Intelligent Anti-virus Mask Based on Gas Detection Sensor

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Abstract. This article developed an intelligent anti-virus mask, which is composed of MQ-135 sensor, single-chip microcomputer, valve mechanism and so on. When there is no poisonous gas, the valve of the canister of the mask is opened to breathe normally; when there is poisonous gas, the valve of the canister of the mask is closed and an alarm is issued, and air enters and exits through the canister. Experiments show that the gas mask can accurately detect the concentration of alcohol gas volatilized by alcohol diluents of 30%, 50% and 80% concentration, and trigger the mask to perform alarm and protective actions in a timely and accurate manner. The experiment verifies the safety and versatility of the smart gas mask, indicating that the product has high engineering application value and practical promotion significance.

1. Introduction

Common gas masks currently on the market directly isolate the human respiratory system from the outside world when worn. During the wearing process, because of the need to actively breathe, it will cause breathing difficulties and other problems [1]. Many laboratories do not usually have toxic gases, and only in specific experimental links may accidentally leak and cause toxic gases to escape [2]. Therefore, many experimenters are lucky and do not wear masks [3] during the experiment. However, some toxic gases have less irritating odor and are difficult to detect by the human body. When you feel unwell, you may have inhaled a lot of toxic gases [4]. Therefore, a smart protective mask is designed. The valve is opened when worn normally, and it is closed when toxic gas is detected and alarms to ensure the safety of the experimenter, ensuring safety while taking into account the comfort of wearing and the convenience of operation.

2. System structure and principle

Figure 1 shows the system block diagram of the smart gas mask. This system uses MQ-135 harmful gas detection sensor [5][6], which mainly monitors the concentration of toxic gases such as ammonia, sulfide, benzene vapor, etc. in real time (Note: In order to ensure the safety of the sample during the experiment, the MQ-3 alcohol ethanol sensor simulation test is used). The amplifying circuit amplifies and converts the signal into a voltage signal that the single-chip microcomputer can recognize, and then sends it to the single-chip microcomputer and converts it into a digital signal through ADC[7]. The concentration data will be displayed on the OLED display in real time. When the concentration data detected by the sensor reaches different values, it will trigger actions such as smart mask alarm, protection, and sending of emergency SMS. At the same time, the system maintains real-time communication with the mobile phone through Bluetooth communication [8] to ensure data transmission and command reception.
3. System hardware design

3.1. The main controller hardware circuit

The system controller adopts STC15W4K single-chip microcomputer [9], which is a single-clock/machine cycle (1T) single-chip microcomputer produced by STC. It is a new generation of 8051 single-chip microcomputer with wide voltage, high speed, high reliability, low power consumption and super anti-interference. The code is fully compatible with 8051. The chip is packaged in LQFP48, 46 I/O ports are available, and 4 serial UARTs are supported, which is convenient for connecting multiple modules. The enhanced 8051 core is 7-12 times faster than the traditional 8051. High-speed 8-channel 10-bit ADC, the speed can reach 300,000 times per second, 8 PWM can also be used as 8 D/A [10]. Built-in comparator, more powerful. General I/O port, each I/O drive capacity can reach 20mA, the schematic diagram of the single-chip microcomputer is shown in Figure 2.

3.2. MQ-135 sensor

The gas sensitive material used in MQ135 gas sensor is tin dioxide (SnO2) with low conductivity in clean air [11][12]. When there is polluted gas in the environment where the sensor is located, the conductivity of the sensor increases with the increase of the pollutant gas concentration in the air. Using
a simple circuit, the change in conductivity can be converted into an output signal corresponding to the gas concentration. The MQ-135 sensor has high sensitivity to ammonia, sulfide, and benzene vapors, and it is also ideal for smoke and other harmful monitoring. This sensor can detect a variety of harmful gases and is a low-cost sensor suitable for a variety of applications.

4. System software design

4.1. Software implementation flowchart

Figure 3 is a schematic flow chart of the system software.

