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Intelligent Water Monitoring System Based on the Internet of Things

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Keywords: Internet of Things; Monitoring system; STM32G030F6P6; Water quality testing

Abstract: This paper introduces an intelligent water monitoring system based on the Internet of Things, which includes water use information acquisition board, mobile phone APP and Internet of Things cloud platform. The system uses STM32G030F6P6 as the main control chip, and combines with water quality detection module, water pressure detection module, water flow module, solenoid valve control module, ESP8266-01S WIFI module and OneNet cloud platform big data analysis technology to realize real-time supervision, monitoring water data recording and water leakage warning. The system can detect information such as water quality, temperature, total water use and water leakage, and transmit the data to the cloud platform in real time for the convenience of subsequent big data analysis and resource recycling. At the same time, users can realize remote monitoring of data and remote control of valve switch through mobile phone APP, so as to avoid the occurrence of leakage accidents in the home. The system is not only practical, but also has certain promotion value. It can be extended to various fields, such as household, industry and agriculture, so as to promote sustainable water resource utilization and management. The intelligent water supervision system proposed in this paper has certain innovation and practical application value, which is of great significance for improving the utilization efficiency of water resources and managing water resources.[1]

1. Introduction

With the continuous development of Internet of Things technology, people's demand for home intelligence is getting higher and higher. As a result, various smart devices are used more and more widely in the home. Among them, water quality monitoring system as an important part of smart home, is more concerned. At present, most of the domestic water quality monitoring system market has not been effectively developed, and the existing product function is not perfect. In this context, this design is born in line with the trend of emerging smart home. This design uses STM32G030F6P6 as the main control chip, combined with water quality detection module, water flow module, water pressure detection module, solenoid valve control module, ESP8266-01S WIFI module and OneNet cloud platform big data analysis technology. Through real-time supervision and recording of water use information, feedback of water leakage and other information, the water flow detection, water monitoring, water pressure monitoring, drinking water quality monitoring, water leakage warning, remote opening and closing of valves and other functions are realized.[1] At the

same time, users can obtain water flow, total water consumption, TDS value, PH value and other related data through mobile APP to realize remote monitoring of data. This design has perfect function and strong practicability, which will help solve the problems of family leakage and improve the quality of life of residents. In this paper, the hardware and software implementation of the system are introduced in detail, and compared with the current products in the market[2]. Finally, the advantages and future development direction of this system are discussed. This system can not only improve the utilization rate of water resources and ensure the health of water use, but also has important practical application value.

2. Design the overall scheme of the system

First of all, the water quality detection terminal is the core part of the whole system, which is mainly composed of STM32G030F6P6 controller, water flow detection module, water pressure detection module, solenoid valve remote control module, PH detection module, temperature detection module, TDS detection module and so on. This part is designed to realize the comprehensive monitoring of water quality and water leakage warning function. Specifically, the water flow detection module can monitor the value of water pressure and water flow in real time to determine whether there is leakage; pH value detection module, temperature detection module, TDS detection module can collect water pH value, temperature value, total dissolved solids in water (TDS) and other data and transfer to STM32 microcontroller. Finally, the sorted data will be timely sent to One Net cloud through WiFi module in accordance with the predetermined protocol format for storage and management [3].

Secondly, the OneNet cloud platform is the data center of the entire system, which is mainly used to receive, process and store the data uploaded from the water quality testing terminal. OneNet cloud platform has powerful big data analysis technology, which can monitor and analyze data in real time, and can provide a series of data interfaces [4], which is convenient for developers to carry out secondary development and application. Through the OneNet cloud platform, users can view monitoring data, set alarm thresholds and remote control switches at any time.

Finally, the mobile App is the user interface of the whole system. Users can connect to the OneNet cloud platform through the mobile App to realize real-time view of water quality monitoring information and remote control of water leakage warning function. Users can also make use of mobile App for data analysis and monitoring records, so as to facilitate users to know their own water consumption and rational use of water.

