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Research Article

Structure Optimization and Governance of Multilevel Rail Transit Integration under the Background of a Metropolitan Area Based on the Industrial Internet of Things Security Data Fusion Method

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In recent years, the urban rail transit network architecture has gradually grown, the contradiction between rail transit passenger flow and transport load has been deepening, and its carrying capacity has also been tested. Passenger flow risk has become the most important source of risk in rail transit. The key to restricting rail transit service quality is how to effectively monitor and manage rail transit passenger flow and provide accurate and convenient early warning to staff. In order to effectively manage the complex passenger flow scene, the premise is to distinguish the real-time state of its moving target. The time series data feature extraction and LSTM data fusion were used to analyze the traffic data sequence in the multilevel rail transit network model. The multilevel rail transit integration of the Internet of things is modeled by the method of data fusion. It can be seen from the experimental data that in the data fusion mode, the network comprehensive evaluation prediction value fitting effect can quickly converge, and the error rate is less than 4%. By comparing the mean square error (MSE) and mean absolute error (MAE) data of the traditional method and the experimental method used in this paper through two different datasets, it was understood that the MAE under the data fusion method was reduced by 8 compared with the traditional method, and the MSE was decreased by 33, indicating that this method can bring better simulation effect to the model. The improvement of the synergistic and complementary functional network and the acceleration of the efficient and convenient flow of elements are the inevitable results of the integration of multilayer rail transit in the metropolitan area.

1. Introduction

Data fusion is an emerging research field. In recent years, data fusion technology has been continuously applied to various industries and achieved certain results. Accelerating metropolitanization and urban mobility have put tremendous emphasis on the progress of China's cities. Cities are increasing in size, congestion is worsening, and the urban landscape is becoming increasingly polluted. Two primary strategies have been used to address many of the transport challenges caused by rapid demographicization and mobility. The first is to offer a better-defined urban road map and its complementary transport infrastructure to residents who use small cars to travel, with the aim of solving traffic congestion and delay problems. This automobile-oriented transportation development strategy has been implemented, and as cities have been built and developed, problems such as traffic congestion have gradually emerged. The second is that finite city spatial assets, notably in urban zones, are unable to meet the development requirements of roads and supporting facilities needed for motorized travel.

At this stage, the type of urban rail transit has developed from a single subway to a variety of operational types, including subways, light rail, and intercity trains. The subway has the characteristics of large transportation volume, a low failure rate, safe and stable travel, and is favored by various cities. Many cities make it their first choice for daily travel infrastructure. The degree of modernization of rail transit construction between cities is an important indicator to measure the city's transportation system, and it has a huge impetus to improve the dilemma caused by the increase in traffic pressure between cities due to the increase in passenger flow. Only the continuous improvement of urban rail transit can alleviate the situation of ground traffic congestion, bring changes to the city's style, refresh the urban traffic environment, promote the development of the city, bring convenience to people's travel, and improve people's work efficiency. Real-time detection of multilevel rail transit networks through time series data feature extraction and data model construction in data fusion can not only improve prediction accuracy but also facilitate the travel of residents.

The multilevel rail transit system as the skeleton to guide the development of suburban new cities is the direction of the future multicenter development model of large cities. Many large cities in China have built a single rail transit line to connect suburban new towns with urban areas, but in most cases, the expected effect has not been achieved. At the same time, some large cities have begun to build multilevel rail transit systems in suburban new towns to guide the development of new towns. The reference to the relatively successful multilevel rail transit system is helpful in providing ideas and experiences for the construction of an urban multilevel rail transit system. On the basis of comparing and analyzing the construction cases of suburban new towns guided by different public transports, the characteristics of suburban new towns adapted to the multilevel rail transit system are summarized. Through the experience of urban development under the guidance of multilevel rail transit in Shanghai, this paper discussed the deficiencies of suburban new cities guided by rail transit in China at the present stage and explored the construction mode of the multilevel rail transit system in the suburban new city in line with the stage of China's social and economic development and the multilevel rail transit system model of the compact, high-density, and intensive development of the suburban new city space.

2. Related Work

Planning and policy for the siting of HSR stations and a wide spectrum of supplemental physical, transportation, and municipal plans are important. Liang investigated the capitalization effect of fast-developing Beijing's proximity to rail transit and bus rapid transit (BRT) and concluded that the average price premium for properties near rail transit stations was about 5%. However, no statistically significant effect was found in the BRT station area [1]. In order to fill the gap in urban rail transit identification service and strengthen the coordination of multilevel urban traffic modes, Zheng established an urban public transportation system based on the optimization method of the tabu search algorithm [2]. Cheng believed that poor performance was caused by frequent prototype collisions, and dynamic prototype allocation and adaptation can provide better results by reducing these collisions [3]. Tsai addressed this gap by controlling for socioeconomic and traffic characteristics to assess the spatial impact of HSR at multiple spatial levels to assess the overall impact of metropolitan areas [4]. However, previous studies have produced mixed results on the magnitude of this effect, and few influencing factors have been controlled for in the assessment process.

It is fashionable to have multisensor structures to better understand the perception of the surrounding environment in smart vehicles, and many of them are used to handle the sensing mission in a wealthy context is a logical answer. Chen proposed a convolutional neural network and deep learning-based framework for analyzing individual video frames for crack detection [5]. Bouain proposed a multisensor data fusion embedded design for vehicle perception tasks using stereo cameras and light detection and ranging sensors [6]. Gomathi focused on comparing naive Bayes, multilayer perceptrons, sequence minimal optimization, random forests, and support vector machines. It turned out that SVM combined with Firefly optimization provided better results [7]. Alsafasfeh proposed a data fusion model based on the backpropagation neural network (BPNN) model. In the process of information transmission, the output function of the neural network was used to process a large amount of sensory data, and the eigenvalues of the sensory data were extracted and transmitted to the sink node, in order to solve the problem of a large number of invalid or redundant data [8]. Zhao proposed a new approach to modeling the overall operational risk of discrete manufacturing systems, based on the characteristics and nature of operational data. In the task reliability framework, operational performance was improved based on quantifying machine performance, task execution, and product quality [9]. Yaxi enhanced data dependencies by rescuing metabolic features missed by traditional software and classifying metabolic features into four confidence levels based on their chromatographic peak shape and the presence of corresponding MS/MS spectra [10]. These studies were instructive to a certain extent, but in some cases, the demonstrations were insufficient or inaccurate and can be further improved.

