Research Article

Traffic Flow Prediction and Application of Smart City Based on Industry 4.0 and Big Data Analysis

Yuqian Gong

Beijing Huak Technology Development Co Ltd., Beijing 10002865292, China

Correspondence should be addressed to Yuqian Gong; kevin_space@163.com

Received 6 April 2022; Revised 6 June 2022; Accepted 13 June 2022; Published 1 August 2022

Academic Editor: Man Fai Leung

Copyright © 2022 Yuqian Gong. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

For smart city traffic flow prediction in the period of big data and industry 4.0, the prediction accuracy is low, the prediction is difficult, and the prediction effect is different in different geographical locations. This paper proposes a smart city traffic communication forecast based on Industry 4.0 and big data analysis application. Firstly, this paper theoretically explains the application scenario of urban traffic fault text big data and analyzes the characteristics of related problems, especially the fault problems. Secondly, the AC traffic prediction algorithm is studied, and the application analysis of PVHH, IDT, and Ford–Fulkerson algorithms is applied, respectively. Finally, the above three algorithms are used to predict and analyze traffic flow.

1. Introduction

With the advent of the industry 4.0 era, artificial intelligence and big data analysis play an important role in China’s information construction. In order to understand the occurrence, development, diagnosis, and treatment of diseases more accurately, it is necessary to analyze the whole molecular measurement in multiple groups and obtain more abundant information resources from the analysis, so it is necessary to evaluate more data. At this time, the above problems can be effectively solved by using artificial intelligence [1]. Depression is a common psychological disease in today’s society. There are many people suffering from this disease, which seriously affects everyone’s health and social function [2]. Depression alone affects 11% of the world’s population, where mental health has caused great pain and damage. In order to effectively treat this disease, artificial intelligence and big data technology are increasingly used in depression, providing new methods for clinical diagnosis and treatment. Of course, there are not many markers to prove mental health, so that it depends on the questionnaire data of patients and doctors for explanation [3]. Nowadays, microbiology is one of the important disciplines in biology, which includes a wide range of bacteria, viruses, and fungi, and all belong to microorganisms, and it is closely related to human beings [4–6]. It has been identified as one of the causes of many cancers, such as Helicobacter pylori. Man is its only host, and it is almost impossible to heal after being infected. Helicobacter pylori plays a very important role in the treatment of gastric cancer. With the development of sequencing technology, a large number of complex data has been generated. However, there are still obstacles in the analysis of these data, which is not conducive to making correct decisions. However, the emergence of artificial intelligence helps and properly solves the doctors’ processing of these data [7].

The rapid development of artificial intelligence (AI) and big data has stimulated the tide of various social networks and produced a lot of social data worth analyzing [8]. Mining the relationship among social organizations, networks, and media is a key point of social computing. The large increase of these data makes it more difficult to mine large-scale social data. Now, the combination of human intelligence and artificial intelligence is applied to social computing, which provides more methods for the analysis and detection of social data, and is a new direction of artificial intelligence and big data research [9]. Today’s electromagnetic environment is still not optimistic, and spectrum resources are relatively few. In actual division, there will be uneven distribution, and the existing
monitoring level is not enough, so there is no way to fully grasp the frequency usage. In order to solve this problem, an electromagnetic spectrum monitoring scheme combining big data and artificial intelligence is proposed, which mainly aims at various applications and related businesses and strengthens the construction of handheld monitoring systems, big data analysis systems, and electromagnetic spectrum monitoring system [10].

In teaching, the effect of online education is far less than that of actual classroom teaching. In order to improve the learning effect of online teaching combined with the actual needs of online education, the evaluation technology based on artificial intelligence big data technology is established with evaluation as the center of teaching. Model analysis is carried out through actual teaching, and various functional modules are established based on learning objectives, all of which are aimed at developmental evaluation. The results show that some models have good performance [11].

The safety of urban traffic is a permanent theme. Bus, as an important national facility and a means of transportation with high frequency, has a great responsibility for ensuring the safety of people’s lives and property. In recent years, with the rapid development of expressways in China, expressway undertakes more important transportation tasks. However, the occurrence of various disasters and other unexpected events also bring great hidden dangers to highway transportation safety. This paper focuses on the research and application of big data analysis technology for urban traffic accidents, as well as the establishment of cloud service network for urban traffic emergency management and the proposal of highway cloud resource scheduling based on cloud computer and double-layer particle swarm optimization. The integrated management of high-speed emergency big data and the optimization of the emergency scheme were studied, and good results were achieved [12–15].

