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Public Transportation Development in Smart Forest City Based on Cloud Computing

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Abstract:

The intelligent level of public transportation in smart forest city is an important symbol of urban development and industrial manufacturing development. Urban road network in smart forest city is a kind of complex network. Complex network theory is an important branch of complex systematic science. At first, complex networks are used to describe the interrelated theories in natural and Social Sciences and engineering technology. Later, they have been widely used in other fields, and become one of the hot topics in many disciplines. This paper uses the theory of complex network knowledge, combined with the intelligent algorithm developed in modern times, to generate and optimize the urban public transport network. The optimization of urban public transport network is mainly for the convenience of residents' travel and urban development. Starting from the topological structure, this paper analyzes the mutual attraction relationship of public transport traffic volume between nodes, and combines with genetic algorithm to determine the optimal route selection. Finally, we get the urban public transport network to meet the urban development and residents' travel needs.

Keywords: *Forest city, intelligent transportation, manufacturing, cloud computing.*

I. INTRODUCTION

Driven by the environment, China is in a period of rapid development, and people's living standards are also increasing. As an essential element of people's daily life, residents' travel is gradually getting people's attention. At the same time, the progress of science and technology has greatly reduced the manufacturing cost of vehicles, making the number of residents of motor vehicles increase year by year. In order to alleviate the traffic congestion problem, the state strongly encourages residents to take public transport to relieve the traffic pressure, which is one of the reasons why major cities are competing to build the subway. Giving priority to the

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development of public transport is an effective way to solve the problem of congestion. Residents taking public transport can release part of road resources. At the same time, it can also help to control energy consumption and environmental pollution. With the state's strong support for the development of urban public transport industry, some disadvantages and problems of urban public transport are gradually showing to people:

(1) The structural layout of public transport network is unreasonable, which brings some inconvenient factors to residents. The construction of road resources often can't keep up with the development of cities. Due to the lack of early planning in most cities in China, the development of urban road structure is unbalanced, and the laying of public transport lines is completed on the basis of urban roads. Therefore, there are some similar problems in public transport network, such as coverage area, public transport network structure and line concentration. The problems of the existing public transport lines will lead to the inconvenience of residents' travel, thus reducing its attraction to people.

(2) The development of public transport lags behind, and people lack the awareness of public transport priority. China's transportation planning started late, and each city has not strictly implemented the corresponding transportation planning and policies, which will lead to the weak awareness of top-down transportation. Public transport priority exists only as a slogan in some cities and has not been implemented. Public transport priority measures need all-round support of a city in order to be effectively implemented. Policy encouragement, facilities construction and residents' awareness of public transport travel need all-round development. However, the current situation of the city is that public transport priority can not be effectively guaranteed, and there is no way to enter a virtuous development cycle.

(3) Public transport services are not guaranteed. As a populous country, China's cities are more densely populated. Generally, there are peak and flat periods in urban traffic. The traffic volume in rush hours is significantly higher than that in other times, so the passenger satisfaction of public transport service will be greatly reduced at this time. The existing public transport system can not complete the passenger transportation under the condition of "quality and quantity", which will reduce the attraction of public transport to residents.

(4) Public transport can not give full play to its own advantages. China's transportation planning started late, so the corresponding traffic laws and regulations are not perfect. The public transportation system is built based on the urban road system, so that some problems in the road system are also reflected in the public transportation system. Unreasonable structure and low line coverage will affect the public transportation system, Unable to play its own advantages, it will cause a certain waste of resources.

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Now the research of public transport network is mainly in the network structure, through the optimization of its processing to achieve the maximum network capacity, so as to enhance the income of urban public transport companies to achieve a virtuous circle, so as to better provide services for urban residents. Taking advantage of the large transport capacity of public transport system, we can reduce the traffic volume of other modes of transportation to reduce the traffic pressure of urban road system, which can alleviate the problem of urban traffic congestion. Through the analysis of the relationship between the city and the public transport system, to build a modern public transport network to meet the needs of urban development, so as to enhance the attractiveness of public transport to residents' travel, and meet the travel needs of more citizens under the condition of limited road resources, and finally realize the scientization and humanization of the public transport system.

