A Design of a Class of Temperature Stabilization System and Implementation

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Abstract: In this paper, we proposed a design for a class of temperature stabilization system based on the feedback control theory and the corresponding technology of microchip MC89C51 and sensors theory. Besides, the proposed design was implemented on a set of temperature control system to determine whether the current status of fishes tank fitting fishes survival or not. Therefore, we can control the temperature of fishes tank. There are three stages in this design. First, we set the temperatures at the fish tank harming fishes life are not suitable for the safety status. Second, we use the MC89C51microprocessor combined with the A/D converter to process the analog measuring temperatures of the sensor measurements into digital data. Finally, a software program was designed to process the obtained digital data and control the solid-state electric relay to increase or decrease the target temperature of the water tank.

Key-Words: MC89C51 microprocessor, A/D converter, Digital signals, Sensors, Feedback control theory

1 Introduction

Feedback control theory is widely used in advanced industrial such as the papers listed [1]-[37]. In this paper, We used sensors to detect analog signals and use A/D converter to convert the analog signals into digital signals, and then introduced into the microchip MC89C51, after that decoded on display at Seven-Segment Display by 74LS47, so that it measured the level of the outside temperature to determine the current state of the environment is satisfactory or not, and then for it to do heating and cooling to achieve the purpose of increasing or decreasing in temperature. Fishes tank heating equipment has broad application in the aquaculture industry or individuals. Because of the current global warming and changing climate, the climates dip or a few days of heavy rain against the amount of breeding. The main purpose of this paper is to use the feedback control theory, combined with the microchip MC89C51 technology and the sensor theory to propose "A design of a class of temperature stabilization system". Implementation of the controller can set the temperature at a constant temperature range of safety to achieve the stabilization the temperature of fish tank.

We organized the paper in the following manner.

Section 2 presents the methodology of the proposed design. Design technology is presented in section 3. Section 4 gives the hardware implementation. Finally we make a brief conclusion in section 5.

2 Methodology

In this section we will introduce "A design of a class of temperature stabilization system". There are two important part of the internal structure that includes (a) A/D and D/A converter (b) MC89C51

2.1 ADC0801~ADC0805 converter

In this paper, we use ADC converter to converter the analog temperature signal data into digital signal data. Nowadays the microcomputer can precede a variety of digital data quick and precise treatment, but human beings are encountered in a variety of physical analogies in everyday life. Such as temperature, brightness, weight, therefore, we must convert the analog signal into digital signal and then sent to microcomputer. Analog to digital converter referred to as A/D converter, A/D converter function is to input analog signals into digital signal output. In this paper we used the converter are of the ADC0801 series of A/D converter, ID from the ADC0801 to ADC0805. Their pins and characteristics are compatible, designers can use each other substitution, and the details are as follows:

—Function: 8-bit A/D converter

—Map pin: Figure 1 shows the ADC080X block diagram and Figure 2 shows the ADC0804 Pin's diagram. And the features are stated below.

∗ 8-bit CMOS continuous progressive ADC

∗Tri-state latch output.

∗ Maximum error ± 1LSB.

∗ Conversion time 100uS @ 640KHZ.

∗ Internal Clock Generator circuit containing frequency by plus R, C decision.