2. Theoretical Basis

2.1. Analysis and Application of Urban Traffic Fault Text Big Data. Urban transportation has entered the era of big data. The analysis of urban traffic faults should be composed of safety supervision report, accident database, and other parts. Big data analysis is used to realize the functions of retrieval, extraction, intelligent classification, and related analysis of urban traffic faults [16, 17].

China’s urban traffic safety monitoring system is composed of monitoring object layer, monitoring layer, and management layer. Because of the different monitoring objects, it can be divided into three types: people, equipment, and environment. Its dataset has four characteristics, namely, scale, diversity, rapidity, and value.

(1) Scale generally refers to the amount of data.

(2) Diversity: It means that its data comes from many kinds of sources, which is beyond the data range previously included, including semistructured data and unstructured data. In addition, it also analyzes various data such as weather, earthquake, and ministry of public security, shown as follows: Figure 1 describes the classification of traffic big data and whether the internal data and external data mainly come from the transportation department are being judged. In internal data, structured data can be stored directly while Figure 1 unstructured data cannot be stored directly, so it needs to be converted into structured data for storage by technical means.

(3) Fast speed: big data mining lies in the fast processing speed, that is to say, data streams are mostly high-speed and need fast and continuous real-time processing by processing all kinds of data in time to ensure the safety of urban road driving.

(4) Value: the value of road safety lies in the use of data, statistical analysis, and classification algorithm to analyze big data, so as to find correlation and knowledge, predict accident failure safety problems, and provide basis for ensuring driving safety.

Urban traffic is a complex transportation system. Many experts analyze accidents and faults around safety evaluation, which provides favorable decisions for the prevention of safety accidents and faults. Experts use the accident fault data accumulated over the years to analyze the development rules of accident fault from the perspective of data analysis. This paper uses text big data analysis technology for statistical analysis to promote the application of urban traffic safety big data.

The application of fault analysis to accidents includes the following functions: feature extraction, accident-prone areas, fault analysis, full-text search, association analysis, and system management (Figure 2).

2.2. Full-Text Retrieval of Urban Traffic Faults. In the era of big data, it is of great significance to realize full-text retrieval through urban traffic big data technology. In this paper, through the establishment of full-text retrieval, combined with the actual traffic situation, the storage of traffic unstructured accident fault text, index building, Chinese word segmentation, and full-text retrieval is realized to find important messages in accident fault text.

Failure text retrieval is about indexing documents, queries, and the relationship between the users by using TF-IDF to retrieve and text analysis.

TF denotes word frequency, and the formula is as follows:

$$TF_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j} + 1}. \quad (1)$$

In the above formula, $n_{i,j}$ represents the number of occurrences, $\sum n_{k,j}$ represents the second sum of occurrences, and the denominator is added with 1 to prevent the denominator from being 0.

IDF denotes the reverse document frequency as follows:

$$IDF_i = \log \frac{N}{k_i + 1}, \quad (2)$$
where $k_i$ represents the number of documents and $N$ represents the size of $D$. The denominator is added by 1 to prevent the denominator from being 0.

Combine TF with IDF to get the weight:

$$W_{i,j} = TF_i \times IDF_j$$  

(3)

Document $D_j$ is reorganized into vectors with word weights:

**Figure 1:** Sources of road safety data.

**Figure 2:** Functional architecture.
Figure 3: Functional diagram of urban traffic emergency platform.

\[
d_j = \left( W_{1,j}, W_{2,j}, W_{3,j}, \ldots, W_{n,j} \right)
\]  

The cosine distance is calculated as follows:

\[
sim (q, d) = \frac{\sum W_{q,i} \times W_{i,j}}{|q| \times |d|}
\]

Finally, according to the results, the documents can be arranged to select the most suitable document for the user.

