Scholar Publishing Group
Nature Environmental Protection
https://doi.org/10.38007/NEP.2021.020106
ISSN 2790-2684 Vol. 2, Issue 1: 50-59

Feedback Neural Network and Symmetrical Connection Network in Human Environment

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Keywords: Human Environment, Feedback Neural Network, Symmetrical Connection Network, Environmental Pollution, Environmental Monitoring

Abstract: Human survival and development are constantly responding to the environment, and human participation has changed the original appearance of the entire natural environment to a certain extent. In recent years, pollution has intensified, and many countries have paid more attention to and actively controlled pollution, including air pollution, water pollution, solid waste and urban noise. Although pollution control has improved in recent years, urban environmental quality has improved significantly and developed steadily, many problems need further management to improve environmental quality. Effective environmental monitoring measures can provide a good basis for decision-making and implementation of environmental management, which is an effective measure for scientific evaluation of environmental management work of governments at all levels. According to the requirements of modern management, relevant government environmental monitoring agencies must change their monitoring strategies, actively introduce the concepts and methods of supervision and control, and improve the overall monitoring efficiency. In order to better carry out environmental monitoring, this paper uses symmetric connection network and feedback neural network to carry out environmental monitoring research. This paper constructs the structure of the Internet of Things for environmental monitoring, introduces the node structure and network system framework of wireless sensor networks, and classifies environmental images using symmetric connection networks. In this paper, feedback neural network is used for data fusion of the Internet of Things for environmental monitoring. In the experimental part, the environmental monitoring system is used for air monitoring experiment. The experimental results show that the monitoring system has good environmental monitoring effect, and the accuracy rate of air quality monitoring is 86.7%, with a high accuracy rate.

1. Introduction

The construction and development of the economy are facing serious pollution problems, which have brought many troubles to people's lives. In terms of pollution control, the relevant monitoring and management level is relatively low. It is necessary to strengthen the monitoring and management of pollution control. Only by continuously improving environmental monitoring can the environmental quality be improved and the strategic policy of sustainable development be implemented. Pollution control monitoring and management should be supported by environmental concepts, which define the scope and methods of environmental monitoring to meet human environmental needs.

At present, many scholars have studied environmental pollution. Zandalinas Sara I conducted multifactor analysis on global warming, climate change and environmental pollution [1]. Liu Kui conducted spatial quantitative analysis on the impact factors of environmental pollution [2]. Li Kunming studied the impact of population and energy prices on environmental pollution [3]. Liang Wei studied the impact of urbanization economic growth on environmental pollution [4]. Siddiqua Ayesha studied the impact of landfill and open-air dumping on environmental pollution and human health [5]. Liu Lina summarized the effect of genetically engineered bacteria on pollutant degradation [6]. Although there are many studies on environmental pollution, with the development of industrialization, environmental pollution is becoming more and more serious. In order to prevent and control environmental pollution, it is necessary to timely monitor the environmental situation.

Neural network has been applied in the field of monitoring. Uddin M. Irfan uses neural network model to monitor and follow COVI safety guidelines to guide people to avoid infection [7]. Reddy Thippa uses neural network to monitor marine environment [8]. Hesser Daniel Frank uses neural network to monitor tool wear of CNC milling machine [9]. Kong Ziqian proposed a new method of wind turbine condition monitoring using neural network data monitoring and acquisition [10]. Velappally Sajith used neural networks to study the Internet of Things medical teeth installation sensors, monitoring teeth and food levels [11]. Zhang Yong-gang has established a new neural network optimized by water cycle algorithm for landslide dynamic prediction [12]. Symmetrically connected neural network and feedback neural network are both branches of neural network, but how to carry out environmental monitoring for symmetrically connected neural network and feedback neural network needs to be further studied.

In order to better protect the environment, this paper uses symmetric connection network and feedback neural network to carry out environmental monitoring research. This paper introduces the current situation of environmental pollution and environmental pollution monitoring, then constructs the structure of the Internet of Things for environmental monitoring, and introduces its network node structure and network system architecture. The symmetrical depth neural network model is used to classify the environment image, and then the feedback neural network is used to classify the data fusion. In the experiment part, the environmental monitoring system is used to monitor the environment and verify the monitoring effect of the system.

