Research Article

Analysis of Real-Time Early Warning Algorithm of Environmental Risk of Air Pollutants Based on Computer Simulation Technology

Yongcai Rao and Chunli Feng

Xuzhou Environmental Monitoring Center of Jiangsu, Xuzhou 221000, China

Correspondence should be addressed to Yongcai Rao; 2016120942@jou.edu.cn

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In order to monitor the air pollutants in the living environment in real time, the computer simulation technology is used to monitor the air pollutants, and the weighted algorithm is used to warn the pollutants exceeding a certain content, so as to facilitate the air quality control. Air is an essential element for everyone’s survival. With the development of manufacturing industry, air quality has deteriorated sharply, which has a certain impact on human ecological environment and does harm to residents’ health. When more and more attention is paid to environmental problems, the state has issued corresponding measures to monitor air quality and formulate air quality indicators. Once an element in the air is found to exceed the standard, an alarm will be issued, which is convenient for management and detection. This study analyzes the risk early warning algorithm of pollutants in the air through computer simulation technology to realize the management of air quality. Lay the foundation for human living environment in the future.

1. Introduction

The state of the air is closely related to the human living environment. With the development of social economy, the industrialization process is getting higher and higher, and the pollutants discharged into the air are also on the rise, resulting in a bad living environment, which affects people’s daily life and brings hidden dangers to residents’ health [1]. At the same time, the excessive emission of carbon dioxide and other gases in the air will not only bring health risks to human body but also affect the ecological environment and cause environmental changes, such as greenhouse effect, which makes people deeply feel how terrible the disaster caused by natural changes [2]. When environmental problems are more and more hotly discussed, especially the haze phenomenon in recent years, people find that the harm of air pollution has reached the point of urgency. It not only affects people’s daily travel safety but also restricts economic development. Therefore, air pollution has become a global concern. Air quality has become an important indicator to evaluate the quality of local life. Good air quality has become the first consideration for people’s pension and vacation.

According to Wu et al. [3], after the improvement of people’s living standards, especially the enthusiasm of young people for tourism, many cities attract tourists with local customs and scenic spots with local characteristics, so as to drive local economic construction. Through the analysis of urban air quality in the Yangtze River Delta by different analysis methods, it is found that there is no obvious correlation between the dust in the air and the local tourism economy. Different regions have their particularity, so we should treat this problem flexibly [3]. According to Wang [4], air pollution in cities with high industrial level is relatively serious, while the economic development of some light industrial cities is mainly concentrated in other industries. Through the analysis of air quality and labor resource allocation in different cities in China, it is found that air quality affects the income of workers and the inflow of labor resources. Through air quality assessment, the inflow of labor resources in Han areas can promote China’s green development and improve the rational flow of labor resources [4]. The development of a city needs the support of industry to provide
convenient conditions and jobs for people, but the air quality of a city will also restrict the overall development of the city. At present, China’s air monitoring mostly depends on the visualization of computer environment, which can monitor the air quality at any time, which is conducive to the protection of ecological environment. According to Dong Qun [5], when the air quality problem has become an influencing factor affecting residents’ physical health, the state has issued corresponding measures for remediation, and the emergence of air quality indicators has become the standard for people’s evaluation of air quality. The problem of air pollution has become a problem that puzzles people’s daily life and travel, and it is also a global problem that needs to be solved [5].

With the rapid development of science and technology, more and more science and technology have entered our life. Similarly, the detection of air by science and technology is more accurate, and the value of science and technology serving mankind will be fully realized. The development of science and technology makes people more convenient to monitor air. Using computer technology to monitor air quality in real time is one of the methods of environmental management in China. This research introduces the algorithm of real-time monitoring and early warning of air quality by computer simulation technology, so as to better manage air quality and make the ecological environment develop well.