II. COMPLEX NETWORK THEORY AND ALGORITHM

Complex network theory is an important part of complexity science. With the deepening of complex network research, its ideas and theories provide new solutions and ideas for network problems. Urban public transport network is a simple network composed of points and edges in structure. Its stations can be abstracted as network nodes, and public transport lines can be abstracted as paths composed of points and edges. At the same time, urban public transport network also has other attributes, such as road section travel time and bus stop capacity, which together constitute the urban public transport network system, Therefore, when solving urban public transport problems, we can learn from the theory of complex network, and complex network has good performance in clustering and network flexibility.

The definition of complex network is still controversial. A large number of studies by experts and scholars at home and abroad show that complex network usually has the following characteristics: (1) complex network is obtained from the topological abstraction of complex system. (2) The reason why complex networks are complex is that they are more complex in topology than regular networks and random networks, and they are closer to real networks. At present, the definition of complex network summarized by Qian Xuesen, a famous scientist in China, is widely used: complex network is a network with some or all properties of self-organization, self similarity, attractor, small world and scale-free characteristics [7-8].

In order to determine the network type of urban public transport network and analyze the generation law of the network, through the analysis and summary of the research of domestic and foreign experts and scholars [9-10], the general classification of complex network is as follows: (1) according to the structural characteristics of the network, the network is divided

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into scale-free network and wide scale network. (2) According to the characteristics of network edge, the network is divided into two types: weighted network and no right network. (3) According to the directivity of network edge, the network is divided into directed network and undirected network. (4) According to the distribution characteristics of network node degree, the network is divided into exponential network and scale-free network. The structural characteristics of complex networks which is shown in Figure 1 are described by corresponding statistical indicators, which include the degree and distribution of nodes, betweenness, average path length and so on. According to the optimization goal of urban public transport network, this paper mainly analyzes the degree and edge betweenness of nodes.

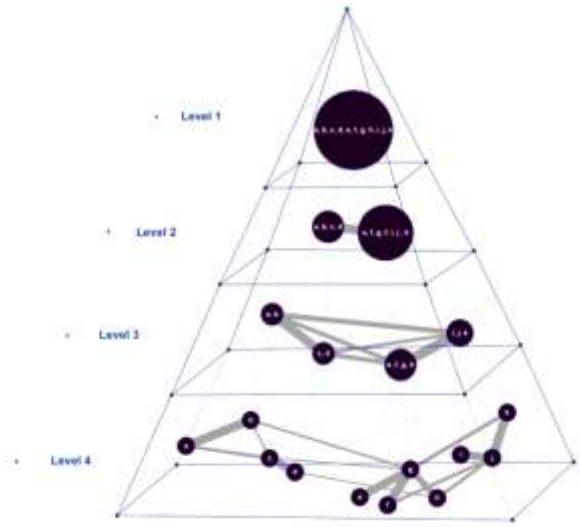

Fig 1: The structural characteristics of complex networks

Genetic algorithm can be defined as an array genetic algorithm (AGA):

$$AGA = (C, F, P_t, N, \Phi, \Gamma, \Psi, T)$$

Among them, C is the code of individuals in the candidate domain, F is the fitness function for the selection of excellent individuals, P_t is the initial population in the candidate domain, N is the size of the population, Φ, Γ and Ψ are the selection operator, crossover operator and mutation operator in the genetic operation respectively, and T is the end condition of the iteration of the genetic algorithm.

The definition of average load in Appendix strategy is given as follows:

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$$L_{ave} = \frac{CSL + NTL}{N} \quad (1)$$

Here, L_{ave} = average load, which is the average load;

CSL = the current system load, which is the node load in the current service cluster system;

NTL = the new tasks load, which is the total load to be allocated to the system in the sliding window;

N represents the total number of service nodes;

Mean-Variance model solves the problem of portfolio optimization in the field of economics, and maximizes the return rate and minimizes the risk by rationally allocating the path of assets and the weight of the path. Based on the theoretical basis of Mean-Variance model, the expected return and risk of investment portfolio are established, and the objective function of Mean-Variance model is set as follows

:

$$min\sigma\left(r_p\right) = \sum\sum x_i x_j Cov\left(r_i r_j\right) \quad (2)$$

$$r_p = \sum x_i r_i \quad (3)$$

The limitations of the objective function:

$$1 = \sum x_i \quad (4)$$

Mean-Variance mathematical model reveals the conclusion that "the expected return of assets is determined by its own risk", that is, the return of assets is determined by the path risk of asset allocation, that is, by variance, and the return is determined by covariance.

