Water Supply System Design Based On Single-Chip Microcomputer

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Abstract—Using 51 microcontroller as its main control chip, this system is designed to repair the deficiencies of the traditional water supply system in programming and functionality. Therefore, it is regarded as an innovation in the field of single chip microcomputer intelligent control. It senses height of user's cup by sensor and adds water automatically according to the set water volume of users. It also has safety lock function, its function of security lock can protect the users from accidental scald. The unit includes infrared on the tube, power module, ultrasonic ranging module, pyroelectricity body infra red sensor module, One-chip computer module, drive module and execution module. Experiments have shown that this system can fill bottles in varied sizes with 60% and 80% volume of water. Therefore, it is proved that microcontroller automates water supply system. More effective, intelligent and secure water supply system can thus be produced to break a new ground that users can preset the water level and be protected from scald by a security lock in water supply system. As a result, this system has a wide range of application.

Keywords- single chip microcomputer(SCM);opt coupler relay; buck DC-DC converter; pyroelectricity body infra-red sensor module; ultrasonic distance measuring

I. INTRODUCTION

As electronic equipment used by millions of families, water fountain has no great breakthrough in functions and convenience. There is no wonder that present water fountains have security risk and disadvantages. Therefore, this paper proposes design method to improve security and convenience of water fountain against this problem. By using sensor, it can sense cup size of users to add water automatically, avoiding water running over. As our intelligent water fountain can sense the cup size and run water automatically according to the water volume set by users, it conforms to present conserving and environment-friendly social requirements.

II. BASIC OPERATION PRINCIPLE OF TRADITIONAL WATER FOUNTAIN

As shown in figure 1, effluent rendezvous device is equipped at water exit of traditional water fountain. The water exit of micro electric pump joints with intake of effluent rendezvous device through pipeline. The vertical position of effluent rendezvous device is higher than interior water level of the water fountain. Water exit of effluent rendezvous device joins with single water exit of the whole water fountain through pipeline. Pipe diameter of connected with water exit is larger than pipeline diameter connected with intake. There is another vent age opened at the effluent rendezvous device, which will join with normal temperature tank through pipeline. This vent age keeps inside of effluent rendezvous device higher than internal water level of water fountain at ordinary pressure. The single water exit's vertical position is lower than internal water level of water fountain, contributing to arrangement of whole structure of water fountain

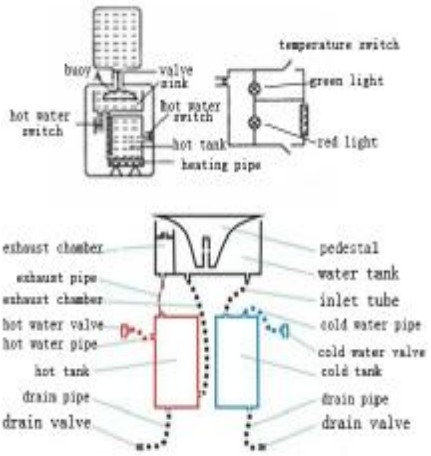

Figure 1 internal structure of ordinary water fountain

III. BASIS OPERATION PRINCIPLE OF WATER SUPPLY SYSTEM

A. Design method

This system is multi-function water supply unit setting measuring cup height, measuring level of water in cup, anti-scald safety lock, adding water to the set position and stopping adding water into an integration. It is made of

power module, data acquisition module, one-chip computer module and drive module. As shown in figure 2, data acquisition module contains many sensors application. The sensor transmits acquired information related to cup and water to single chip microcomputer, which outputs level order to control drive module after making judgment. It makes drive module drive the needed units to operate.

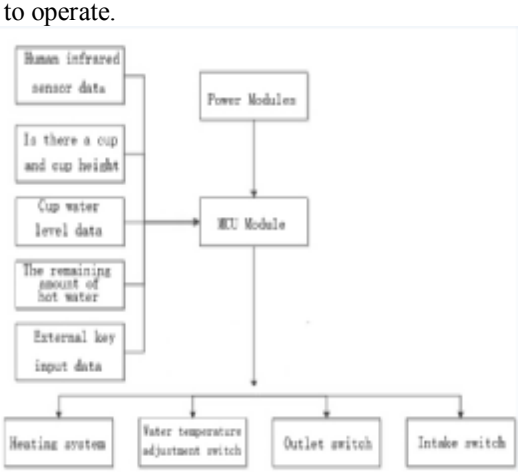

Figure 2 system chart

B. *Water volume control module*

Pin-out of single chip microcomputer is 5V, with level 20 mA, power 0.2W, magnetic valve power 4W. It is impossible for the SCM to control effluent of magnetic valve directly, therefore, drive module of magnetic valve needs to be added. As shown in figure 3, drive module of magnetic valve is made of magnetic valve and relay circuit. Relay output end joins with SCM pin, realizing function of using low-power level to drive high -power element.

