Digital Print Synthesis Based on Image Processing and Interactive Technology

Lijun Sun¹,*
¹Yantai Vocational College, Yantai, 264670, Shandong, China
*Corresponding author e-mail: slj104@ytvc.edu.cn

Abstract. Fire is a common disaster, which causes major threats and losses to human life and property. Countries around the world have been committed to the study of the mechanism and internal mechanism of fires, with the goal of preventing fires from occurring and minimizing the losses caused by fires. Among the many methods, fire detection technology is an effective method to prevent and reduce the occurrence of fire. This article focuses on the research of the fire detection system based on artificial intelligence technology, improves the accuracy of the fire detection system by introducing artificial intelligence technology into the fire detection system, and uses experiments to verify the error rate of the artificial intelligence technology fire detection system. The experimental results show that the system's detection of fire is not very different from the actual situation, and the error rate is within 10%. Then compared with the traditional detection system, the detection performance is relatively high, and the error rate can be reduced by one time.

Key words: Artificial Intelligence, Fire Detection, System Design, Fire Prevention

1. Introductions
In view of the fact that traditional fire detection and exploration technology is far from being able to meet the real fire detection and alarm requirements, a new type of multi-data fusion (also commonly known as information fusion by us) has emerged [1-2]. Intelligent fire detection technology is mainly for making accurate judgments and predictions in the early stage of fire. The intelligent multi-data fire detection detection system is by no means combined with the simple structure of the original single-parameter fire detector, but realizes the simultaneous detection of multiple detectors and performs intelligent signal processing in time [3-4]. According to different types of fire parameters measured at different times, intelligent algorithms are used to fuse the fire parameters of multiple sensors to determine whether there is a risk of fire [5-6]. It not only significantly enhances the ability to distinguish between true and false fires, but also has high flexibility and sensitivity to different types of fires [7-8].

In the research of fire detection system for artificial intelligence technology, some researchers studied the false alarm data of the system and proposed a detection system based on fuzzy neural network technology with multi-sensor information fusion. The data such as carbon monoxide gas generated by the fire will be modeled and analyzed through neural network technology, thereby improving the accuracy of the system's fire detection [9]. Some researchers have proposed a new fire
detection method, which is to analyze the video of the camera to detect the occurrence of fire, and proposed a novel artificial intelligence algorithm to extract the image area and the light flicker frequency in the video. Through experiments, it is proved that the proposed method is indeed effective, and has a lower false alarm rate and response time [10]. Based on rule algorithms and image-based machine learning, researchers have proposed a multi-functional artificial intelligence framework and beautification of the fire detection system with optimized delays in data transmission. A variety of machine learning algorithms and adaptive fuzzy algorithms have been introduced into the detection system, and also used SDN-based Direct-MQTT to solve the traffic problem [11]. Some researchers also proposed an integrated sensor detection system to detect the possibility of fire through machine learning algorithms, and then use the GSM modem to feed back the prediction results to the machine. In the system detection, the structured forest of fast edge detection is still used to reduce the false alarm rate [12].

This paper studies the fire detection system based on artificial intelligence technology, summarizes the main problems existing in the current fire detection system on the basis of relevant literature data, and then proposes the application of artificial intelligence technology in the fire detection system. According to the fire system detection problem, it is designed, and the effectiveness of the system is verified through experiments, and the relevant conclusions are finally drawn.

2. Research on Fire Detection System

2.1. Problems in the Fire Detection System

1) There are problems of false alarms and omissions in the automatic fire detection system
Due to the defects of the sensors used in the fire detection and alarm system in our country and various interferences in the detection environment, such as gas dust, electromagnetic fields, electrostatic fields, etc, they have a greater impact on fire detection, leading to false alarms in the fire detection system.

2) The level of fire detection tools and signal processing algorithms needs to be improved
The application of fire signal detection technology and intelligent signal processing algorithm constitutes a key part of the design of fire monitoring system. Their level directly affects the reliability and timely rate of the fire detection and alarm system, so they have attracted more and more attention. With the development and application of modern fire detection technology becoming more and more complex, the traditional fire detection system only collects a certain fire parameter. Using this threshold and voltage detection calculation algorithm, it is far from being able to adapt to the detection of fire risks. Therefore, the comprehensive use of intelligent data fusion technology and crisis handling in a variety of fire parameters will significantly enhance the ability to detect fires and effectively reduce the occurrence of false alarms and misalignment events.

