Active acquisition system of LBS-based logistics freight source information

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Abstract: In order to solve the bottleneck of logistics information exchange and meet the demand for getting freight source information in time, this paper proposes a solution of active acquisition system of logistics sources information based on LBS with Android mobile terminal. By using GPS/WIFI positioning technology to achieve the acquisition of the information of user's current location and through wireless network, the data are further sent to the spatial-temporal database of service terminal, where the spatial data and attribute data about logistics sources information are integrated and stored. Then these data are analysed and processed by use of the dynamic programming algorithm based on real-time logistics sources information. Finally the Baidu API is used

to realise the visualisation of post-processing of logistics sources information so that the services in active acquisition of peripheral logistic information and optimal receiving route planning might be provided.

Keywords: logistics freight source information; LBS; Android intelligent mobile terminal; optimal receiving route.

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1 Introduction

Logistics informationisation increasingly deepens with rapid development of modern logistics. Logistics information takes a greater and greater proportion of logistics activities (Wang and Shao, 2011). Logistics information is one of the main factors which have an impact on traffic efficiency and information of transport capacity is the major power for supporting logistics transportation trading. As road transportation takes use of market mechanism, various social capital swarms into the industry. The base unit of road transportation has a large amount and is miniaturised (Pan, 2005). It becomes necessary

whether they can obtain information of freight source in the increasingly fierce competition.

Traditionally, collection and release of information of freight source are primarily conducted by logistics intermediaries who play a leading role in the market. Such a model mostly relies on logistics intermediaries who have to manually hunt for goods to be carried and vehicles of carrying goods and keep a record of information of freight source and information of transport capacity. Publishing of both types of information has to take use of LED screen or blackboard (Ge, 2008). It wastes time and labour from acquisition to publishing of the information with poor timeliness which has a strong impact on traffic efficiency. The separation of information of freight source and that of transport capacity results in lack of timely and effective communication between goods owner and vehicle owner increasing empty driving-back of vehicle and transportation cost. As only logistics intermediary can acquire information of freight source, goods owner and vehicle owner have no chance for two-way selection. Logistics transportation cost is increased wasting lots of social resources (Zhang, 2010).

With continuous improvement of positioning and navigation technology, the industry associated with location-based services (LBS) develops rapidly and becomes one of the most potential technological industries. Up to June 2014, internet penetration reached 46.9% and our mobile internet users were 527 million (2014). LBS Apps based on smart mobile terminal rise sharply and gradually turn to a new internet hotspot with rapid development of mobile internet and spreading of smart mobile terminal (Spinney, 2003). LBS achieve positioning and service between fixed users or mobile users with the help of the internet or wireless network (2011). Generally speaking, the LBS mainly include the following function modules: positioning system, information management system, information push system, GIS, mobile terminal (Li, 2009).

The application of LBS was developed rather earlier abroad and pretty fast development has been achieved (Longal et al., 1996; Cheverst et al., 2000; Kirste and Encarnacao, 2000). The DEEPMAP system of the European Media Lab is one of the typical representatives (Malaka and Zipf, 2000). At present, the domestic LBS application has also been integrated into people's daily life. Meituan.com and Dianping.com, Wowotuan and other companies have successively released the applications with LBS function (Tang, 2011). Although the intelligent mobile terminals become more and more intelligent and diversified currently (Wierenga and Komisarczuk, 2005), Android smart phones have become the main carriers for LBS applications by virtue of their own advantages for Android smart phones are available for internet surfing anywhere at any time even if there is no WIFI network (David Mountain and Jonathan Raper, 2001; Kushwaha and Kushwaha, 2011), basically meeting the functional requirements on hardware as required by the system. LBS system usually makes use of Android smart phone as data collecting and receiving tool because Android could satisfy functional requirements of the system.

In the process of studying the acquisition of positioning data, Mountain and Raper (2001) have done some research on the basic characteristics of the location service on the basis of positioning data which has been acquired, and they put forward the corresponding solution in the view of the time limitation and the space limitation in the position service.

In the study of the application of LBS technology, Kushwaha and Kushwaha (2011) designed a kind of location service based on Android mobile operating system, the characteristics and advantages of using Android system as a kind of location service class

is given in their paper. Through the analysis, we found that there are still some deficiencies in the research as follows.

