Research on Intelligent Detection Device of Toxic and Harmful Gas Alarm

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Abstract. With the deepening of industrial production, the emission of toxic and harmful gases is also growing, which is not only reflected in the quantity of toxic and harmful gases, but also in the category of gases. In order to ensure the safety of the production process, it is necessary to carry out efficient and continuous detection and early warning of these gases. Based on this, this paper first analyses the functional requirements and settings of toxic and harmful gas intelligent detection and alarm device, then studies the design of toxic and harmful gas detection and alarm device based on AI, and finally gives the specific device setting process.

Keywords: Intelligent Detection Device, Toxic and Harmful Gas, Alarm

1. Introduction

With the iterative progress and maturity of modern intelligent tech represented by AI, it has been widely and deeply applied and studied in many fields, especially in the field of detection and alarm of toxic and harmful gases, which effectively promotes the detection efficiency and accuracy of toxic and harmful gases [1]. Moreover, with the continuous development of energy industry represented by petrochemical industry in recent years, the emission of a series of toxic and harmful gases produced in the process of production and operation is also growing continuously. This increase is not only reflected in the amount of toxic and harmful gas emissions, but also reflected in the type of gas level. If these toxic and harmful gases cannot be effectively disposed, it will produce more serious hidden dangers and consequences.

In order to ensure the stable operation of related industries and the safety of production and transportation process, it is necessary to effectively monitor the relevant links that may produce toxic and harmful gases, especially the intelligent detection and alarm of toxic and harmful gases. In this context, the intelligent detection device of toxic and harmful gas alarm has been widely studied and applied, which has brought and played a more significant role and function [2]. Generally speaking, common toxic and harmful gases mainly include several types as shown in Figure 1 below. For different types of toxic and harmful gases, there are different restrictions and requirements at the national level, which requires the detection device to be able to carry out targeted detection and alarm according to the type of gas and the specified limit range.
At present, most of the toxic and harmful gas detection and alarm devices do not have the ability of measurement and verification, and some devices have certain intelligent control ability, but their reading and gas path switching cannot be carried out automatically. That is to say, most of the current toxic and harmful gas detection and alarm devices lack of other intelligent dynamic gas distribution, intelligent detection and control capabilities. With the iterative maturity and progress of AI tech, its effective application in gas intelligent detection and alarm device can meet the requirements of intelligent and automatic measurement verification, and realize automatic detection and calibration of toxic and harmful gases.

In addition, because the toxic and harmful gas detection and alarm device is often in a bad environment, the detection device is required to have high reliability and accuracy, so as to achieve continuous and stable detection of toxic and harmful gas [3]. The application of AI tech makes the detection device further rely on machine vision, remote control and automation tech to achieve remote accurate detection and alarm. Therefore, the research on the design and development of intelligent detection device for toxic and harmful gas alarm based on AI has important engineering practice value.

2. Functional requirements of intelligent detection and alarm device for toxic and harmful gases

2.1. Functional requirements of toxic and harmful gas detection and alarm device
First of all, the intelligent detection and alarm device for toxic and harmful gases should be able to operate stably and accurately under the interference of temperature, humidity and other non-toxic and harmless gases. Secondly, due to the harsh environment of the detection and alarm device, it is also required that the device has strong protection ability against external factors such as rain, wind sand and mechanical external force. In addition, in the strong electromagnetic environment, in order to ensure the smooth operation of the device, strong anti-electromagnetic interference means are needed to ensure the fidelity of signal feedback.

2.2. Setting requirements of toxic and harmful gas detection and alarm device
The setting of alarm value of toxic and harmful gas detection and alarm device should follow the principle of safety, science and feasibility to ensure timely response of operators, and take effective emergency rescue measures to eliminate abnormal conditions and ensure personal safety [4]. For toxic and harmful gas detection alarm value setting level, mainly includes forecast value and alarm value. Among them, the forecast indicates the preventive and control measures, and the alarm value indicates that the toxic gas in the air of the workplace has reached or exceeded the national occupational health standards. The release point should be inspected immediately, and the corresponding measures such as prevention of release, ventilation and exhaust and personnel protection should be taken.

In addition, the toxic and harmful gas detection alarm signal should be sent to the attended field control room, central control room for display alarm, and the fault signal of the alarm control unit of the toxic and harmful gas detection and alarm system should be sent to the fire control room [5].

![Common toxic and harmful gases.](image)

**Figure 1.** Common toxic and harmful gases.
In order to ensure that the combustible gas and toxic gas detection and alarm system can still work normally when the production process control system of the process unit fails or is stopped, the toxic and harmful gas detection and alarm system should be set independently from other systems.