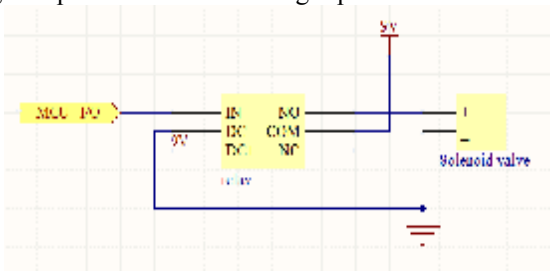

Figure 3 magnetic valve drive module

1) Operation principle of optocoupler relay: As shown in figure 4, optocoupler relay is a kind of solid-state relays. Ordinary relay is mechanical contact. By current, it control the switch by magnet changed from coil to attract electronic shock. However, operation principle of optocoupler relay is similar to that of optocoupler .It is a unit transmitting electronic signal by taking light as medium, encapsulating light-projector (IR LED) and light receptor(photoconductive semiconductor tube) into the same pipe. When the input end adds electronic signal, light-projector gives off light. When light receptor receives light, it will produce light current, which flows out from output end. Hence, transition of "current-light-current" is realized. It makes input end signal coupling with photoelectric coupler of output end taking light as medium . Then it controls magnetic valve efficiently.

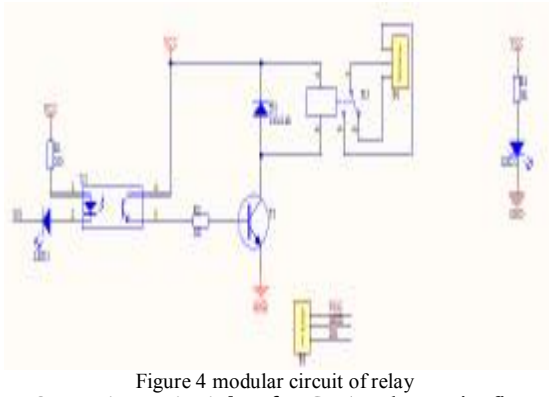
Figure 4 modular circuit of relay

2) Operation principle of DC: As shown in figure 5, LM2596S-3.3 DC-DC is used. LM2596 switching voltage regulator is step-down monolithic integrated circuit of power management, which can output 3A drive current and is equipped with linear and load regulation characteristics at the same time. Frequency compensation and fixed frequency generator are set into inside of the unit. The frequency of switch is 150KHz, which can use smaller-size filter element compared with low-frequency switching generator. As this unit needs only 4 external devices, it can use universal standard inductor and DC module. It can also reduce 9v to 5v, making SCM operate normally.

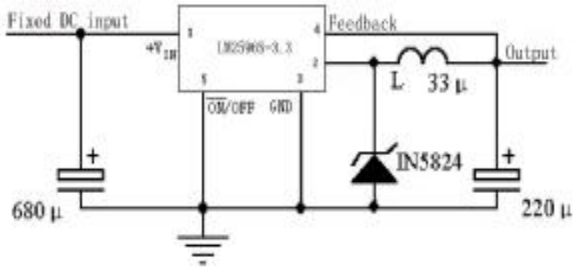

Figure 5 buck DC module circuit

3) Safe lock- operation principle of pyroelectricity body infrared sensor : Pyroelectricity body infrared sensor, thermal infrared sensor, is a new high-sensitivity infrared detecting element which can check infrared ray given off by body. It checks energy change of infrared ray given off by body in non-contact form, transits it to voltage signal to output and expands the output voltage signal.

HC-SR501 pyro electricity body infrared sensor is used. Its sensing module uses dual probe. When the body moves from the left to the right or right to the left, there is difference in time and distance when infrared spectrum reaches dual probe. The greater difference is, the more sensitive the induction is. When body goes to probe from the front or goes from up to down or down to up, the dual probe cannot check distance change of infrared spectroscopy and there is no difference. Therefore, the sensor is not sensitive or operational.

The intelligent water fountain puts pyro electricity body infrared sensor beside water exit. When anybody enters into the sensing area, high level (3v) is input. When SCM reads output control level, it outputs signal to close magnetic valve; when anybody leaves dangerous area, 0V low valve is output. The software inputs normal signals to control adding water. As shown in figure 7, when checking body infrared ray, module outputs high level

against SCM pin and uses pyro electricity body infrared sensor to avoid scalding uses. Therefore, the function of safe lock is realized.