2. Development History of Real-Time Detection of Air Pollutants

In the early days of China, the monitoring of the atmosphere was usually collected manually outdoors and then sent to laboratory personnel for analysis [6]. Due to the different quality of manual operation and operators, it is easy to cause errors, which is limited by the technical level at that time. Subsequently, scientific and technological progress made the relevant monitoring instruments develop to the level of online monitoring, which can monitor the air quality data in a certain area in real time. However, although the technology has improved a lot at this time, the online monitoring system, whether electrochemical automatic monitoring system or photochemical automatic monitoring system, has certain limitations, that is, spatial limitations [7]. The existing radar and laser automatic monitoring system can more widely and accurately provide the content of pollutants in the atmosphere, let people know the air condition in real time, and provide a basis for the national treatment of air problems. At the same time, some enterprises with excessive emission of air pollutants can be given corresponding measures to rectify or stop production. The monitoring items of air pollutants in China are shown in Table 1:

Table 1: Air pollutant monitoring items.

| Name   | Air pollutants |
|--------|----------------|
| SO₂    |                 |
| NO₂    |                 |
| PM₁₀   |                 |
| PM₂.₅  |                 |
| O₃     |                 |
| CO     |                 |

In Table 1, SO₂ and NO₂ are gases often emitted in industrial production. Especially in heavy industrial production bases, they rely too much on basic energy, resulting in high concentrations of SO₂ and NO₂ in the air, which has a certain impact on the local ecological environment, such as acid rain. Residents who often live under such conditions are also prone to upper respiratory tract-related diseases. With the improvement of people’s living standards, people pay more and more attention to health. Some people will move to cities suitable for life, so as to get rid of the impact of the environment on their personal quality of life. PM₁₀ and PM₂.₅ are the abbreviations of the size of suspended particles in the air. When the particles are smaller than microns, they are suspended in the air, which not only affects the city appearance, but also easily breathed into the lungs, causing allergies, asthma, chronic lung inflammation, and other diseases. Although O₃ exists in the atmosphere and can play a certain role in preventing direct ultraviolet radiation, if the concentration of O₃ in the air exceeds a certain content, it will also do some harm to human body, stimulate eyes and lungs, and do some damage to plants.

3. Application of Computer Simulation Technology

Computer simulation technology is a new technology integrating many disciplines with the progress of science and technology. It includes mathematics, management, statistics, system theory, and system engineering [8]. Especially in the experimental stage, it can simulate the objective things and data through computer technology and get the desired results. The air is mobile, and there are other influencing factors for its monitoring, such as cloudy days, seasons, wind direction, and temperature [9]. In order to get the concentration of air pollution more accurately, we can use computer simulation technology to establish the air quality index model of a certain area, simulate the relevant laws and influencing factors of air quality in this area by computer, and then screen out these influencing factors by algorithm, so as to obtain accurate data and warn the pollutants exceeding a certain concentration, so as to facilitate the management of air quality.

4. Research on Real-Time Early Warning Algorithm of Environmental Risk of Air Pollutants

4.1. System Framework Diagram of Early Warning Algorithm. Weather conditions have a certain impact on the monitoring of air pollutants. In order to better monitor pollutants, computer simulation technology is used to remove weather influencing factors and make regression analysis, so as to obtain accurate air quality data [10]. The computer simulation technology is used to input the historical air pollutant data and historical weather data, as well as the real-time pollutant data and real-time weather data into the computer system for data processing, and then build the algorithm model to output the pollutant concentration to be processed, respectively, extract the pollutant data whose concentration...
exceeds the standard, and sends out the alarm signal. At the same time, evaluate the future air quality and rank the pollutants with high concentration, suggesting that the chemical elements with high concentration in this area. The specific frame diagram is shown in Figure 1.