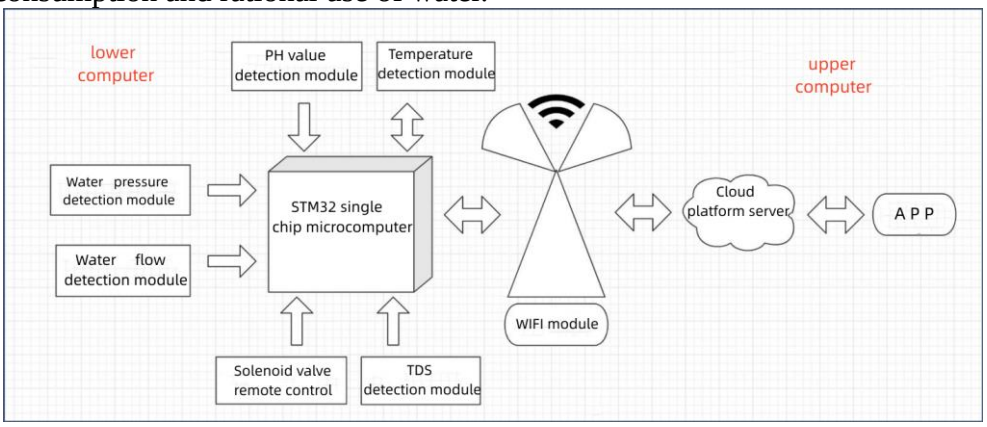

Figure 1: Schematic diagram of the overall scheme design

To sum up, the overall scheme of the product system adopts the design concept of intelligent water supervision system based on the Internet of Things, integrates a variety of sensor technology,

WiFi communication technology, big data processing technology and other advanced technologies, which can provide a comprehensive water quality monitoring scheme, effectively avoid household water leakage and other problems, and provide users with intelligent and efficient water management schemes. The overall schematic diagram is shown in Figure 1.

3. System hardware circuit design

3.1 Main control part

The device adopts STM32G030F6P6 series microcontroller, which is a mainstream value line Arm Cortex-M0+ microcontroller unit (MCU) produced by STMicroelectronics. The chip has the following features:

(1) 32KB Flash memory and 8KB RAM can provide efficient and stable execution environment for embedded applications.

(2) Up to 64 MHz CPU main frequency, can meet the complex computing needs.

(3) Dual USART, timer, analog digital conversion (ADC), communication interface and other peripherals, providing a wide range of interface options for various application scenarios.

(4) The working voltage range is 2-3.6V, which can adapt to different power supply environment.

STM32G030F6P6 has a wide range of applications in intelligent hardware, Internet of Things, industrial control and other fields. As a high performance, low power consumption, cost advantage of the MCU, it can help users quickly achieve the goal of product design and development [5].

The pin of STM32G030F6P6 chip is shown in Figure 2.

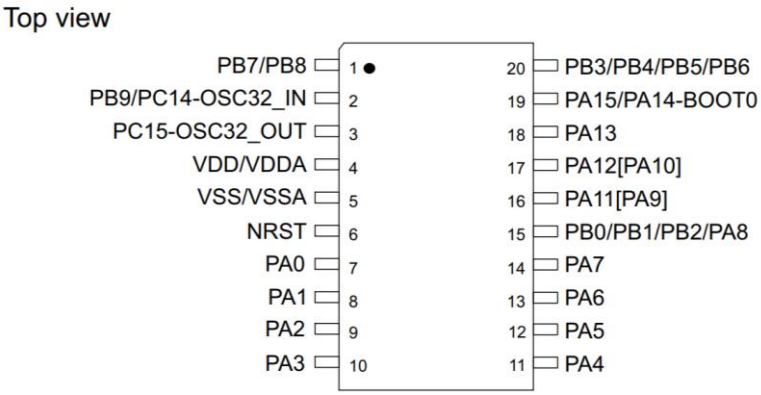

Figure 2 STM32G030F6P6 Pin drawing

3.2 Power supply circuit design

The XL1509-3.3E1 is a synchronous rectifier step-down DC-DC converter with adjustable output. The input voltage ranges from 4V to 40V and the output voltage ranges from 1.23V to 37V. Here, the chip is used to step-down a 12V DC voltage to a 3.3V voltage output.

In the design of the power supply, the 12V DC voltage is used for the control circuit, and the step-down chip of XL1509-3.3E1 is used to step-down to 3.3V voltage as the power supply of the main control chip and the input voltage of other modules [6]. The 3.3V single chip microcomputer can be directly compatible with a large number of 5V external chips, which brings a lot of convenience. This power supply design method can not only save system space, but also improve the stability and efficiency of the system is shown in Figure 3.