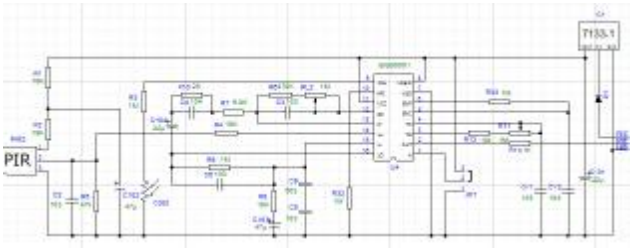

Figure 6 pyroelectricity module circuit

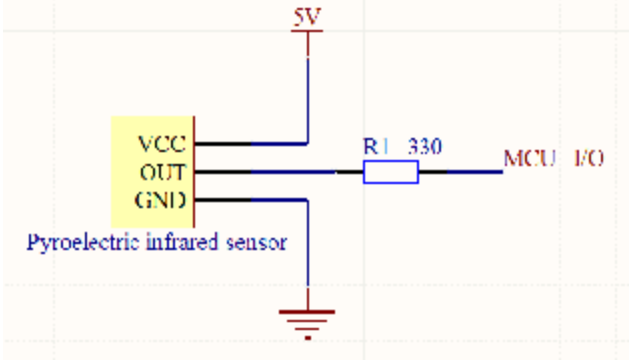

Figure 7 pyroelectric sensors joining with SCM

IV. PRINCIPLE OF USING ULTRASONIC TO MEASURE DISTANCE

As shown in figure 8, ultrasonic transmitter launches ultrasonic to some direction. When launching, time is counted. The ultrasonic spreads in the air and returns when meeting obstacles. Ultrasonic receiver stops counting time when receiving reflected wave. The speed of ultrasonic spreading in the air is 340m/s, According to time t recorded by timer, distance (s) from launching site to obstacle can be calculated, namely s=340*t/2 . This is the method of time difference to measure distance. As shown in figure 9, using two I/O can finish handling data processing of ultrasonic module.

The principle of measuring distance by ultrasonic: using known spreading speed of ultrasonic to measure return time of wave when it meets obstacles. Then according to launching and receiving time difference, actual distance from launching time to obstacle is calculated. Therefore, principle of measuring distance by ultrasonic is the same with that of radar. Formula of distance measuring: L=C×T

In the formula, L is measuring distance; C is spreading speed of ultrasonic in the air; T is spreading time difference of measuring distance(T is half of the time from launching to receiving). As ultrasonic is easy to make directional transmission with advantages of good directivity, easy-control strength and no need to contact with measured object directly, it is an ideal method to measure height of water level. It can control water yield to gain the aim of controlling water level inside the cup.

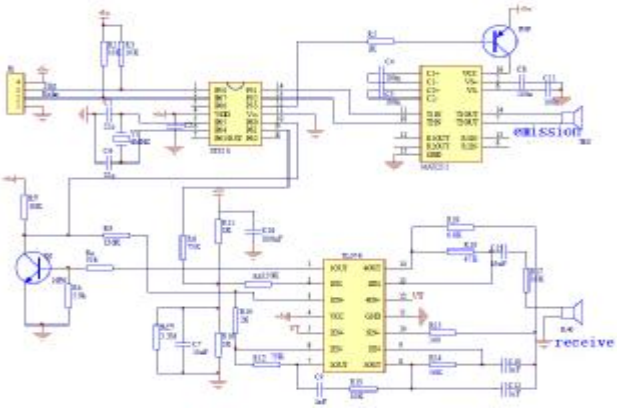

Figure 8 ultrasonic module

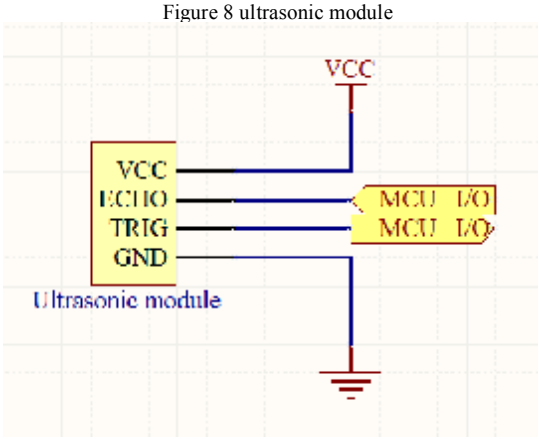

Figure 9 ultrasonic joining with SCM

V. TEST RESULT

As space exits between infrared tubes, it is normal that error exists between real water injection rate and set water volume. As shown in figure 10, C in the first row of display screen LCD1602 is cold water and H is hot water. The top five digit of the second row is XXX.X, representing measuring distance of ultrasonic. In the middle, 0 XXA is set water volume percentage. Then, it corresponds with C and H, if 1 is displayed, water injection of hot water or cold water is made. If 0 is displayed, water injection is stopped.

We set the water level of cup to be 80% cold water; experimental cup height is 12.5CM. When cup is put to the set position, the ultrasonic displays that the cup is empty and it measures the distance as 17.5CM. 080A represents the water volume is the 80% of cup. C=1 means water injection on the way is cold water. As shown in figure 11, the unit is injecting water to the cup and the distance measured by ultrasonic is reducing. As shown in figure 12, the unit finished water injection, the distance measured by ultrasonic is 7.5CM. When C=0, water injection is accomplished.

TABLE I. Experimental Results

cup height h(CM)	set water volume A	Final water level h*A=H(CM)
12.5	0.60	7.2
10.3	0.60	6.0
8.8	0.60	5.1
12.5	0.80	9.3
10.3	0.80	8.1
8.8	0.80	6.9

Figure 10

Figure 11

Figure 12

VI. CONCLUSIONS

This intelligent water fountain's main control chip uses 51 SCM, which has many functions and easy operation. It operates the module in the unit by data collecting, analysis and processing. As the unit is convenient, safe and resource-conserving, it has broad prospect in the market.

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