Design of Comprehensive Service System for Fresh Food E-commerce under the Background of "Rural Revitalization"

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Abstract. The traditional system takes a long time to adjust the fresh food storage temperature. Therefore, under the background of "village revitalization", the comprehensive service system for fresh food e-commerce is designed in this paper. First of all, on the hardware side, by optimizing the physical architecture, the application layer and the data server layer are separated; on the software side, the system database is designed to extract customer order data. Then the ant algorithm is used to select the optimal logistics configuration path, and the temperature control algorithm is used to adjust the temperature environment so that the fresh food reaches the optimal storage temperature in the transportation path. Finally, the hardware and software design are combined to realize the comprehensive service system design. The experimental results show that compared with the traditional system, the designed system in this paper shortens the control time of fresh storage temperature and strengthens the service control of cold chain logistics.

Keywords: Rural revitalization; E-commerce; Comprehensive service
1. Introduction
In the context of "rural revitalization", the sales model of fresh agricultural products has been innovated. Through e-commerce sales channels, a new retail model of fresh products has been realized. Therefore, the research on the comprehensive service system for e-commerce has important practical significance [1]. The foreign e-commerce service system is centered on enterprise logistics services, realizes customer satisfaction evaluation, promotes the realization of corporate profits, concentrates system services in enterprise logistics, and realizes the integrated process of product logistics. Among them, large manufacturers have set up logistics centers and independent distribution centers for products, forming a multi-channel and multi-level integrated service system. The domestic e-commerce service system is customer-centric, makes full use of customer purchase history information, helps customers realize online shopping experience through professional intelligent shopping guide assistants, and makes personalized recommendations to customers, realizing communication between client and back-end comprehensive service system. The intelligent agent technology is applied, the rule engine is used to build an expert recommendation module, to make comprehensive service meet the requirements of stability and reusability, and the chain tree data structure is designed as the storage structure of comprehensive service system based on the specific background of manufacturer [2]. However, due to the natural attributes of fresh agricultural products, there are higher requirements for logistics and storage temperature, traditional service systems are prone to damage to fresh produce and with higher service costs. In order to solve this problem, combining the above theories, a comprehensive service system for fresh food is designed.

2. Design of Comprehensive Service System for Fresh Food E-commerce

2.1 System hardware design
The physical architecture of the system is redefined, customer management and fresh information management are integrated into a whole through the integration of business modules, and is able to support multiple deployment methods based on the traditional multi-business model of the system. Transmit the customer's order request through the entry server, use the message consistency middleware to perform service management distribution on the customer request, write the request data into the main database, call the corresponding service content in the system, as a reliable guarantee for request data transmission. Finally, the read result in the system database is returned through the network [3]. Its physical architecture is shown in the figure below:
As shown in the figure above, the overall service system architecture is divided into 4 layers, which are from bottom to top, the data layer, server layer, application layer, and user layer, respectively. The user layer can view the payment settings of fresh products, and the administrator can add, delete, modify, and check all records. The application layer is the realization layer of the various functions of the system, and the various modules of the application layer are used to realize the payment configuration and order settlement of fresh products. The specific structure of this layer is shown in the following table:

| Service level       | Role                              | Structure content                                      |
|---------------------|-----------------------------------|-------------------------------------------------------|
| Access control      | Ensure that each position is within the scope of authority specified by the system | Distinguish customer and administrator roles           |
| Business process    | Core business process processing  | Fresh food logistics distribution and inventory, financial reconciliation of sales orders |
| Basic data          | Define fresh and customer         | Unstructured data such as fresh food                  |
Front display
Help customers quickly realize online fresh shopping

| Field name   | Data type  | Data length | Field description     |
|--------------|------------|-------------|-----------------------|
| userId       | varchar    | 11          | Fresh customer ID     |
| Sett-status  | varchar(50)| 14          | Order settlement status|
| projectcode  | varchar(50)| 11          | Order                 |

Tab.1 Specific structure of system application layer

Storing the customer payment gateway on the external network, and directly accessing all clients connected to the Internet according to the parameters passed by the merchant, then, according to the payment page provided by the payment gateway, the transaction is further processed and the order module data is updated, the error part of the order is processed for error, and the order module is added, deleted, modified, and checked. Managers can directly view and modify account information in the process of clearing money. The logic processing is used to directly process the server layer and data layer of the system, converting the above service modules into instantiated objects, storing application layer data in the data layer, and formulating business logic according to business rules to make the application layer and data server layer separated from each other [4]. So far, the system architecture has been optimized, and the hardware design of the business integrated service system has been completed.