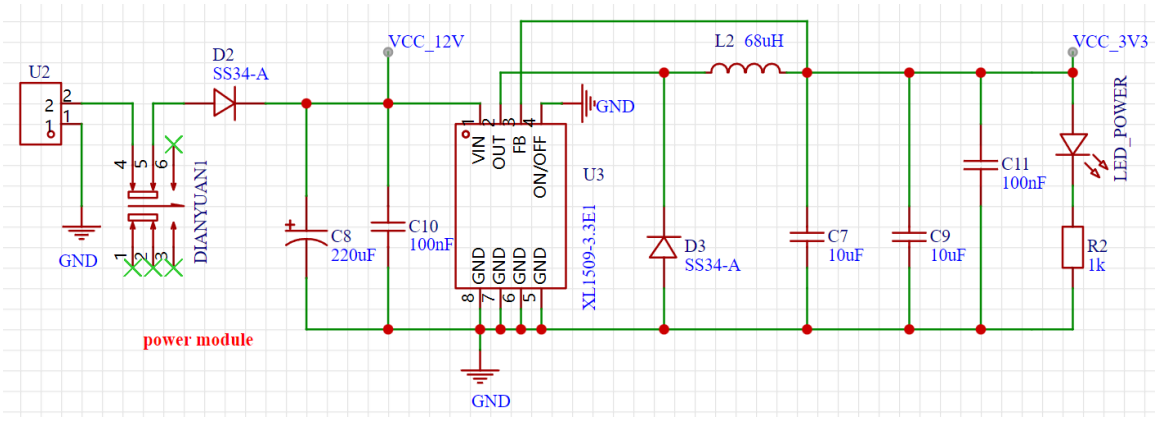

Figure 3: Power module design diagram

3.3 Water quality testing circuit design

Water quality detection circuit includes metal probe, bipolar square wave output, analog port, warning circuit four parts.

Metal probe: Mainly used to detect the content of particulate matter in water. Different materials of metal probe can be selected, such as copper, aluminum, iron, etc.

Bipolar square wave output: The main control chip needs to output bipolar square wave to the metal probe to reduce the electrode polarization phenomenon and the error caused by charge accumulation effect. The realization method can make use of Timer and Pulse-Width Modulation (PWM) function built in STM32G030F6P6, and generate corresponding square wave signal through programming control [7].

Analog port: The main control chip is connected to the metal probe through the analog port to measure the conductivity of the water source. The Analog port usually uses the analog input mode and converts the analog signals fed back by the metal probe into Digital signals through the ADC (analog-to-Digital Conversion) module for processing, and then calculates the conductivity of the water.

Alarm module: The main control board needs to monitor the water conductivity in real time and judge whether the water quality is up to the standard. If the water quality is not up to the standard, the alarm module will be triggered and the alarm information will be sent to the user's mobile phone APP. Alarm module can choose buzzer, LED light, etc., through programming control in the alarm when the corresponding prompt is shown in Figure 4.

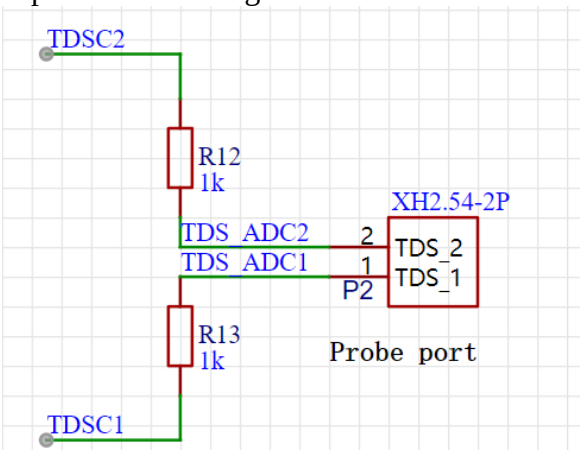

Figure 4 Water quality test module circuit design

3.4 Design of wireless transceiver circuit

The ESP8266-01S WIFI module is a Wi-Fi module based on the ESP8266 chip. It is produced by Le Xin and is manufactured using Surface Mount Technology (SMT) process, which has the advantages of small size, low power consumption and low cost. In addition, the module has a built-in Flash memory of 1M byte (8M bits), which can meet the data storage requirements in different application scenarios.

