# Automatic Monitoring System of Vehicle Pollutant Emission Based on Fusion Algorithm

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**Abstract.** To improve that automatic monitoring capability of the vehicle's pollutant discharge, a design method of the auto-monitor system for the emission of vehicle pollutant is proposed based on the fusion algorithm. The system design includes a large data analysis model design and system software for automatic monitoring of vehicle pollutant discharge. In that method, a quantitative statistical analysis method is adopt to carry out cloud computing fusion processing of automatic monitoring of pollutant discharge of a motor vehicle, and the invention relates to an information fusion and recombination model for automatically monitoring large data of pollutant discharge of a motor vehicle, the method of automatic monitoring of vehicle pollutant discharge based on the fusion algorithm is improved by the effective feature of the automatic monitoring of the pollutant discharge of the motor vehicle. In the development of B/S and embedded PCI bus, the software development and design of the automatic monitoring system for pollutant discharge of motor vehicle are carried out, and the hardware structure and software development of the automatic monitoring system for pollutant discharge of motor vehicle are carried out. The results of the test show that the automatic monitoring system for motor vehicle pollutant discharge is good in stability and strong in the sampling and statistical analysis of the physical information.

**Keywords:** Fusion algorithm · Motor vehicle · Pollutant · Discharge · Automatic monitoring system

## 1 Introduction

With the improvement of the people's living standard and the rapid development of the transportation and transportation industry in our country, the number of cars has risen sharply, and the transportation line is also getting busy [1]. In the course of carrying out the transportation, the automobile can discharge a large amount of tail gas, which has a great burden on the air and the environment pollution.

Under the information management platform, a database management platform of a motor vehicle pollutant discharge automatic monitoring system is designed, a database management platform of a motor vehicle pollutant discharge automatic monitoring system is constructed, a large data analysis method is adopted, the development and design of the automatic monitoring system for pollutant discharge of the motor vehicle, the combination of the combination networking technology and the embedded


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technology are carried out, and the algorithm design and software development of the vehicle pollutant discharge automatic monitoring system are carried out. The man-machine interaction and information management platform of the automatic monitoring system for the pollutant discharge of the motor vehicle is established, the bus scheduling of the vehicle pollutant discharge automatic monitoring system is carried out by adopting the embedded ARM addressing technology, the database development design of the system and the development of the control platform are carried out, the research on the design method of the auto-monitoring system for pollutant discharge of motor-driven vehicles is of great concern to people. Literature [3] analyzed the law of vehicle pollution emission changing with traffic parameters by monitoring the low altitude vehicle emission data, and proposed the vehicle pollution emission factor model for different vehicle types. The model is calibrated and tested, and the results can effectively reflect the real emissions of road vehicles. Literature [4] obtained the environmental basic data of freight hub through the real-time monitoring of vehicle pollutant emission in freight station, The emission characteristics of three functional areas in the station, i.e. cargo handling area, internal road intersection and entrance and exit, are studied. It is found that the concentration of NOx and particulate pollutants is positively correlated with the vehicle flow; the proportion of large and medium-sized trucks in the vehicle flow has a significant impact on the emission of NOx and particulate matters; the increase of pollutant emission during forklift operation is the most serious pollution in the loading and unloading area of the station Important reasons. However, the automatic monitoring accuracy of vehicle pollutant emission in the above two methods is low.

In view of the above problems, this paper proposes a design method of vehicle emission automatic monitoring system based on fusion algorithm. The system design includes the design and system software of the large data analysis model for the automatic monitoring of the pollutant discharge of the motor vehicle, firstly the algorithm design of the vehicle pollutant discharge automatic monitoring system is carried out, and then the software development design of the automatic monitoring system for the pollutant discharge of the motor vehicle is carried out, Finally, the simulation test is carried out to show the superiority of the method in the improvement of the automatic monitoring and information management capability of the vehicle's pollutant discharge.

