

Design and Development of Intelligent Logistics Tracking System Based on Computer Algorithm

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Abstract. With the development of social economy, the logistics industry continues to flourish. This article attempts to build an intelligent logistics tracking system based on computer technology, focuses on the intelligent inventory decision support system, introduces the detection algorithm based on the integrity of goods packaging and the detection algorithm of goods behavior and posture based on the three-dimensional acceleration sensor, and conducts its work flow. The detailed design is finally carried out in the actual cabin environment to verify the experiment and evaluate the performance of the system.

Keywords: Intelligent Logistics, Computer Algorithm, Decision Support System

1. Introduction

With the development of social economy, the logistics industry continues to flourish and improve [1-3]. Logistics refers to the physical movement of physical entities from suppliers to demanders. It consists of a series of economic activities that create time value and space value, including transportation, storage, distribution, packaging, loading and unloading, circulation processing, and logistics information processing. The basic activities are the unity of these activities [4-5].

Traditional cold storage environment monitoring systems usually use wired networking technology, which has problems such as difficulty in wiring, high cost, large measurement data errors caused by line transmission loss, and easy aging and damage of lines, increasing maintenance costs in later stages [6-8]. Traditional refrigerated trucks usually use manual methods to collect monitoring data regularly, which not only takes time and effort, but also brings safety hazards to the cargo due to poor real-time performance [9-10].

Relying on computer algorithms, this article attempts to explore the design and development of intelligent logistics tracking system, aiming to provide logistics enterprises with efficient logistics management platform support and provide customers with value-added services.

2. System design

2.1. System goals

The significant difference between modern logistics and traditional logistics is that it can provide value-added services that traditional logistics cannot provide. The whole-process tracking and control

of logistics is one of the most important value-added services provided by modern logistics, and it has also become one of the core technologies of modern logistics development. Therefore, the design goal of the intelligent logistics real-time tracking service system is to comprehensively apply advanced computer technology, communication technology, artificial intelligence and other technologies to the logistics system, and solve the real-time information collection of logistics operations through GPS, barcode and other technologies, and intelligently analyze and process the collected information, provide decision support for logistics managers, and provide customers with detailed information and value-added logistics services under the operating environment of EC.

2.2. System structure design

The "Intelligent Logistics Tracking Service System" is composed of four subsystems: logistics platform management subsystem, warehouse management subsystem, transportation scheduling and monitoring subsystem, and e-commerce platform subsystem, as shown in Figure 1.

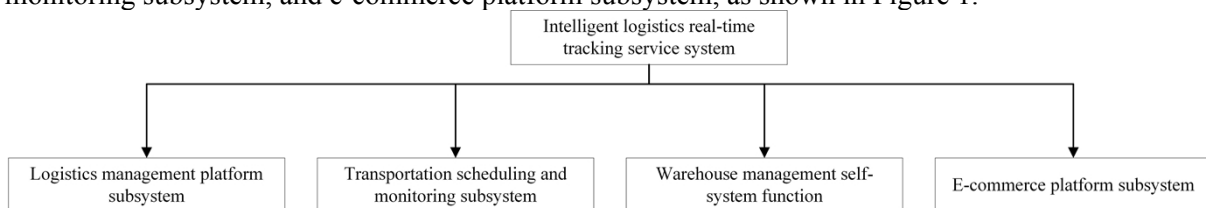


Figure 1. System logical structure diagram

The intelligent logistics tracking system consists of 4 parts: a wireless sensor monitoring network, a data transmission network, a monitoring center (remote monitoring terminal) and a secondary monitoring center (transportation staff). The base station is responsible for the long-distance transmission of data, and can also provide communication for the monitoring terminal and the sink node. The monitoring terminal is responsible for further analysis of the data, monitoring and tracking the status and integrity of the cargo behavior.

The wireless sensor monitoring network is the core of the entire monitoring system. Responsible for the collection of cargo status data and preliminary detection of abnormal behavior. When the cargo behavior is abnormal, the detection results are transmitted to the secondary monitoring center in real time, and the status data under the abnormal behavior is transmitted to the primary monitoring center. Each cargo in the carriage of the primary monitoring center has a detection node. The entire monitoring network consists of multiple The detection node is composed of a sink node (gateway).