- First, lower intelligence. The logistics intermediary could only provide information of freight source without real-timely updating it to obtain maximum profits. It is short of time-space attribute description of information of freight source. The existing time and space data storage is not good for data analysis and time-space coupling simulation cannot be realised (Kenyon and Morton, 2003).
- Second, poor timeliness. Vehicle owners have to query information of freight source by visiting logistics intermediaries. Usually, they could get appropriate goods to be carried after visiting several intermediaries, which wastes time and energy. Information acquisition cannot be realised anytime anywhere.
- Third, low coverage. So far, there are plenty of LBS related Apps which are mostly about traffic, entertainment and social areas. Few Apps of logistics information service are developed (Ak and Erera, 2007).

This system takes the logistics informationisation as an opportunity and studies the method for active acquisition of freight source information with the help of Android intelligent smart phones based on the LBS pattern. It concentrates on three main issues: location information collection, transmission analysis and generation service. The collection of vehicles' location is realised by fully utilising the functions of Android smart phones like universality, portability and real-time location information acquisition capability and the rapid acquisition of freight source information is fulfilled by adopting LBS mode to search the periphery freight source information based on the current location of vehicles. Then, the dynamic programming algorithm for real-time sources of information is adopted to generate the most profitable receiving route. This system provides us with effective support in realising the informatisation of logistics and offering scientific way for rapid butt joint of freight source information and logistics vehicles, which are of great significance for the logistics informatisation improvement.

The remainder of the paper is organised as follows: Section 2 describes the system needs, and systematic design is presented in Section 3. The core technology is given in Section 4. Section 5 concludes the paper.

2 System requirements

The LBS-based information of freight source active acquisition system creates a more convenient information of freight source acquisition mode by Android smart phone with support of LBS technology aiming to the information acquisition issue in development of logistics informationisation to serve all vehicle owners, reduce difficulties of hunting for goods to be carried and promote the matching accuracy of information of freight source and that of transport capacity having great values for optimising the development mode of logistics industry. In order to timely and accurately acquire information of freight source, the requirement analysis of the system is as follows.

- User needs: the system divides the users into common users and administrators. The common users, who are namely the drivers using the system, can send their location information to acquire the peripheral freight source information and the optimal receiving route; the administrator mainly take charge of daily system maintenance, analysis and handling of abnormal information.
- Functional requirements: the process of achieving logistics freight source information is as follows: get the current position of the driver, then transmit and store data, analyse and process the data and finally publish the information of logistics freight source. So the basic functions of the system shall cover the collection of user's location information, data transmission and analysis, data analysis and integration, generation of visual and optimal route for peripheral freight source information and the basic login and registration functions, etc.
- Data requirements: for the freight source information data, currently, collection of freight source information is mainly executed by the logistics intermediaries. The data grasped by a single freight forwarding intermediary is usually in small volume and disperse, causing a series of problems in statistics and analyses of freight source information and vehicle dispatching in that area.

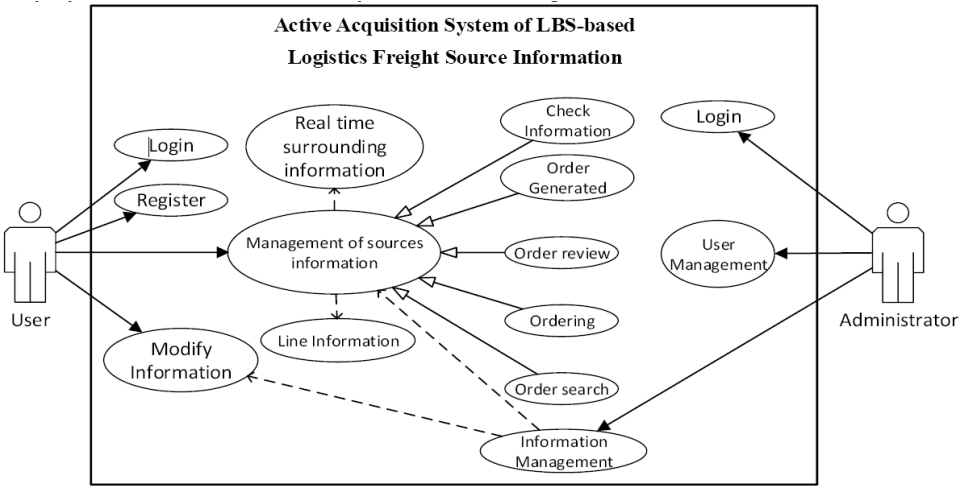
3 System design

This system is developed by application of the C/S framework, involving intelligent mobile client and server. The client APP running under the Android system, use JSON data format to encapsulate the data and make data interaction with the server through WIFI/GPRS. The functions of getting the current position of the driver, the data transmission, the display of the logistics freight source information are achieved by intelligent mobile client. The servers mainly realises the aggregate storage of spatial data and attributes data among the logistics freight source information, user's requests analysis and the optimal receiving route generation.