3. Multilevel Rail Transit Data Fusion System

3.1. Relationship between Urban Construction and Rail Transit. At present, various metropolitan circles in China are taking shape. Rail transit construction is mainly concentrated within cities, and small and medium-sized cities and large cities are mainly connected through expressways. There is no example of multilevel rail transit construction. The research on the interaction between rail transit and spatial structure also remains at the inner level of the city, and there is a lack of theoretical research and empirical research on the development of urban spatial structures guided by multilevel rail transit [11]. The construction of China's metropolitan area started late, but its development speed is far faster than that of other regions in the world. However, the development history of metropolitan areas such as Tokyo, New York, Paris, and London, which have been studied more at present, is not in line with China's

Table 1: Common urban rail types and parameters.

Streetcar	City size (10,000 people)	CBD employment scale (10,000 people)
Light rail	10–500	>3
Subway/heavy rail	45–350	>4
Suburban railway	>500	>15
Streetcar	>350	>5

national conditions [12]. As the second largest metropolitan area in the world, the Seoul Metropolitan Area is similar to China's big cities in terms of urban development processes and rail transit construction sequences. The metropolitan area has a stable spatial structure and a developed rail transit system. Its development process has important research value. The Seoul Metropolitan Area is the second largest metropolitan area in the world [13].

Through the comparative analysis of the suburban new city guided by the multilevel rail transit system and other cities guided by public transportation, the feasibility and superiority of constructing a multilevel rail transit system to guide the construction of the suburban new city can be studied on the basis of summarizing the experience of the transportation connection between the suburban new city and the urban area [14]. Multilevel rail transit is composed of urban rail transit and intercity rail transit, mainly referring to the urban rail transit mode that undertakes commuting needs within the metropolitan area [15]. Urban rail transit is mainly responsible for the passenger flow on the urban transportation corridor, and it is the backbone of the public transportation system. It can effectively meet the travel needs of urban residents, ease the pressure on urban traffic, and promote the sustainable development of the city. Compared with conventional buses, cars, and other transportation modes, rail transit has many advantages, such as large transportation capacity, high efficiency, safety, and punctuality, energy saving and environmental protection, and full utilization of urban space [16]. Common track types are shown in Table 1.

Rail transit, as the main connection tool between residents' daily behavior and urban space, ensures the close connection between the urban transportation system of the new city and the urban space. By building a good coupling relationship between the two, the travel efficiency of suburban new cities can be greatly improved [17]. Similarly, the planning and construction of suburban new towns, such as urban spatial layout and station area design, also affect the operational efficiency of rail transit. However, in the practice of combining the construction of suburban new towns with the rail transit system in China, there are still problems such as the uncoupling of rail transit stations and the urban space of suburban new towns and the failure of rail transit to guide residents to use public transport. Further research is needed to improve the fit between the construction of suburban new towns and the rail transit system.

In the past, the planning of rail transit systems in large cities in China currently focused on network planning and its construction, lacking in development strategic planning [18]. The functional positioning of each system is vague, and the traffic level hierarchy is not clear enough. Most rail transits systems favor the development of subway systems in public transportation [19]. There is a lack of in-depth research and analysis on the functional positioning of low- and medium-volume rail transit systems. With the exception of a few key metropolitan planning options, most cities have largely ignored low- and medium-rail mass transit systems. As the urban development model moves towards the metropolitan area, the development model of the metropolitan area gradually emerges [20]. One rail system has been unable to adapt to various travel needs, and various rail systems, such as light rail, monorail, maglev, and modern trams, have begun to appear. Integration is necessary to ensure the continuity and efficiency of rail transit systems at all levels within a metropolitan area. Many large cities have begun to build multilevel rail transit systems for different needs, regions, transportation capacities, standards, and route characteristics.

The research on the rail transit system focuses on the research on the single-level rail transit system, and most of the studies involving the multilevel rail transit system are also between the two levels of the national high-speed railway and intercity rail and the urban rail transit [21]. There are few studies on rail transit between suburban new cities and urban areas and within suburban new urban areas [22]. In cities that have been constructed and operated for a long time, due to the unclear functions of rail networks at all levels, the following problems were exposed. The high density of the urban line network caused congestion. The extensive traffic area caused confusion in the functional positioning and service scope of different lines. Some rail services in new development zones and urban fringe areas were relatively low or even lacking.

Regarding the research on the interactive relationship between urban rail transit and urban spatial structure, the research method is mainly based on the combination of theory and empirical methods, which leads to the fact that most of the indicators obtained in the research have strong "regional" characteristics and do not have universal guiding value [23]. At the same time, given that China's social development stage is different from that of Western developed countries, some experiences and planning and design strategies cannot be used directly. In contrast, in Southeast Asia, such as Tokyo and other places, in the planning practice of large cities with high-intensity and intensive development, the implementation of high-density and intensive land combinations guides the compact and intensive development of cities by vigorously developing public transportation systems [24].

The suburban new city rail transit mode under the multilevel rail transit system involves economic, social, environmental, and other aspects. Under the guidance of related theories such as urban transportation and urban economics, it is carried out from an interdisciplinary and multiangle research perspective. Based on the practical experience in the construction of advanced suburban new cities at home and abroad, a multilevel rail transit system and a multilevel rail transit mode suitable for suburban new towns are proposed from the perspective of planning and design. It mainly adopts the analytical method, combining theoretical research and empirical research. The qualitative analysis is the main method, and the quantitative analysis is supplemented by the analytical method.