## 2 Composition of Motor Vehicle Pollutants and Its Impact on Environmental Pollution

With the increase of the motor vehicle and the congestion of the transportation line, the pollutant discharge of the motor vehicle is increased day by day, and the pollutant of the motor vehicle can cause a fatal harm to the environment, and the CO, NOx, SOx and unburned hydrocarbon HC discharged by the automobile can seriously damage the ozone layer and generate acid rain, the greenhouse effect and the haze, etc., in which toxic substances such as hydrocarbons, nitrogen oxides, lead compounds, benzene, and the like in motor vehicle pollutants can cause harm to the human body and the animals and plants, therefore, it is necessary to increase the prevention and treatment of motor

vehicle pollutants and reduce the emission of tail gas. The main pollutants discharged by the automobile are carbon monoxide (CO), hydrocarbon (HC) and the like, and the combustion of the gasoline in the engine cylinder does not fully produce other nitrogen oxides such as NO2, and the nitrous acid and the nitric acid are generated in the air and the oxides, After being inhaled by a human body, a great harm to the lung can be generated, the exhaust pollution of the motor vehicle is also great to the environment and the health of people, the pollutants of the motor vehicle are mainly composed of the pollutants such as CO, NOx, Sox and the like, and the content of the CO and the sulfide in the tail gas accounts for the main part through the chemical analysis. In addition, CO2 is an important component of that vehicle's pollutant, and with the increase of CO2, the greenhouse effect is caused, according to the analysis, 30% of the CO2 in the air content is about from the vehicle exhaust, wherein the CO2 and the CO are harmful substances discharged from the combustion chamber for insufficient fuel combustion of the motor vehicle, In addition, the particulate matter discharged from the tail gas of the motor vehicle forms a solid carbide, as well as a hydrocarbon, a sulfide, and ash containing a metal component, and the like. The inhalation of these harmful substances in the human body makes it difficult for the person to breathe, the red and the throat of the eye, and the brain is faint. NOx is an exhaust gas that has a pungent smell in the vehicle's pollutants, and can form nitrous acid and nitric acid after entering the alveoli, and has great harm to the ecological environment and the plant and plant. In a comprehensive analysis, the harmful substances in the composition of motor vehicle pollutants are more harmful to the human body and the environment, and the pollution of motor vehicle pollutants to the environment is mainly manifested in the following aspects:

The main results are as follows:

(1) The excessive emission of motor vehicle pollutants will cause Greenhouse Effect and make the global climate warm. The sharp increase of CO_2 is the main cause of Greenhouse Effect, the global temperature will be listed, the north and south polar ice will melt, the sea level will rise, and the damage to the ecological environment will be enormous, while the main production of CO2 comes from motor vehicle pollutants, which intensifies with the increase of the number of cars. It is necessary to strict automobile emission standards, adopt end-of-life renewal, improve engine technology and reduce exhaust pollution.

(2) Harmful substances in motor vehicle pollutants will destroy the ecological balance. A large number of hydrocarbons, sulfides and metal components in motor vehicle pollutants have a great influence on animals and plants. When diesel engine fuel combustion is incomplete, hydrocarbons (HC) and sulfides will be produced, which will affect plant photosynthesis, cause vegetation damage, animals and humans inhaled such harmful substances, and will cause congenital defect diseases.

(3) Excessive emission of motor vehicle pollutants will cause great harm to human health. After absorbing human body, CO in motor vehicle pollutants binds to hemoglobin of human body, which causes toxic symptoms such as headache, dizziness, vomiting and so on. Respiratory failure and lung tissue diseases will be produced by inhaling NOx and HC in respiratory tract. NO2 and other nitrogen oxides in motor vehicle pollutants have severe stimulating effects on lung tissue. To sum up, motor vehicle pollutants are of great harm to the environment and ecology, and seriously

pollute the environment. It is necessary to take corresponding measures to reduce the emissions of motor vehicle pollutants, improve engine technology, reduce traffic congestion, improve fuel combustion efficiency, make fuel combustion sufficient, reduce CO and CO2 emissions in exhaust gas, and effectively reduce traffic congestion. In order to reduce the emission of motor vehicle pollutants and reduce the impact of motor vehicle pollutants on environmental pollution [5].

