Design and Implementation of Water-saving Thermostatic Mixing Valve

Yali Tao, Zhiyong Liu, Cheng Wang*

College of Mathematics and Physics, Huanggang Normal University,

Huanggang 438000, China

*Corresponding Author: wangc80@163.com

Keywords: Temperature; Water saving; Energy saving; Mixing valve; Water heater

Abstract. This paper designs a intelligent bathroom mixing valve controller by using the single chip. Our aim is to achieve the measurement and control of the outlet water temperature. In this design, we use DS18B20 sensors to measure temperature, which consists of two counter and two crystals. By controlling the open angle of the size of valve, we can realize the change of the cross-sectional area, and control the quality proportion of the mixed cool and hot water to reach a pre-set temperature.

Introduction

Currently, hotels, homes and public baths are used mechanical mixing valve widely, they are basically adjust the hot and cold water temperature manually, water supply system is almost the solar water heater or an electric water heater. While its exterior design variety, nice, but bather to adjust the water temperature are relying on mechanical mixing valve to open the proportion of hot water pipes and cold water pipe valves to achieve, and have a lot of water does not meet the pre-user cold water temperature requirements will be wasted. People use conventional bath process often requires tools (e.g., hand) to a tactile feel, in order to determine whether the mixed water temperature through body proper. The use of traditional tools bathing very inconvenient and prone to burns and other dangers. The pressure instability where traditional bathing tool easily lead to frequent fluctuations in temperature, the frequent need to adjust the mixing valve. This causes the user to feel uncomfortable, mixing water valve life will be shortened, but also cause a lot of waste water.

In this paper, we use the MCU, to design a smart shower mixing valve automatically to measure and control the outlet water temperature, which is designed to meet the needs of people's lives. When water flows through the mixing valve, microprocessor control valve opening angle, changing cold water mixing ratio, and adjusting the mixing temperature to reach a preset temperature. Response saving society-building needs, saving valuable water resources, have practical value for promoting people's health living, smart home has a practical significance.

The Overall Design

In this design, we use the software method to simulate the 1-Wire protocol to complete access to the DS18B20 chip. After the adoption of sensors collect temperature, comparing the mixing water temperature and the preset temperature, using the principle of negative feedback(Mixed outlet water temperature is too high ↑ → increase the cold water ↑, reducing the hot water into the mixing ↓ → outlet water temperature drops ↓; on the contrary, the mixed outlet water temperature is too low ↓ → reduce the cold water ↓, increase the hot water ↑ → outlet mixed water temperature increases ↑), combined pump the water to improve the dynamic adjustment of speed, you can quickly adjust temperature and save water.

Experiments using MCU control all devices, such as DS18B20, stepper motors, pumps, 1602 LCD, keypad, buzzer, LED, etc., in order to achieve outlet temperature measurements, cold and hot water proportion regulation, pumping cold water, preset temperature and real time temperature display, preset temperature regulation, alarm prompts. monitoring and adjusting the outlet water temperature automatically.

Finally, resorted to the outlet water temperature is maintained at a preset temperature fluctuation range of ± 1˚C.

The System Design Schematic

The system design diagram and the schematic diagram of the system are given as following Figure 1 and Figure 2 respectively.