In Figure 1, according to the computer simulation model, the data of historical air pollutants and weather data, as well as the data of real air pollutants and weather data, are regressed and analyzed, and an early warning algorithm model is established to remove the interference of external factors, so as to obtain accurate monitoring data, extract the air pollutants with excessive concentration, and do early warning processing, so as to better supervise the air quality.

\[ R = \sum_{i=1}^{m} \sum_{j=1}^{n} \beta_{i,j} \rho_{i,j}, \]  
(1)

where \( \beta_{i,j} \) is the weighting coefficient of control point in row \( I \) and column \( J \), \( \rho_{i,j} \) are evaluation factors in row \( I \) and column \( J \), \( m \) is the total number of head offices, and \( n \) is the total number of trains.

\[ \rho_i = \delta_i \cdot \text{FNN}(R_i, G_i, B_i), \]  
(2)

where \( R_i, G_i, B_i \) are data of 3 satellite probes, \( \text{FNN} \) ( * ) is the output result of neural network, \( \delta_i \) is the weighting coefficient of the \( i \)th data, and \( \rho_i \) is evaluation output result of the \( i \)th data.

If there are \( N \) training samples, for each neuron, the training error of each training sample in the neuron can be expressed as

\[ Er = \frac{1}{2} \sum_{i=1}^{L} \sum_{j=1}^{n} (y_{i,j} - y_{c,j})^2, \]  
(3)

where \( NC \) represents the number of neurons in each layer of neural network (net), \( L \) represents the number of corresponding layers, and \( YC_j \) represents the actual output value. Therefore, for all training samples, the total error of net algorithm can be expressed as

\[ E = \frac{1}{2} \sum_{r=1}^{N} Er. \]  
(4)

Through this training error, BPNN constantly adjusts and corrects the connection weight between neurons in each layer of net algorithm until the total error of the algorithm is reduced to an acceptable level. The formula for correcting the connection weight is as follows:

\[ w_{ij} = w_{ij} - \mu \frac{\partial E_r}{\partial w_{ij}}, \]  
(5)

The main steps of classification with neural network algorithm are data standardization, neural network creation, neural network training, and neural network classification.

The average absolute error is calculated as follows:

\[ \text{MEPA} = \sum_{i=0}^{N} |\tilde{y}_i - y_i|. \]  
(6)

5. Test Results and Verification Analysis

Take the air pollutant detection data of a city from March 2018 to February 2020 as the training sample, which will eliminate the inconsistent data information and take these data as an example for learning and training. Then,
according to the construction of the above algorithm model, Matlab is used to analyze the accuracy of the data. MAPE evaluation and questionnaire survey are used to evaluate the two algorithm models.

5.1. Accuracy Analysis of Real-Time Early Warning Algorithm for Air Pollutants. Nowadays, people pay more attention to air quality. In the face of these health threats, establish a real-time monitoring and early warning system for air pollutants, analyze the air pollutants after receiving the data, and timely receive the early warning in the accuracy processing and analysis of the data, so as to better monitor air quality in real time. According to the comparison of real-time early warning accuracy data of various air pollutants by different algorithms, the data in Table 2 are obtained.

Table 2 shows the comparison of the effects of two different algorithms on the real-time early warning accuracy of air pollutants. Through the monitoring of air pollutant data, it is found that the ability of using this research algorithm to the real-time early warning accuracy of air pollutants is significantly better than the previous algorithm. In particular, the early warning accuracy of PM$_{10}$ and O$_3$ is more than 90%. The results show that this research algorithm has obvious advantages in the real-time early warning accuracy of air pollutants and can better manage air quality.

In order to better compare the monitoring data results, two groups of different algorithms are used for the real-time early warning accuracy of air pollutants. Figure 2 is drawn according to the data in the above table, so as to better understand the data.

As shown in Figure 2, according to the monitoring data results, the previous algorithm is compared with this research algorithm. The real-time early warning accuracy ability of the previous algorithm for various air pollutants is about 70%. The real-time early warning accuracy ability of this research algorithm for various air pollutants is significantly better than the previous algorithm, which directly opens the gap between the two algorithms. This research algorithm also needs to be compared with PM$_{2.5}$ to further improve the accuracy of real-time early warning.