4.2. Software design ideas

The system software is designed according to the application of the smart gas mask in the actual experiment, and the action response is mainly divided into four levels:

- When the concentration of toxic gas in the environment is less than 300ppm, it is a "safe" level. The concentration of toxic gas will not cause harm to the human body. The OLED screen displays the real-time gas concentration detected by the mask, and the mask does not perform actions.

- When the concentration of toxic gas in the environment is greater than 300ppm and less than 500ppm, it is a "three-level alarm". The toxic gas in the air will not cause harm to the human body in a short time. At this level, the indicator light is on, the buzzer emits a short and one long beep, and the OLED screen displays the real-time gas concentration, and at the same time displays ">Alarm is on", and at the same time, the message “Buzzer On!” will be displayed on the mobile phone via Bluetooth module transmission.

- When the concentration of toxic gas in the environment is greater than 500ppm and less than 800ppm, it is a "secondary alarm". The concentration of toxic gas in a short period of time is relatively high, causing damage to the human body in a short period of time. In this level, the indicator light is on, the buzzer emits two short and one long beeps, the mask is closed immediately, and the OLED screen displays the real-time gas concentration at the same time. ">Alarm on", "Protection on", and at the same time display the prompts of "Buzzer On!” and "Protection On!” on the phone via Bluetooth module transmission.

- When the concentration of toxic gas in the environment is greater than 800ppm, it is a "level one alarm". The concentration of toxic gas is high, and there is a big safety hazard. The indicator light is on, the buzzer emits a long beep, the mask is closed immediately, and an emergency text message "Lab Emergency!" [13] is sent to the designated mobile phone, and the OLED screen displays real-time at the same time as the gas concentration, after displaying ">Alarm On" and "Protection On", then "---SMS SENT---" is displayed, and the prompts of "Buzzer On!” and "Protection On!” are displayed on the phone.
5. Experimental results and analysis

5.1. Experimental procedures and methods
After the system was built, the smart gas mask was tested in various gas concentration environments. Because the MQ-135 toxic gas detector is more dangerous to detect samples, the MQ-3 alcohol detection sensor [14] [15] is used instead of the toxic gas detection sensor during the test. Alcohol is highly volatile and its diffusion process is extremely uncontrollable. To ensure the relative stability of the gas concentration, the test is carried out in a windless environment. Use a transparent plastic cup to cover the 80%, 50% and 30% alcohol diluent cotton balls. After standing for 30 seconds, pick up the plastic cup and place the cup mouth close to the gas detection sensor to test 10 sets of data at different concentrations.

5.2. Experimental data
During the experiment, 10 groups of experimental tests were carried out under different conditions. The experimental data are shown in Figures 4, 5, and 6.

![Figure 4. Single-chip microcomputer detects the concentration of volatile gas in 30% alcohol dilution.](image)

![Figure 5. Single-chip microcomputer detects the concentration of volatile gas in 50% alcohol dilution.](image)
5.3. Analysis of experimental results
During the test, different concentrations of alcohol gas in the simulated environment are achieved by controlling the volatilized gas of different concentrations of the alcohol diluent. In the 80%, 50%, 30% alcohol dilution concentration and natural environment, this smart gas mask can accurately identify the different concentration of gas, and complete different protection or alarm actions according to different concentration levels. Through 10 sets of actual tests, it has been verified that the intelligent anti-virus mask can have high recognition accuracy for the gas concentration in the environment, and the reliability of the overall design of the intelligent anti-virus mask system is also verified.

5.4. Prototype display
Figure 7 is the front display of the smart gas mask prototype. All modules are distributed on the shell identification. The picture above shows the matching goggles, and the bottom shows the main body of the gas mask.

Figure 6. Single-chip microcomputer detects the concentration of volatile gas in 80% alcohol dilution.

Figure 7. Display diagram of smart mask prototype.
6. Conclusion
This smart anti-virus mask, when the environment is safe, opens the valve to ensure the comfort of wearing, and closes and alarms when toxic gas is detected to ensure the safety of the experimenter. Through the design and construction of the hardware system and the writing of software programs, the expected functions have been basically achieved. Compared with traditional protective masks, the smart mask not only guarantees safety, but also takes into account the comfort of wearing and the versatility of use, and has higher promotion significance and social practical value.

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