## 3 Big Data Analysis and Feature Extraction of Auto-Monitoring Vehicle Pollutant Emissions

### 3.1 Big Data Analysis of the Auto-Monitoring of the Emission of Motor Vehicles

Based on the above analysis of the composition of vehicle pollutants and its impact on environmental pollution, the big data of vehicle pollutant emissions are analyzed and feature extraction is carried out. Firstly, a big data information collection model for automatic monitoring of vehicle pollutant emission is established, and the method of combining fuzzy correlation feature detection and big data collection is used for detection and big data collection, the real-time data acquisition and the level analysis of the automatic monitoring of the pollutant discharge of the motor vehicle are carried out, a directed graph $G_1 = \left(M_1^{\alpha}, M_1^{\beta}, Y_1\right)$ and $G_2 = \left(M_2^{\alpha}, M_2^{\beta}, Y_2\right)$ are adopted as the candidate set of the automatic monitoring data liniment for the pollutant discharge of the motor vehicle, in that invention, $A = \{a_1,\ a_2, \ldots,\ a_n\}$ is a real-time health information distribution feature set for automatically monitoring the pollutant discharge of a motor vehicle, a statistical analysis method is adopted to establish a large-data information acquisition model for automatic monitoring of pollutant discharge of a motor vehicle, and in a cloud computing environment, a fusion scheduling model of automatic monitoring data for pollutant discharge of a motor vehicle is established through the automatic monitoring data distributed structure recombination of the pollutant discharge of the motor vehicle, and the physical health service description is carried out, In that cloud computing environment, the automatic monitoring data for pollutant discharge of the motor vehicle is sample to obtain the information acquisition and fusion model of the automatic monitoring data of the pollutant discharge of the motor vehicle [6].

The finite feature distribution set of automatic monitoring data of motor vehicle pollutant emissions is represented by quaternion $O = (C, I, P, Hc, R, A^0)$. $C$ is the utility threshold item set of sampling time series of automatic monitoring data of motor vehicle pollutant emissions, $I$ is the statistical feature distribution set of massive automatic monitoring data of motor vehicle pollutant emissions, and the efficient use itemsets of automatic monitoring of motor vehicle pollutant emissions are as follows:

$$x(t) = \sum_{i=0}^{p} a(\theta_i) s_i(t) + n(t) \tag{1}$$

wherein, p is the number of the minimum utility threshold of the automatic monitoring data of motor vehicle pollutant emissions, $s_i(t)$ is the statistical characteristic item of the automatic monitoring data of motor vehicle pollutant emissions, $a(\theta_i)$ is the fuzzy clustering measure of the automatic monitoring data of motor vehicle pollutant emissions, and H is the automatic monitoring data set of motor vehicle pollutant emissions. At this time, the data updating rules of automatic monitoring of motor vehicle pollutant emissions meet.

$$R_s^{(0)} = \sum_{n=0}^{k} \left\langle R_s^{(n)}, d_{\gamma n} \right\rangle d_{\gamma n} + R_s^{(k+1)} \tag{2}$$

According to the above analysis, the big data sampling analysis model of automatic monitoring of motor vehicle pollutant emissions is constructed, the cloud computing fusion of automatic monitoring of motor vehicle pollutant emissions is carried out by using quantitative statistical analysis method, the grid distribution structure model of automatic monitoring of motor vehicle pollutant emissions is constructed, and the system design and information distributed reorganization of automatic monitoring of motor vehicle pollutant emissions are carried out on the platform of cloud computing. Improve big data's management and information fusion ability for automatic monitoring of motor vehicle pollutant emissions [7].