The detection node is deployed inside the cargo, close to the surface opening position. The hardware structure is composed of a local storage module, a processor module, an energy supply module, a magnetic sensor module, a three-dimensional acceleration sensor module, and a wireless communication module. When the goods are packaged, the door magnetic sensor module and the permanent magnet are close together to passively sense the opening and closing information of the goods package. If the goods package is opened during transportation, the detection node will use the wireless communication module to transmit the current monitoring to the convergence node data. The three-dimensional acceleration sensor module samples the acceleration of the cargo in 3 dimensions (X, Y, Z) at a certain sampling frequency. The processor analyzes the collected data and judges the current behavior of the cargo. When the cargo behavior is abnormal, the wireless communication module is used to report The sink node transmits the current behavior and monitoring data of the goods.

The GPS node is deployed on the top of the carriage of logistics transportation, and the hardware structure is composed of a local storage module, a processor module, an energy supply module, a pre-Puddle module, and a 5G module. The GPS receiving module regularly measures its current position. In order to receive satellite signals normally, its GPS antenna needs to be led out and installed outside the vehicle. The Zigbee communication module conforming to the IEEE802.15.4 standard provides geographic location information and time information to the wireless sensor monitoring network in the carriage.

The gateway is deployed on the top of the carriage of logistics transportation, and the hardware structure is composed of a local storage module, a processor module, an energy supply module, an advance module and a 5G module. The wireless communication module is used to receive the data sent by each detection node. The pre-Puddle module provides real-time notifications of abnormal cargo behavior to the transportation personnel. The 5G module transmits the received monitoring data of the abnormal behavior of the cargo to the remote monitoring terminal for supply. further analysis. In order to receive 5G signals normally, its GPS antenna needs to be drawn out and installed outside the vehicle.

The data transmission network is composed of GSM network and adopts 5G wireless communication mode. 5G is a 5G packet-switched data network based on China Mobile' s GSM network. It has good signal coverage. In most areas of the country, it can automatically attach to the 5G network as long as it is turned on, and establish a communication link with the data center to provide stable data. transmission. At the same time, 5G charges fees according to the number of data packets received and sent, and no fees are charged when there is no data flow. Therefore, the use of 5G communication can ensure the reliability, real-time, stability and economy of monitoring data transmission.

2.3. System function design

After extensive research, in view of the current status of most logistics companies in my country and the actual needs of the logistics market, the system requirements are mainly reflected in the following aspects: ① Realize the order processing, planning, storage, inventory, transportation, ordering, etc. of the logistics system It is the most basic requirement for the system to support the logistics business and be compatible with other information systems of the enterprise. ② Collect and transmit the dynamic information of cargo vehicles through the GPS positioning system, and the driver can also send various short messages to the logistics center through the on-board equipment on the way. ③ Customers connect to the e-commerce platform through the Internet. On the one hand, they can place orders, and on the other hand, they can also inquire about the order or goods information, so as to understand the order and the running status of the goods in real time. ④ The logistics manager can monitor the vehicle in real time through GPS and GIS. Understand the operating status of the vehicle and conduct real-time scheduling. ⑤ Able to realize auxiliary decision support for transportation scheduling and inventory management and other issues.

3. System research

Since the two logistics links of inventory and transportation involve a large number of decision-making optimization problems, and these problems cannot be solved by simply relying on the experience of the logistics manager. Therefore, the system is required not only to provide information for the logistics manager, but also to assist the manager in providing decision-making. Support us to establish their own intelligent decision support systems in the transportation scheduling and monitoring system and the warehouse management subsystem to assist the decision-making of the shopkeeper and the warehouse manager. Take inventory as an example here to design an intelligent decision support system, as shown in Figure 2.