3. Design of toxic and harmful gas detection and alarm device based on AI

3.1. Structure of toxic and harmful gas detection and alarm device

First of all, the toxic and harmful gas detection and alarm device should be composed of combustible gas or toxic and harmful gas detector, on-site alarm, alarm control unit, etc. Secondly, the alarm signal of toxic and harmful gas and the fault signal of alarm control unit should be sent to the control room for graphic display and alarm. The overall structure of toxic and harmful gas detection and alarm device is shown in Figure 2 below.

![Figure 2](image)

**Figure 2.** Structure of toxic and harmful gas detection and alarm device.

3.2. Transmission mode of toxic and harmful gas detection alarm signal

There are three transmission modes of toxic and harmful gas detection and alarm signal transmission: automatic alarm system transmission alarm signal, graphic display transmission alarm signal and alarm control unit installed in the general control room. The transmission mode of using automatic alarm system to transmit alarm signal requires the alarm signal of toxic and harmful gas detector to be transmitted to the toxic and harmful gas control unit. And after the alarm, it can ensure the rapid acceptance of alarm information and the rapid development of emergency measures. Secondly, in case of toxic and harmful gas alarm, the automatic alarm system in the general control room should be able to accurately display the specific point information of toxic and harmful gas detector.

When the graphic display is used to transmit the alarm signal, the alarm signal should be transmitted to the toxic and harmful gas control unit, so as to ensure that the emergency information can be taken timely after receiving the alarm information. Special graphic display for toxic and harmful gas detection and alarm system is installed in the general control room. The alarm signal of the detector is transmitted to the graphic display through the control unit, and the graphic display can display the level alarm signal of body detection and the fault signal of alarm control unit, as shown in Figure 3 below.

In addition, the toxic and harmful alarm control unit is installed in the general control room and managed by the personnel on duty. Its principle structure is basically the same as that of using graphic display to transmit alarm signals.
3.3. Design of intelligent detection and alarm device for toxic and harmful gases

The toxic and harmful gas detection and alarm system shall be divided into alarm zones according to the production and transportation devices or units, and each alarm zone shall be equipped with on-site regional alarm. The system mainly includes automatic gas distribution system, image acquisition and recognition device, control terminal and verification information platform [6]. Among them, the automatic gas distribution system is mainly used for metrological verification, so as to facilitate the replacement of gas cylinders with different concentrations, without the need to replace gas cylinders and pressure relief valves. Image acquisition and recognition device realizes automatic acquisition and recognition of verification data of toxic and harmful gas detection alarm without data transmission interface.

4. Design of toxic and harmful gas detection and alarm device based on AI

4.1. Automatic gas distribution device

High precision infrared gas analyzer is used to analyze the prepared standard gas, analyze the accuracy of the prepared gas, and use the analyzer to measure the prepared gas volume fraction. The main technical index of the automatic gas distributor is the accuracy of the volume fraction of the standard gas. In addition, the calibration of toxic and harmful gas detection alarm is compared with the standard gas of cylinder, and the comparison error of measurement data is analyzed, so as to verify whether the gas distribution system achieves the expected goal.

4.2. Image acquisition and recognition based on AI

In the process of image acquisition and recognition based on AI, the color image should be grayed and smoothed. Secondly, the image is processed by corrosion expansion to reduce the external noise interference. In addition, the image is processed by edge processing to obtain the internal contour, so as to extract the character features. Finally, the string is separated into a single character for processing. After the segmentation of the image, a higher acquisition recognition rate is achieved. The identified character data is stored in the computer, and the test results are sent to the handheld terminal for analysis and processing.

4.3. Control terminal and verification information platform

The main function of the control terminal is to display the basic information in the measurement process in real time, such as indication error, repeatability and response time. The verification information platform adopts B / S architecture mode, and the software is only installed in the server to realize the management of the basic information, inspection information and verification information of the detected alarm. In addition, the application of AI network and database tech, to achieve efficient and suitable for toxic and harmful gas detection alarm verification process, so as to further improve the
detection efficiency. Using the remote control terminal, it can remotely control the verification device to carry out a series of operations, so that the verification personnel are far away from the verification site and ensure the safety of personnel.

5. Conclusion
In summary, if the toxic and harmful gas cannot be effectively disposed, it will produce more serious hidden dangers and consequences. The application of AI tech makes the detection device further rely on machine vision, remote control and automation tech to achieve remote accurate detection and alarm. This paper analyzes the function and setting requirements of toxic and harmful gas intelligent detection and alarm device. Through the analysis of the design of toxic and harmful gas detection and alarm device based on AI, the design of intelligent detection and alarm device for toxic and harmful gas is studied. Finally, the flow chart of AI image acquisition and recognition, automatic gas distribution and control terminal of the intelligent detection device is given.

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