3.1 Logical structure design of the system

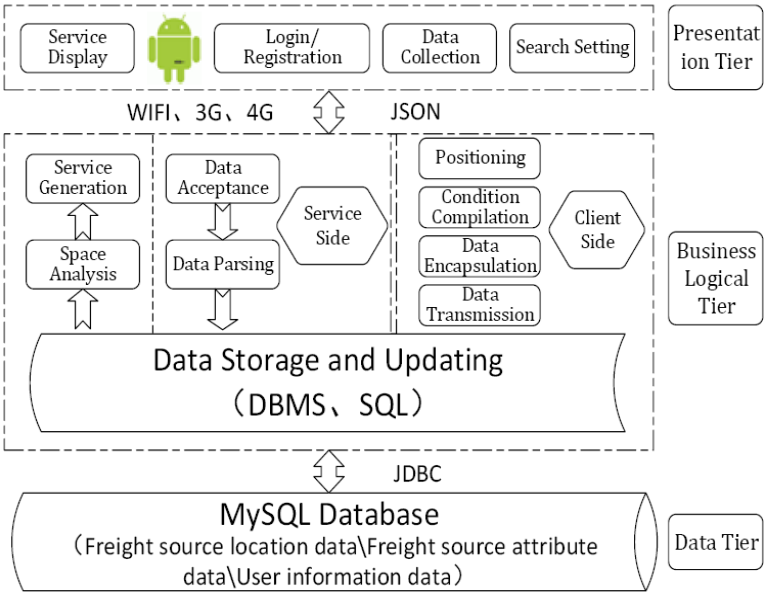
The research core of this system is the active acquisition of logistics freight source information, the system integrates data acquisition, storage and analysis to actively acquire information of freight source by building 'presentation layer, business logic layer and data layer' as shown in Figure 1. Presentation layer runs on the Android smart mobile terminal of vehicle drivers to offer them information interactive interface, search criteria settings and thematic map display, etc. Business logic layer has logical processing to data based on user request to realise data analysis and storage, space information analysis and processing, searching of information point of freight source and development of maximum return path. Data layer is responsible for storage of location and attribute information of freight source and historical route information, and implements adding, deletion, amendment and display of information data of freight source.

Figure 1 System use case diagram



The logical structure of the system is shown in Figure 2.

Figure 2 Logical structure of the system (see online version for colours)



3.2 System function design

3.2.1 Function design of android client

- Collection of user location data: the efficient access to the information of logistics freight source depends on three conditions: the user's request time, current position and the type of needs, i.e., the user needs to provide three elements of geographical

attributes including the current time, space and attribute. Collection of time element: the system automatically acquires the current time of intelligent mobile terminal as the time for the user to submit the search request; collection of space element: it acquires the user's current location information through the positioning function of the intelligent mobile terminal; collection of attribute element: the user can set the search radius according to its own situation. This system has set the priority of search conditions to improve the retrieval efficiency and enhance the matching ratio between logistics freight source information and users. Users can choose the price, type, distance, and other search conditions to search according to their own situation and further set the attribute parameters like unit price, type of freight source, retrieval radius.

- Data management: data management of Android client terminal mainly comprises packaging, storage and transmission of user location and attribute information. The client terminal will package the user location and attribute information in JSON data acquisition format when it acquires the information and send the packaged user information to appointed servers with HTTP protocol packets through WIFI/GPRS.
- Service display: server will search for the eligible information in the spatial-temporal database after receives a request for search of the peripheral freight sources information from the Android client, and the search result will be fed back to client through WIFI/GPRS The Client then will invoke Baidu API to load the freight source information points up to the base map of Baidu sitemap and integrates the freight source information point and user's current location into a thematic map to be shown on the interface of Android client.