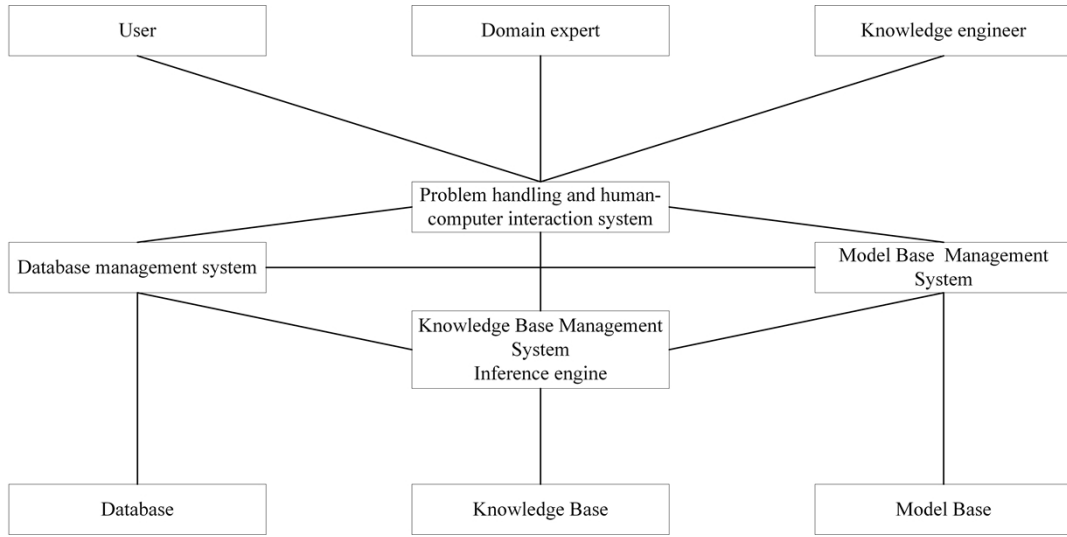


Figure 2. Overall structure of inventory IDSS system

The basic workflow of the intelligent inventory decision support system is as follows: ① The user enters the inventory information table through the man-machine dialogue interface. ② Search the case library in the knowledge base. If there are existing cases, use the inventory model in the case to optimize and output the optimization results, otherwise go to the next step. ③ Using an inference engine to find matching rules, output the found inventory model, and apply the model and related methods to solve it. ④ Evaluate and compare each inventory model selected by the system, and return the comparison result to the user. ⑤ Choose the best inventory model and store the case in the knowledge base. ⑥ Output the final decision result. In order to realize the above-mentioned functions, the detailed design of each link of the system is as follows.

3.1. Selection of inventory model

The selection of inventory model plays adopts the strategy of combining case matching and rule matching. Case matching is a deterministic inventory model selection strategy. It compares the user's problem with the case in the case library (actually also expressed by the IF<condition>THEN<case> rule). If the same case is found, it will be used. The inventory model provided in this case is used to solve the problem—otherwise, the rule matching method is adopted. This method is an uncertain selection strategy. It can produce a variety of inventory models. The system also needs to compare and select the best on this basis." To determine the final inventory model rules to adopt production rules, that is, IF <selection conditions> THEN <inventory beam type> IF-THEN rules are stored in the knowledge base, and the knowledge base management system maintains the reasoning engine using depth first. The forward reasoning mechanism of the search strategy performs rule matching search. The selection conditions in the rules consist of inventory information in a standardized format, taking into account the components of the inventory model and the manager's experience judgment, and the specific design of the goods information.

The description of the model variables is shown in formulas (1) and (2):

$$x_{v,v+1}^i = \begin{cases} 1, & \text{Choose the } i\text{-th path between nodes } v \text{ and } v+1 \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

$$y_v = \begin{cases} 1, & \text{Choose to carry out logistics processing activities at node } v \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

Among them, $c_{v,v+1}^i$ is the unit transportation cost between nodes v and $v+1$; q is the volume of goods in the logistics chain; $l_{v,v+1}^i$ is the length of the i -th path between nodes v and $v+1$; r_v is the logistics at node v The unit processing cost of the processing activity; V is the set of available logistics nodes; I is the set of available logistics routes.