In this design, ESP8266-01S WIFI module, as a data transmission controller, can upload all kinds of water information collected to OneNet cloud platform for big data analysis and processing. At the same time, users can obtain relevant data such as water flow, total water consumption, TDS value and PH value through mobile APP in real time. In addition, the ESP8266-01S WIFI module also supports remote valve opening and closing. Users can control the opening and closing of the valve through the mobile phone APP, which is convenient for remote control[8].

In short, the ESP8266-01S WIFI module can be widely used in the Internet of Things, smart home and other fields, with the advantages of fast data transmission speed, short response time, and high stability. In this design of intelligent water system, as a data transmission controller, it provides users with real-time and convenient water monitoring services, making water use more intelligent and efficient is shown in Figure 5.

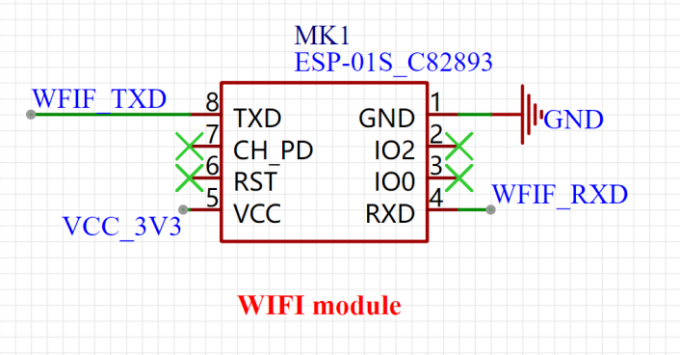

Figure 5 WIFI Wireless transmission module circuit

3.5 Display circuit design

This device uses a 1.8-inch TFT display, a color LCD screen designed on the technology of Thin Film Transistor (TFT). Is a high-speed stable, easy to operate color LCD screen, widely used in smart home, Internet of things and other fields. In this design of intelligent water consumption system, it serves as a user interaction interface to provide users with convenient water consumption monitoring experience. The display adopts SPI serial communication protocol, which can be easily connected to various controllers, realizing high-speed data transmission and large amount of information display. Through the TFT display, users can easily read and operate. In addition, the display also supports man-machine interaction, such as menus, buttons and other interactive operations, making users more convenient and flexible.

In this design of intelligent water system, the display screen as a user interactive interface, can real-time display water flow, water pressure, water quality test value and other related data, so that users can intuitively understand the current situation of water. At the same time, the display can also display water leakage warning information, reminding users to deal with the problem in time is shown in Figure 6.

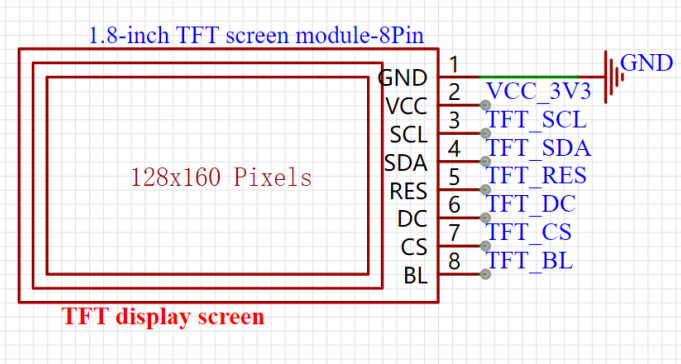

Figure 6 Design of TFT display circuit

3.6 Design of solenoid valve control circuit

Solenoid valve control circuit is an important part of the design of intelligent water system, used to control the opening and closing of parallel pressure solenoid valve. The circuit uses STM32G030F6P6 as the main control chip, with the solenoid valve control module to complete the remote control of the solenoid valve. When the user sends a signal to close the valve through the mobile APP, the cloud platform will send the signal to the main control board. After receiving the signal, the main control board will send a control signal to the solenoid valve control circuit. The control circuit will close the solenoid valve according to the signal, so as to achieve the effect of remote closure of water leakage.

