ATLANTIS PRESS

Advances in Economics, Business and Management Research, volume 100

International Conference of Organizational Innovation (ICOI 2019)

STUDY ON TEMPERATURE AND HUMIDITY WIRELESS NETWORK MONITORING SYSTEM OF HOSPITAL IMAGING ROOM

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Abstract—Study a wireless temperature and humidity control system for hospital's imaging room. SHT11 as sensors, the system realized one to multiple communication using wireless communication module CC1020, and then set up the communication between system and the central station with serial communication controller MSCOMM. The system uses VISUAL C + + programming, to realize the video room temperature and humidity alarm control. It is wireless, good effect and saving manpower.

Keywords—*Imaging Equipment Room, Wireless Network, Temperature and Humidity, Monitor System*

I. INTRODUCTION

The diagnostic and therapeutic functions of medical imaging equipment are increasingly prominent in modern medicine. From imaging equipment such as general radiology equipment, CR, DR, CT, and MRI to therapeutic equipment such as ECT, DSA and accelerator, medical imaging equipment has become an indispensable device for hospitals[1]. Advanced image equipment cannot be separated from computers, and its normal operation has high requirements on environmental temperature and humidity. A large number of electronic components such as semiconductor devices, resistors, and capacitors are used in imaging equipment. When the imaging equipment is working, the rising ambient temperature will affect the normal operation of the electronic components. Too high or too low temperature may cause the working parameters of some components to drift and affect the stability and reliability of the circuit. Excessive humidity will also affect the normal operation of the components[2-4]. In serious cases, it can cause breakdown damage of the components, leading to equipment failure. Therefore, it is very important to control the ambient temperature and humidity to maximize the performance of the system, extend the life of the equipments, and ensure data security and accuracy. The centralized real-time monitoring and control of the ambient temperature and humidity of the image room has become a problem in hospitals[5].

Based on the characteristics of the distribution of medium-sized hospital image rooms, we designed a temperature and humidity monitoring system based on wireless network. In each important position of the equipment room, the temperature and humidity detection module is installed, which can monitor and control the temperature and humidity in the environment in real time[6-8]. The recorded temperature and humidity curve is for the management personnel to query. Once the temperature and humidity are found, the alarm will be started immediately, and the management personnel will be reminded to adjust the working setting value of the air conditioner in time or adjust the equipment distribution in the equipment room. At the same time, the system can also automatically adjust the working setting value of the air conditioner. After the problem occurs, you can easily find the problem based on the historical curve, which is convenient for solving the problem. Compared with wired communication, the system does not need to set up transmission lines, and is not limited by communication distance. Therefore, the system has the advantages of good mobility and quick construction[9-10].

II. OVERALL DESIGN

A. System composition

The system consists of two parts: the central station and the temperature and humidity detection extension. The central station is responsible for receiving the information sent by each extension and displaying the test results of each indicator on the screen, automatically collecting, recording, processing (average, maximum value, alarm) temperature and humidity data of each measuring point, and issuing an alarm signal when the information exceeds the

limit[11].The temperature and humidity detection extension consists of a digital temperature and humidity sensor, a single chip microcomputer and a wireless communication module.

B. Function introduction

1) Real-time on-site monitoring and measurement, display temperature and humidity data. The computer monitors the real-time online, selects the corresponding interval, and displays the test results of each indicator.

2) Automatically collect, record, and process (average, maximum value, alarm) temperature and humidity data of each measuring point. The data is expressed in the form of tables, curves, and alarms.

3) The data storage interval can be set arbitrarily.

4) The name and alarm range of each monitoring point can be arbitrarily defined.

5) The data query method is flexible and diverse, and the test record is stable and reliable.

III. SYSTEM HARDWARE CIRCUIT DESIGN

A. The whole frame

The overall frame is shown below, and the sensor uses SHT11.