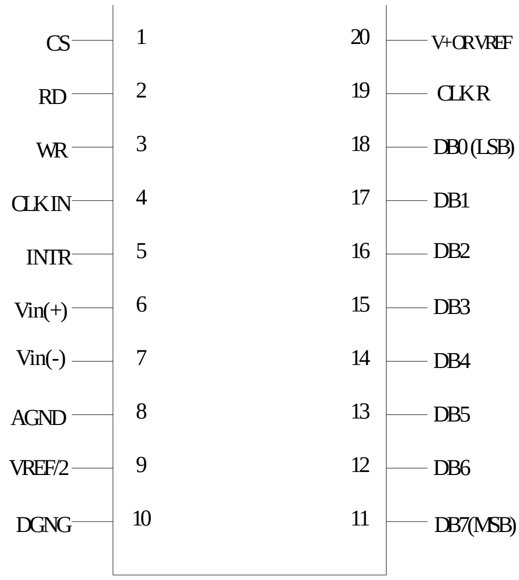


Fig. 1 ADC080X block diagram

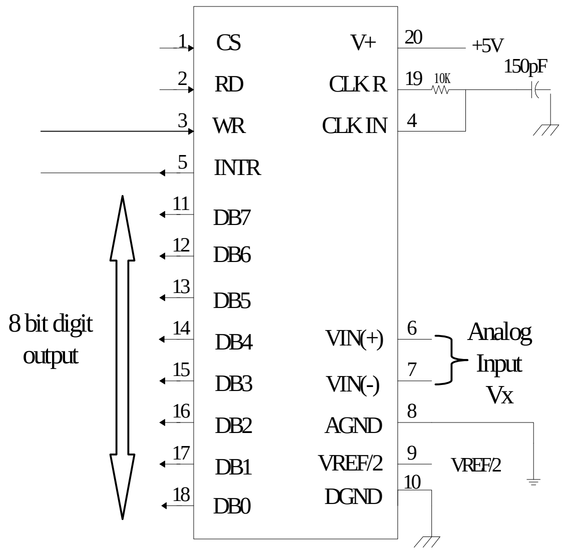


Fig. 2 ADC0804 Pin's diagram

The code of ADC0804 are stated as follows：

—If the CS and WR pin are "0", then the INTR pin is set to be "1", hence, to make the analog signal into the chip to complete the preliminary work.

—After 100ns waiting, if the CS and WR, there are any more than one pin into a "1", the analog to digital converter circuit to enter the "enable", status will begin analog input voltage Vx to convert 8-bit digital data.

—Once the analog signal converted into the digital signal, the digital data stored in the Latch device, and the INTR pin outputs "0" indicated that they had completed the conversion, figure 3 shows the clock sequence of ADC0804.

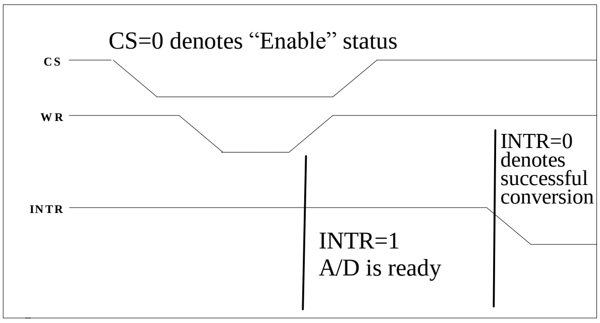


Fig. 3 ADC0804 clock sequence

—If the CS and RD pin are "0", the tri-state buffers conduction, the tri-state buffers on-the digital data output from DB7~DB0

—No. 9 pin (1/2 VREF) is a very important input pin, Labeled VREF/2, VREF express half as long as the input to Pin9, can obtain the step size＝VREF/2^N＝VREF/2^8＝VREF/256.

—Pins 10 and 8, respectively, (D GND) and (A GND) are digital and analog ground of the device.

—DB=51 Vx are the digital output signal DB and analog input voltage Vx relations.

ADC0804 has built a group of clock generator circuit, as long as 4 pin at 19 and the indirect one resistor R, and at 4 pin and then a grounding capacitance C can be generated using the clock for ADC0804, and its frequency is about the size of fCLK ≒ 1/1.1RC.

We use the following two methods to prevent noise.

—Added a 1uF capacitor at the pins 20 and 10.

—Added a 0.1uF capacitor at the pins 8 and 9 pins.

2.2 MC89C51

Intel Corporation developed MCS-48 series of single-chip in 1976. It is an eight Yuan CPU, with a maximum of internal 4 K bytes of ROM or EPROM, and up to 256 bytes of RAM, and 8 bit of a timer and 27 I/O. Intel in 1980 under the MCS-48 improved the structure and development of MCS-51. This single chip still using 8 bit CPU, but ROM or EPROM space up to 64 K bytes, there are 256 bytes of RAM and two of the 16 bit timers and 32 I/O. The proposed design used a single-chip MC89C51, has the following characteristics：

—The chip of the MC89C51 is of 8 bit.

—A-bit computing logic.

—128 bit RAM and 4K bit ROM.

—There are four 8 bit I/O.

—There are two 16-bit time/counter.

—It has a full-duplex UART.

—There are five interrupt source priority interrupt and a two-tier structure.

—It has a clock circuit.

—It has an external circuit expanded to 64-bit ROM.

The MC89C51 diagram is shown in figure 4.