### 3.2 Large-Data Feature Extraction for Automatic Monitoring of Pollutant Discharge of Motor Vehicles

The quantitative statistical analysis method is used to carry out the cloud computing fusion processing of automatic monitoring of motor vehicle pollutant emissions, and the method of block feature criticism and template data analysis is used to carry out big data information fusion and cluster analysis of automatic monitoring of motor vehicle pollutant emissions. Combined with adaptive learning algorithm, the optimization learning in the process of automatic monitoring of motor vehicle pollutant emissions is realized, and the automatic monitoring ability of motor vehicle pollutant emissions is improved [8]. The difference value of motor vehicle pollutant emission automatic monitoring project score is analyzed, and the correlation feature extraction model of big data, which is constructed for automatic monitoring of motor vehicle pollutant emission, is expressed as follows:

$$\begin{cases} x = (x_1, x_2, \ldots, x_n) \\ y = F(x) = (f_1(x), f_1(x), \ldots, f_m(x))^T \end{cases} \tag{3}$$

By adopting the self-adaptive learning algorithm, the optimized characteristic matching of the automatic monitoring of the pollutant discharge of the motor vehicle is carried out [9], and the characteristic matching set of the automatic monitoring of the pollutant discharge of the motor vehicle is obtained as follows:

$$RTT_s = (1-\alpha) \times RTT_s + \alpha \times RTT \tag{4}$$

According to the difference control, the spatial ambiguity cluster analysis model of automatic monitoring of vehicle pollutant emissions is established by adding the difference factor. The optimal value of ambiguity function $\overline{Q}$ of automatic monitoring of motor vehicle pollutant emissions is as follows:

$$Opti = \sum_{k=1}^{m} \alpha_i^{-1} \alpha_k t_{i,k} \alpha_k^{-1} \alpha_j t_{k,j} = \sum_{k=1}^{m} t_{i,k} t_{k,j} = \begin{cases} 1 & i = j \\ 0 & i \neq j \end{cases} \tag{5}$$

By using the method of feature alignment, combined with the sampling time delay, the global effective quantitative feature distribution set of automatic monitoring data of motor vehicle pollutant emissions is extracted [10–12], and the limited data set of automatic monitoring data of motor vehicle pollutant emissions is obtained as:

$$X = \{x_1, x_2, \cdots, x_n\} \subset R^s \tag{6}$$

Wherein, the automatic monitoring data set of motor vehicle pollutant emissions contains n samples, for sample $x_i$, $i = 1, 2, \cdots, n$. The quantitative relationship between the process of automatic monitoring of motor vehicle pollutant emissions is obtained by using the method of identifying related parameters.

$$h(t) = \sum_i a_i(t) e^{j\theta_i(t)} \delta(t - iT_S) \tag{7}$$

The association rules of automatic monitoring data of motor vehicle pollutant emissions are excavated. By using the method of autoregression analysis, the fuzzy index set of the process of automatic monitoring of motor vehicle pollutant emissions is obtained as follows:

$$\Lambda_0 = \left\{ \beta \in \Gamma : \left| \langle f, d_{\gamma_0} \rangle \right| \geq a. \sup_{\gamma \in \Gamma} \left| \langle f, d_\gamma \rangle \right| \right\} \tag{8}$$

By the analysis, a fuzzy information clustering and fusion method is adopted for automatically monitoring the relevance feature extraction of the large data of vehicle pollutant discharge, and the effective characteristic quantity of the automatic monitoring of the pollutant discharge of the motor vehicle is excavated, to improve the adaptability of the automatic monitoring of the pollutant discharge of the motor vehicle [13].

