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Remote Control of Home Appliances

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Abstract: Taking the STC89C52RC single-chip microcontroller as the core, this paper designs a new type of home appliance remote control system. This control system enables users to remotely control home appliances through a cloud platform. It is also equipped with temperature and humidity sensors, carbon monoxide sensors, and smoke sensors, allowing users to monitor indoor environmental data in real time via the cloud platform. In addition, the system is installed with a key module, which enables users to manually set the limit ranges for temperature, humidity, carbon monoxide concentration, and smoke concentration. It is also equipped with a fan module and a light relay alarm module. When the temperature, smoke concentration, or carbon monoxide concentration exceeds the limit ranges set by the system, the system will perform temperature adjustment and trigger an audible and visual alarm.

Keywords: *Remote Control; Single-Chip Microcontroller; Sensor*

I. OVERVIEW

As a crucial component of smart homes, the home appliance remote control system enables remote control of home appliances through wireless communication technology, significantly enhancing the convenience of people's daily lives. With the continuous advancement of Internet of Things (IoT) technology and the vigorous development of the smart home industry, the home appliance remote control system has gradually become an integral part of people's daily life, bringing numerous conveniences to users.

II. OVERALL SYSTEM DESIGN

This design aims to develop a home appliance remote control system based on the 51-series single-chip microcontroller. Its purpose is to enable users to remotely control home appliances anytime and anywhere, while allowing real-time reception of indoor environmental information. In case of household emergencies such as fires or gas leaks, the system can trigger real-time alarms. The overall design scheme consists of two parts: hardware and software, and the system block diagram is shown in Figure 1.

The home appliance remote control system is built with the STC89C52RC single-chip microcontroller as its core. Keil5 is used as the software development tool. Specifically, the system adopts the following components: the STC89C52RC single-chip microcontroller and its minimum system module serve as the control core; a 4G module is used to realize remote data transmission with the cloud platform; the sensor group module includes a temperature and humidity sensor, a smoke detection sensor, and a carbon monoxide detection sensor; the user interaction part is equipped with a key control module; the power management module ensures stable operation of the system; the relay control module is used to control the on/off of home appliances; the fan module provides cooling support; the alarm system module is used for emergency notification; and the display module is used to show real-time indoor environmental data and the status information of home appliances.

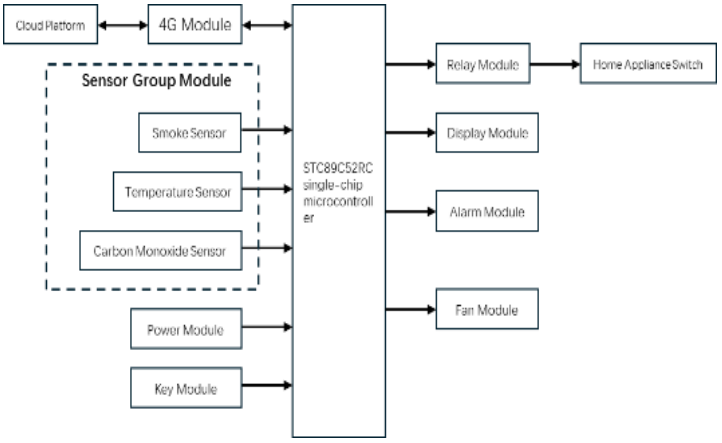

Figure 1:System Overall Design Block Diagram

When the system is powered on, it initializes and configures the system data appropriately. Then, the home appliance remote control system collects environmental data (smoke concentration, carbon monoxide concentration, temperature and humidity) through the Sensor Group Module. The collected environmental data is transmitted to the Tashi Cloud Platform via the 4G Module and displayed on the system's Display Module.

III. HARDWARE DESIGN

The hardware circuit of the home appliance remote control system based on the 51-series single-chip microcontroller in this design consists of nine parts in total, which are: the single-chip microcontroller and its minimum system circuit, key circuit, temperature and humidity sensor circuit, light relay control circuit, display module circuit, 4G module circuit, fan drive circuit, sound and light alarm circuit, and the AD conversion module circuit composed of an AD converter, smoke sensor, and carbon monoxide sensor.