III. DESIGN OF ALLIANCE CHAIN FOR INTERNET OF VEHICLES

The network of vehicles alliance chain is a private blockchain composed of on board unit (OBU) and road side unit (RSU) in the city. OBU is a mobile node installed on the vehicle. Its main function is to realize information sharing between vehicles and communicate with RSU, and also obtain safety information sent by RSU, such as traffic line optimization, road condition information and collision avoidance. All central nodes participate in the consensus process of the alliance chain of the vehicle network, while OBU and boundary nodes only participate in data exchange, but ask the consensus process of data block. The flow chart of the alliance chain

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of the vehicle network is shown in Figure 2.

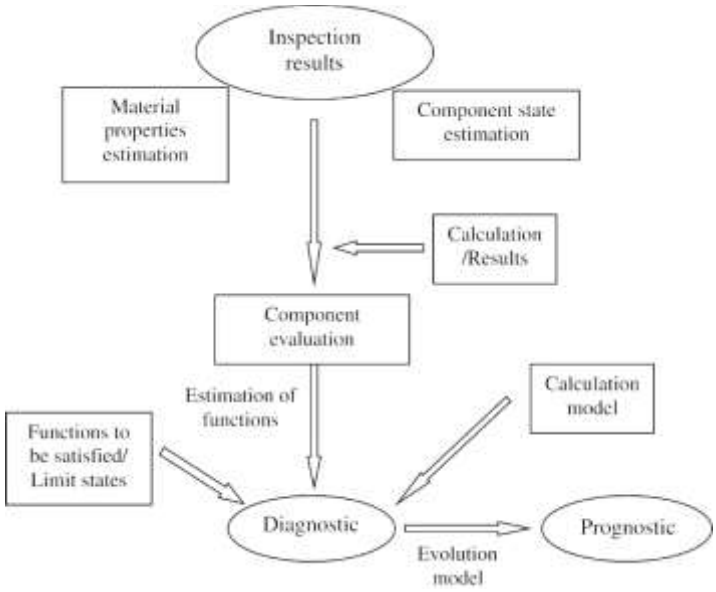

Fig 2: Flow chart of Internet of vehicles alliance chain

The design of the alliance chain of the Internet of vehicles mainly includes three parts: the establishment of node communication, the communication between nodes, and the generation of alliance chain block. The node communication part also includes vehicle to vehicle (V2V) communication, road to road (R2R) communication, and vehicle to road (V2R) communication. Wave is a protocol for vehicle to vehicle and vehicle to road information interaction. The application layer of the protocol uses SAEJ2735 protocol as the security message set. In the process of communication, in order to ensure the integrity and verifiability of information and mutual trust between nodes, a digital signature is added after the information. The digital signature adopts the elliptic curve digital signature algorithm (ECDSA). When the node needs to send information, it uses its own private key to sign the information. The receiver uses the sender's public key to verify the signature. After the verification, it obtains the location, speed and other information.

Basic safety message (BSM) is exchanged between vehicles. BSM defines the information of vehicle itself: position, speed, direction, braking status, etc. The data exchange process between vehicles is as follows:

1. Sending information, the on-board sensors of the vehicle node monitor the state of the vehicle at all times, and transmit the monitored data parameters to the OBU. The OBU will

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receive various data parameters, which are defined according to the SAE J2735 protocol standard. The basic security message (BSM) is the information that must be sent for data exchange between vehicles. The OBU sends BSM periodically without interruption.

2. After the application layer defines the security message, it encrypts it with its own private key to generate the signature Sigprivx (m), where privx represents the private key of vehicle X and sends the information and signature to the network layer together. The corresponding security information is encapsulated by wsmp (wave short message protocol) protocol and TCP / IP protocol of network layer to get WSM (wave short message) packets, which are sent out in the form of multi triangle network multicast communication routing through LLC layer and physical layer.

3. the sent WSM information is monitored by the OBU of the surrounding vehicle on the control channel (CCH). When the OBU of the surrounding vehicle monitors the WSM information, the data package will be submitted to the corresponding application program of the application layer.