Different types of rail transit systems have different technical characteristics to meet the transportation needs of different regions and levels. According to the typical rail transit planning, construction, and operation management experience at home and abroad, the multilevel rail transit system is a comprehensive transit system with master and slave and master-slave cooperation. The multilevel rail transit system referred to in this study is composed of large-capacity rail transit and medium and low-capacity rail transit. The main research objects involved are urban rail transit, urban rail transit, light rail, and modern trams. The main structure is shown in Figures 1 and 2.

According to functional types, the rail transit network system is mainly divided into four levels: trunk line railway, intercity railway, municipal railway, and urban rail transit. The rail transit systems at all levels have different characteristics in terms of the traffic system, operating speed, station spacing, service scope, and service objectives, as shown in Table 2. The main railways include high-speed railways and ordinary railways. Considering the travel speed, only high-speed railways are analyzed here, and the service targets of high-speed railways are mainly long-distance traffic objects within the specified range.

Different types of rail transit have obvious differences in operating speed and carrying capacity, so there is an inherent relationship between the multilevel rail transit network and the multiscale space that corresponds to each other, adapts to each other, and coordinates with each other. For megacities, the public transportation system with rail transit as the main body can meet the time requirements of urban residents for long-distance commuting. For the peripheral stretches of the central urban area, the reduction in the development intensity of construction land and the reduction in the service scope and service accessibility of the rail transit network have kept the vitality of most areas relatively low. Only along the rail transit line can there be good development vigor and development potential, and the construction of railways in the peripheral cities is the premise to ensure the concentration of an employed population and jobs. Fundamentally, the spatio-temporal adaptability of rail and space is mainly based on accessibility. Through the cooperation of different transportation modes, such as rail transit systems, station spacing, operation modes, etc., the compatibility between the expected service area and the transportation service level is guaranteed. Most cities in China are not clear about the hierarchical division of rail transit systems, usually regard the construction of subway systems as the main task, and even believe that the continuous extension and densification of the subway network can replace other types of rail transit. In the United States, Western Europe, Japan, and other mature regions, relatively complete rail transit networks have been built. The wide coverage of urban railways plays an important role in solving the traffic between urban and suburban cities and between satellite cities. The relationship between rail transit and the city is shown in Figure 3.

As the scope of large cities continues to spread to the new peripheral urban areas, the demand for the construction of urban railways is also increasing. When more and more regions begin to deploy urban railway construction, how to solve the existing problems will become the key to the future development of metropolitan areas. The coordinated development system of the rail transit network and spatial structure in the metropolitan area is a comprehensive system, which is composed of two subsystems, the rail transit network and the spatial structure. These two subsystems also contain some of their respective subsystem elements. Subsystem elements of rail transit networks mainly refer to the content elements of network quantity and network quality. Among them, the change of network quantity refers to the improvement of factors such as the type of network, the scale of operation, the mileage of the network, the number of stations, and the level of the station. The change in network quality mainly refers to the optimization and improvement of the degree of network connectivity, the degree of transfer convenience, the degree of accessibility, and the degree of service scope. The evolution of the spatial structure subsystem of the metropolitan area includes two aspects: scale structure and regional structure. The scale structure generally refers to the urban population or the scale of construction land in a certain area. The regional structure refers to the urban spatial distribution pattern and the urban topological spatial organization structure in the metropolitan area. In order for the system composed of the evolution of the rail transit network in the metropolitan area and the evolution of the spatial structure to reach the level of coordinated development, the elements in the respective systems need to promote each other. Specifically, there is an interactive development relationship between the two aspects of the rail transit network subsystem and the two aspects of the space structure subsystem. The coordination between the rail transit network and urban structure is shown in Figure 4.

3.2. RNN (Recurrent Neural Network) Time Series Data Feature Extraction. Data fusion mainly uses the data resources of multiple sensors or information sources in different times and spaces, and uses computer technology, artificial intelligence, and other technologies to obtain the observation data of multiple sensors or information sources in time series, so that the system can obtain more components for fuller information. The main difference between time series data and ordinary data is that time series data contains time characteristics. Therefore, when analyzing time series data, it is necessary to take the time series characteristics into consideration and try to retain the

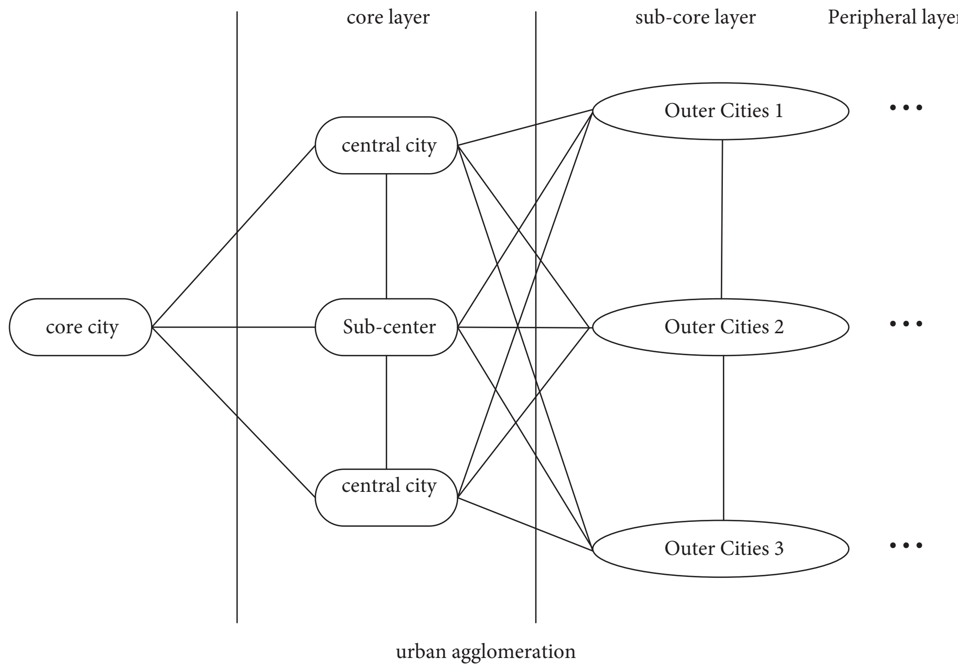

Figure 1: Urban scale vertical structure.