3.2.2 Function design of server

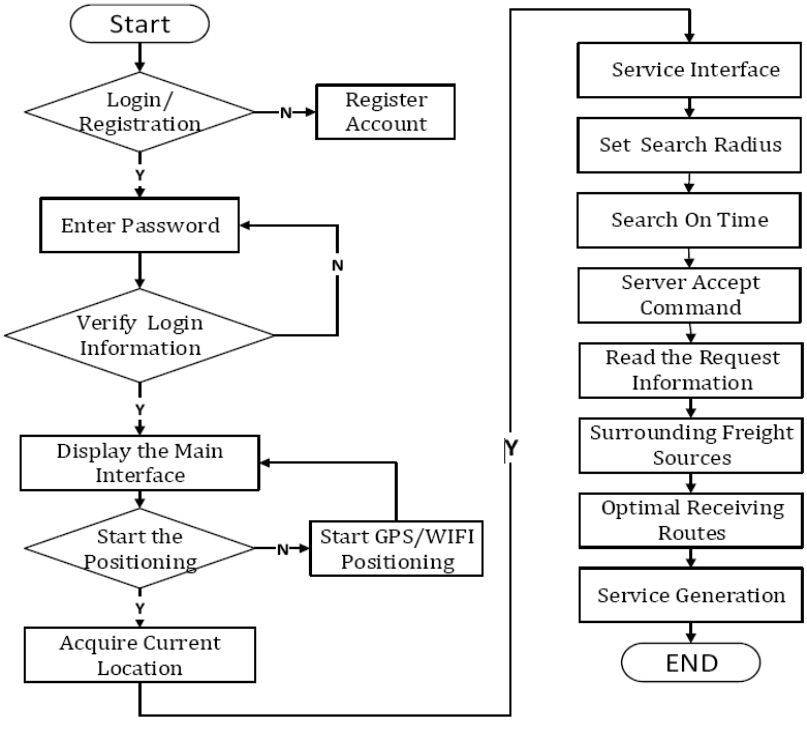
The server mainly realises the data analysis, storage and the generation and publication of services; In term of data storage, spatio-temporal database that integrates time and space elements is used; In respect of data processing, the aggregate analysis of spatio-temporal and attribute data is used to generate the peripheral freight source visualisation and optimal receiving route services to meet the individualised needs of customers.

- Information database of freight source: it adopts spatial-temporal database which contains time elements in information storage of freight source to achieve aggregate storage of both spatial-temporal data and attribute data. Timely and effective information of freight source could reduce no load ratio of vehicles. In traditional storage mode, space, location and attribute are stored separately. It can meet the quick query demands at early stage but is not good for statistical analysis at the later stage. If we only focus on spatial distribution of information of freight source, the sequence of information release within current scope and intensity in time cannot be described accurately. However, if we only pay attention to the sequence of information release and intensity, the spatial distribution cannot be stated clearly. Giving consideration to both query efficiency and data analysis at the later stage, the system makes use of Oracle database which is OK for spatial data storage to establish an information database of freight source containing both time-space and attribute for aggregate storage of both spatial data and attribute data. The

combination of release time and location of information of freight source provides more powerful data support for data analysis of information of freight source.

- Fixed-point service: such mode is appropriate for vehicles which are parking and waiting for goods to be carried. Users could specify search criteria on LBS-based service-class APP with Android smart mobile terminal to send a search query actively. APP obtains the current location information of vehicles with the positioning system of smart mobile terminal and sends both the location information and search criteria to the server which could provide location-based service through mobile internet. The server searches location and attribute information of freight source which could meet the requirements (designated area and price range) in information database of freight source based on search criteria priority level. For example, search all information of freight source within the scope centring on vehicle location with radius of designated search distance. The information database of freight source sends all location and attributes information of freight source which conforms to criteria to the server who forwards it to the smart mobile terminal of vehicle drivers through mobile internet. A thematic map of surrounding information of freight source appears on the terminal interface. The vehicle driver could view detailed information of freight source and contact of goods owner's by clicking the point of information on the map. Then the service will be finished as soon as driver contacts goods owner for picking up goods.
- Route service: the travelling track of logistics vehicles will be stored in the system database offering a track data base for route service, in which vehicle driver could specify starting point and the system will produce hot route along the road according to historical route. The driver could view information of freight source which meets search criteria in the designated area at both sides of the track, and can plan an optimum goods-collecting route in travelling based on the periodic updating information of freight source.
- Search process: a driver logs into the system, activates the search service, and sends out the request for freight information search within the search radius of Android intelligent mobile terminal; the system invokes the positioning function of the intelligent mobile terminal to acquire the real-time location information of vehicles on time, and sends the driver's current location information as well as the search radius to the server through wireless network. The server that provides the location service searches for the eligible location and attribute information of freight source according to the priority levels of search radiuses in the freight source information database, which then feeds back the search result to the server; when the user clicks to generate a work order, the server will carry out the search in the freight source information database again, uniformly keep the effective freight source information in the array and invoke the optimal route algorithm to screen the most beneficial receiving route within the current scope; the server will send the most beneficial receiving route as well as the location and attribute information of all the freight source points on the route to the driver's intelligent mobile terminal. The driver can look over the optimal route and the detailed freight source information on the map, add or delete some freight source information points manually, and contact the owner of cargo to receive the goods to complete a service. The system flowchart is shown in Figure 2.