2. Environmental Pollution and Monitoring

2.1. Current Situation of Environmental Pollution

(1) Serious domestic pollution

With the development of technology, air conditioners, refrigerators, stoves and other household appliances have spread to tens of millions of households and are widely used in daily life. Although beneficial to human beings, a large amount of harmful gases emitted would also affect the air quality. In addition, people's quality of life has been steadily improved, and exhaust emissions have become an important source of pollution. Every year, haze is related to this [13].

(2) Serious industrial pollution

In the actual operation of enterprises, chemical plants, cement plants, steel plants, etc., all of these need to burn a large amount of coal. However, cleaning up coal pollution requires high cleaning costs and advanced cleaning technologies, resulting in many companies burning and directly discharging dust and other exhaust gases, exacerbating air pollution [14].

2.2. Environmental Pollution Monitoring

Monitoring refers to monitoring and measurement. The environmental monitor is called "electronic eye" to monitor pollution.

Environmental monitoring includes chemical monitoring used to analyze and test pollutants, physical monitoring of physical elements, biological monitoring of environmental quality and environmental monitoring process, usually including on-site investigation, development of monitoring plan, sampling monitoring and monitoring point optimization, sampling, transportation and storage, analysis and testing, data processing, comprehensive evaluation, etc. [15].

Most environmental monitors are medium and low level products produced by small and medium-sized enterprises, with medium technical level, small product type, high failure rate, instability and short service life. For example, the online monitoring system of various pollution sources cannot solve the measurement problems related to high temperature, high humidity and high content of inhaled particulate matter, which seriously limits the implementation of the entire inhaled particulate matter control system.

Environmental work and technological innovation in the field of environmental protection are inseparable. The basis for strengthening environmental monitoring is to continuously carry out scientific and technological innovation and improve environmental monitoring technology. Relevant industries should keep pace with the times, constantly improve the level of environmental monitoring technology, actively absorb the advantages of the world's environmental monitoring technology, improve and develop scientific and effective environmental monitoring technology, improve the overall quality of environmental monitoring, make the quality of environmental work orderly and promote development.

3. Environmental Monitoring System

3.1. Environment Monitoring IoT Structure

The Internet of Things is composed of sensors, transportation layer and application layer. The main task of the sensor layer of the Internet of Things is to collect and transmit short-range data, including environmental monitoring, industrial control, green agriculture and other application services. Among them, the Internet of Things has broad prospects in environmental monitoring. A large number of wireless sensor nodes are deployed in the regions that need to be monitored, which can collect, transmit and process the monitoring data in the region in real time, so as to realize the global monitoring of the region. The structure of the Internet of Things is shown in Figure 1.