5.2. MAPE Prediction Results of Air Pollutants. MAPE is the average absolute percentage error. The obtained index value can not only reflect the difference between the predicted value and the real value of each air pollutant but also compare and analyze different air pollutants under the same standard, so as to avoid the result difference caused by the different proportion of different pollutants in the air. All air pollutants are processed by MAPE to obtain the data in Table 3.

Table 3 shows the MAPE average predicted value data of air pollutants with different algorithms. It can be clearly seen from the table that the prediction accuracy of this research algorithm in the MAPE average predicted value data is higher than that of previous algorithms, especially in PM$_{10}$ and PM$_{2.5}$. In the average MAPE prediction value of 5, the algorithm in this study is better than the previous algorithm, and the accuracy of SO$_2$ prediction should be improved in the future.

In order to better compare the MAPE average predicted value data of air pollutants, two groups of different algorithms are used to visualize the data, as shown in Figure 3, so as to facilitate the understanding and comparison of the data.

As shown in Figure 3, it shows the visual diagram of the comparison of the average MAPE predicted values of air pollutants of two different algorithms, which can more clearly and intuitively show that the effect of this research algorithm on the average MAPE predicted values of air pollutants is better. This research algorithm is significantly different from the previous algorithms, and the average predicted values of NO$_2$ and Co are more accurate.
5.3. Evaluation of Two Algorithm Models. With people’s higher and higher requirements for air quality, the attention of using computer technology to monitor air pollutants in real time has generally increased. The ease of use and practicability of application equipment is not a new topic. At this stage, through the integration of science and technology, we can better understand air pollutants and their hazards and operate the equipment faster to achieve real-time monitoring, with high practical performance, and give full play to the application of the model so that it can be more widely used, narrow the direct gap with users’ expectations, so as to improve users’ satisfaction and reduce the complaint rate. Nowadays, computer simulation technology can make the model more convenient, flexible, and controllable and simulate the model object well.

In the previous algorithm and this research algorithm, the investigation and evaluation are made according to the ease of use, practicability, and satisfaction of the model. In
order to study and compare, the data results are tabulated, and the data in Table 4 are obtained.

In Table 4, the two groups of algorithms are statistically analyzed for ease of use, practicability, and satisfaction. The results show that the comparison results of the two algorithms are $T < 10.000$, $P < 0.05$, both of which have obvious statistical significance. This algorithm is better than the previous algorithm in terms of satisfaction, usability, and practicability. Draw Figure 4 according to the data in Table 4 to facilitate a more vivid understanding of various data.

As shown in Figure 4, the relevant results of the two algorithms in the comparison of ease of use, practicability, and satisfaction are shown. The comparison results show that the algorithm in this study is higher than the previous algorithms in ease of use, practicability, and satisfaction, especially in satisfaction, which is closer to people’s requirements, so as to reduce the complaint rate and improve the practicability and ease of use.

6. Summary

The emergence of computer technology has led to rapid development in many fields, especially in the research and development stage of science. Computer simulation technology is used to establish relevant models, so as to minimize the influencing factors and obtain the required data [11]. In this process, the establishment of the model is relatively important and is the basis for subsequent analysis. It can be said that the computer simulation technology is a regression analysis of the required data using statistical algorithms [12]. Aiming at the discussion of real-time monitoring of air pollutant concentration, this study outputs the historical air pollutant data and weather data with the real-time air pollutant data and weather data to the computer system for simulation experiments and constructs an algorithm model to remove the influence of weather on pollutants, so as to obtain the relatively prepared data, extract the elements with excessive pollutant concentration, predict the pollutants that may have the greatest impact on air quality in the future, and give early warning to this element, so as to provide basis for future air control work. Although the current level of science and technology can minimize some interference factors as much as possible and obtain relatively prepared data, any technology has its limitations. In the future, with the continuous emergence of high and new technologies, there will be simpler means to monitor air pollutants.

Data Availability

The data underlying the results presented in the study are available within the article.

Disclosure

The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

Conflicts of Interest

There are no potential conflicts of interest in our paper.

Authors’ Contributions

All authors have seen the manuscript and approved to submit to your journal.

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