## 4 Automatic Monitoring of Pollutant Discharge of Motor Vehicle

Based on the analysis and feature extraction of big data of vehicle pollutant emission, the vehicle pollutant emission is monitored automatically. In that method, a block characteristic criticism and a template data analysis method are adopted to automatically monitor large data information fusion and cluster analysis of vehicle pollutant discharge, and the optimized monitoring index is $(RT_1, RT_2)$, and the degree of fuzzy clustering is $RW$, a fuzzy information clustering and fusion method is adopted to sample the automatic monitoring data of vehicle pollutant discharge, and the fuzzy degree function is obtained as follows:

$$F_j = \sum_{k=1}^{n} X_{kj},\ Q_j = \sum_{k=1}^{n} \left(X_{kj}\right)^2 \tag{9}$$

The method comprises the following steps of: acquiring a sample set length of a vehicle pollutant discharge automatic monitoring data flow time sequence of $\{x(t_0 + i\Delta t)\},\ i = 0, 1, \ldots, N-1$ and motor vehicle pollutant discharge automatic monitoring data by adopting a fuzzy association degree mining method, wherein the sample set length is $K$. The fuzzy convergence control function for automatic monitoring of pollutant discharge of motor vehicle is as follows:

$$\begin{aligned} M_v = w_1 \sum_{i=1}^{m\times n} (H_i - S_i) + M_h w_2 \sum_{i=1}^{m\times n} (S_i - V_i) \\ + w_3 \sum_{i=1}^{m\times n} (V_i - H_i) \end{aligned} \tag{10}$$

Carrying out the correlation analysis of the automatic monitoring of the pollutant discharge of the motor vehicle, obtaining the load of the automatic monitoring data of the pollutant discharge of the motor vehicle as the $M_h$, the high-order statistical characteristic distribution function is $V$, and the large data fusion scheduling of the automatic monitoring of the pollutant discharge of the motor vehicle is carried out, the statistical feature quantity of the obtained data fusion is as follows:

$$s(t) = s_c(t) e^{j2\pi f_0 t} = \frac{1}{\sqrt{T}} rect(\frac{t}{T}) e^{j2\pi(f_0 t + Kt^2)/2} \tag{11}$$

The invention discloses a cloud computing quantitative characteristic decomposition function of automatic monitoring of pollutant discharge of a motor vehicle, which comprises the following steps of:

$$f(k) = \begin{cases} f(k-1) - \frac{1}{n}, 1 \le k < n \\ 1, k = n \end{cases} \tag{12}$$

wherein, $k$ represents the clustering center of distributed automatic monitoring of vehicle pollutant emissions, and the optimized monitoring output function model is as follows:

$$\left.\begin{aligned} &\min_{\alpha} \tfrac{1}{2}\sum_{i=1}^{l}\sum_{j=1}^{l} y_i y_j \alpha_i \alpha_j K\left(x_i, x_j\right) - \sum_{j=1}^{l} \alpha_j \\ &s.t. \quad \sum_{j=1}^{l} y_j \alpha_j = 0 \\ &\qquad 0 \le \alpha_j \le u\left(x_j\right) C, \qquad j = 1, 2, \ldots, l \end{aligned}\right\} \tag{13}$$

According to the above analysis, a fuzzy information clustering and fusion method is adopted to automatically monitor large data fusion of vehicle pollutant discharge, and a binary structure combination method is adopted to carry out hierarchical clustering, and the self-adaptability of the automatic monitoring of the pollutant discharge of the motor vehicle is improved according to the clustering result [14].

## 5 System Software Development and Design

By adopting the RFID technology and the multi-mode VIX bus technology to carry out the automatic monitoring information sampling of the pollutant discharge of the motor vehicle, a large data characteristic analysis is carried out on the collected automatic monitoring data of the pollutant discharge of the motor vehicle, and a communication module is established [15], the bus transmission control and the remote communication design of the vehicle pollutant discharge automatic monitoring system are carried out, and the bus transmission and the optimization control of the vehicle pollutant discharge automatic monitoring system are completed by the ARM chip controller, and the overall design framework of the system is shown in Fig. 1.