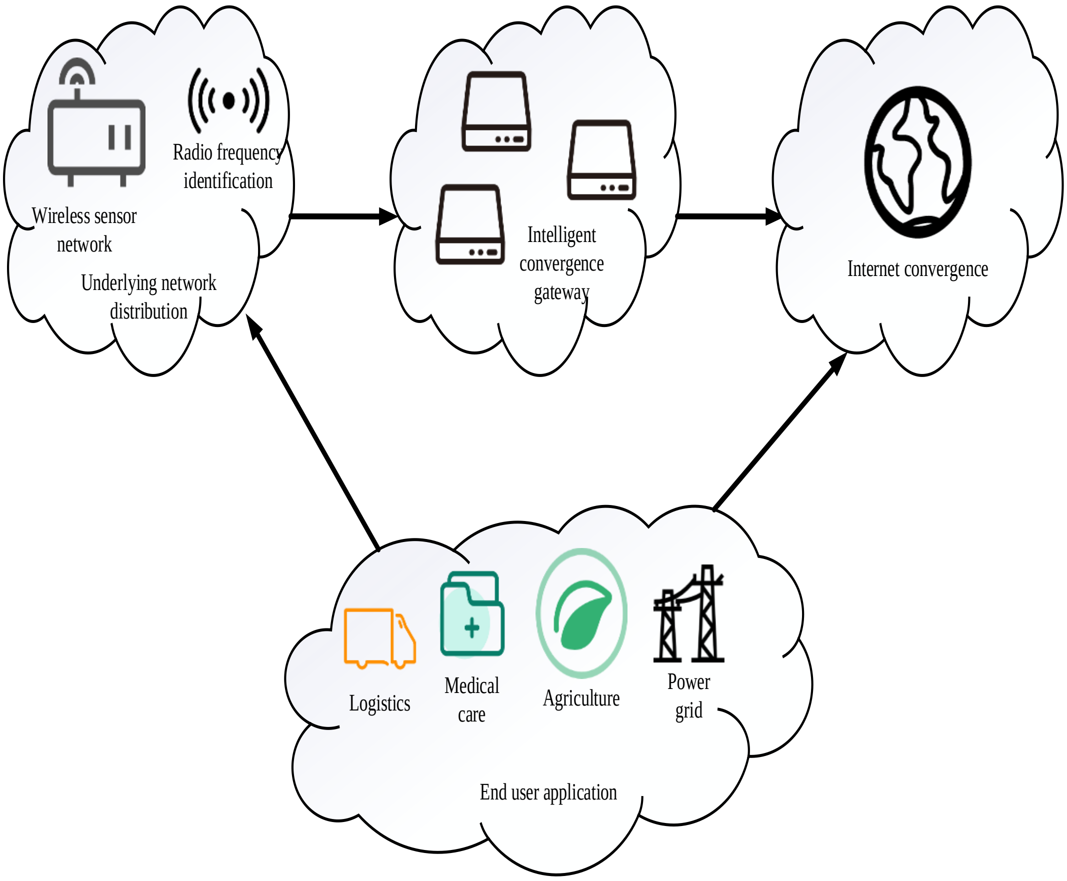


Figure 1. Structure of the Internet of Things

3.2. Node Structure of Wireless Sensor Network

The IoT node of environmental monitoring is mainly responsible for collecting, transmitting and processing monitoring information. Sensor module includes sensor and modular converter, processor module includes microprocessor and memory, and power module is different from existing battery power module.

3.3. Wireless Sensor Network System Architecture

The underlying network architecture of the Internet of Things studied in this paper is shown in Figure 2.

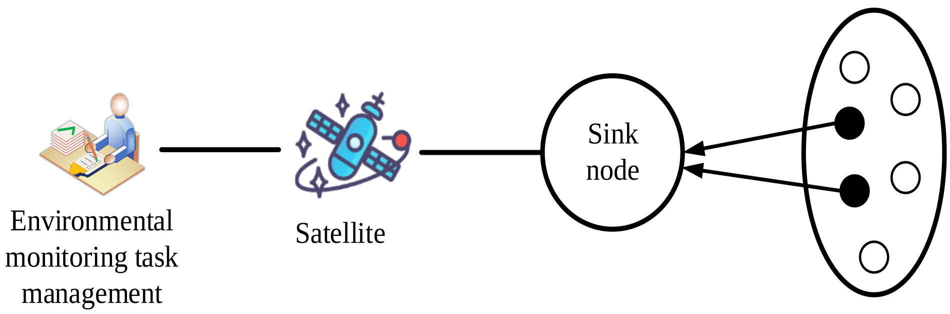


Figure 2. Internet of Things underlying network architecture

The whole architecture is composed of sensor nodes, intermediate nodes and integration nodes. Through the environmental monitoring center, sensor nodes build wireless communication networks according to their organizational characteristics, and reverse nodes communicate through the Internet. The way to transmit data to the environmental monitoring task control center through satellite and other means is as follows. First, the network node collects the environment data and sends it to the front-end node of the cluster according to the specific routing algorithm. Then the cluster node combines and summarizes its information with the data, which is sent by other public nodes, and then sends the results to the aggregation node. The processing node sends data and sends it to the environmental monitoring task management center, so that users can evaluate the monitoring situation and assign environmental monitoring tasks according to the actual needs of each sensor node. This node can collect relevant data.