2.2 System software design

2.2.1 Design system database

On the basis of the system hardware design, the system database is designed to record fresh customer information and service transaction information. The database relationship diagram is used to display the composition and internal relations of each entity data, and MySQL database is used to view each database table. The multilingual SQL, integrate with PHP/PERL and Apache are adopted to make the database support multithreading and multiple connection methods [5]. Among them, MySQL database adopts the dual authorization mode of community edition and commercial edition to provide administrators with dynamic website technology. The main record data of the database is shown in the following table:
| areaname        | varchar(50) | 14 | Delivery area name |
|-----------------|-------------|----|---------------------|
| paymentplan     | varchar(100)| 64 | Payment plan        |
| flowNum         | varchar(255)| 64 | Order processing status |
| description     | varchar(255)| 11 | Administrator permission description |

**Tab.2 Comprehensive service system database**

As shown in the above table, customers can access databases within the scope of authority under the premise of complying with the GPL agreement. The distributed technology is used to customize MySQL database to support different requirements such as single-point replication and cluster scale, so as to meet the business needs of fresh customers [6]. Compared with traditional systems, MySQL database has better compatibility. The development of the combination of Linux+Apache+MySQL can realize the processing of tens of millions of data records. So far, the design of the integrated service system database is completed.

### 2.2.2 Configuration process for improving the fresh food logistics route

According to the order customer record information stored in the database, the configuration process of the fresh food logistics path is optimized, and the optimal path for e-commerce delivery is selected. Using the ant algorithm, assuming that the e-commerce shipping point is randomly placed in the logistics route, the initial values of pheromone on all routes are obtained and used as the initialization parameters of the route configuration process. In the logistics and transportation process of fresh food, the geographic location firstly visited is placed in Tabuk, and many iterations are conducted on the initialization parameters for many times until the ants go to the whole fresh food configuration city, all logistics configuration paths are recorded, and their selection probability is calculated. The calculation formula of path selection probability is described below:

\[
p = (1-\rho)h_{ij} + \Delta c
\]

In the formula, \(i\) and \(j\) are the cities where two customers need fresh food before and after delivery, \(h_{ij}\) is the sum of the pheromone concentration from city \(i\) to city \(j\), \(\Delta c\) is the pheromone concentration on the path, and \(\rho\) is the convergence speed of the ant colony algorithm. Using the formula (1), all logistics configuration paths are sorted, and the configuration path with the largest selection probability is selected as the optimal configuration path from city \(i\) to city \(j\). The above steps are repeated to select the configuration path of the next city until all the ants have gone
through all the cities. The total path length traversed by all ants is calculated, revising and updating the pheromone on all paths in time, by comparing and selecting the shortest path traversed by ants, it is regarded as the optimal delivery path for fresh logistics configuration, and the logistics path configuration process is improved.

2.2.3 Optimizing fresh temperature control algorithm

On the basis of selecting the optimal logistics route for fresh food, the temperature control algorithm is used to control the temperature environment of the fresh food so that the fresh food can reach the optimal storage temperature during the transportation of the route. The step response method is used to express the temperature change of the fresh food, drawing the response curve of the temperature change, and applying a step signal to the stored fresh food, using Matlab software, the inertial time constant of the fresh temperature change is obtained, the static gain is introduced for the pure delay of temperature control, and the first-order inertial time lag is used to express the transfer process of the fresh temperature environment. Then the transfer function $G$ of the fresh temperature change is expressed as:

$$G = \frac{K \cdot e^{-t}}{Ts + 1}$$  (2)

In the formula, $T$ is the delay time of the fresh temperature change, $s$ is the inertial time constant, $K$ is the temperature static gain value, and $\sigma$ is the inertial transfer coefficient of the fresh temperature [7]. The formula (2) is taken as the temperature transfer function of the integrated service system, and then the initial value of the temperature control parameter is calculated, the temperature change characteristics of fresh food and the derivative time and integral time of temperature control are obtained, and the quantitative factor is also obtained according to the fuzzy control rule. The calculation formula is described below:

$$m = \frac{Nt_1t_2}{n}$$  (3)

In the formula, $m$ is the quantitative factor for temperature control, $N$ is the maximum value of the fuzzy subset, $n$ is the maximum value of the continuous universe, $t_1$, $t_2$ are the differential time and integration time of the control, respectively. The quantitative factor can improve the temperature control effect of the system, and the formula (3) is used to stabilize the fresh temperature change [8]. Then the fuzzy control algorithm is used to correct the input parameters of the system, performing approximate inferences on the fresh temperature changes, the membership degrees of different input parameters and the error rate of change of the input parameters are obtained, and the trimf function $s$ used to fuzzy temperature control the error of the input parameters [9]. Inputting the parameters and using the transfer function $G$ to act on the output parameters in the fresh temperature environment to achieve the regulation of the target temperature, and the optimization of the fresh temperature control algorithm is completed. At this point, the software design of the system is
completed, combining hardware design and software design to realize the design of a comprehensive service system for fresh food e-commerce.