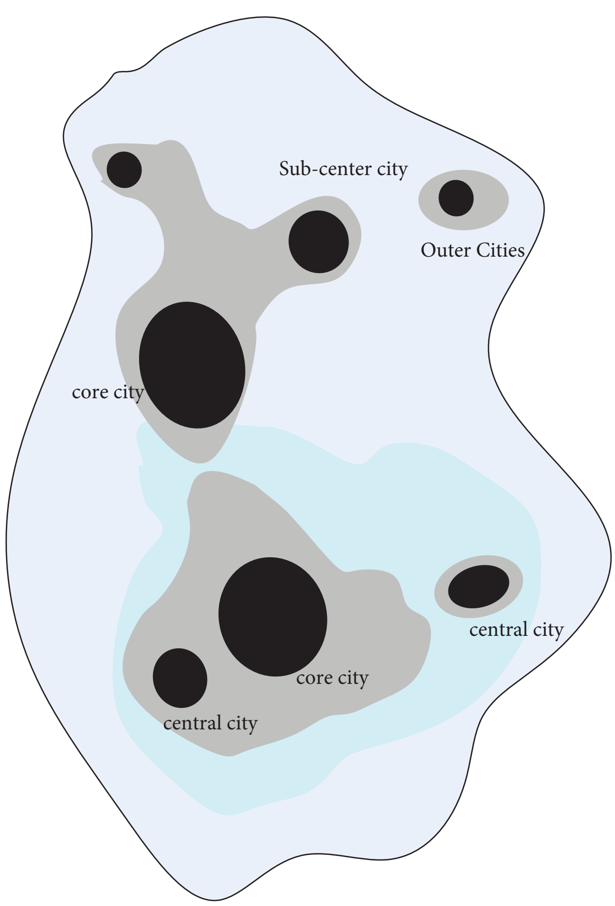

Figure 2: Urban scale horizontal structure.

maximum amount of time characteristic information. Commonly used time series feature extraction methods can be divided into four categories: statistical-based feature extraction methods, transformation-based feature extraction methods, variability theory-based feature extraction methods, and model-based feature extraction methods. In the recurrent neural network structure, the recurrent network retains the previous input information through the hidden state and serves as the output of the current network, which effectively solves the problem of the persistence of the logical sequence and correlation information between the data. Among them, x^t is determined by the input layer a^t and the output layer y^{t-1} of the previous hidden layer, as shown in the following formula:

$$\begin{aligned} x_h^t &= \sum_i w_{ih} a_i^t + \sum_i w_{ih} y_{h'}^{t-1}, \\ y_h^t &= f\left(\mathrm{x}_h^t\right). \end{aligned} \tag{1}$$

Then, the output of the output layer is shown in the following formula:

$$\begin{aligned} x_h^t &= \sum_{\mathrm{h}} w_{ih} y_i^t, \\ y_h^t &= \frac{e^{x_j^t}}{\sum_{\mathrm{j}} e^{x_j^t}}. \end{aligned} \tag{2}$$

The residual and reverse conduction process of the output layer of the RNN at time t is as follows:

$$\begin{aligned} \varepsilon_{\mathrm{h}}^t &= b_k^t - d_k^t, \\ \varepsilon_{\mathrm{h}}^t &= \mathrm{f}\left(x_h^t -\right)\left(\sum_k \varepsilon_k^t w_{hk} + \sum_{h'} \varepsilon_{h'}^{t+1} w_{hh}\right). \end{aligned} \tag{3}$$

When the sequence length is T, its residuals are all 0. At this time, the reciprocals of parameters B, P, and M for time t are given as follows:

Table 2: Characteristics of the multilevel rail transit system.

Orbital collapse	High-speed railway	Intercity railway	City railway	Urban rail transit
Running speed (km/h)	200–350	130–200	110–150	20–50
Station spacing/km	40–100	10–35	5–15	0.5–3
Travel distance/km	>160	45–210	20–60	3–20
Service area	Country scope	City area	Central city	Main cities and towns

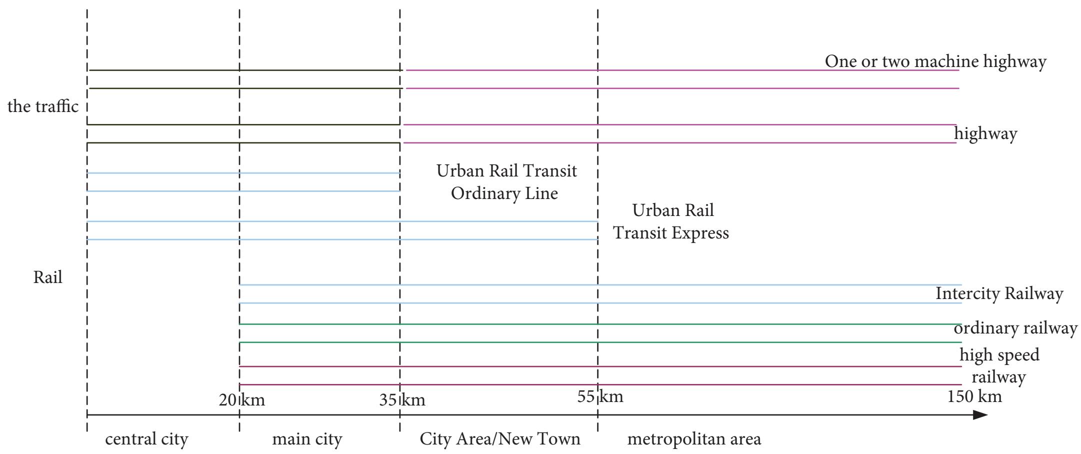

Figure 3: Relationship between multilevel rail transit and cities.

