

## Design and installation of air quality monitoring equipment in Model IAQ-II

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### Abstract

**Indoor air quality (IAQ) in the hospital has a direct impact on everyone's health from clinic to wards. Due to the hospital's large flow, pathogenic microorganisms in the air, temperature, humidity, carbon dioxide (CO<sub>2</sub>), fine particulate matter (PM<sub>2.5</sub>) and formaldehyde (HCHO) concentration is higher than the general environment. Therefore, this paper designs a ward air quality monitoring system based on MCU, intuitively reflect the quality of the air. When the concentration of PM<sub>2.5</sub> and formaldehyde gas exceeds the standard value, the corresponding sound and light alarm, the corresponding color LED light-emitting diode lights up and speaker voice. At the same time, with a 12V radiator to simulate start fan or air purifier. The design and installation of air quality monitoring equipment in ward are given.**

### Keywords

**Construction equipment; indoor air quality monitoring; gas sensor; mechanical and electrical equipment installation**

### 1. Introduction

Mechanical and electrical equipment installation engineering is an Indispensable part of the construction, it is a great concept that relates to many subjects and professionals including industrial, civil, public works in various types of equipment, electricity, heating, ventilation, fire protection, communication and automatic control system. Its construction activities from the beginning of equipment procurement, related to the installation, commissioning, production and operation, completion, acceptance, and ultimately meet with the building's use function. The problem of air quality in hospital, in fact, is a kind of indoor air quality problem with higher degree of attention and higher requirements. At the same time, all kinds of harmful gases chemical filled for a long time in the people around, there has been "sick building syndrome (SBS)" and other new health problems [1]. In the large scale and high level hospital of our country, due to the large flow of people and disposable utensils disinfection is destroying the bacteria and viruses, plastic products are still emit harmful chemical gases, therefore the air pollution is serious, causing cross infection. Due to the wards are in rough balance of temperature and humidity, carbon dioxide, PM<sub>2.5</sub> condition for a long time, formaldehyde gas concentration is too high, people's body feels unwell, thus unable to work efficiently, resulting relationship between doctors and patients are in tension. From then on, people began to realize the importance of air quality in hospital wards.

With the popularization of information technology in the medical system, the embedded electronic and computer integrated, has become a hot issue in the field. Data acquisition system is designed to collect environmental data, and automatic processing and control, this can make the rehabilitation of the patients more comfortable and safe, medical staff more enthusiastic, with strong practicability.

### 2. Overall design scheme

In this paper, the essence is the design for embedded system, this involves two parts of the design of hardware circuit and software program, so in general scheme determined to do both independent and complete [2]. Based on the design idea of embedded system, the overall scheme of this paper is determined, and the concrete scheme is shown in Figure 1.

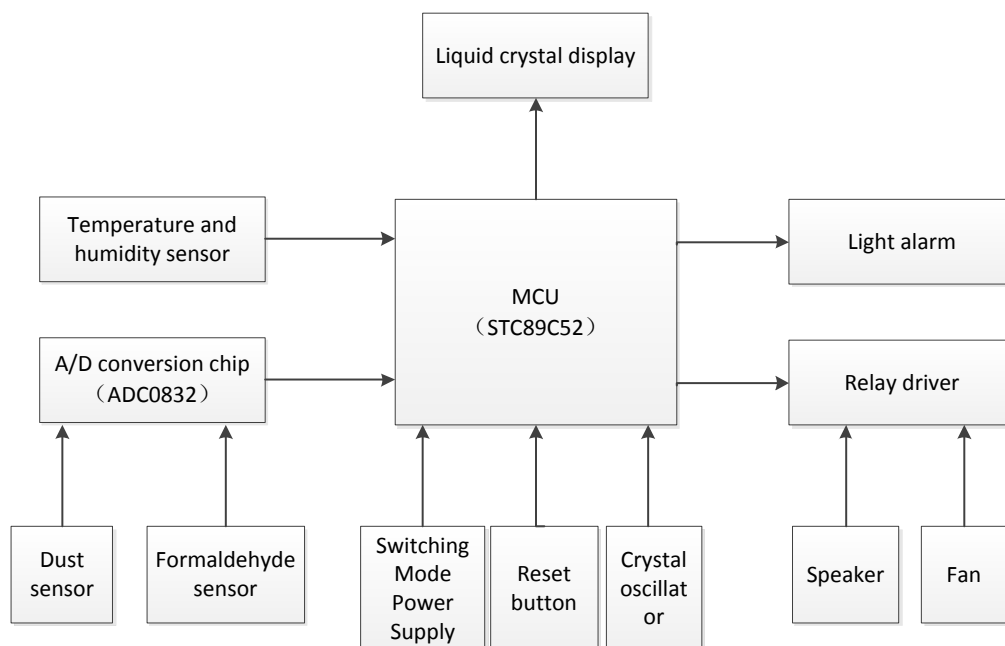


Figure 1 Overall plan

From the figure can be seen, the scheme is based on STC89C52 as control core, in the smallest single-chip system, including part of the power input, reset circuit and oscillator circuit; temperature and humidity sensor directly read digital data from MCU, analog quantity of dust sensor and formaldehyde sensor convert from analog to digital by A/D converter; the datas are displayed by LCD, when the system enter alarm module and corresponding light alarm start, also drive the relay to start the speaker and fan.