3. Experimental demonstration analysis
For comparison experiments, the system designed in this article is marked as experimental group A, and the traditional system is marked as experimental group B. Regulate duration is taken as a comparison indicator to compare the control effects of the two systems on the fresh storage temperature during the fresh transportation process.

3.1 Experiment procedure
Juicy peach is selected as the experimental object. There are three main e-commerce sales models, namely self-built e-commerce, cooperation with third-party platforms, and cooperation with express logistics companies. During transportation, according to the characteristics of the thin and soft skin of the peaches, the Boeing 767 wide-body self-owned all-cargo aircraft is used to store the peaches, and the peaches are packed with knitted cotton. The two sets of experiments monitored the temperature of the cold chain of peaches during the logistics and distribution process. The hardware environment of the system is shown in the following table:

| Hardware unit     | Model                      | Hardware unit     | Model                      |
|-------------------|----------------------------|-------------------|----------------------------|
| Whole machine     | X86 compatible desktop     | RAM               | Intel Core2 Quad CPU 2.66GHz Quad core |
|                   | 4GB RAM                    | Graphics card     | Nvidia GeForce G 100       |
| Operation         | Windows 2000               | Web server        | Jboss4.0.1                 |
| Development tools | Jess6.1                    | Background database | Oracle10g                  |

**Tab.3** System hardware environment

Using refrigerated vehicles for distribution, selecting 5 customer orders, the customer's cooling demand for peaches is shown in the following table:

| Client | Need for cooling | No need for cooling | Total demand (tons) |
|--------|------------------|---------------------|---------------------|
| 1      | 0.2              | 0.4                 | 0.6                 |
| 2      | 0.2              | 0.1                 | 0.3                 |
| 3      | 0.6              | 0.4                 | 1.0                 |
| 4      | 0.1              | 0.2                 | 0.3                 |
| 5      | 0.7              | 0.5                 | 1.2                 |

**Tab.4** Fresh refrigeration demand

Collecting the peaches that need to be refrigerated by 5 customers and choosing the optimal route for delivery, the refrigerated truck has a driving distance of 38.5 kilometers. The temperature in the
refrigerated truck is set to 5°C. The optimal temperature during the storage of peaches is 0.5°C. The relative temperature should be controlled at -1~13.3℃. When the two sets of experiments are tested, the storage temperature of the peaches should be controlled at 0.5°C.

3.2 Experimental results

The adjustment values of the two sets of experiments on the storage temperature of peaches are shown in the following table:

| Time (s) | Control temperature of experimental group A (℃) | Control temperature of experimental group B (℃) |
|----------|-----------------------------------------------|-----------------------------------------------|
| 0        | 5                                             | 5                                             |
| 20       | 2.7                                           | 2.9                                           |
| 40       | 1.3                                           | 1.6                                           |
| 60       | 0.7                                           | 0.9                                           |
| 80       | 0.3                                           | 0.1                                           |
| 100      | 0.4                                           | 0.2                                           |
| 140      | 0.5                                           | 0.7                                           |
| 160      | 0.5                                           | 0.8                                           |
| 200      | 0.5                                           | 0.6                                           |
| 220      | 0.5                                           | 0.5                                           |
| 240      | 0.5                                           | 0.5                                           |

Tab.5 Experimental comparison results

It can be seen from the above figure that the storage temperature of group A is basically stable at about 140s, while the temperature of group B is about 220s, and the temperature tends to be stable. Calculating the performance parameters of the two sets of experimental control temperature, the comparison results of the performance parameters are shown in the following table:

| Parameters                  | Experimental group A | Experimental group B |
|-----------------------------|----------------------|----------------------|
| Temperature drop time       | 56s                  | 74s                  |
| Temperature adjustment time | 68s                  | 143s                 |
| Steady-state error          | 0.070℃               | 0.001℃               |

Tab.6 Statistics of experimental results

It can be seen from the above table that the total time length of the experimental group A to regulate the storage temperature of peaches is 124s, and the total time length of the experimental group B to regulate the storage temperature of peaches is 217s. Compared with the experimental group B, the control time of the experimental group A is shortened by 93s. To sum up, in the process of fresh
food transportation, compared with the traditional system, the system designed this time shortens the control time of fresh food storage temperature, has a better temperature control effect than the traditional system and strengthens the service control for fresh cold chain logistics.

4. Conclusion
Aiming at the problem of inadequate logistics services in the traditional system, a comprehensive service system was designed to shorten the control time of fresh storage temperature and bring great convenience to customers and manufacturers. However, due to the limitation of development time and cycle, the system designed this time does not deepen the application of intelligent agent technology. In future research, multiple intelligent agents will be introduced into the service system to increase offline recommendation functions and improve customers' online shopping experience.

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