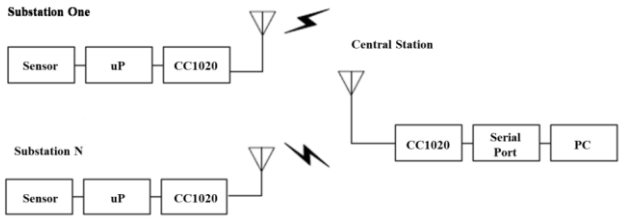

Fig.1 Hardware Structure

B. Temperature and humidity detection machine room substation

The traditional temperature and humidity detection method is the output voltage or current signal of the temperature and humidity sensor, which is transmitted to the computer through the analog quantity acquisition module[12]. The voltage or current signal is inevitably affected by wire quality, transmission distance and electromagnetic interference in the transmission process, which will inevitably cause errors. In order to ensure that the measured value of temperature and humidity is not affected by the above factors, we choose the digital temperature and humidity sensor, which directly converts the detected temperature and humidity value into a digital signal, ensuring the accuracy of temperature and humidity detection to the maximum extent.

C. Internal structure and working principles of SHT11

SHT11 is a digital temperature and humidity sensor chip. Its internal structure is shown in figure 2, and its working principle is as follows.

SHT11 includes a capacitive polymer humidity sensor and a temperature sensitive component made of a gap material[13]. These two sensitive components convert humidity and temperature into electrical signals, which first enter the weak signal amplifier for amplification, then enter a 14-bit A/D converter, and finally output a digital signal through the two-wire serial digital interface. The SHT11 integrates a heating element inside. When the heating element is turned on, the temperature of the SHT11 can be increased by about 5 °C, and the power consumption is also increased. This function is mainly to compare the temperature and humidity values before and after heating, and can comprehensively verify the performance of two sensor components.

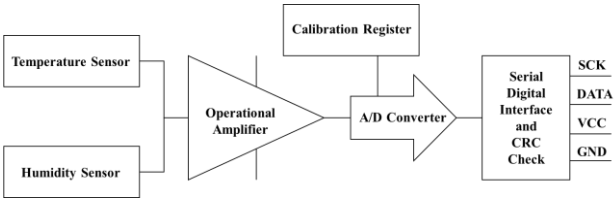

Fig.2 Internal structure of the flow chart

The heat transfer equation of the temperature and humidity sensor can be expressed by the formula (1):

$$dQ_{Cond} = -\lambda S \frac{dt}{dx} \tag{1}$$

Where: λ is the thermal conductivity; dt/dx is the temperature gradient vector, the direction is pointing to the direction of temperature rise, For the integration of x in the above formula from 0 to 1, we can get:

$$Q_{\text{Cond}} \int_0^h dx = -\lambda S \int_{T_1}^{T_2} dx = \frac{\lambda S(T_1 - T_2)}{h} \tag{2}$$

The temperature compensation coefficient $C(T)$ of the temperature and humidity sensor is:

$$C(T) = \frac{V_A(T) - V_0(T)}{V_A(T_C) - V_0(T_C)} \tag{3}$$

The signal conditioning circuit outputs a voltage value V at any temperature T, and is corrected by temperature compensation.

$$V_C = \frac{V - V_0(T)}{C(T)} \tag{4}$$

D. CC1020 wireless communication module

CC1020 is an ideal UHF single-chip transceiver chip, which is mainly used in the ISM(industrial, scientific research and medical treatment) band and the 426/429/433/968/915mhz band, and can also be programmed to use multi-channel equipment with frequency of 402MHz~470MHz and 804MHz~940MHz. The main operating parameters of the CC1020 can be programmed via the serial bus interface, such as output power, frequency and AFC.

In receive mode, CC1020 can be regarded as a traditional superheterodyne receiver. The RF input signal is amplified by a low noise amplifier (LNA and LNA2) and flipped through the integrator (I and Q) to produce an intermediate frequency IF signal. In the intermediate frequency processing stage, the I/Q signal is mixed, filtered, amplified, and converted to a digital signal by the ADC. Then, automatic acquisition control, channel filtering, demodulation and binary synchronization are performed[14].