In that B/S and the SOA framework system, the cross-compile control of the automatic monitoring system of the emission of the motor vehicle is carried out, and the information cross-compilation of the automatic monitoring system for the emission of the vehicle pollutant is carried out by executing the “Make menuconfig” program, the bus development of the automatic monitoring system of vehicle pollutant discharge is carried out on the embedded Linux kernel platform.

## 6 Experimental Test Analysis

In order to test the application performance of this method in the automatic monitoring of motor vehicle pollutant emissions, the simulation experiment is carried out with Matlab and C tools. The kernel of the automatic monitoring system for motor vehicle pollutant emissions is started based on B/S mode and SOA architecture technology, and the software integration design of the automatic monitoring system for motor vehicle pollutant emissions is carried out under the environment of Linux2.6.32 kernel.

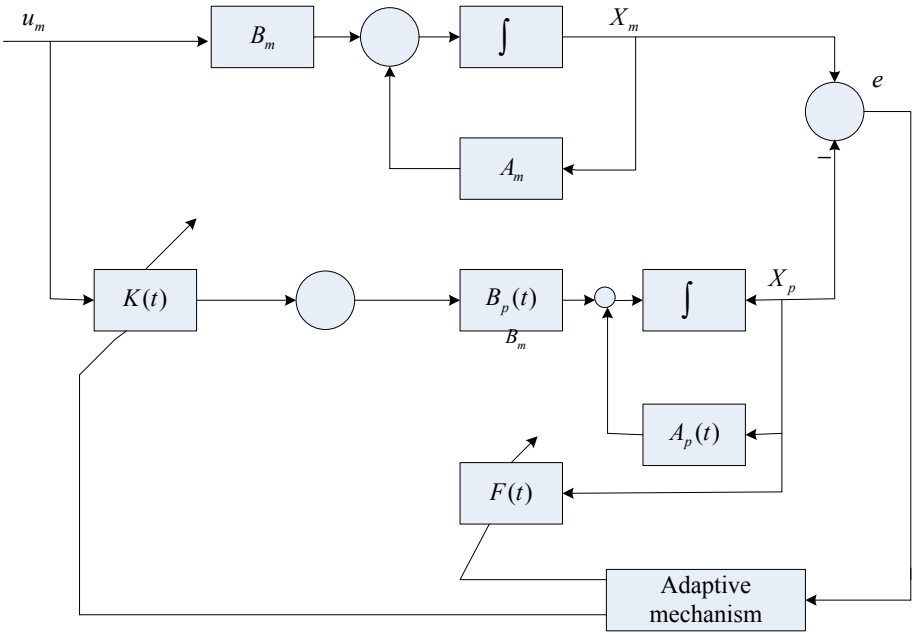


**Fig. 1.** Overall framework of automatic monitoring system for motor vehicle pollutant emissions

The output response of automatic monitoring of vehicle pollutant emissions is carried out by the test system, and the results are shown in Fig. 2.

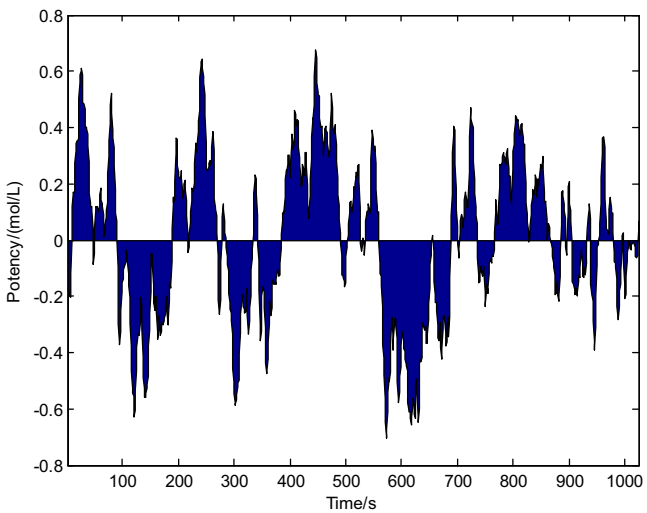


**Fig. 2.** Output response of automatic monitoring of vehicle pollutant emissions

According to the analysis Fig. 2, the method carries out the automatic monitoring output response of the pollutant discharge of the motor vehicle, and the accuracy of the automatic monitoring of the pollutant discharge of the motor vehicle is tested according to different methods, the comparison result is shown in Table 1.