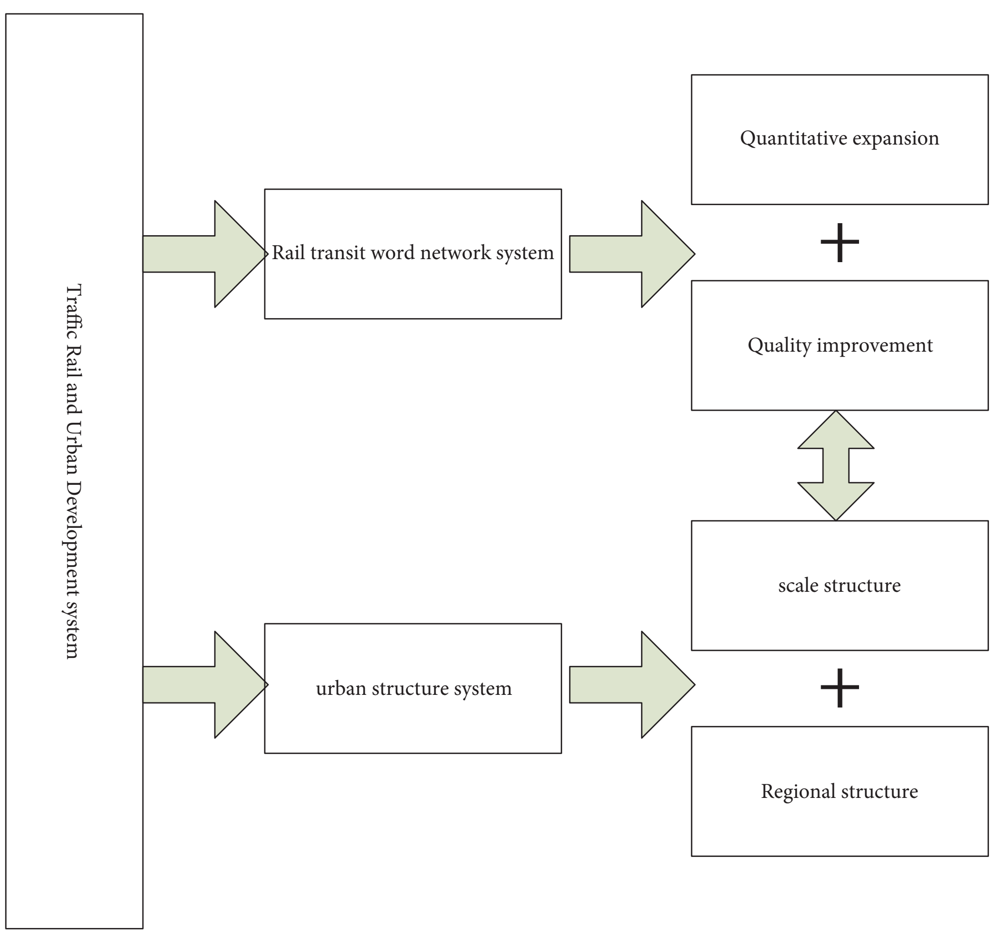

Figure 4: Coordinated development of rail transit network and urban structure.

$$
\begin{aligned}
B&: \frac{\mu O}{\mu \mathrm{m}_{ih}} = \frac{\mu x_h^t}{\mu \mathrm{m}_{ih}} \frac{\mu O}{\mu x_h^t},\\
&= \varepsilon_h^t a_i^t,\\
P&: \frac{\mu O}{\mu \mathrm{m}_{ih}} = \frac{\mu x_{\mathrm{k}}^t}{\mu \mathrm{m}_{hk}} \frac{\mu O}{\mu x_h^t},\\
&= \varepsilon_k^t y_h^t,\\
M&: \frac{\mu O}{\mu \mathrm{m}_{h'h}} = \frac{\mu x_{\mathrm{k}}^t}{\mu \mathrm{m}_{h'h}} \frac{\mu O}{\mu x_h^t},\\
&= \varepsilon_k^t y_{h'}^t.
\end{aligned} \tag{4}
$$

If there is $a_i^t = \mathrm{x}_i^t = y_i^t$ in the input layer, the formula is simplified to

$$
\frac{\mu O}{\mu \mathrm{m}_{jih}} = \frac{\mu x_j^t}{\mu \mathrm{m}_{ij}} \frac{\mu O}{\mu x_j^t} = \varepsilon_j^t b_i^t. \tag{5}
$$

For time $t = 1, 2, \cdots, m$, by recursively summing the formula, the derivative of the RNN network with respect to the weight parameter can be obtained as follows:

$$
\begin{aligned}
\frac{\mu O}{\mu \mathrm{m}_{jih}} &= \sum_{\mathrm{t}} \frac{\mu O}{\mu x_j^t} \frac{\mu x_j^t}{\mu \mathrm{m}_{ij}},\\
&= \sum_{\mathrm{t}} \varepsilon_j^t b_i^t.
\end{aligned} \tag{6}
$$

The value of the hidden layer of the recurrent neural network does not only depend on the current input. The value of the last hidden layer also affects the value of the hidden layer. Data fusion processes and fuses multisource, heterogeneous data by selecting appropriate models and fusion methods to obtain more accurate information. As a multisource information fusion technology, data fusion technology was initially widely used in complex battlefield environments to make automatic decisions based on battlefield information. With the development of computer technology and information technology, data fusion is also widely used in the civilian field.