The circuit uses DC12V power supply, and through the solenoid valve control module to control the solenoid valve switch. When the solenoid valve needs to be closed, the control module converts the control signal into the corresponding operation signal, and transmits it to the solenoid valve to make it close. At the same time, the circuit also uses some protective measures, such as transient voltage suppressor, overvoltage protector, etc., to ensure the stability and safety of the circuit[9].

Solenoid valve control circuit is an important part of the design of intelligent water system, can realize the remote control of the solenoid valve, and a series of protective measures, to provide users with safe and reliable water leakage monitoring and remote shutdown function is shown in Figure 7.

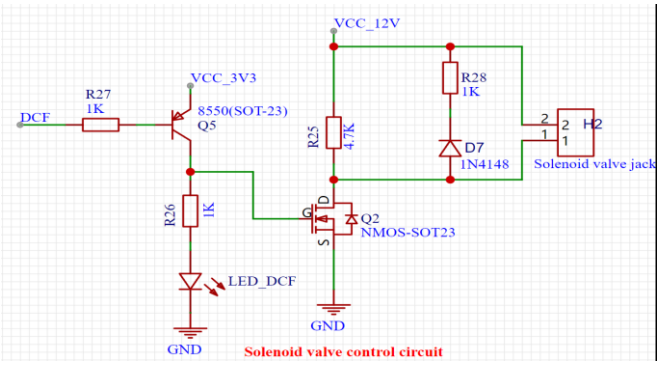

Figure 7 Solenoid valve control circuit design

3.7 Circuit design of flowmeter and download port

Flowmeter circuit is an important module in this design intelligent water system. Its main function is to monitor the flow of water. The unit circuit is connected with the main control chip STM32G030F6P6 to realize data acquisition and processing, and the results are displayed on the 1.8

"TFT screen. At the same time, the flow meter module is also connected with the solenoid valve control module, to realize the remote switch valve function. Flowmeter module often uses some sensors or rotary flowmeter and other equipment, through the flowmeter reading, to obtain the current water flow size information.

The download circuit is the circuit used to download the program to the main control chip. In this design of intelligent water system, the download circuit is usually composed of USB to serial port module, MCU download, used to download program files to the main control chip. In the use of the system, the download circuit has a very important role, because only the program is correctly downloaded to the chip, to ensure the normal operation of the system. It should be noted that in the download circuit, the model of the MCU download must match the model of the main control chip, otherwise the download may fail or the operation is abnormal.

Flowmeter module and download circuit are the important parts of the intelligent water system. The flowmeter module is used to monitor the flow of water and realize the function of remote opening and closing valve and water leakage warning. The download circuit is an important tool to download the program to the main control chip to ensure the normal operation of the system is shown in Figure 8.

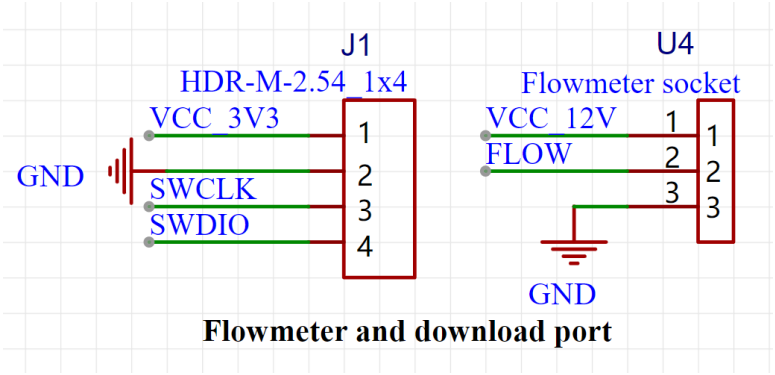

Figure 8 Flowmeter and download port circuit diagram

4. System software design

4.1 System software introduction

Keil uVision5, a popular embedded development environment, is the compiler used in the Intelligent water monitoring system in this article. The software is compatible with a wide range of mainstream microcontroller chips, such as the ARM Cortex-M family, STM8 and C251. Keil uVision5 provides a comprehensive and easy-to-use platform that enables developers to quickly develop high-quality embedded applications.