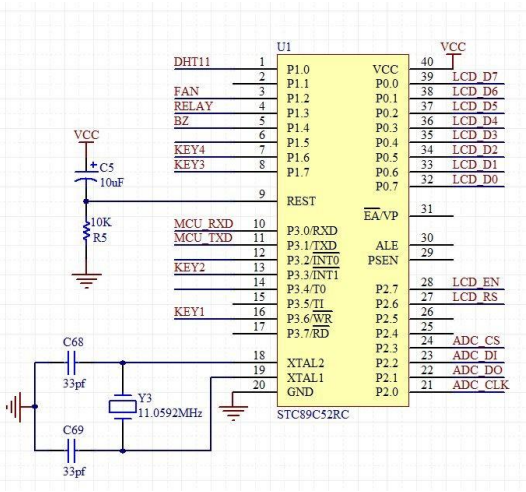

Figure 2:Circuit Design Diagram of the Single-Chip Microcontroller and Its Minimum System

The design of the system's hardware circuit is a crucial link in the construction of the home appliance remote control system, as it determines the stability and functionality of the system. This section will elaborate on the hardware circuit design of each module, including the presentation of hardware circuit design diagrams, pin connection methods, and the introduction of each module's functions.

The single-chip microcontroller and its minimum system circuit form the most basic circuit structure that enables the single-chip microcontroller to operate. The design diagram of the single-chip microcontroller and its minimum system circuit is shown in Figure 2.

The single-chip microcontroller and its minimum system circuit form the foundation for the normal operation of the single-chip microcontroller, consisting of two key components: the reset circuit and the clock circuit. The main function of the reset circuit is to reset the single-chip microcontroller to its initial state, facilitating restart or fault recovery. When the single-chip microcontroller is powered on, the reset circuit generates a high-level pulse with a specific duration. This pulse signal is sent to the RST pin of the single-chip microcontroller, triggering it to perform the reset operation. Only after resetting can the single-chip microcontroller execute programs.

The 4G module is responsible for wireless remote communication with the Tashi Cloud Platform, receiving commands sent by the Tashi Cloud Platform, and transmitting home environment data and status information of home appliances. The circuit design diagram of the 4G module is shown in Figure 3.

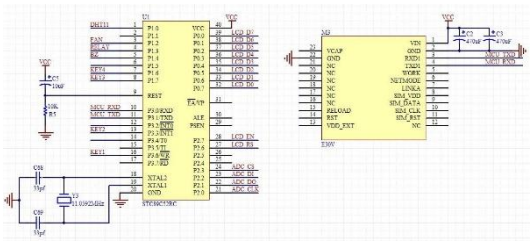

Figure 3:Circuit Design Diagram of the 4G Module

The function of the key circuit is to set parameters for the system. The design diagram of the key circuit is shown in Figure 4.

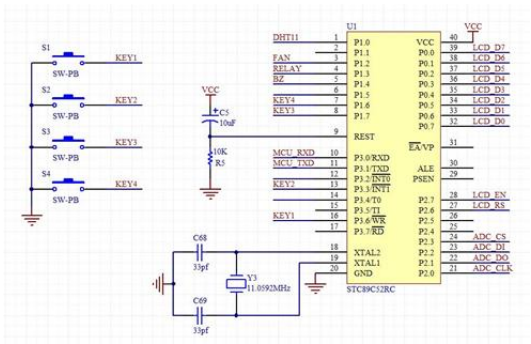

Figure 4:Circuit Design Diagram of the 4G and Key Module

The key circuit in this design is responsible for sending key operation signals to the single-chip microcontroller. The selected key type is an independent key, which consists of contact points and conductive metal sheets. One group of these components is connected to the ground wire, while the other group is connected to the corresponding pins of the single-chip microcontroller. When a key is pressed, the contacts are connected through the metal sheet, causing a short circuit in the circuit. Since the single-chip microcontroller is always powered on and in a high-level state, detecting that a pin is grounded is equivalent to informing the single-chip microcontroller that this pin is in a low-level state. At this point, the single-chip microcontroller will execute the preset program corresponding to the low-level state of this pin, thereby realizing the control function of the single-chip microcontroller.