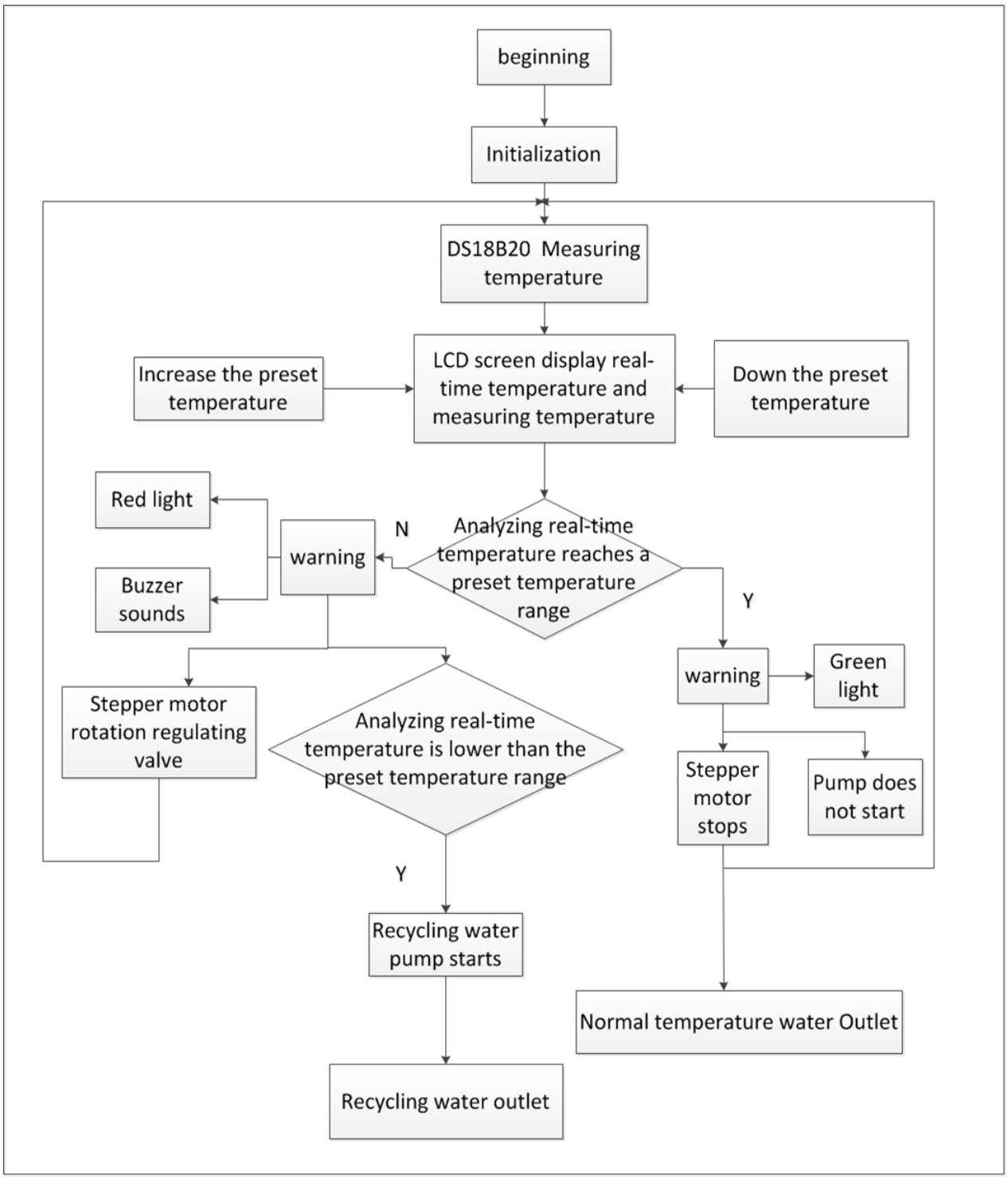

Figure 1. System design diagram

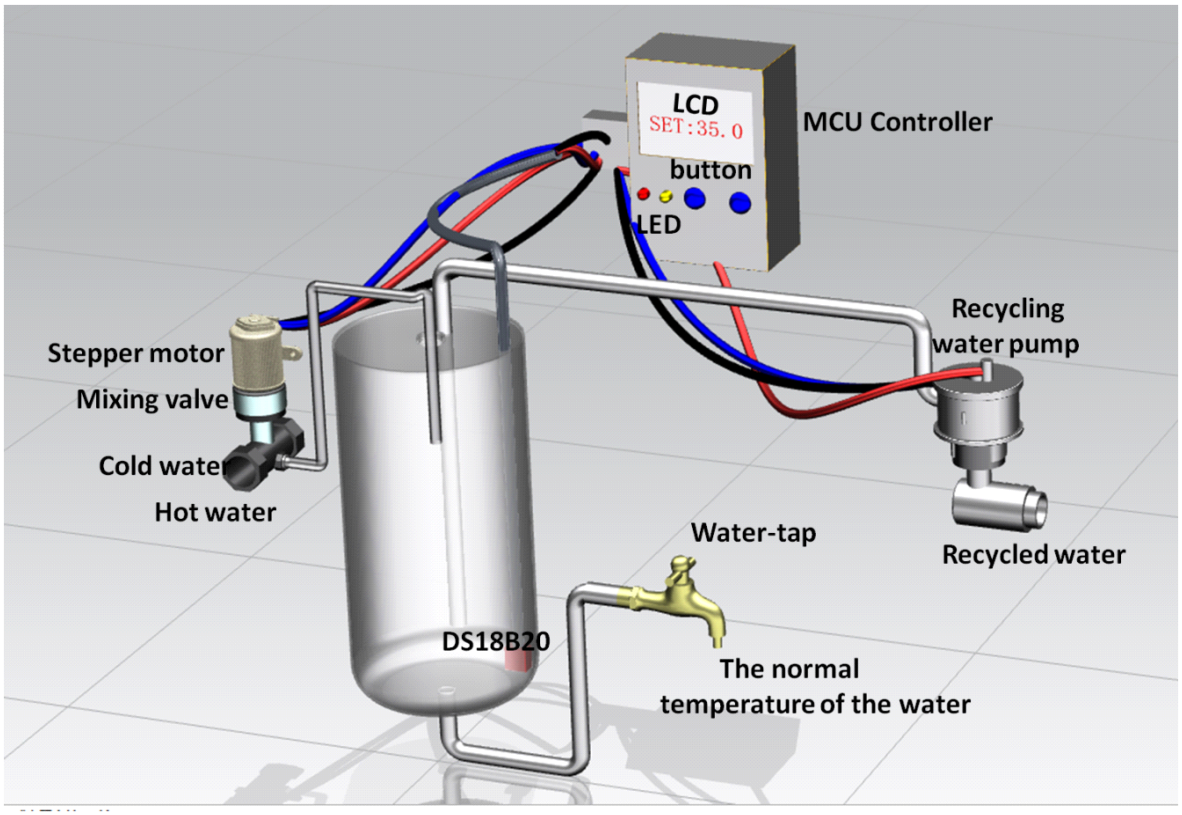

Figure 2. Schematic diagram of the system

The Display and Control Outlet Water Temperature

In this design, we used metal temperature sensors, temperature heat conduction through the metal. Using software method to simulate the 1-Wire bus protocol to complete access to the DS18B20 chip and collecting temperature. The measured temperature after treatment by the microcontroller can be displayed on the LCD screen. This system measure temperature and analyze the current mixed water temperature is lower than the preset temperature set by the user continuously. If the mixed water temperature is lower than the preset temperature range, DC pumps start working, take away the cold water, recycling, then the red led light and buzzer alarm, suggesting that this case can not use water; If the mixed water at a preset temperature range, DC pumps stopped working, the green led lights and buzzer does not alarm.

After the system is powered on and start working, LCD shows "Set: 35 ± 1˚C"(35˚C is the preset temperature, it can be adjusted manually by buttons, ± 1˚C is a preset temperature range)、"Current: ×××˚C" (real-time temperature). To adjust to the preset temperature, users only need to press the button, the preset temperature can be increased; users only need to press another button, the preset temperature can be reduced. If the real-time temperature higher than the preset temperature of the permissible range (± 1˚C),the red LED lights, system controller audible alarm and start the stepper motor, controlling valve opening angle, changing cold water mixing ratio. When the mixing temperature is lower than the preset temperature, the pump began pumping cold water, and recycling. Ultimately, to achieve rapid temperature reaches the preset temperature in the range. If the real-time temperature just at the preset temperature range, the stepper motor and the buzzer does not work, the green LED lights.

Conclusions

To achieve the water temperature is accurate, fast measurement, display real-time temperature, the temperature preset, pre-cold water recycling, avoiding waste of water resources, the water temperature is too cold, overheating the system will sound and light alarm automatically, ensure user safety. The use of negative feedback, control the temperature automatically, improve the accuracy of controlling. Intelligent