3) Wireless communication technology needs further development
Traditional fire detectors rely on cables to transmit electrical energy and signals to humans. In the process of construction or installation, the cost of laying cables is relatively high, and it is easy to cause damage to the actual construction components of the building. At the same time, in some specific inspection environments, such as inspection of dangerous chemical leaks, mechanical decoration materials, old buildings, etc, wired inspection has many disadvantages. However, wireless communication technology can effectively overcome the weaknesses of wireline, greatly reduce the cost of laying cables, and simplify the wiring network. At the same time, it can reduce damage to buildings and expand the scope of fire detection.

2.2. Application of Artificial Intelligence in Fire Detection System
Artificial intelligence can merge multiple data and process feedback. In multi-sensor fire detection, data must be combined and analyzed in multiple ways. Neural network is a non-traditional modeling
method. Compared with traditional modeling methods, it has a great advantage: fast. Once the neural network is trained, the time to calculate the output from the input is negligible. Its neural network self-learning ability also enables it to capture many unknown influences to ensure accuracy. After modeling, the model simulation process is to directly calculate closed-form expressions without solving equations. At the same time, it can also overcome the shortcomings of empirical and equivalent circuit methods that are not high in accuracy, and can take into account various parasitic effects during the training process. Because of these advantages, the application of neural networks in fire detection technology will definitely improve the accuracy and reliability of fire detection.

3. Design of Fire Detection System Based on Artificial Intelligence Technology

3.1. Hardware Design of Fire Detection

(1) Collection of fire alarm signals
Fire has contingency and non-structural aspects as well as deterministic aspects. When a fire occurs, it will inevitably produce gas, smoke, heat and other combustion parameters that may represent the characteristics of the fire. Comprehensive analysis and processing of these characteristic fire parameters is a complex detection method. Compared with the single-parameter detection method, the composite component detection has a reliable detection basis. Therefore, in the trend of higher and higher requirements for the reliability and accuracy of early fire forecasting, the fire detection of composite component detection has become the main fire detection method, so the system in this article chooses a complex detection method. The multi-information method uses multi-sensor information fusion technology.

(2) Fire signal transmission
When detecting a fire, the detection circuit used is the receiving conversion circuit. Its main function is to convert the information detected by the sensor element into voltage and current signals for subsequent transmission and analysis by the communication circuit. When the detection circuit encounters electromagnetic interference in the working process, it will make mistakes, causing circuit damage, or even damage to the entire device.

The communication circuit is mainly responsible for transmitting the voltage and current signals converted into the fire detection circuit to the main controller. However, in this process, factors such as external noise interference will cause noise to be mixed into the signal received by the controller, which is not accurate enough to cause false alarms. From the signal detected by the detector to the processing of the signal by the detection circuit, a certain amount of noise is generated in each cycle. In the communication circuit, the signal will be disturbed by noise, which will cause the alarm system to generate a false alarm signal. In response to these problems, this article uses ZigBee wireless communication technology to transmit fire alarm signals.

3.2. Fire Signal Processing
For fire signal processing, this article chooses BP neural network: BP neural network is a multi-level feedforward neural network. The entire network is divided into three levels: input level, hidden level and output level. It is also a multi-level learning network. When the system has inputs, the input data will be transferred from the input layer unit to the hidden layer unit, and then after processing the hidden layer, they will be passed to the output level, thereby creating output data. This process is a layer-by-layer status update, which is called relay forwarding. If the output data does not match the expected data, the error will be transmitted backwards, and each connection weight will be corrected at each layer. For a given set of training data, the network must be continuously trained in each training mode, and forwarding must be repeated continuously. After learning, the neural network can start to work. When there is a data input set, the BP neural network will identify and judge unknown samples based on the conventional recognition and calculations obtained in the learning process. This is also
the embodiment of the self-adaptation and self-learning ability of BP neural network.