**Table 1.** Comparison of accuracy of automatic monitoring of vehicle pollutant emission

| Iterations | Proposed method | Reference [3] | Reference [4] |
|---|---|---|---|
| 100 | 0.925 | 0.854 | 0.845 |
| 200 | 0.956 | 0.865 | 0.875 |
| 300 | 0.987 | 0.912 | 0.943 |
| 400 | 0.999 | 0.935 | 0.976 |

According to Table 1, the automatic monitoring accuracy of vehicle pollutant emission in this paper can reach 99.9%, which is higher than that of the literature method.

In order to further verify the effectiveness of the method in this paper, the error of vehicle pollutant emission automatic monitoring results of the method in this paper, the method in literature [3] and the method in literature [4] are compared and analyzed, and the comparison results are shown in Fig. 3.

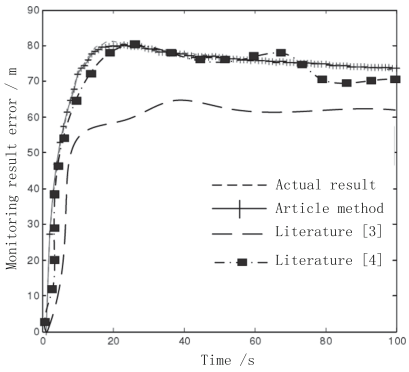


**Fig. 3.** Error comparison of monitoring results

According to Fig. 3, the fitting degree between the auto monitoring results of vehicle pollutant emission in this method and the auto monitoring results of vehicle pollutant emission in actual test is 100%, while the auto monitoring results of vehicle pollutant emission in literature [3] and literature [4] are quite different from the auto monitoring results of vehicle pollutant emission in actual test, which shows that this method has high vehicle pollution Automatic monitoring effect of material emission.

## 7 Conclusions

Because of the low precision of the traditional auto monitoring system, a design method of auto monitoring system based on fusion algorithm is proposed. In this paper, the database management platform of the automatic monitoring system for pollutant discharge of motor vehicle is constructed, and the development and design of the automatic monitoring system for pollutant discharge of motor vehicle are carried out by using the method of big data analysis. The invention relates to a large-data sampling analysis model for automatically monitoring the pollutant discharge of a motor vehicle, in that method, a block characteristic criticism and a template data analysis method are adopted to automatically monitor large-data information fusion and cluster analysis of vehicle pollutant discharge, By means of the fuzzy information clustering and the fusion method, the correlation feature extraction of the vehicle's pollutant discharge is automatically monitored, the effective feature quantity of the automatic monitoring of the pollutant discharge of the motor vehicle is excavated, and the improvement of the automatic monitoring algorithm for the pollutant discharge of the motor vehicle based on the fusion algorithm is realized. By adopting the RFID technology and the multi-mode VIX bus technology to carry out automatic monitoring information sampling of the pollutant discharge of the motor vehicle, a large data characteristic analysis is carried out on the collected automatic monitoring data of the pollutant discharge amount of the motor vehicle, and a communication module and a cloud computing platform are established, to realize the optimal design of the automatic monitoring system for the pollutant discharge of the motor vehicle. In this paper, the output stability of vehicle pollutant discharge automatic monitoring system is good and the automatic monitoring accuracy of vehicle pollutant emission is high. Since the change of traffic parameters is not considered in the research process, in the future research, the law of vehicle pollution emission with the change of traffic parameters will be analyzed by monitoring the emission data of low altitude vehicles on the road, and the model of vehicle pollution emission factor will be constructed for different vehicle types, and the model will be calibrated and tested.