### 2.3. Technical Research and Analysis of Urban Traffic Emergency Management

The achievements of China’s urban transportation can be said to attract worldwide attention, and it has won worldwide recognition for its characteristics of “high efficiency, high safety, and high quality service.” It is very important to establish a perfect safety early warning and emergency management model. Because emergencies are unpredictable, an emergency management mode derived from cloud computing can be formed, a cloud service network can be established, and technologies such as Internet of Things and big data can be used to improve the efficiency of dealing with emergencies.

#### 2.3.1. The Main Functions of the Urban Traffic Emergency Platform (CEP)

Figure 3 illustrates the main functions of the urban traffic emergency platform (CEP), which is mainly divided into 9 functions, each of which can achieve different target requirements. It has certain intelligent control value for traffic control and realizes the goal of intelligent transportation in Industry 4.0 (Figure 3).

By establishing an “emergency cloud” to realize the application and deployment of network resources, the utilization rate of resources is greatly improved.

### 2.3.2. Emergency Cloud Service Virtualization Modeling

In the field of cloud computing, virtualization technology is a very important key technology. For virtualized storage resources, the formula is as follows:

\[
D_i = \left\{ D_{i1}, D_{i2}, D_{i3}, \ldots, D_{ij}, \ldots, D_{is} \right\}
\]

where \( D_{ij} \) is the \( j \)-th virtual machine virtualized from the \( i \)-th storage server and \( s_i \) is the number of virtual machines in the storage.

For computational virtualization, the formula is as follows:

\[
C_i = \left\{ C_{i1}, C_{i2}, C_{i3}, \ldots, C_{ij}, \ldots, C_{is} \right\}
\]

where \( C_{ij} \) has similar functionality to \( D_{ij} \).

For virtualized rescue services, the formula is as follows:

\[
T_i = \left\{ T_{i1}, T_{i2}, T_{i3}, \ldots, T_{ij}, \ldots, T_{is} \right\}
\]

where \( T_{ij} \) is the virtual rescue vehicle service from the \( i \)-th rescue vehicle server and \( 4s_i \) is the virtual service number in the rescue vehicle service.

### 2.3.3. Cloud Service

The virtualized storage resources of the emergency cloud are gathered together to form a storage pool, and the formula is as follows:

\[
DP = \left\{ D_{11}, D_{12}, \ldots, D_{n_1} \right\} \cup \left\{ D_{21}, D_{22}, \ldots, D_{n_2} \right\} \cup \ldots \cup \left\{ D_{m_1}, D_{m_2}, \ldots, D_{n_m} \right\}
\]

where \( n_1 \) refers to the number of storage servers.
The virtual network energy gathered together is the network pool, and the formula is

\[ NP = \{N_1 \cup N_2 \cup N_3 \cup \ldots \cup N_{n-1} \cup N_n\} \]

\[ = \{N_{1,1}, N_{1,2}, N_{1,3}, \ldots, N_{1,5}\} \]

\[ \cup \{N_{2,1}, N_{2,2}, N_{2,3}, \ldots, N_{2,5}\} \]

\[ \{N_{3,1}, N_{3,2}, N_{3,3}, \ldots, N_{3,5}\} \]

\[ \cup \ldots \cup \{N_{n,1}, N_{n,2}, N_{n,3}, \ldots, N_{n,5}\}, \]

where \( n_3 \) is the number of network servers.

2.3.4. Cloud Computing Model. The resources used by the emergency platform are virtual cloud services and they are shared, but there are also constraints as follows.

All rescue system resources should be less than the total storage pool resources, and the formula is

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle DG_{\text{max}} \rangle. \]  

In the above formula, \( y_n \) is the number of emergency rescue systems and \( DG_{\text{max}} \) is the total number of virtual resources in the storage pool.

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle CG_{\text{max}} \rangle. \]  

In the above formula, \( CG_{\text{max}} \) is the total number of virtual resources in the calculation pool.

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle NG_{\text{max}} \rangle. \]  

In the above formula, \( NG_{\text{max}} \) is the total number of virtual resources in the network pool.

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle TG_{\text{max}} \rangle. \]  

In the above formula, \( TG_{\text{max}} \) is the total number of virtual resources in the rescue vehicle service pool.

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle PG_{\text{max}} \rangle. \]  

In the above formula, \( PG_{\text{max}} \) is the total number of virtual resources in the rescue team service pool.

\[ \sum_{i=1}^{n} k_i(i) \cdot \langle RG_{\text{max}} \rangle. \]  

In the above formula, \( RG_{\text{max}} \) is the total number of virtual resources in the emergency materials service pool.