4. Environment Image Classification Based on Symmetrical Connection Network

The hierarchical learning depth model can be used to extract more accurate feature expressions. The random processing of deep neural networks leads to completely different connection values, which are studied in neural networks with the same topology. Even though these networks have the same classification attributes, the features extracted from the deep neural network are also different.

Inspired by the symmetrical structure of the left and right sides of the brain, a symmetrical deep neural network (SDNN) model is proposed. This model can use different depth network structures to model relatively independent left and right hemispheres and simulate the function of human visual cortex.

SDNN network is composed of two subnets, each of which is a deep network and has the function of extracting the feature expression of the same layer. In some implementation examples, the depth of the left and right subnets and the number of subnet nodes can be independently controlled. The left and right subnets are called public subnets, which can be combined into the whole feature extraction layer. The SDNN decision part connects the chain layer at the input end and the class layer at the output end, connecting the network together to form a symmetric neural depth network at the region classification layer.

The characteristics of the independent front-end communication between the left and right networks are that the objective functions used to improve the network reverse distribution are different, and the network settings between them are limited, which is in line with the network's assumptions about the differences between the left and right networks, thus expanding the noise-free display space of the network.

RBM (Restricted Boltzmann machine) can be formed for each adjacent two-layer structure (excluding class layer) of the left and right subnets of SDNN, which is defined as visible layer and hidden layer. There is a complete connection between hidden layers and visible layers. There is no connection between visible layers and hidden layers. Joint configurations between visible and hidden layer nodes have joint energy.

$$E(v,h;\theta) = -\sum b_i v_i - \sum b_j v_j - \sum v_i h_j w_{ij} \quad (1)$$

Among them, the model parameters are $\theta = \{w, b\}$, v_i and h_j are the binary states of visible layer node i and hidden layer node j respectively, b_i and b_j correspond to the displacement of visible layer node i and hidden layer node J respectively, and w_{ij} is the connection weight.

To check the image, the possibility that the binary state of the hidden layer verification node is set to 1 is:

$$p(h_i = 1|v) = \delta(b_j + \sum v_i w_{ij}) \quad (2)$$

$$\delta(x) = \frac{1}{(1+e^{-x})} \tag{3}$$

After selecting the state of the hidden layer node, the probability of restoring the image and setting each pixel to 1 is as follows:

$$p(h_i = 1|h) = \delta(b_i + \sum h_i w_{ij}) \tag{4}$$

The conditional probability principle of the two subnets of SDNN is similar. SDNN is used for classification. The logical regression network composed of combination layer and class has not been trained in advance, and its processing is random initialization. Traditionally, the value of RBM parameters is solved by maximizing the probability function of the gradient increasing process. The number of gradient increasing functions based on the energy model is as follows:

$$\frac{\partial}{\partial\theta}L(\theta) = -[\frac{\partial E(v;\theta)}{\partial\theta}]_{data} + [\frac{\partial E(v;\theta)}{\partial\theta}]_{model} \tag{5}$$

$E(v;\theta)$ represents the energy of V, $\langle\cdot\rangle_{data}$ and $\langle\cdot\rangle_{model}$ represent the expected values of all values of visible layer nodes controlled by data and model respectively. This parameter must run the gain algebraic function, and the RBM update parameter corresponds to the following expression:

$$\Delta w_{ij} = \varepsilon([v_i^0 h_i^0]_{data} - [v_i^{\infty} h_i^{\infty}]_{model}) \tag{6}$$

ε is the learning rate, v^0 is the data distribution, h^0 is calculated from the known data distribution and the expression $h(h^0|v^0)$, v^{∞} is generated from infinite data samples, and h^{∞} is calculated from the expression $p\left(h^{\infty}\middle|v^{\infty}\right)$.

5. Environmental Monitoring IoT Data Fusion Based on Feedback Neural Network

5.1. Data Fusion Function

In the environment monitoring of the Internet of Things, due to the low cost and high reliability of the micro-sensor nodes used in the monitoring area, the wireless communication mechanism of the sensor makes the data transmission process more vulnerable to interference and damage. Due to the abnormal operation of the node, incorrect data may be transmitted, so it is necessary to use data fusion technology to improve the accuracy of sensor acquisition and overcome the dual constraints of sensor cost and volume. Adopt data fusion technology to reduce network congestion frequency and improve channel utilization efficiency and data acquisition efficiency. The data fusion method is adopted to reduce the impact of sensor abnormal operation on the final monitoring results.