4. after receiving WSM data package by corresponding program of application layer, it unpacks WSM, obtains signature and information in accordance with SAEJ2735 standard format. OBU of surrounding vehicles uses public key of sending vehicle to decrypt signature, and obtains information about location and speed after verification, and displays it on the developed user interface. The data exchange process between OBU and OBU is shown in Figure 3.

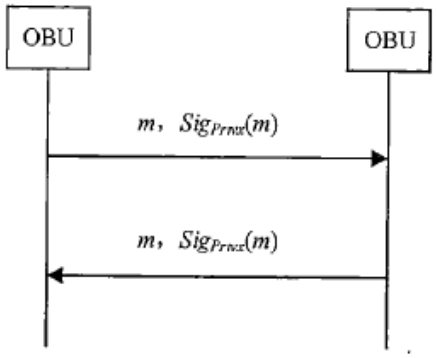

Fig 3: OBU and OBU data exchange process

IV. PUBLIC TRANSPORTATION NETWORK GENERATION BASED ON CLOUD COMPUTING

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The degree of a node is an important concept in complex networks. It represents the number of edges connected to the node. In other words, the greater the degree of a node, the more important it is in the network. For the stability of the network, up to 80% of the common nodes in the scale-free network are randomly selected to fail, and the remaining networks may form a complete cluster and maintain connectivity. However, as long as 5% ~ 10% of the central nodes fail at the same time, the network will collapse. It is found that there are cascading failures in many real networks. The main performance of cascading failures is that the failure of a few nodes will cause the failure of other related nodes. Through the fault propagation between the network nodes, it will eventually lead to the collapse of the whole network.

In urban public transport network, nodes with large degree of nodes can be called hub points. Once traffic congestion occurs at the hub points, the adjacent nodes will also be affected in the future. Residents usually need to arrive at the destination in the shortest time, but when the city scale is relatively large, the traffic volume also increases greatly. When people choose to travel too intensively, it will lead to serious traffic congestion. In the topological structure of the transportation network, it can be considered that the minimum support tree and minimum support cluster undertake a lot of transportation tasks, and this kind of traffic bottleneck is the main cause of congestion.

According to the analysis of the above situation, how to deal with the nodes with large degree of traffic congestion and make them have greater anti-interference ability and greater carrying capacity is the key to the optimization of public transport network under urban traffic congestion. Through the analysis of previous studies, it is found that the cascading failure of the network can not be eliminated, only to alleviate the impact of cascading failure on the network. This paper puts forward the idea of node diversion, which shares the traffic volume of important nodes and edges to the surrounding nodes and edges. In this way, the traffic volume on the minimum support tree and minimum support cluster will be reduced, so as to alleviate the occurrence probability of traffic congestion. There are two reasons for line adjustment: one is to reduce the number of multiple lines on a certain section of urban public transport network; the other is the high repetition rate of a certain line and other lines. For the first phenomenon, first of all, according to the mutual substitution of lines, the lines with less impact on the public transport network are selected.

The impact includes the capacity of the public transport network, the convenience of residents and the needs of urban development. If the impact of the line on the public transport network is small, the line will be removed; On the contrary, we should adjust its trend. For the second case, the route to be reserved is selected according to the repetition rate between routes,

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and the route adjustment is made according to the impact of two public transport routes on the surrounding traffic flow. Generally speaking, there are only two ways to adjust the line at this stage: one is to adjust the line, the other is to delete the line.

If the repetition rate of one line and other lines is too high, then this line can be replaced by another line, which can not only reduce the number of double lines on the road, but also reduce the occupation of road resources by public transport network, so as to release road resources to other people in need, so as to achieve the purpose of changing traffic pressure. This paper defines the line similarity coefficient to describe the degree of repetition of two lines, and then determines the deletion of lines according to the line similarity coefficient. For example, there are lines La and lb in a public transport network, where the section of La includes L1, L2, L3, L4, L5 and L6, and the section of line LB includes L10, L4, L5, L6, L7, L8, L9 and L11. The length of line La is 4.48 km and the length of line Lb is 7.01 km, as shown in Figure 4.