The function of the temperature and humidity sensor is to collect data on ambient temperature and humidity, allowing users to understand the indoor environment and better control home appliances. The circuit design diagram of the temperature and humidity sensor is shown in Figure 5.

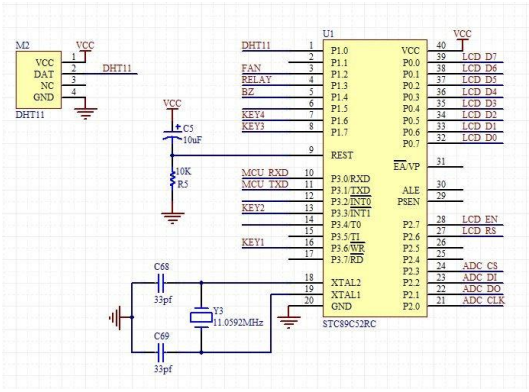

Figure 5: Circuit Design Diagram of the Temperature and Humidity Sensor

The function of the display module is to show environmental data and the status of home appliances. The circuit design diagram of the display module is shown in Figure 6.

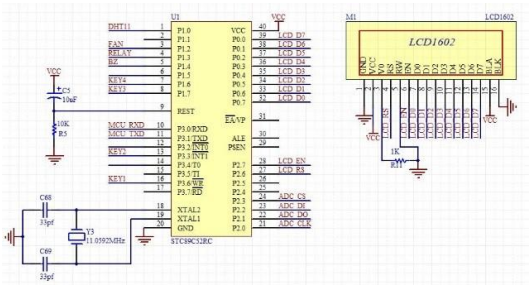

Figure 6:Circuit Design Diagram of the Display Module

The function of the sound and light alarm circuit is to trigger a buzzer alarm when emergencies occur at home, such as fires or gas leaks. The circuit design diagram of the sound and light alarm circuit is shown in Figure 7.

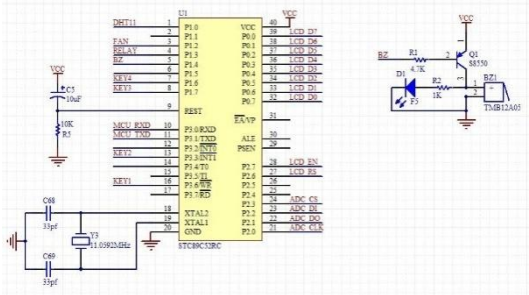

Figure 7:Circuit Design Diagram of the Sound and Light Alarm Circuit

IV. SOFTWARE DESIGN

The software design of the system plays a vital role in the home appliance remote control system based on the 51 single-chip microcontroller, as all operations of the single-chip microcontroller are controlled by the system software.

Software flowcharts embody developers' ideas. Programs are written according to the functions of each module reflected in the flowcharts to achieve the functional requirements of the design. This system design uses the Keil5 software development environment and is programmed in C language.

This design adopts the Tashi Cloud Platform as the console for remote control of home appliances. Users can open the cloud platform interface via mobile phones or PCs to remotely control home appliances based on the environmental data collected by the sensor group module and the home appliance status information sent by the home appliance remote control system. Its basic process is as follows: After the system is powered on, the program starts and the system initializes, including initializing the serial port, timer, and hardware parameters of each module. Then it enters the main loop: scan the key status and change settings according to the key status; collect temperature and humidity data regularly; judge whether the environmental data is abnormal, and if so, drive the sound and light alarm circuit to alarm; display environmental data and home appliance status information; parse the serial port status and judge whether an instruction sent by the cloud platform is received from the serial port, and execute the instruction if received. This loop repeats continuously.

V. SUMMARY

This system is equipped with a temperature and humidity sensor, a carbon monoxide sensor, and a smoke sensor, as well as a key module. The key module is used to set the upper limits of temperature, humidity, carbon monoxide concentration, and smoke concentration. When the environmental data exceeds the set values, the fan and the sound-and-light alarm module installed in the system will perform temperature adjustment and sound-and-light alarm functions respectively.

The system exhibits stable performance, can meet the requirements of remote home appliance control, and has achieved the expected objectives.

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