Keil uVision5, as the main software development tool, plays a crucial role in the development process of the intelligent water regulation system introduced in this article. It provides software developers with a wealth of compilers and debugging tools to help create high-quality, efficient applications, and has a visual graphical interface that is easy for users to use. With Keil uVision5 support, users can easily write software code to adapt to various hardware modules, and carry out system testing and debugging in a relatively short time, and finally meet the requirements of stability and security.

In summary, Keil uVision5 is a very powerful embedded software development tool that has played a central role in the development of the intelligent water regulatory system described in this article. In terms of programming efficiency, code quality, stability and security, Keil uVision5 provides developers with a very convenient and efficient programming environment.

4.2 System software workflow

The overall software flow of the system is as follows:

(1) The system starts

MCU initialization

(2) Including serial port, GPIO, ADC and other peripherals initialization

OneNet cloud platform connection

Connect to OneNet cloud platform and establish HTTPS connection for data transmission and reception

(3) Data collection

Data such as water quality, temperature, total water use and water leakage are collected through various sensors, including:

Water quality sensor: real-time collection of various parameters in water, such as PH value, COD concentration, ammonia nitrogen content, etc.

Temperature sensor: collect water temperature in real time and transmit the data to MCU;

Metering sensor: real-time collection of total water consumption data;

Water leakage detection sensor: collect humidity and temperature data around the water meter in real time to determine whether there is water leakage;

(4) Data processing

Determine the threshold value of the collected data. If the data exceeds the set threshold, it needs to be processed. Include:

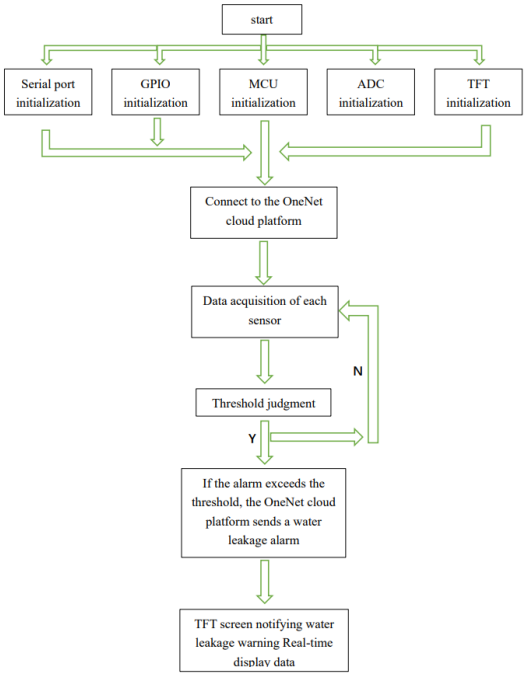

Figure 9: System software flow chart

Water leakage warning: When water leakage detection sensor detects water leakage, the system will automatically send water leakage warning information to the OneNet cloud platform and alarm;

Data analysis: According to the collected data, generate specific statistical reports, such as water consumption, water quality data trends, etc.

Real-time display: All kinds of data collected and the results of threshold judgment are displayed on the TFT screen in real time for the convenience of users' observation;

(5) Data transmission

The collected data is uploaded to the OneNet cloud platform for storage and analysis. At the same time, data can be obtained from the OneNet cloud platform and various devices in the system can be controlled.

(6) Shut down the system

When shutting down the system, release related resources and shut down related peripherals to ensure secure and effective system running.

The overall software flow of the system is shown in Figure 9.

5. Conclusion

This design is an intelligent water monitoring system based on the Internet of Things technology, which is of great significance in the utilization and management of water resources. The system finally realizes the real-time collection of water quality, temperature, total water consumption and water leakage data through various sensors, and transmits the data to the cloud platform for analysis, to help users understand the water problems in real time. At the same time, the system also has a remote control function, users can realize the valve switch control through the mobile phone APP, easily avoid the occurrence of water leakage accidents in the home.[10]

The designed intelligent water monitoring system is not only practical, but also scalable, and can be extended to various fields, such as household, industry and agriculture, so as to promote sustainable water resource utilization and management. The intelligent water supervision system proposed in this paper has certain innovation and practical application value, and provides a new idea and a new way to further promote the utilization and management of water resources.

Acknowledgement

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