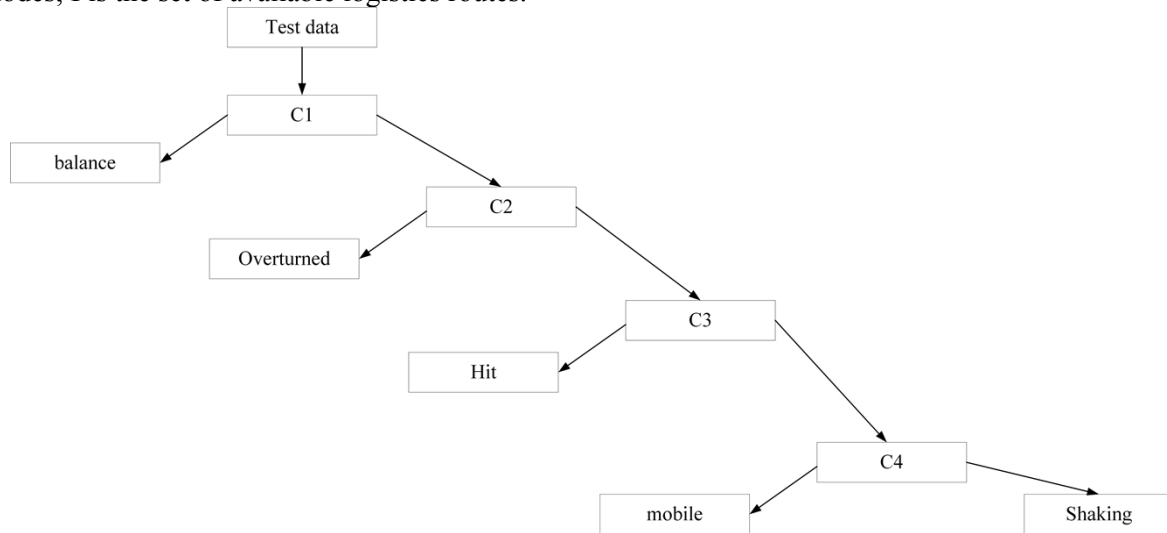


Figure 3. Classification tree of the algorithm

The selection and priority setting of various data statistical characteristics for determining cargo behavior in Figure 3 are based on the definition of cargo behavior and the analysis results of characteristics of cargo behavior.

The first two pieces of information are automatically extracted from the relevant database by the system, and the last five pieces of information are provided by the user to the system. The specific representation methods for each field are: demand characteristics: 00 means definite demand, demand is constant; 01 means definite demand, demand is variable ; 10 means random demand, demand does not change; 11 means random demand, demand changes-replenishment strategy: 0 means instant replenishment; 1 means delay-out of stock strategy: 00 means no out of stock is allowed; 10 means out of stock is allowed, the missing goods are replenished immediately when the order arrives; 11 means that the shortage is allowed, and the missing goods will no longer be supplemented. Inventory strategy: 0 means continuous inventory; 1 means regular inventory. Importance and ease of purchase are expressed in vague language. The fuzzy comment sets are (important a1, more important a2, general a3, less important a4, minor a5), (easy to buy b1, easier to buy b2, general b3, more difficult to buy b4, difficult to buy b5), and use 5 points system for representation, stipulate that $b1=a1=5, b2=a2=4, b3=a3=3, b4=a4=2, b5=a5=1$.

3.2. Comparison of inventory models

Evaluate and compare each inventory type selected by the system-the evaluation indicators include: fixed costs, storage costs, loss of stock, service levels, and management work volume, etc. The system compares the above indicators of the inventory models that participate in the comparison, and compares them. The result of the comparison is returned to the user.

3.3. Inventory model selection

The system provides two ways to select the best inventory beam type. One is that the decision-maker directly makes the best inventory model selection based on the comparison results of the model stocks based on his own experience. The second is that the decision-maker feels the choice is difficult and uncertain. Request the system to assist in selecting the best. Here, the fuzzy comprehensive evaluation

method is used for system-assisted selection to reduce the decision-makers' decision-making bias caused by the uncertainty and ambiguity of various subjective and objective factors.

The case is saved. The result of this system is stored as a case in the case library in the knowledge base. In addition, the knowledge base management system can also collect and accumulate empirical knowledge of inventory lock type selection that users consider valuable through the man-machine interface for later use when selecting a model plow.

4. System implementation

The system adopts 3-layer C/S and BIS hybrid method for development. In the main business department, the three-tier C/S structure is used, while for the personnel of other departments, their purpose is to query information. Using BIS technology, various information can be released on the e-commerce platform for decision-makers and employees. Inquire. The e-commerce platform is connected to the Internet through the firewall, so as to realize the functions of placing orders, information publishing and querying various customer services on the Internet.