3.3. Data Fusion Model Based on LSTM (Long Short-Term Memory Network). LSTM is a special recurrent neural network. Due to its special network structure, it is suitable for predicting events with long time intervals. At present, long and short-term memory networks have a wide range of applications. The LSTM is mainly used in robotics, automatic target recognition, traffic control, agriculture, remote sensing, medical diagnosis, pattern recognition, and other fields. As can be seen from the formula, in the RNN network, the residual will decay over time.

$$
\begin{aligned}
\varepsilon_h^t &= f'\left(x_h^t\right)\left(\sum_{\mathrm{k}} \varepsilon_k^t \mathrm{m}_{hk} + \sum_{h'} \varepsilon_{h'}^{t+1} \mathrm{m}_{hh'}\right),\\
\varepsilon_h &= f'\left(x_h\right)\left(\sum_{h'=1}^{h_{t+1}} \varepsilon_{h'} \mathrm{m}_{hh'}\right).
\end{aligned} \tag{7}
$$

The long short-term memory network is a time-recurrent neural network, which is specially designed to solve the long-term dependence problem of the general recurrent neural network. The key to the phenomenon is the nonlinear activation function *f*, and the commonly used nonlinear activation functions are the sigmoid function and the tanh function. Most of the activation functions used in the nonlinear hidden layer are RBFs with symmetric properties. The linear output layer weights the output of the hidden layer nodes, and the number of neurons in the linear output layer is the same as the dimension of the output vector. The input vector is nonlinearly transformed, and the sample points are transformed from the input space. Since the slope of the activation function *f* outside the interval [−1, 1] has a small change, that is, the derivative f' is small, the value of f' will be severely attenuated after a long time of back-propagation, which will eventually lead to feedback at a certain moment. The signal has little effect on the previous information, as shown in the following formula:

$$
\begin{aligned}
\frac{\mu O}{\mu \mathrm{m}_{ji}} &= \frac{\mu x_j}{\mu \mathrm{m}_{ij}} \frac{\mu O}{\mu x_j},\\
&= \varepsilon_j b_i.
\end{aligned} \tag{8}
$$

As a rule of thumb, RNNs are more difficult to handle sequences with long time spans. To solve this problem, the LSTM network replaces the hidden layer unit in the RNN with a storage unit and uses the storage unit to store information. g^{t} is the input at time *t*, and the storage unit contains both the state of time *t* and time t − 1, namely:

$$
\begin{aligned}
s^t &= g^{\mathrm{t}} \Theta i^{\mathrm{t}} + \mathrm{s}^{\mathrm{t}-1},\\
\mathrm{v}^{\mathrm{t}} &= s^{\mathrm{t}} \Theta o^{\mathrm{t}},\\
\mathrm{s}^{\mathrm{t}} &= g^{\mathrm{t}} \Theta i^{\mathrm{t}} + \mathrm{f}^{\mathrm{t}} \Theta \mathrm{s}^{\mathrm{t}-1}.
\end{aligned} \tag{9}
$$

According to the particularity of this task and the research done in the existing work, in order to better analyze the advantages of the data fusion model, the proposed model is evaluated by MAE, MSE, and index R^2. The smaller the values of MAE and MSE, the smaller the error value of the model results. The better the performance, the stronger the generalization ability of the model. The specific formula is expressed as follows:

$$
\mathrm{MAE} = \frac{1}{\mathrm{M}} \sum_{m=1}^{M} \left| b_m - \wedge\, b_m \right|,
$$

$$
\mathrm{RMSE} = \sqrt{\frac{1}{\mathrm{M}} \sum_{m=1}^{M} \left(b_m - \hat{b}_m \right)^2},
$$

$$R^2 = 1 - \frac{\sum_{M}^{M}\left(b_m - \hat{b}_m\right)^2}{\sum_{m-1}^{M}\left(b_m-\right)^2}. \quad (10)$$

4. Optimization of Multilevel Rail Transit Integration under the Internet of Things

4.1. Measuring the Evolution of the Spatial Structure of Metropolitan Areas Based on Remote Sensing Images. While the problems of motor car-oriented cities gradually emerged, public transportation-oriented urban design began to gain the respect of policymakers and researchers. By comprehensively considering the geographical space and the closeness of regional connections, the construction land within the Shanghai metropolitan area and some areas of Kunshan City is mainly used as the research object of land use in the Shanghai metropolitan area. In the research, supervised classification and unsupervised classification processing are carried out using historical image data within the Shanghai area and Kunshan area, and the image interpretation processing is completed by combining manual correction and interpretation. Similar to the classification method of land use in the Beijing metropolitan area, the land use in the Shanghai metropolitan area is divided into four categories: construction land, agricultural land, forestry land, and land along rivers and lakes. Then, a dynamic database for the development and utilization of construction land in the Shanghai metropolitan area is established. The historical image data of land use in the Shanghai metropolitan area is based on the needs of the research on the evolution of the spatial structure. The satellite image data of 1997, 2002, 2007, 2012, and 2017 were obtained with a five-year evolution cycle, as shown in Figure 5.

Comparing the scale of construction land in the Shanghai metropolitan area over time reveals that from 1997 to 2017, the area of construction land in the Shanghai area increased rapidly, the scale of land expanded rapidly gradually spread outward along the corridor, and the peripheral areas began to spread. There are more and more group-type construction land agglomeration areas. To sum up, with the constant expansion of construction land and the continuous construction of rail transit, the multicenter cluster structure characteristics of the Shanghai metropolitan area have become more and more obvious. From the initial port development along the Huangpu River, to the construction of satellite cities such as Minhang, Jiading, and Songjiang, to the development of Lujiazui in Pudong, the south bank of the Yangtze River, and the north bank of Hangzhou Bay, the growth rate of construction land in the main urban area of Shanghai has slowed down and become more saturated. Under the guidance of radial rail transit, the development of peripheral new city nodes such as Jiading, Qingpu, Fengxian, Songjiang, and Nanhui has accelerated, and the regional spatial development pattern has gradually shifted from concentrated development along the river to multicenter synchronous development. Contacts are getting closer and closer, and cities such as Kunshan and Suzhou have become development trends.