In transmit mode, the synthesized RF signal is fed directly to the power amplifier PA. The RF output is the FSK signal, which is generated by the digital bit feeding to the DIO pin flowing through FSK modulation. A high frequency filter can be used to get the gaussian frequency shift keying GFSK, and the receiving/sending switch circuit inside the chip makes the antenna easy to access and match.

E. Serial communication control MSComm

The MSCOMM control(Microsoft Communication Control), is an ActiveX control provided by Microsoft to simplify serial communication programming under Windows. It provides a series of interfaces for standard communication commands, which can be used to establish a connection to a serial port and can be connected to other communication devices (such as a modem) through a serial port. MSCOMM controls can be used to create phone dialers, serial communication programs, and full-featured terminal programs[15].

Serial communication control MSComm32.OCX provides all protocols for data communication using RS-232. The VC++ programming language provides standard event handlers and procedures for the control, and provides serial communication settings through properties and methods.

After opening the required serial port, we need to consider the timing of serial communication. In the process of receiving or sending data, it may be necessary to monitor and respond to some events and errors, so event-driven is a very effective method to deal with serial port interaction. The OnComm event and CommEvent properties are used to capture and check the communication event and the wrong values. OnComm events will be triggered when a communication event or error occurs, the value of the CommEvent attribute will be changed, and the application will react accordingly by checking the CommEvent attribute value.

IV. WIRELESS COMMUNICATION SYSTEM DESIGN

A. Module and central station interface

The interface between the module and the central station is as shown in Figure 3:

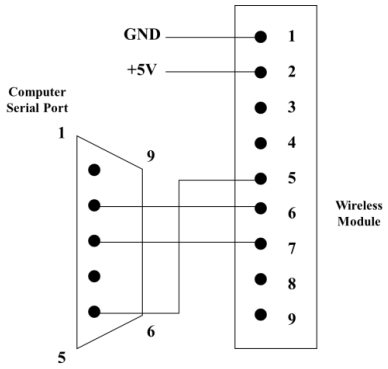

Fig.3 Communication Interface

B. Communication mode

For communication systems, reliability and security are the first issues to be considered. The anti-interference ability and error handling ability of communication are also very important. Based on the characteristics of the communication system itself, the host computer and its communication must meet its specific requirements, so we use the following communication methods.

1) Master-slave mode

The upper computer is the master and the lower computer is the slave. In general, the lower computer cannot send messages to the upper computer. Only when the upper computer gives instructions to the lower machine, the lower machine can respond.

2) Data frame mode

Adopting data frame mode is helpful to ensure the integrity of data packets and facilitate data reception and processing. In our communication system, both the upper computer and the lower computer use the same protocol to package and unpack the communication data.

3) Data validation

Due to many possible factors such as transmission distance, on-site conditions, etc., communication data between the computer and the microcontroller often has unpredictable errors. In order to prevent the impact of errors, data verification is generally used during communication. In the process of data transmission, due to interference may cause information error, "error code" appears. In order to ensure that the data does not go wrong during transmission, a check byte is added after each packet. Verification is the process of sending

TX end and receiving RX end. We adopt a simple and practical method of XOR verification.

4) Automatic retransmission mechanism

When the lower bit machine receives the wrong data frame, it will discard the data frame and return the error code to the upper bit machine. At this time, the frame data needs to be resent. If you hand over the resend task to the application, the program will become more complicated. We can pass this task to the control, which makes it easy to implement the resend function. Inside the control, the data is backed up before the new data is sent, until it is confirmed to be correctly received. If it is found to be wrong, it will be sent again.

5) Central Station Software Design

The central station uses a PC or laptop, and the program is written by VISUAL C++ under WINDOWS.

V.CONCLUSION

The temperature and humidity monitoring and control system of the image room can continuously collect and record the temperature and humidity values of the environment. The system has high degree of automation, powerful functions, stable performance, strong adaptability and complete unattended operation. It is a powerful tool to build digital, scientific and modern hospital computer rooms.

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