4.1. Logistics platform management subsystem

The functions of the logistics platform management subsystem mainly include order processing, distribution planning, order planning, and real-time monitoring of delivery vehicles.

4.2. Warehouse management subsystem

The warehouse management subsystem realizes the processing of warehousing operations such as warehouse entry and exit, and uses bar code technology to identify and describe the goods, so as to realize the real-time collection of goods in and out of the warehouse.

Another function of the warehouse management system is to optimize inventory and support decision-making: the system can interact with managers, understand their problems, wishes and preferences, output optimization results, and assist managers in inventory decisions.

4.3. Transportation scheduling and monitoring subsystem

The transportation dispatching and monitoring subsystem is composed of a mobile target vehicle-mounted unit and a dispatching center. The mobile target vehicle-mounted unit includes a GPS receiving module, a GSM two-way wireless communication module, an antenna and other equipment, which can achieve two-way wireless communication with the monitoring center through GSM, and through the GPS module collect vehicle positioning information, and send the positioning information and cargo information to the monitoring center through GSM short messages. The Dispatching Center is composed of SMSP, server, SQL Server database and GIS. It can track and monitor the delivery vehicles, and use GIS, IDSS, computational intelligence and other technologies for static and real-time transportation dispatch. Among them, the real-time monitoring function can display the operating status of all or part of the vehicles on the same screen, realizing real-time dynamic monitoring of the whole process of logistics cargo distribution.

Distribution route planning is an important part of the transportation scheduling and monitoring subsystem, which can provide dispatchers with real-time vehicle scheduling and static support for powerful decision-making. The basic function is to embed the algorithm software into the GIS by setting the starting and ending points and nodes of the goods distribution on the map, so as to obtain the optimal route of the distribution, and provide an animated demonstration of the user's image.

4.4. E-commerce platform subsystem

The e-commerce platform adopts the B/S model, and its publishing form is a logistics website. The customer operation interface is a web browser. On the corresponding website, goods and orders can be tracked in real time, and the in-transit transportation of their goods and the completion of orders can be inquired. System personnel can review and preliminarily process orders placed by customers on the e-

commerce platform, monitor and dispatch vehicles in real time, and publish relevant information on the platform. Transport dispatchers and customers can inquire about the cargo status in real time.

The corresponding recorded cargo behaviors during the experiment are: impact, shaking, moving and overturning, and the detection results are consistent with the recorded results.

After detecting the four types of abnormal behavior data of the goods, it can be seen from the results that the algorithm can accurately detect the overturning and impact behavior of the goods, mainly because the intelligent algorithm in this paper is based on the most similar multi-feature recognition, and the feature is the priority. Sort by level to ensure that cargo behaviors with obvious characteristics can be detected first. By comparing the recorded results and detection results of the experiment, and observe the three-dimensional acceleration data signal characteristics of the cargo when the detection error occurs, it is found that the abnormal behavior characteristics of the cargo are fuzzy. Sex has led to errors in the test results. The slight and stable movement is not detected, and it is considered that the cargo is in equilibrium; the rapid acceleration of the train starting and stopping causes the steady increase in the three-dimensional acceleration of the cargo, which is misdetected as the movement of the cargo itself; slight shaking of the cargo (The shaking amplitude is very small) will also be detected as movement.

From the above analysis, it can be seen that the intelligent algorithm for the detection of abnormal cargo behavior has high accuracy. In the existing 80 tests, the error rate is less than 5%. At the same time, the detection results verify that in the classification tree of the intelligent algorithm, the farther the cargo behavior from the root node (the deeper the leaf node) is, the more complicated the detection process, the less obvious the feature, and the higher the probability of detection error.

5. Conclusion

This paper proposes an intelligent tracking system based on intelligent algorithm for the demand of logistics goods status perception, which can accurately obtain the environmental parameter information and related geographic location information of logistics goods in real time and conduct experiments and tests in the actual vehicle environment. The results show that : The algorithm can accurately obtain the movement behavior state of the goods, and can accurately and promptly report to the police when the goods are unpacked.

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