In order to test the vehicle system safety index, signal system safety index, power supply system safety index, communication system safety index, interval electromechanical system safety index, and track safety assurance index for infinite tempering treatment, this paper adopts the fusion method to form the line layer equipment index. The driver's business ability index and the dispatcher's business ability index are integrated to form the line-level management index. Based on the actual operation data of urban rail transit, one month of operation data was selected, and 10 were randomly selected and calculated according to the calculation method of the macro safety assessment index, as shown in Table 3.

4.2. Dataset Test of Multilayer Rail Transit. In order to verify the effectiveness of the algorithm proposed in this chapter, its effect is verified on a standard crowd dataset. As shown in Figure 6, the comparison of the results of the IoT security data fusion method adopted in this paper and other methods on the Shanghai crowd data set is listed, and the MAE and MSE are compared. Part 1 uses the traditional multilayer rail transit data model, and Part 2 uses the model of the data fusion method to compare and analyze the Shanghai crowd data.

Figure 6 shows the variation of MAE and MSE training on the Shanghai standard crowd dataset. As can be seen from the figure, compared with some previous models, the counting accuracy of the data fusion model has been improved. In Part 1, MAE of 28 and MSE of 58 were obtained. In Part 2, the MAE of 20 and the MSE of 25 were obtained. Especially compared with MCNN with multiarray structure, both MAE and MSE indicators have been greatly improved. It shows that this model has better multiscale extraction ability than the traditional one. At the same time, compared with the traditional algorithm, the MAE of the data fusion algorithm in Part 2 is reduced by 8 and the MSE by 33 compared with the traditional method, and the model has achieved good results.

Taking the comprehensive index of road network line safety, road network capacity and capacity matching degree, road network connectivity state index, road network transfer capacity matching degree, and road network comprehensive environmental index as the input of a wavelet neural network, the experts scored the results. As the output node, the number of hidden layer nodes is given by the empirical formula, and the test results are shown in Figure 7.

Finally, the program self-tuning algorithm is determined to be 10. The data in the table is used as the prediction test sample of the network after passing the training sample. The systematic error is set to $\varepsilon = 0.001$. Through the running graph, it is found that in the data fusion mode, the network comprehensive evaluation prediction value fitting effect can quickly converge, and the error rate is less than 4%. It can be seen from the data that the experimental method has a good data-fitting effect.

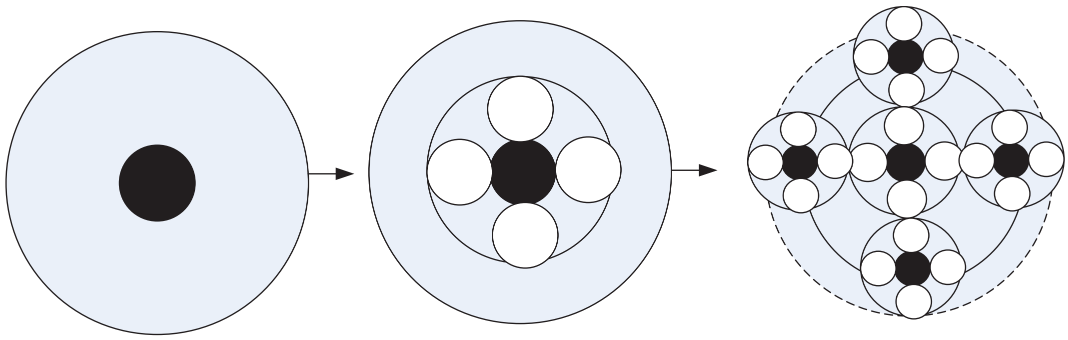

Figure 5: Formation process of metropolitan area.

Table 3: Operational safety data of the urban rail transit network.

Serial number	Composite index	Suitability	State index	Transfer matching degree	China environmental index
1	5.35	0.77	1	0.156	0.285
2	5.17	0.86	0.996	0.117	0.254
3	5.90	0.65	0.995	0.169	0.17
4	7.10	0.73	0.992	0.117	0.205
5	6.94	0.84	1	0.219	0.14
6	7.22	0.77	0.994	0.143	0.22
7	8.48	0.92	0.994	0.219	0.17
8	9.07	0.75	1	0.224	0.19
9	6.96	0.65	1	0.156	0.17
10	7.99	0.77	0.991	0.217	0.16