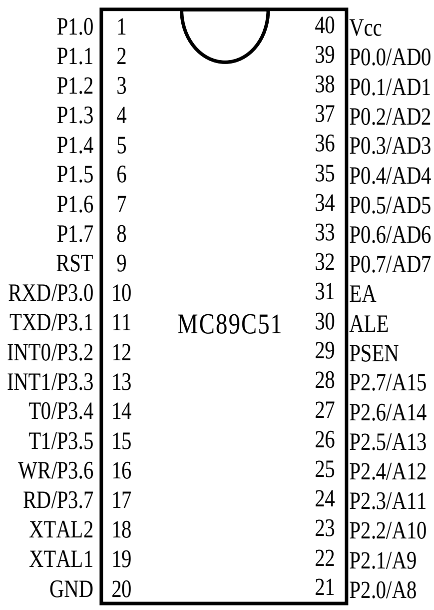


Fig. 4 MC89C51 diagram

—Vcc: set to be +5V.

—GND: Grounding pin, 0V.

—P0.0~P0.7: Port 0 is of the opening Drain two-way I/O.

—Ports: As the expansion of external memory, they can address the low 8 bit (A0~A7 address line) and data bus dual function.

—P1.0~P1.7: port 1 is with internal promotion of two-way circuit I/O ports.

—P2.0~P2.7: port 2 is with internal promotion of two-way circuit I/O ports. As the external memory expansion, 8 high state of “1” for the address line will be set (A8~ A15 address line).

—P3.0~P3.7: port 3 is with internal promotion of two-way circuit I/O ports. Port 3 each pin has another special feature, its functions are as follows:

- ✓ RXD (P3.0): Serial transmission of the receiver.
- ✓ TXD (P3.1): Serial transmission of the output.
- ✓ $\overline{INT\,0}$ (P3.2): External interrupt inputs.
- ✓ $\overline{INT\,1}$ (P3.3): External interrupt inputs.
- ✓ T0 (P3.4): Time/counter external input.
- ✓ T1 (P3.5): Time/counter external input.
- ✓ $\overline{WR}$ (P3.6): External data into the memory strobe.
- ✓ $\overline{RD}$ (P3.7): External data memory read strobe.

—RST: Reset input. Single chip work, keep this in the pin "Hi" two mechanical cycles, CPU will be reset.

—ALE: Address Latch Enable. Each machine cycle will appear, as the external circuit clock source.

— $\overline{PSEN}$: Program Strobe Enable. Enter the external ROM can be read signal.

— $\overline{EA}$: External Access Enable. When the EA-pin is "L0" state, and then read the implementation of external program memory.

—TAL1: RP-oscillation amplifier input.

—TAL2: RP-oscillation amplifier output.

3 Design Technology

3.1 Circuit implementations

3.1.1 BCD to Seven-Segment Decoder 74LS47

The proposed design shows that temperature of double-digit, if the direct drive ADC0804 pin will cause less than, so must be read in conjunction with decoding IC and using ADC0804, BCD code for the 4-bit (such as 1001), directly correspond to and light up Seven-Segment Display. This IC is called BCD to Seven-Segment Decoder, we use the 74LS47 in this propose design. Since the 74LS47 output pin 7 are OPEN COLLECTOR, so to tie in with the Seven-Segment Display total anode, pin and wiring as shown in figures 5(a)-(b), its truth table as shown in Table 1. The Two 7 segments connection diagram are shown in figures 6.