Through the above establishment and application research of emergency cloud, cloud computing, and big data technologies, the application and deployment of emergency platform network resources are completed, and a double-layer particle swarm optimization algorithm is proposed to establish constraints and effectively determine the number of emergency cloud resource scheduling.

2.3.5. Urban Traffic Operation Model. With the rapid development of urban transportation in China, the demand for passenger transport is also growing day by day, and various capacity scheduling problems in passenger transport are obvious. In order to solve the capacity problems, the adjustment of operation scheme and operation diagram has become very frequent. Passenger flow is the basic basis for determining the operation plan. Short-term passenger flow forecasting method and gradient lifting decision tree method are used for comparative analysis.

(1) The classification of short-term passenger flow forecasting methods is as follows (Figure 4): Passenger flow forecasting is based on the time characteristics of historical passenger flow and predicts the total amount and distribution of future passenger flow. Measurement, such as the prediction of future lines and related traffic at each station.

(2) CART decision tree and gradient lifting algorithm.

Decision tree model is a nonparametric classifier, which is composed of regression tree and classification tree, and the two tree types are different in essence.

The CART decision tree formula is as follows:

\[ F(j, s) = \text{arg min} \left[ \min_{x_i \in R_1(j, s)} (y_i - C_1)^2 + \min_{x_i \in R_2(j, s)} (y_i - C_2)^2 \right]. \]

In the above formula, \( C_m \) is the mean value generated after division.

J.H. Friedman, a professor at Stanford, invented gradient lifting method, which is one of the ensemble algorithms. As an iterative decision tree algorithm, it has fast training speed and can reduce prediction deviation, so it is one of the most effective methods in machine learning algorithms. Its basic origin is as follows:

\[ F(x) = \sum_{m=0}^M \beta_m h(x; a_m). \]

In the above formula, \( h(x; a_m) \) is the subtree, \( a_m \) is the parameter, and \( \beta_m \) is the weight in the prediction function.

The first regression tree:

\[ F_0 = \text{arg min} \sum_{i=1}^N L(y_i, h_0(x_i, a)). \]

Negative gradient of loss function:

\[ \tilde{y}_{mi} = \left[ \frac{\partial L(y_i, F(X_i))}{\partial F(X_i)} \right]_{F(x) = F_{m-1}(x)} \]

\[ a_m = \arg \min_{i=1}^N \left[ \tilde{y}_{mi} - h(X_i; a) \right]^2, \]

\[ \beta_m = \arg \min_{i=1}^N \left[ L(y_i, F_{m-1}(X_i) + \beta h(X_i; a_m)) \right]. \]

Update prediction function:
\[ F_m(X) = F_{m-1}(X) + \nu \beta_m h(X; a_m). \] (21)

**3. Model Application**

3.1. **PVHH Prediction Model and IDT Prediction Algorithm.** Combining the model analysis of urban traffic in the previous chapter with the passenger data of Tianjin network car and taxi, this paper puts forward the PVHH prediction model and IDT prediction algorithm of passenger capacity. The general framework of its passenger hotspots is shown in Figure 5.

The PVHH prediction model is based on the collected data of taxis and network cars and then analyzes the popular passenger points in the past, extracts the flow and distribution of passengers, and understands the trend of mobile personnel in the whole city.

The IDT algorithm mainly uses the information gain theory in decision tree to analyze the influence of different data at each moment on the predicted value. The labels of prediction models are original features (hotspotsi, m) and original labels (hotspotsi, m), respectively. In order to be suitable for machine learning classification algorithms, it is especially necessary to quantify data and weigh them. The
specific characteristics of prediction model labels are as follows:

\[
\begin{align*}
\text{features}(\text{hotspots}_i, m, w) &= \left\{ P_{i1}^{m-k} \ast w_{m-k}, P_{i1}^{m-k+1} \ast w_{m-k+1}, \ldots, P_{i1}^{m-1} \ast w_{m-1}, P_{i2}^{m-k} \ast w_{m-k}, P_{i2}^{m-k+1} \ast w_{m-k+1}, \ldots, P_{i2}^{m-1} \ast w_{m-1}, \ldots, P_{in}^{m-k} \ast w_{m-k}, P_{in}^{m-k+1} \ast w_{m-k+1}, \ldots, P_{in}^{m-1} \ast w_{m-1} \right\}, \\
\text{labels}(\text{hotspots}_i, m) &= [q_{i1}, q_{i2}, \ldots, q_{in}] .
\end{align*}
\]

Adaboost algorithm constantly updates the sample weight value to achieve the correct sample weight value reduction. The wrong sample weight value increases this classification purpose. Because taxis and network cars need to update the data of popular passenger points in real time, the Adaboost algorithm can update the prediction model. The IDT algorithm is shown in Algorithm 1.