## References

1. Shan, Y., Wang, J.: Robust object tracking method of adaptive scale and direction. Comput. Eng. Appl. **54**(21), 208–216 (2018)
2. Razavian, A.S., Sullivan, J., Carlsson, S.: Visual instance retrieval with deep convolutional networks. ITE Trans. Media Technol. Appl. **4**(3), 251–258 (2016)
3. Xiao, Z.: Temporal and spatial prediction and distribution of urban motor vehicle pollution emission. J. Shanghai Maritime Univ. **38**(4), 79–83 (2017)
4. Chen, Y., Qin, W., Li, X., et al.: Monitoring and pollution characteristics of motor vehicle contamination at freight station. J. Chongqing Jiaotong Univ. (Nat. Sci. Edn.) **37**(9), 60–65 (2018)
5. Al-Rawas, G., Abdul-Wahab, S., Charabi, Y., Al-Wardy, M., Fadlallah, S.: Modelling the trends of vehicle-emitted pollutants in Salalah, Sultanate of Oman, over a 10-year period. Stoch. Environ. Res. Risk Assess. **32**(5), 1355–1373 (2017). https://doi.org/10.1007/s00477-017-1464-2

6. Quintana, P.J.E., Khalighi, M., Quiñones, J.E.C., et al.: Traffic pollutants measured inside vehicles waiting in line at a major US-Mexico Port of Entry. Sci. Total Environ. **622–623**, 236–243 (2017)
7. Kosek, K., Kozak, K., Kozioł, K., et al.: The interaction between bacterial abundance and selected pollutants concentration levels in an arctic catchment (southwest Spitsbergen, Svalbard). Sci. Total Environ. **622–623**, 913–923 (2017)
8. Chen, C., Wen, T., Junlin, A.N., et al.: Characteristic of air pollutants in Tianjin before, during and after the Beijing Military Parade in 2015. Chin. J. Environ. Eng. **11**(10), 5446–5456 (2017)
9. Ding, Y., Li, N.: Image quality assessment based on non-local high dimensional feature analysis. J. Electron. Inf. **38**(9), 2365–2370 (2016)
10. Nayeb Yazdi, M., Arhami, M., Delavarrafiee, M., Ketabchy, M.: Developing air exchange rate models by evaluating vehicle in-cabin air pollutant exposures in a highway and tunnel setting: case study of Tehran, Iran. Environ. Sci. Pollut. Res. **26**(1), 501–513 (2018). https://doi.org/10.1007/s11356-018-3611-9
11. Shang, F., Guo, H., Li, G., Zhang, L.: Novel image segmentation method with noise based on one-class SVM. J. Comput. Appl. **39**(3), 874–881 (2019)
12. Anh, H.Q., et al.: Comprehensive analysis of 942 organic micro-pollutants in settled dusts from northern Vietnam: pollution status and implications for human exposure. J. Mater. Cycles Waste Manag. **21**(1), 57–66 (2018). https://doi.org/10.1007/s10163-018-0745-2
13. Zhao, Y., Yuan, Q., Meng, X.: Multi-pose face recognition algorithm based on sparse coding and machine learning. J. Jilin Univ. (Sci. Edn.) **56**(02), 340–346 (2018)
14. Hu, H., Zheng, M., Wang, H.: Optimization of MVB periodic scheduling table based on genetic algorithm. J. Jilin Univ. Sci. Edn. **57**(03), 613–618 (2019)
15. Cai, J., Chen, Y., Zhang, M., et al.: Pollutant emission analysis-oriented application of multi-source heterogeneous data on capital-entering nonlocal trucks. Beijing Gongye Daxue Xuebao **43**(3), 428–433 (2017)