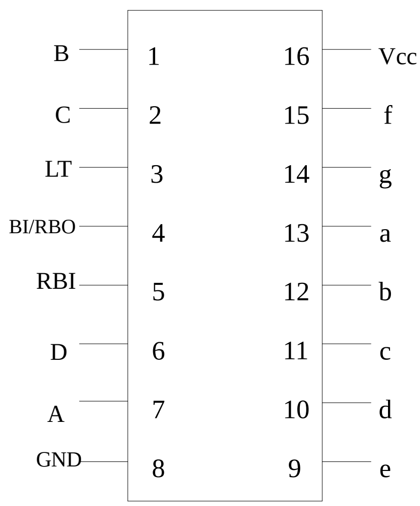


Fig. 5(a) The 74LS47 Pin

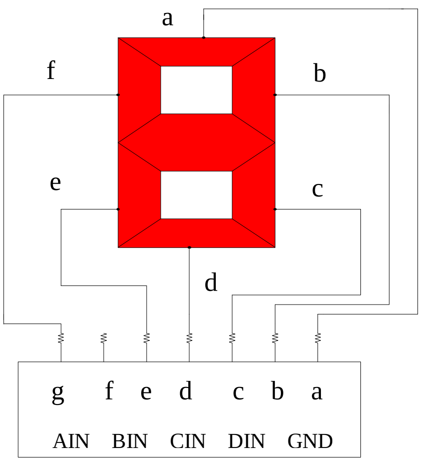


Fig. 5 (b) The 74LS47 connection diagram

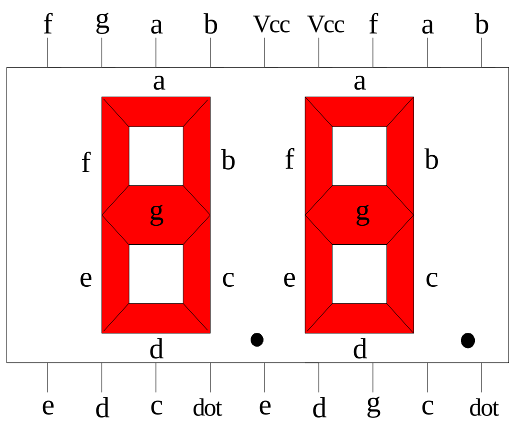


Fig. 6 Two 7 segments connection diagram

Table 1 74LS47 Truth Table

Function	Input						BI/RBI+	Segment ON / OFF						
	CL	RBI	D	C	B	A		a	b	c	d	e	f	g
0	H	H	L	L	L	L	H	ON	ON	ON	ON	ON	ON	OFF
1	H	X	L	L	L	H	H	OFF	ON	ON	OFF	OFF	OFF	OFF
2	H	X	L	L	H	L	H	ON	ON	OFF	ON	ON	OFF	ON
3	H	X	L	L	H	H	H	ON	ON	ON	ON	OFF	OFF	ON
4	H	X	L	H	L	L	H	OFF	ON	ON	OFF	OFF	ON	ON
5	H	X	L	H	L	H	H	ON	OFF	ON	ON	OFF	ON	ON
6	H	X	L	H	H	L	H	OFF	OFF	ON	ON	ON	ON	ON
7	H	X	L	H	H	H	H	ON	ON	ON	OFF	OFF	OFF	OFF
8	H	X	H	L	L	L	H	ON	ON	ON	ON	ON	ON	ON
9	H	X	H	L	L	H	H	ON	ON	ON	OFF	OFF	ON	ON
10	H	X	H	L	H	L	H	OFF	OFF	OFF	ON	ON	OFF	ON
11	H	X	H	L	H	H	H	OFF	OFF	ON	ON	OFF	OFF	ON
12	H	X	H	H	L	L	H	OFF	ON	OFF	OFF	OFF	ON	ON
13	H	X	H	H	L	H	H	ON	OFF	OFF	ON	OFF	ON	ON
14	H	X	H	H	H	L	H	OFF	OFF	OFF	ON	ON	ON	ON
15	H	X	H	H	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF

—The functions in each pin are described below:

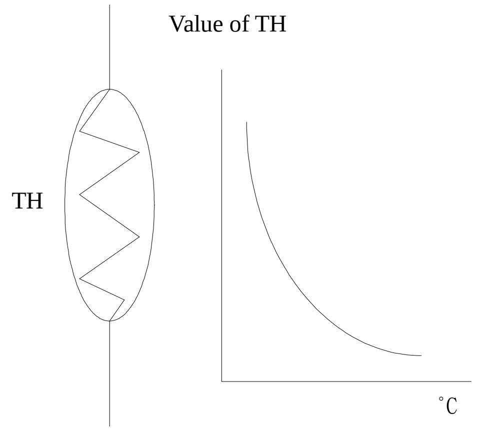
- ✓ Pins a, b, c, d, e, f and g allow designers access to a total of seven-segment display anode.
- ✓ Pins a, b, c, d, e, f and g allow designers access to a total of seven-segment display anode.
- ✓ Normally, BI-pin (No. 4 pin) is set to be a high state ie. “1”, if seven-segment display “0”.
- ✓ Once the LT pin (No. 3 pin) grounded, seven-segment display the original status and check whether it is normal for seven-segment display.
- ✓ The RBI pin (No. 5 pin) is used to erase the display figure while grounded.

3.1.2 Thermal register

This proposed design employed the thermal register to measure the high and low temperature, thermal register (referred to as TH) is the most common and highly stable components. Thermal register is extremely sensitive to temperature of semiconductor components. In general, there are two categories in the thermal register: positive temperature coefficient and negative temperature coefficient. Positive Temperature Coefficient thermal register referred to as PTC thermal register, as the temperature increase in resistance value, on the other hand, Negative Temperature Coefficient Thermal registers is abbreviated as NTC thermal register, with the temperature and resistance value lower. In this paper, we have adopted a negative temperature coefficient NTC thermal register, characteristics shown in figure 7, the formula for obtaining Vx are of Vx=5*RX/RX+RTH, by the experimental through the actual simulations shown in Table 2.