5.2. Data Fusion Classification

In the Internet of Things used for environmental monitoring, data fusion technology has many classification methods, which can be summarized at three main levels, including the change of data volume before and after consolidation, the difference between consolidation objects and the abstraction of consolidation processing.

(1) Differences in data volume changes before and after consolidation

Lossless merging: stores all details of the monitoring information of the sensor nodes. The data merging process only needs to merge the contents of the data packets to avoid sending multiple data packets without opening the data packets to display specific contents. The impact of this data integration is not obvious, and the total amount of data would not be significantly reduced.

Lossy consolidation: When transferring data, not only data packets would be displayed, but also data can be consolidated to reduce some data, thus reducing the amount of data transferred.

(2) Different differences of consolidated processing objects

Merge time: Merge data collected by the same network node in different time periods.

Merge space: Merge data collected from different network nodes at the same time.

Merge time and space: merge data collected by different network nodes at different times.

(3) According to the abstract degree of fusion processing

According to the degree of abstraction of the merge process, it can be divided into three models, each of which has its own characteristics.

Data level consolidation: analyze and process the original data to obtain the corresponding characteristics and attributes. This consolidation model focuses on the integrity of data and hopes to save data details to ensure high-precision consolidation.

Feature-level consolidation: compress the data to the minimum value that the data can display, and combine the feature information of the original data. This merging model can effectively compress data and maximize the recognition information required for preprocessing decisions. The merging algorithm is the merging of feature layers, as shown in Figure 3.

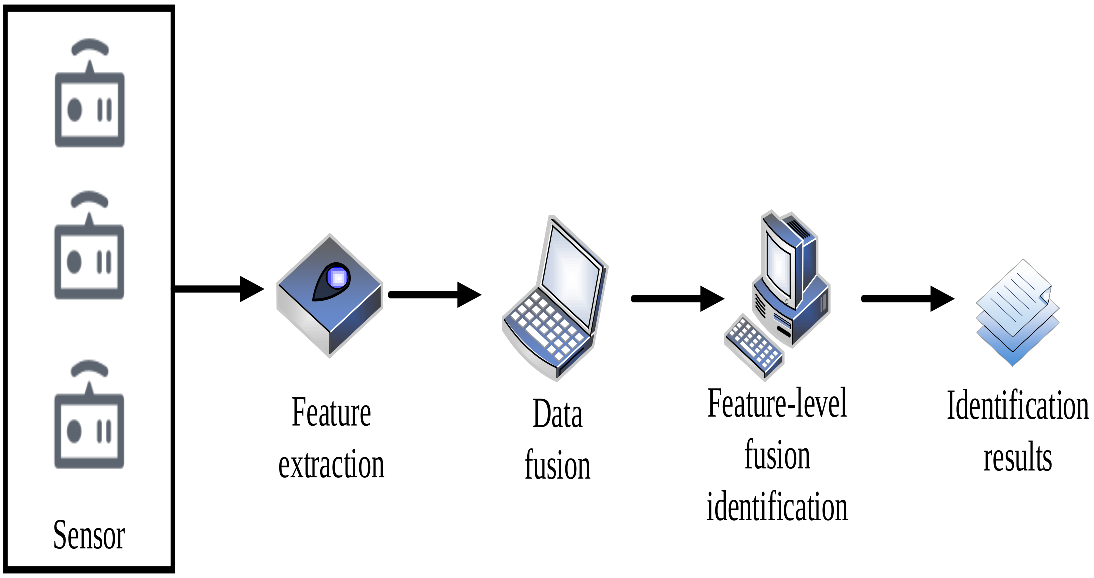
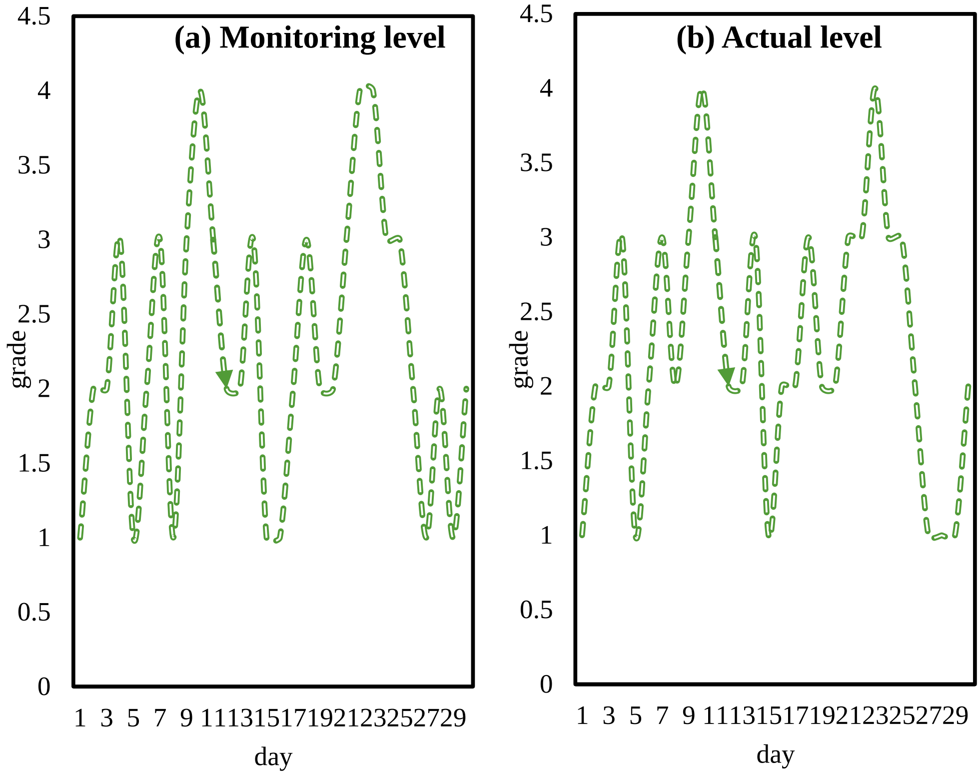