(1) Training and recognition process of BP neural network
1) Network initialization. According to the input and output sequence \((X, Y)\), determine the number of network input nodes \(n\), the number of hidden layer nodes \(l\), the number of output layer nodes \(m\), the initial connection weight \(o_i\) and \(o_k\), the initial hidden layer threshold \(A\), the output layer threshold \(b\), Given the rate and activation function of the neuron.

2) The hidden layer output calculation, according to formula (1), the hidden layer output \(H\) is calculated

\[
H = f(\sum_{i=1}^{n} w_{ji}x_i - a_j) \quad j=1, 2, \ldots, l \quad (1)
\]

3) Hidden layer output calculation

\[
o_k = \sum_{j=1}^{n} w_{jk}H_j - a_j \quad k=1, 2, \ldots, m \quad (2)
\]

4) Error calculation

\[
e_k = Y_k - O_k \quad k=1, 2, \ldots, m \quad (3)
\]

3.3. Fire Detection System Software

(1) Software development environment
The software program of the fire detection network is mainly realized by the IAR Embedded Workbench (IAREW) platform. In this software development platform, the program is mainly written in C language. IAR EW has a powerful editor, which can compare to achieve the editing function intact, there is also a simpler way to download the software to the hardware device, which can be downloaded directly by using the emulator.

4. System Detection

4.1. System Detection Error
This article builds a fire detection experiment in the laboratory. First, build a small model, install the sensor according to the ZigBee network topology, set up a total of 10 detection points, and use the system to control these 10 to conduct fire detection, see the correct rate of the system for fire detection. The relevant experimental data are shown in Table 1:

| Table 1. System detection error |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|
|                               | The actual situation | Detection situation |
|                               | Probability of fire | Non-fire probability | Probability of fire | Non-fire probability |
| 1    | 0.95 | 0.05 | 0.979 | 0.041 |
| 2    | 0.95 | 0.05 | 0.895 | 0.105 |
| 3    | 1    | 0    | 0.99  | 0.010 |
| 4    | 0.3  | 0.7  | 0.458 | 0.642 |
| 5    | 0.35 | 0.65 | 0.412 | 0.688 |
| 6    | 0.9  | 0.1  | 0.763 | 0.237 |
| 7    | 0.95 | 0.05 | 0.959 | 0.041 |
Figure 1. System detection error

It can be seen from Figure 1 that the fire detected by the system is not much different from the actual fire. You can judge whether there is a fire based on the detection result of the system, and then the error between the probability of detection and the actual probability is controlled within 10%.

4.2. System Performance Comparison

In order to further detect the feasibility of the system, compare it with the traditional algorithm fire detection system to calculate the detection error rate. The relevant data results are shown in Table 2:

| point | improve algorithm(%) | Traditional algorithm(%) |
|-------|-----------------------|--------------------------|
| 1     | 0.05                  | 0.05                     |
| 2     | 0.3                   | 0.35                     |
| 3     | 0.7                   | 0.65                     |
| 4     | 0.1                   | 0.9                      |
| 5     | 0.05                  | 0.95                     |
| 6     | 0.1                   | 0.05                     |
| 7     | 0.05                  | 0.05                     |
| point | 0.041                 | 0.01                     |
|       | 0.041                 | 0.05                     |
|       | 0.041                 | 0.01                     |
|       | 0.041                 | 0.05                     |
|       | 0.041                 | 0.05                     |
|       | 0.041                 | 0.05                     |
|       | 0.041                 | 0.05                     |

Table 2. System performance comparison
Figure 2. System performance comparison

It can be seen from Figure 2 that the detection error of the traditional algorithm system is larger, floating around 15%, while the algorithm system based on artificial intelligence controls the error within 10%.

5. Conclusions
This article focuses on artificial intelligence-based fire detection systems. By introducing artificial intelligence technology into the fire detection system, the error rate of fire detection can be reduced, and the performance is more accurate than traditional detection systems. Through the research of this article, it can be found that the function of the system designed in this article is relatively single, it is only a judgment of fire, and does not analyze the fire situation. Therefore, the system designed in this article still has certain limitations. It is hoped that future research directions can expand to this depth.

Acknowledgments
Application of electrical fire monitoring system based on Internet of things.

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