systems to monitor the range of temperature, ultra-double border monitoring, smart tips and automated management. The system of pre-measured water temperature to determine whether to activate the cold recycling, It has a water-saving features, other bath products on the market can not be achieved. It is close to people's real needs, create a comfortable bathing environment; building a conservation-oriented society in response to the needs, saving valuable water resources. The smart thermostat mixing valve system with a water-saving save water, provide a good user experience, guarantee the safety of users, etc. It can be widely used in households and hotels and other places. If the batch production, we can reduce production costs, it will have good market prospects.

Acknowledgments

This work is supported by the Natural Science Foundation of Hubei Province (No.2014CFC1096), and the 2014 Key Project of Hubei Provincial Department of Education (No.D20142903).

References

[1] K.Q. Brand, Water mineralization & purification device for faucets, China's Foreign Trade, 10 (1994) 38-48.

[2] L.Y. Su, Design of RF heat therapy system based on DS18B20 and FPGA, Sensors & Transducers 178 (2014) 140-1158.

[3] W.Y. Gong, X.M. Zhu, Frequency control device design of AC induction motor based on single-chip control, Value Engineering 25 (2014) 32-33.

[4] D.N. Yang, J.X. Zu, D.Y. Gai, Computer aided engineering (CAE) and its development. Mechanics in Engineering, Mechanics and Practice 3 (2005) 7-16.

[5] S.X. Li, The design of the intelligent bathroom mix water valve controller, Microcomputer & Its Applications 6 (2005) 17-19.

[6] S.F. Chen, Design and Development of Teaching Experiment System based on 51 Single-chip, Master thesis of Ocean University of China, 2011.

[7] Y. Chen, Z.K. Ren, C.P. Chen, Research and development of C Language programming experiment assistant management platform based on hybrid architecture, Procedia Engineering, 15 (2011): 67-78.

[8] C. Christidou, K.P. Tsagarakis, C. Athanasiou. Resource management in organized housing settlements, a case study at Kastoria region, Greece, Energy & Buildings 74 (2014) 89-99.

[9] X. Zhang, Research on shower of gas assisted injection molding mould design, Master Thesis of Qingdao University of Science and Technology, 2011.