Figure 3. Feature-level fusion process

Decision-level consolidation: Each node in the network extracts the characteristics of the collected data separately and sends the results to the consolidation center for consolidation. This merging model has good fault-tolerance, but the original data is seriously lost.

6. Environmental Monitoring Experiment

Conduct air monitoring for a place for 30 days to monitor the air quality of the place. The air quality is divided into 6 levels, with Level 1 being excellent, Level 2 being good, Level 3 being light pollution, Level 4 being moderate pollution, Level 5 being severe pollution and Level 6 being serious pollution. The air quality monitoring level and actual level are shown in Figure 4.



(a) Air quality monitoring level *(b) Actual air quality grade*

Figure 4. Air quality level

Figure 4 (a) shows the air quality monitoring level, and Figure 4 (b) shows the actual air quality level.

During the 30-day monitoring of air quality, it was detected that there were 7 days of air quality grade 1, 11 days of air quality grade 2, 9 days of air quality grade 3, 3 days of air quality grade 4, and no air of grade 5 and 6.

For the actual air quality of the place, the air quality level is Level 1 for 6 days within 30 days, Level 2 for 12 days, Level 3 for 10 days, Level 4 for 2 days, and no Level 5 and 6 air.

By comparing the two sets of data, it can be found that the accuracy rate of air monitoring is 86.7%, and the accuracy rate is high, which indicates that the environmental monitoring system can have a good environmental quality monitoring effect.

7. Conclusion

If there is no effective supervision and management in the process of pollution control, the overall effect of pollution control may not be satisfactory. In this paper, symmetrical connection network and feedback neural network are used to study environmental monitoring. In this paper, the Internet of Things environment monitoring system is constructed, and wireless sensors are used as network nodes. SDNN model is proposed and used to classify environment images. The feature level fusion method is adopted, and the feedback neural network is used for data fusion classification. The experimental part verifies the effect of the environmental monitoring system, and the research shows that the system has high environmental monitoring accuracy.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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