3.2. Ford–Fulkerson Algorithm. Nowadays, urban traffic congestion is becoming more and more serious, so it is very important to analyze and evaluate traffic bottlenecks. Aiming at the three problems of node bottleneck, road bottleneck, and regional bottleneck, taking Chaoyang road for 4 days as an example, the congestion situation of this road section is studied, as shown in Figure 6.

It is of new reference significance to analyze traffic flow through data statistics in different time periods, and the traffic state in different time periods is different. Therefore, it is necessary to adopt the most reasonable and scientific forecasting methods for traffic conditions in different time periods. Generally, the traffic pressure is large in the morning and evening, and there are many geographical locations for analysis, so the global analysis scope is large. It can effectively reflect the advantages of the algorithm, can be analyzed for different time periods, and has the advantage of fast convergence speed.

Algorithm is the core model to solve the bottleneck of traffic flow. It uses labeling method to search the augmented path continuously until there is no path to search, and then get the maximum feasible flow. In order to identify the bottlenecks that lead to traffic obstruction and minimize the traffic flow, a bottleneck identification model of urban traffic network can be established by combining the road network framework, as shown in Figure 7.

The bottleneck identification model of urban traffic network is shown as follows:

\[
\begin{align*}
C_p(i, j) \forall P \in P_{D_i}, \\
P \in P_{O_j}, \\
V_{i,j} \in M_p,
\end{align*}
\]

4. Experimental Simulation Comparison

To establish the Ford–Fulkerson traffic flow prediction and analysis model, it is necessary to analyze and apply the whole traffic flow effectively. This paper analyzes the traffic flow data of taxis to analyze the prediction effect and application of traffic flow in different places and different time periods. The four intelligent algorithms used in this paper have the effect of traffic prediction. They have a good application prospect in the field of transportation, especially when there is an optimal problem between global and local. Therefore,
traffic flow forecasting is a global optimal problem, and intelligent algorithms can quickly realize the global minimum cost to achieve traffic forecasting and guide traffic planning.

Among the traffic flow forecasting methods under different algorithms in Figure 8, Ford–Fulkerson has certain advantages, with an average error of 0.31. Other algorithms have large errors and are unstable in prediction accuracy.

In order to forecast the traffic flow at different locations, the paper selects 10 traffic centers to forecast the traffic flow. The prediction effect is shown in Figure 9.

Then, analyze the error comparison of experiments under different algorithms, as shown in Figure 10.

In Figure 10, the prediction error comparison of different algorithms in different time periods every day is based on the deviation of relevant positions after 10 positions are
Figure 8: Traffic flow forecast in different time periods.

Figure 9: Comparison of average time period traffic prediction at different address locations.

Figure 10: Error comparison of different algorithms.
predicted as the position error comparison. Ford–Fulkerson has lower error and better stability (Figure 10).

Next, the prediction effect is analyzed from the prediction accuracy, as shown in Figure 11. In Figure 11, the prediction accuracy of the above four algorithms is compared for different days in one month. The prediction results of the four algorithms are not ideal in the early stage, and the highest prediction results of Ford–Fulkerson are 0.62. With the increase of days, the accuracy of the four algorithms is also improving. Because there are many early learning data, it can provide some reference for later prediction, and the accuracy is constantly improving. Finally, the Ford–Fulkerson accuracy rate is above 0.96, and the prediction effect is good.

5. Conclusion

With the in-depth development and technology application of smart cities, intelligent transportation technology has become a new technical means of urban development. This paper puts forward the prediction and analysis of traffic flow supported by Industry 4.0 and big data technology, which can play a key role in traffic development in smart cities. There are still some problems in the proposed algorithms, such as prediction accuracy, time, and other factors. Future work focuses on time delay and unpredictable factors in traffic forecasting and then puts forward corresponding models and solutions.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding this work.