Table 2 Corresponding values of measurements

Temper-ature	Resistance Value	Vx voltage	A/D value	range	Rounding up
18	1.45	2.040816	104.0816	105.0554	105
19	1.405	2.079002	106.0291	107.5017	108
20	1.34	2.136752	108.9744	110.0427	110
21	1.295	2.178649	111.1111	112.4752	112
22	1.24	2.232143	113.8393	114.8742	115
23	1.2	2.272727	115.9091	117.534	118
24	1.14	2.336449	119.1589	120.2937	120
25	1.1	2.380952	121.4286	122.8185	123
26	1.053	2.43546	124.2085	125.4425	125
27	1.013	2.483855	126.6766	128.0591	128
28	0.97	2.538071	129.4416	130.4425	130
29	0.94	2.57732	131.4433	132.6508	133
30	0.905	2.624672	133.8583	135.2937	135
31	0.865	2.680965	136.7292	138.0367	138
32	0.83	2.73224	139.3443	140.3093	140
33	0.805	2.770083	141.2742	142.4681	142
34	0.775	2.816901	143.662	145.1068	145
35	0.74	2.873563	146.5517	147.6199	148
36	0.715	2.915452	148.688	150.0117	150
37	0.685	2.967359	151.3353	152.4749	152
38	0.66	3.012048	153.6145	154.7889	155
39	0.635	3.058104	155.9633	156.9779	157
40	0.614	3.097893	157.9926	158.124	158



(a)Sign of thermal register (b) Characteristic of TH

Fig. 7 NTC thermal register characteristic

Table 3 Contents as to temperature and corresponding numerical estimates in the proposed design

Estimated as 103

Vx Voltage	A/D Value
2.040816	104.0816
2.079002	106.0291
2.136752	108.9744
2.178649	111.1111
2.232143	113.8393
2.272727	115.9091
2.336449	119.1589
•	•
2.967359	151.3353
3.012048	153.6145
3.058104	155.9633
3.097893	157.9926

Range
105.0554
107.5017
110.0427
112.4752
114.8742
117.534
120.2937
•
152.4749
154.7889
156.9779

Estimated as 159

3.2 Signal processing and program flow chart

Since there is no "greater than directive" code in Micro-chip MC89C51 neither the "less than directive" code, so we employed the "subtraction" instead of "large and small", minus the number of phase if the two happened borrow bit (C=1), that relatively large decreases in, If no borrow bit (C=0), said to be larger subtrahend.

—Signal processing as to the contents of temperature and corresponding numerical estimates in the proposed design are shown in Table 3. In Table we set up 18 degrees for the range of A/D values between 103 and 105, 19 degrees for the range of A/D values between 105 and 108, and so on.

—The application of Table 3, we construct the temperature of the corresponding table to determine MC89C51 program on high and low temperature to explain the use of the previous subtraction instruction, coupled with the look-up table method, the temperature will be pre-input A/D value (MC89C51 temperature program information table) found out and the actual measurements of A/D value minus. For example, the actual measured A/D value of 106, program look-up table method can be found in a value of 103, 106-103>0，C=0 (No borrow, and have not found temperature), program and then found a look-up table values 105, 105-103>0, C=0 not found temperature, found until more than 106(the next value is 108), 106-108<0, C=1 there is borrow-bit, then found the temperature A/D value, and then A/D display, "A noble design of a class of temperature" program flow chart is shown in Figure 8.