Figure 3 System flowchart



4 Realisation of core function of system

The Android client performs the programming based on JDK1.7 and Android SDK in the Eclipse3.8 development environment. The test phone types include Samsung and Huawei series. Both the hardware environment and operating system (OS) version can support the operation of client; the server OS is Centos and is set up with the Tomcat7 supplied by Apache Company; Oracle is selected as the database.

4.1 Vehicle location data collection

The core functions of Android smart mobile terminal acquisition include collection of the vehicle location, time, and condition information. To obtain the current location, the system needs to call the GPS functionality of phones. Firstly, Android system judges whether GPS satellite positioning, the base station location, A-GPS positioning or WiFiAP positioning is enabled by calling is ProisProviderEnabled of LocationManager class. If the function of positioning is not enabled, the system will jump to the GPS control page with prompting the user to open positioning operation and select positioning mode by Intent (settings. ACTION_LOCATION_SOURCE_SETTINGS). Then, the system will call the method of on LocationChanged (Location location) defined in LocationListener interface to get the latitude and longitude coordinates of the current position.

Figure 4 Vehicle position (see online version for colours)

Figure 5 Peripheral freight source points (see online version for colours)

By default, the system will directly call the calendar to get the time, shown on Android smart mobile terminal which will be regarded as the release time of this request. Under special circumstances, the DataPickerAialog class can also be used to set the request time. Then the system encapsulates temporal information and search criteria into JSON strings. The communication between Android smart phones and server follows the HTTP protocol. The transmission of information obtained HttpClient client by using DefaultHttpClient class, and write the packaged JSON strings in the form of key-value pairs into HttpPost Entity and specify the server address. Finally, by executing the method execute of HttpClient, the system will send encapsulated vehicle owner's data to the server which provide location services for processing.

4.2 Optimal receiving route algorithm

The route planning for a logistics vehicle is always one of the core problems influencing the logistics transport efficiency (Yan and Tang, 2008; Eksioglu et al., 2009; Erera et al., 2009; Zhang, 2012; Bräysy and Gendreau, 2005). For the purpose of enhancing the driver's earnings, the system introduces the optimal route algorithm, which studies the optimal receiving route within a small scope based on the freight source information searched out by LBS.

The basic thoughts of optimal receiving route algorithm: firstly, construct an initial route through the 'construction algorithm'; then, improve the initial route via the 'improved algorithm' (Erera et al., 2009). By using the Dijkstra algorithm, the construction algorithm searches for the peripheral freight source points and finds out the freight source point which can bring the maximum earnings. The basic procedures of Dijkstra algorithm: calculate the earnings from the starting point to all the peripheral points till find out the most beneficial point, then set this point as the starting point and traverse the residual points again to finally acquire the most beneficial receiving sequence.

The 'improved algorithm' adopts the 2opt method, exchanging the two edges in the route till failure to continue improving the route. Basic procedure: exchange the two edges with the same starting and ending points every time till the earnings cannot be optimised any more. As shown in the figure, edge (i, i + 1) and edge (j, j + 1) are replaced by the (i, j) and (i + 1, j + 1), and the logistics vehicle's access sequence between i + 1 and j is changed accordingly. In the route optimisation process, the system exchanges with other edges in proper sequence starting from the first edge each time. Once the route with a higher earnings is found, the system will exchange with it (from the first edge) till the route which will bring the maximum earnings for the user is found (Erera et al., 2009).

