When the weather is heavy fog, the accuracy of the two methods has reached a minimum, the accuracy of the traditional method analysis is 38%, and the accuracy of the intelligent logistics distribution route optimization modeling analysis is 56%. It can be seen that, under the influence of the weather, the use of intelligent logistics distribution route optimization modeling has higher accuracy.

Road Traffic Impact

Under the influence of road traffic, the accuracy of traditional method and intelligent logistics distribution route optimization modeling analysis method was compared and analyzed. The results are shown in Fig. 3

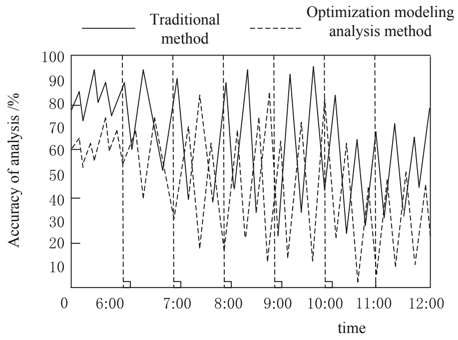

Fig. 3. Comparison of the accuracy of two methods under the influence of road traffic

In Fig. 3, we can see that when the time is 6:00, the accuracy of the traditional method analysis is 35% lower than the accuracy of the intelligent logistics distribution route optimization modeling analysis; When the time is 7:00, the accuracy of traditional method analysis is 60% lower than that of intelligent logistics distribution route optimization modeling; When the time is 10:00, the difference between the accuracy of the traditional method and the accuracy of the intelligent logistics distribution route optimization model is the largest, with a difference of 80%. It can be seen that the use of intelligent logistics distribution route optimization modeling and analysis has higher accuracy.

4.3 Experimental Conclusion

① Under the influence of the weather, the use of intelligent logistics distribution route optimization modeling has higher accuracy.
② Under the influence of road traffic, the use of intelligent logistics distribution route optimization modeling accuracy is high.

From this, we can see that the intelligent logistics distribution path optimization model analysis of agricultural products is accurate under the Internet of Things environment.

5 Conclusion

Agricultural information is the infiltration of modern information technology into every aspect of agricultural production and operation. It is an important hot issue in current social development and the only way for future agricultural development. The study of the distribution model of agricultural products under the Internet of Things environment is essentially how to reasonably use the Internet of Things technology to solve the problem of lagging agricultural product information, making agricultural products add value in the distribution process, making the consumer groups of agricultural products grow, and increasing the competition and overall benefits of the agricultural market. The future research direction is to continuously improve the accuracy of the logistics distribution route selection, and better provide a more convenient way for agricultural product distribution.

Fund Project. Agricultural Science Research Plan in Shaanxi Province of China: "Research on key technologies and applications of Smart agriculture planting and logistics distribution based on the Internet of Things" (NO. 2017NY132).

References

1. Zhu, Z.Y., Chen, Z.Q.: Petri net modeling and analysis of wisdom traceability service system in Internet of Things. J. Intell. Syst. **12**(4), 538–547 (2017)
2. Li, D.L., Yang, W.: Analysis and development trend of agricultural IoT technology. J. Agric. Res. **11**(1), 1–20 (2018)
3. Sun, M.M., Zhang, C.Y., Lin, G.L., et al.: Problem of cold chain logistics distribution and path optimization of fresh agricultural products. Jiangsu Agric. Sci. **45**(11), 282–285 (2017)
4. Fan, S.Q., Zhai, D., Sun, Y.: Research on the optimization of distribution routes for fresh agricultural products cold chain logistics. Freshness Process. **10**(6), 106–111 (2017)
5. Zhang, L.Y., Wang, Y., Fei, T., et al.: Chaotic perturbation simulated annealing ant colony algorithm for low carbon logistics path optimization. ComEngApp **53**(1), 63–68 (2017)
6. Feng, L., Liang, G.Q.: Design and simulation of vehicle distribution scheduling targeting in networking. Comput. Simul. **34**(4), 377–381 (2017)
7. Huang, X.X.: Optimization of cold chain distribution path for fresh agricultural products under carbon tax and carbon limit rules. J. Shanghai Marit. Univ. **39**(1), 74–79 (2018)
8. Jia, X.Z., Qi, H.L., Jia, Q.S., et al.: Optimization of distribution routes of fresh produce in the same city under real-time road conditions. Jiangsu Agric. Sci. **45**(17), 292–295 (2017)
9. Xiao, M.H., Li, Y.N., Li, W.: The analysis of the development of the logistics industry in the Internet of Things environment and its countermeasures: a case study of Jiangxi Province. Bus. Econ. **24**(4), 167–173 (2017)
10. Chen, Y., Liu, Y., Chen, X.R., Liu, R.: Simulation analysis method of pesticide residue pollution based on visual analysis. Comput. Simul. **34**(10), 347–351 (2017)