### 3. Hardware circuit design

In this paper we designed a ward air quality monitoring system based on SCM, choose the two physical indexes - temperature and relative humidity, two chemical index - PM2.5 concentrations and formaldehyde gas concentration for monitoring [3]. Finally, using LCD screen real-time display of the four data, realize intuitively reflect the quality of the air, in order to create a good air environment.

#### 3.1 System control circuit

In this paper, the main control circuit, in fact the STC89C52 microcomputer is the control core of the MCU minimum system. The system related to the main power input, crystal oscillator circuit, reset circuit and I/O port connected pull-up resistor circuit design.

The A/D conversion circuit is designed to convert the digital signals that microcontroller can identify from two sensors. So the A/D conversion circuit should be connected between the sensor and the control circuit, this paper choose American semiconductor company (National Semiconductor) production - 8 bits serial A / D converter ADC0832. This chip has advantages of low power, high performance to price ratio, fast switching speed, strong stability, suitable, and it is portable used in intelligent measurement and control system.

#### 3.2 Sensor circuit

A temperature and humidity sensor is a sensor for measuring temperature and humidity. It converts the temperature and humidity into the electrical signal that can be identified by a microcomputer. This design selects the digital temperature and humidity sensor DHT11, DHT11 temperature and humidity sensor is a kind of digital temperature and humidity sensor with calibrated digital signal output.

PM2.5 dust sensor circuit uses is the Sharp Corporation's GP2Y1010AU dust sensor with small volume, high sensitivity, high accuracy, good stability, long service life and it is convenient for installation and maintenance. This sensor can be used to detect 0.8 m above the particles, widely used in the determination of the concentration of dust, pollen, dust, smoke and other in indoor environment.

The biggest characteristic of the sensor is the built-in airflow generator, which can be inhaled by the external air in order to update the environmental data in a timely manner.

The formaldehyde gas sensor circuit adopts a MQ138 type formaldehyde sensor, which belongs to an electrochemical sensor. The principle is that the gas concentration information collected by the gas detector is converted to the current signal, and then the current signal is converted into a voltage signal which is convenient for the measurement. This kind of electrochemical sensor has the advantages of good reliability, easy to detect and cost-effective, and so on. [4]. The sensor needs to cooperate with the related electrical components to form the peripheral circuit.

### 3.3 Display circuit

Display circuit uses microcontroller I / O port resources the most, because in addition to the power and ground, the display circuit also involves the parallel instruction / data select signal terminal, concurrent read and write selection signal end, parallel signal enable end, 8-bit data terminal and reset terminal. Final design can show the value of the four indoor temperature, relative humidity, PM2.5 concentration and formaldehyde concentration. In order to meet this demand, this paper chooses the LCD12864 as display.

### 3.4 Sound alarm and fan drive circuit

Because the sound alarm and the fan drive uses the fan and speaker with voltages of 12V and 5V, and in the the whole system voltage is 4.5V around in general because the load is large when this circuit in normal operation, thus the system can't meet the 12V and 5V the two voltage levels. Therefore, the design choose the switching power supply as power supply, select 230V as input voltage, + 15V and + 5V as output voltage and common ground voltage. And we use a 5V relay to drive circuit of 12V and 5V voltage level. Generally, the voice alarm part in embedded system mostly use missed buzzer and it can emit sound at work. And this paper ptimized the system, the voice alarm module used the megaphone disassembled loudspeaker module. This circuit has key switch, power indicator light and recording function.

Two light emitting diodes of light alarm circuit of are respectively connected with the monolithic integrated circuit P2.0 and P2.1 port, in order to prevent the light emitting diode response high impulse current, limit current resistance is connected between the power and light emitting diode . In this way, when the PM2.5 concentration exceeds the yellow light, when the formaldehyde gas concentration exceeds the red light.

In order to consider the actual use of fan module, may be indoor air quality is bad, we should drive air purifier or fan start up, so the design can be considered for developing air purifier and air conditioner. Here we choose the computer with 12V fan to simulate the cooling fan or air purifier's start.