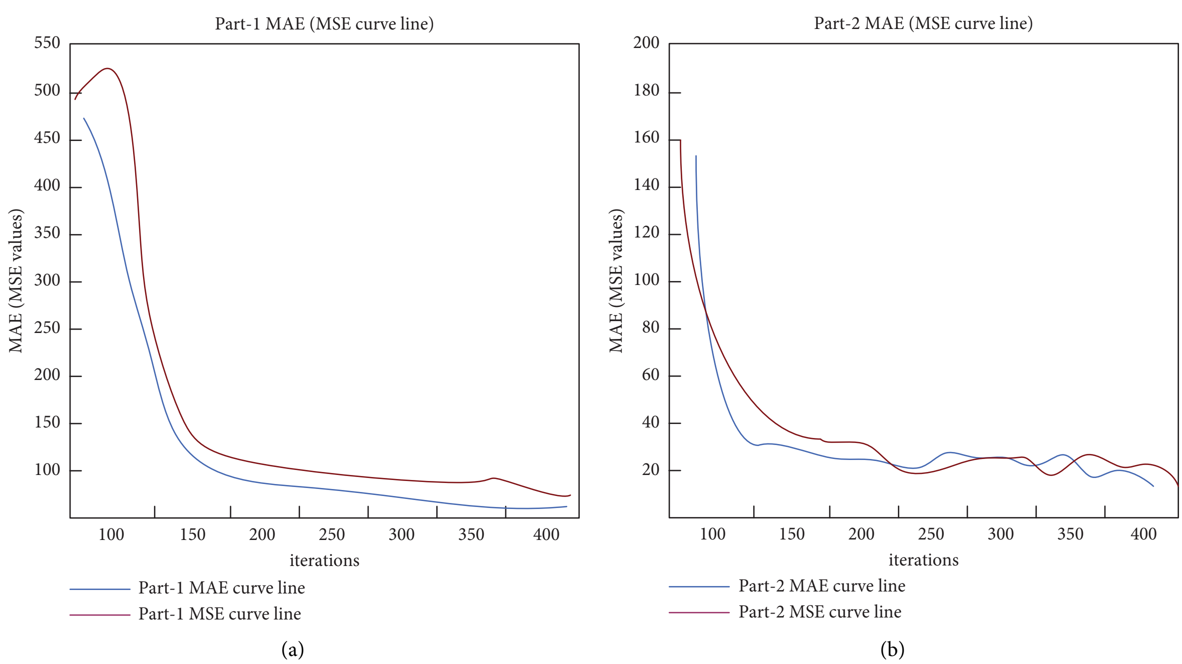

Figure 6: MAE/MSE training trend of the dataset.

4.3. Departure Time Prediction of Urban Multirail Transit. In the calculation process, the operating cost of each line is the total cost of daily operation and maintenance and energy consumption, and the average value of the unit operating cost of each line, including urban rail transit and conventional public transportation, is taken. The values of other parameters in the model are set reasonably according to the prediction results and survey data. It is the departure interval of each line before and after the solution, and the time when each line arrives at the transfer station, after calculating and solving. The calculated departure time interval of the Shanghai rail transit Line 1 and 6 conventional public

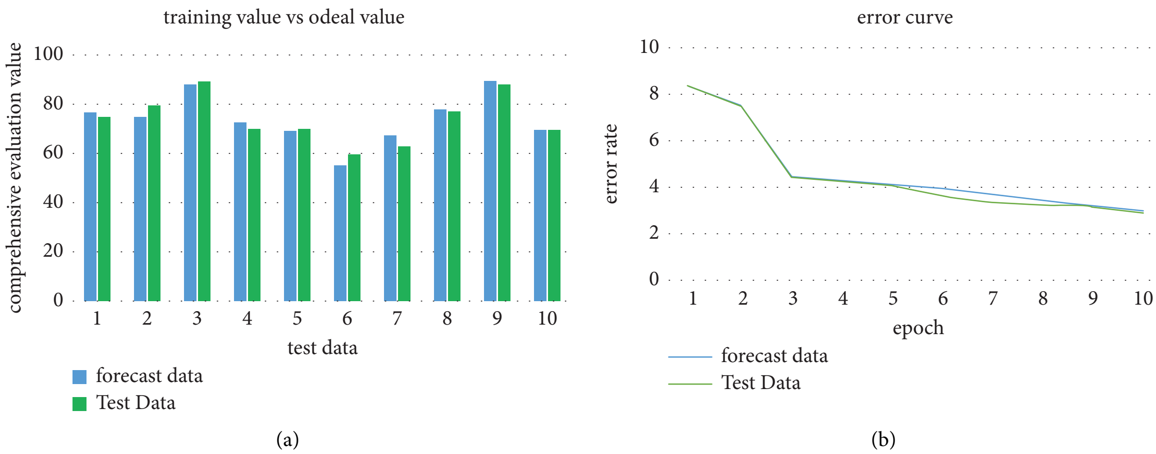

FIGURE 7: Test results of predicted and tested values.

FIGURE 8: Departure interval and arrival time at the transfer station of each line before and after.

transports and the time of arrival at the transfer station can be obtained, as shown in Figure 8.

It can be clearly seen from Figure 8 that, before the solution, the departure time interval of urban rail transit and conventional public transportation lines has no regularity. After solving, the departure time intervals of Shanghai rail transit Line 1 and 6 conventional public transits all show an integer multiple relationships. It can be seen from the data that the data in the line number at point D shows that the departure time after the solution is quite different from the actual departure time. The time difference is 1.5 minutes, and the error is 30%. The solution times for other routes almost match the actual time. Therefore, a scientific and reasonable departure time of each line vehicle at the departure station is then formulated; so as to ensure that Shanghai rail transit Line 1 and 6 conventional public transportation vehicles arrive at the transfer station for coordinated transfer to the greatest extent possible.

5. Conclusion

Through the qualitative summary and quantitative comparative analysis of Shanghai traffic cases guided by the multilevel rail transit system, the characteristics of the multilevel rails in the metropolitan area under the multilevel rail transit system were analyzed and classified. According to different characteristics and categories, the internal reasons and lessons for reference were analyzed. The densification process of the rail transit network improved the radiation capability and service quality of the metropolitan area and strengthened the network connection between each node. The expansion and upgrading of the metropolitan area space in turn stimulated the upgrading and evolution of the system, hierarchy, scale, and robustness of the rail transit network. At the same time, the node differentiation effect brought about by the upgrading of the rail transit network guided the formation of the metropolitan area. Several central growth points and spatial development axes have been established, further optimizing the spatial structure system of the metropolitan area, and promoting the formation of a "multi-center-multi-corridor" spatial structure system. The comparison gap between China's metropolitan areas and foreign mature metropolitan areas is not in the core area, but mainly in the number of peripheral microcenters and node cities. The development and construction of microcenters and node cities are closely related to the rail transit network.

Data Availability

The raw data supporting the conclusions of this paper will be made available by the authors, without undue reservation.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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