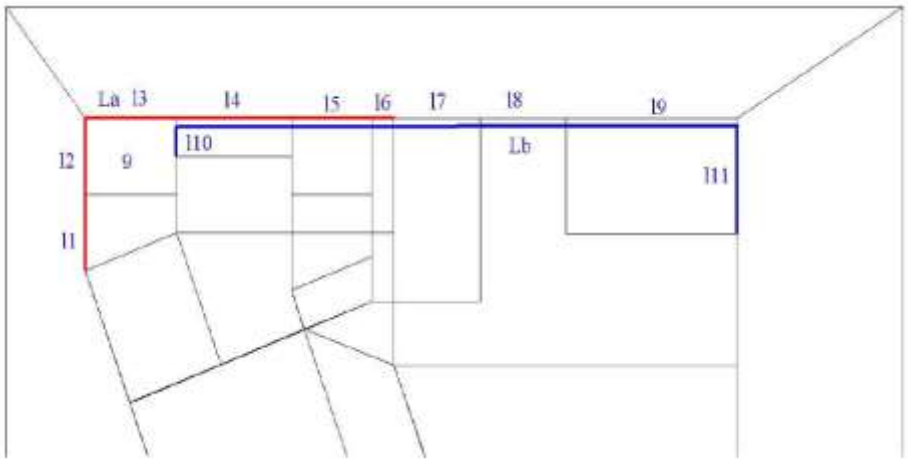

Fig 4: Circuit diagram before adjustment

According to figure 4, the repeated sections of line La and LB are L4, L5 and L6. The total length of the three sections is 2.18 km, and the two public transport lines are related to the ninth traffic district. Line La passes around the ninth traffic district, and line LB starts and ends at the ninth traffic District. The repetition rate of line La is 48%, and that of line Lb is 31%, so the similarity coefficient of line La and line Lb is 48%. According to the traffic data in the network and the principle of maximizing the direct traffic rate of the public transport network, the two public transport lines are merged and deleted. Because the repetition rate of line La is high, La is deleted. At the same time, since LB takes the ninth traffic district as the starting and ending point, the line Lb is adjusted. The merged and deleted public transport lines are shown in Figure 5.

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In view of the problem that the number of multiple lines in some sections of the public transport network mentioned above is too high, the number of multiple lines also means that the degree of some nodes in the line is relatively large. To solve this problem is to solve the problem of large number of nodes and multiple lines in some sections in advance. For the problem of the number of double lines, this paper adopts the strategy of line rectification. There are many similarities between the rectification strategy to solve the problem of large number of double lines and the merger and deletion of lines, but there are essential differences. The merger and deletion of lines is to solve the problem of line repetition rate of public transport network, and its prerequisite is that the similarity coefficient of the two lines needs to reach 40%, that is to say, the merger and deletion of the two lines will be carried out only when the two lines are similar. After adjustment, the efficiency has been improved significantly.

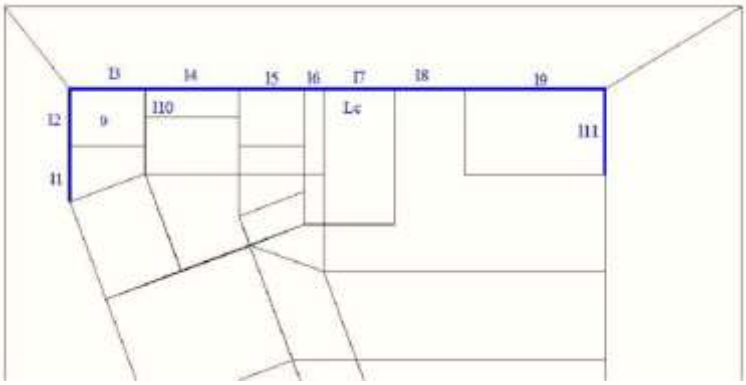

Fig 5: Circuit diagram after adjustment

V. CONCLUSION

This paper mainly solves the related problems of urban public transport network optimization, through the analysis of network related characteristics, combined with the actual situation of urban public transport network, puts forward specific methods for the optimization of urban public transport network. Firstly, the node degree and the number of double lines are analyzed as the breakthrough point of network optimization; Then, the road similarity coefficient is used to optimize the network; Finally, it optimizes the whole network by using the diversion theory. Combined with the previous research and relevant specifications of urban public transport, this paper analyzes the relevant objectives of urban public transport network planning, establishes the network optimization model, and provides the basis for network optimization.

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