## 4. System software design

For the entire system, the design of the modular approach to the preparation of the program, so that the integrity of the software code can be combined together. First, define the header files, MCU I / O port variables, global variables, the preparation of the main function; secondly, write a subroutine modules, to achieve sub function in the main function calls the right; finally, check the logical errors and by KEIL $\mu$ VISION4 C51 software, continuous debugging, and ultimately achieve "0 error (s), 0 warning (s)". The overall design of the design as shown in figure 2.

The final result of this design is real time display 4 groups of data on the LCD screen , so in order to show the dynamic, data , data conversion, data display and alarm function are placed in a large loop. The function of the main function is to initialize the system, initialization of the contents include: the 12V driver circuit of the relay initialization, display module LCD screen initialization and enter the sensor work of the big cycle. The main function flow chart is shown in Figure 3.

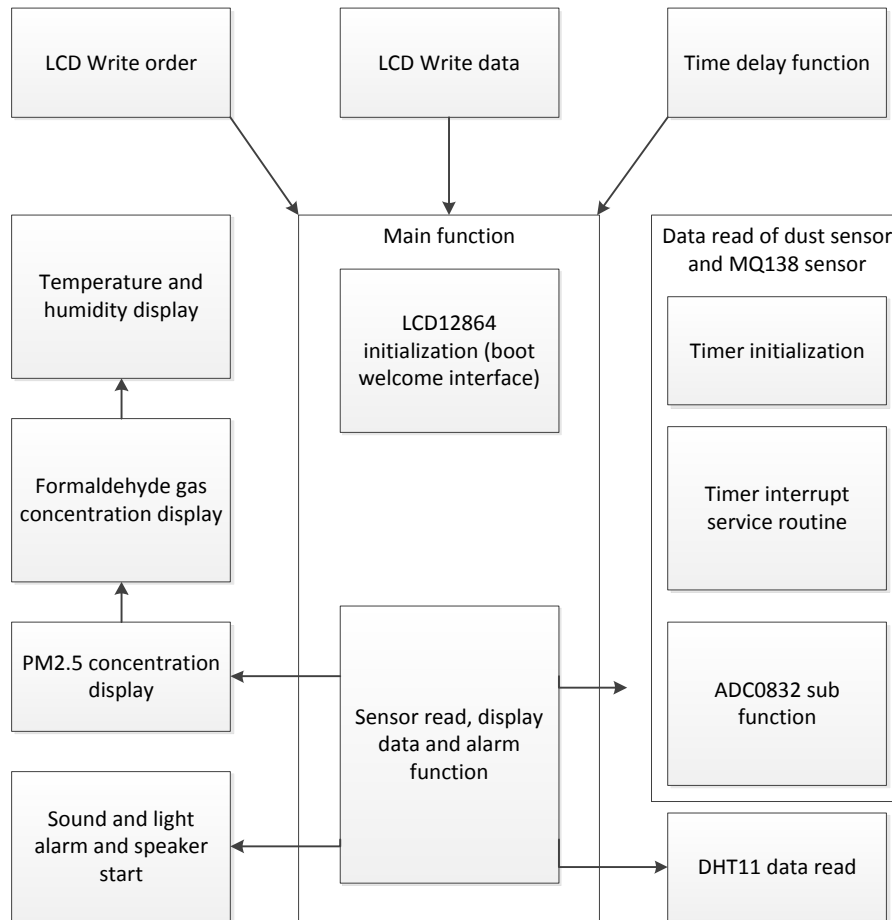


Figure2 Software design master plan



Figure 3 Main function program flow chart

4.1 Strict construction organization design, equipment and facilities selection is agreed by the relevant scientific and technical personnel after joint research agreement. Through technical calculation and checking, this not only make it have use value, but also ensure the good economic benefit. Do not arbitrarily change the selection of equipment, otherwise it will affect the basic progress.

4.2 According to the scheduled plan to carry out the installation work, each mechanical and electrical equipment installation work order has its scientific nature. A installation engineering plan has taken much consideration. After technical demonstration discharged, it has a scientific basis and guidance, do not change easily, so as to avoid back workers idling of the labour force and the progress of the project discontinuous on.

4.3 For large installations,we should carry out the overall layout, unified arrangement. As the number of equipment, installation of complex, therefore must have a general layout for each installation to make a unified arrangement.The construction team must have a unified command of the electromechanical captain (or deputy project manager) to coordinate each work and brainstorming, seek staff comments on the work. As a manager, he should be well aware of installation, know what to do and how to do at the next step. Lack of what materials and equipped with a, what problems still exist, the manager also should be aware. Preparations must be put in place in advance, so as not to cause downtime in the installation work.

## 5. Conclusion

This design enables people to timely monitor the indoor air quality, and timely make the appropriate response, to ensure people's physical health, thus improving the quality of the people's health.

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