Figure 6 2opt example (see online version for colours)

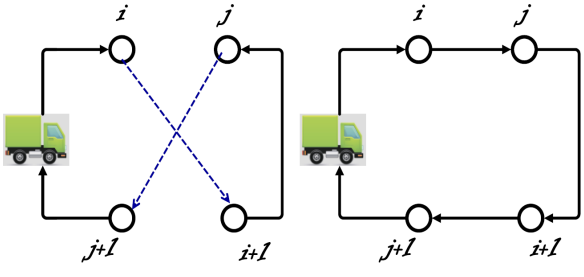


Figure 7 Optimal receiving route (see online version for colours)

The algorithm pseudo-code is shown below.

Step 1 Initiate the program; set 0 for the array of dist, path and s and table open and close; define the number of all the freight source points around n.

Step 2 If (the number of elements in s < n).

- Step 2.1 Find the maximum earning in dist[n] (offer of freight source – route cost) and define the point as nm.
- Step 2.2 Output dist[j] and path[j].
- Step 2.3 Modify data dist and path.
- Step 2.4 Add the maximum point of earnings in the array s.

Step 3 Else takes out the first node nm1 from array s and insert nm1 in the closed table.

Step 4 If nm1 is the targeted node, return the result to Step 6.

Step 5 Else jumps to Step 9.

Step 6 Set 0 for reset and starting point count 1 of the first edge.

Step 7 Circulate the starting point count 2 of the second edge from count 3 to count N.

- Step 7.1 If the total revenue becomes more when the two edges are exchanged, set 1 for reset.
- Step 7.2 Carry out count1 = count1 + 1. If count1 < N-1, return to Step 7; or else, Step 8.

Step 8 End this inquiry.

After data collection of the driver, the research service generated is shown in Figure 7.

5 Conclusions

The system has been running in Shihezi city from March 2014, according to the test, this system can use the communication-base stations or GPS for positioning and get the owner's location within 1~3 seconds. Positioning accuracy of it can reach 30 cm more or less by the higher accuracy of existent point and suitable converting parameters. In this test, it cost 0.56 KB of traffic flow per time, mobile phone has 30 M traffic per month and costs 5 yuan. So this system can provide about 54,857 times a month to meet the needs of the system economy and service times. If the communication network under normal circumstances, fixed-point service needs 1~2 seconds to complete the display, route service needs 3~6 seconds to complete the drawing for meeting the requirements of rapid response.

The characteristic of this paper lies in the application of innovation, for combining LBS technology with logistics field. This thesis was written when similar systems and applications have not yet appeared. Therefore, there was a lack of contrast at that time. Mayun mentioned the APP named huochebang at the APEC summit talks with Obama, huochebang help truck drivers to solve the problem of empty vehicle, in 2015. The function of the huochebang is basically consistent with the system in this paper, especially in the field of application, This APP is more detailed than our system in terms of the type of goods and the maturity of huochebang is higher too. The advantage of our system is that can not only query the surrounding information, but also plan a reasonable receiving route. The huochebang helped freight cars in China save 10 billion yuan of oil in 2015. The system in this paper is still in the free trail stage, has not yet vigorously promote. There are 25 users in the system, after using the system users save two hours a day and bringing 200 yuan extra income. The analysis proves the practical contribution of the system.

In allusion to the low intelligent degree and poor timelines in the logistics information interaction, this paper designs the active acquisition system of freight source information by analysing the advantages of LBS pattern based on the Android smart phones. As shown in the preliminary test, the system has been proved to have good interaction.

1 From the viewpoint of users, the system has good economic efficiency with simple system interface design and character of easy operation; from the viewpoint of technologies, the system realises the timely and correct acquisition of freight source information through the Android intelligent mobile terminal, by using JSON data format, the communication flow has been reduced greatly. As for data storage, spatio-temporal database is used to provide a data basis for the following time-space analysis and coupling stimulation.

2 But the generation of optimal receiving route as well as the calculating efficiency for the optimal receiving route planning algorithms till need to be improved. The next step is to combine Markov chain model and discover the law of supply information release in time and space on the basis of analysing the existing supply information. It will improve the revenue of single path and provide better service.

This system has improved the traditional freight source information acquisition mode. On the one hand, it provides a new service mode for the highway transportation and has constructed a new bridge between the transport organisations and the logistics organisations; on the other hand, the circulation of freight information will allocate the logistics resources reasonably and save the cost of logistics which will further optimise the matching efficiency between the logistics freight source and transport information and has important economic value and social significance for promoting the development of logistics informationisation.

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