References

[1] M. T. Odenkirk, D. M. Reif, and E. S. Baker, “Multiomic big data analysis challenges: increasing confidence in the interpretation of artificial intelligence assessments,” Analytical Chemistry, vol. 93, no. 11, 2021.

[2] W. W. K. Zung, “A self-rating depression scale,” Archives of General Psychiatry, vol. 12, no. 1, p. 63, 1965.

[3] A. Rosenfeld, D. Benrimoh, and C. Armstrong, “Big Data analytics and artificial intelligence in mental healthcare,” Applications of Big Data in Healthcare, pp. 137–171, 2021.

[4] R. Simon, U. Priefer, and A. Puhler, “A broad host mobilization system for in vivo genetic engineering: transposon mutagenesis in Gram-negative bacteria,” Bio/Technology, vol. 1, no. 9, pp. 37–45, 1983.

[5] Y. Zhen, Z. Lan, and Z. Jin-Fa, “New geographic distribution and molecular diversity of Citrus chlorotic dwarf-associated virus in China,” Journal of European Economy, vol. 21, no. 1, p. 6, 2022.

[6] L. Schütz, K. Saharan, and P. Mder, “Rate of hyphal spread of arbuscular mycorrhizal fungi from pigeon pea to finger millet and their contribution to plant growth and nutrient uptake in experimental microcosms,” Applied Soil Ecology, vol. 169, no. 248, Article ID 104156, 2022.

[7] Z. M. Li and X. Zhuang, “Application of artificial intelligence in microbiome study promotes precision medicine for gastric cancer,” Journal of European Economy, vol. 2, no. 4, p. 6, 2021.

[8] G. He and Z. Luo, “Artificial intelligence in second language learning,” Raising Error Awareness, no. 3, pp. 74–80, 2008.

[9] W. Zhang, H. Ning, and L. Liu, “Guest editorial: special issue on hybrid human–artificial intelligence for social computing,” IEEE Transactions on Computational Social Systems, vol. 8, no. 1, pp. 118–121, 2021.

[10] L. Qiao and X. Zhang, “Frequency management method based on cloud computing, big data and artificial intelligence,” Journal of Physics: Conference Series, vol. 1757, no. 1, (8pp), Article ID 012106, 2021.

[11] X. Bai and J. Li, “Personalized dynamic evaluation technology of online education quality management based on artificial intelligence big data [J],” Journal of Intelligent and Fuzzy Systems, no. 3, pp. 1–10, 2021.
[12] J. Rasmussen, "Human errors - a taxonomy for describing human malfunction in industrial installations," Journal of Occupational Accidents, vol. 4, no. 2-4, pp. 311–333, 1982.

[13] F. Zegrari and A. Idrissi, "Modeling of a dynamic and intelligent simulator at the infrastructure level of cloud services," Journal of Automation Mobile Robotics & Intelligent Systems, vol. 14, no. 3, pp. 65–70, 2021.

[14] C. Qiu and N. Liu, "A novel three layer particle swarm optimization for feature selection," Journal of Intelligent and Fuzzy Systems, no. 3, pp. 1–15, 2021.

[15] Y. Wang, ""Co-Construction" to "symbiosis"," Research on the Integrated Governance Mechanism of Industrial Colleges in Higher Vocational Colleges, no. 9, pp. 142–146, 2021.

[16] Y. Li, S. Wang, and Y. Yang, "Multiscale symbolic fuzzy entropy: an entropy denoising method for weak feature extraction of rotating machinery [J]," Mechanical Systems and Signal Processing, vol. 162, no. 7, Article ID 108052, 2022.

[17] S. Zhang and E. Forssberg, "Intelligent Liberation and classification of electronic scrap," Powder Technology, vol. 105, no. 1-3, pp. 295–301, 1999.

[18] L. Ping, W. Pu, and Z. Jinzi, "Research on global optimization scheduling method of high-speed railway emergency resource based on service pool," in Proceedings of the IEEE International Conference on Advances in Electrical Engineering and Computer Applications (AEECA), pp. 100–108, Dalian, China, August 2020.