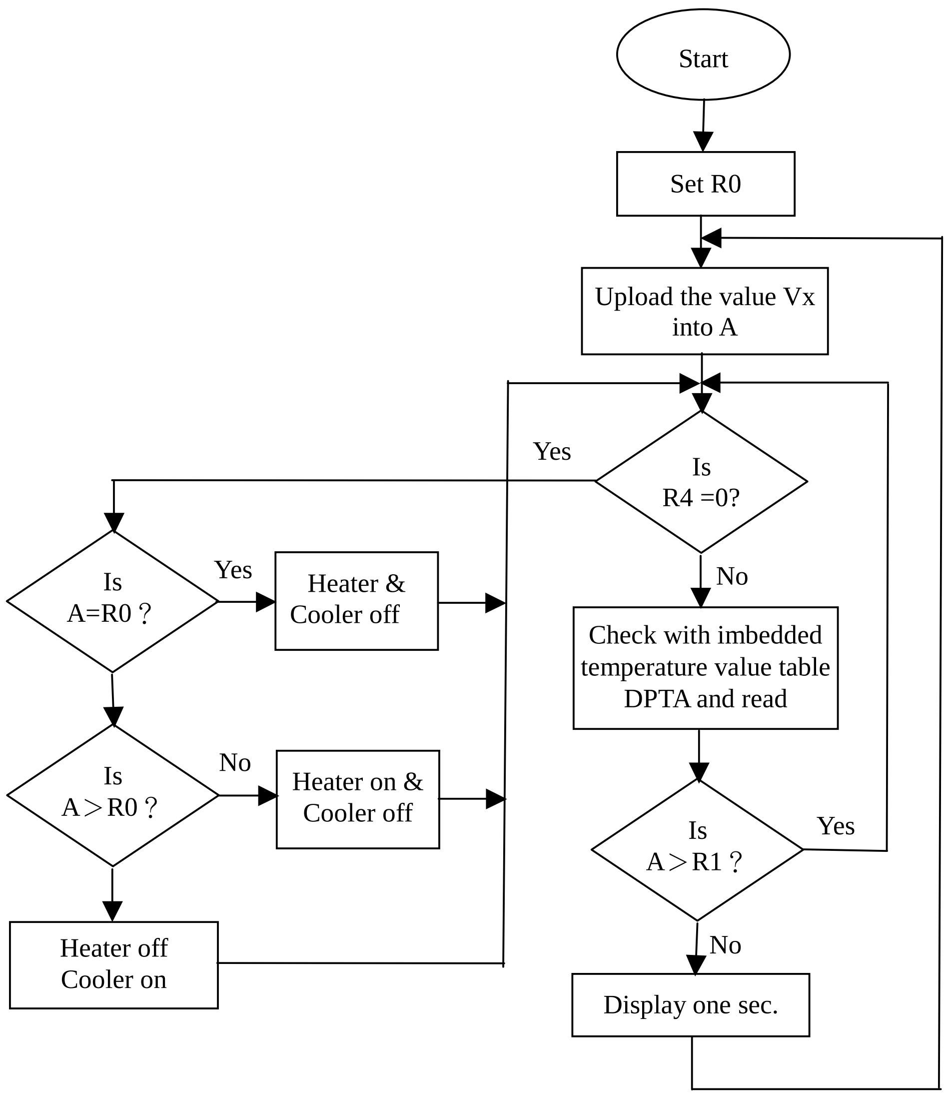


Fig. 8 Flow Chart of the proposed design of a class of temperature stabilization system

First start the program button to set the temperature detection, after the set temperature, the temperature value into R0, then put thermal register voltage values into digital 8 bit values and deposit accumulation inside the device A. And R4 is set to begin just 10, R4 is not 0 the program to continue, once each R4 minus one, R4 heaters are used to set whether the number of action values. We set for each operation 10 times and then want to judge or not to activate the temperature controller; temperature controller has both heating and cooling system. If the room temperature is less than the set temperature (A<R0) heater start, if the room temperature is greater than the set temperature (A> R0) cooler start. Program to continue, DPTR points to put the thermal register by the experimental data (MC89C51 temperature program information table), is 18 ~ 40 degrees the temperature (Table 2) read one by one into the R1. When the data are ready to begin than to temperature, than for A> R1, In other words, the A-R1 has been running this step. A values did not know, R1 will change the look-up table, when R1 available from small to large values than the A large after, express finding on the value of the value of A, then the temperature at this time displayed, Re-start, repeat loop. Because of nonlinear characteristics thermal register, so the temperature measurement is not very accurate numerical, but the sensitivity is very high, In order to improve accuracy can be more accurate and linear temperature sensing element to replace, although this circuit has 7805 voltage regulator IC for voltage regulator, however, a small amount of noise will cause the MC89C51 crash, it can be solved this problem by adding a 0.1uF capacitor at MC89C51 pins 40 (Vcc) to eliminate the noise.

4 Hardware Implementation

In this paper, the authors employed the feedback control theory and combined with the sensors and microchip MC89C51 technology to present "A design of temperature stabilization system". Completed works are stated as follows: figure 9 is an temperature controller with an infrared remote control function; figure 10 shows the device of heater and cooler to increase or decrease in temperature; figure 11 is the completely design of the proposed design "A design of a class of temperature stabilization system".

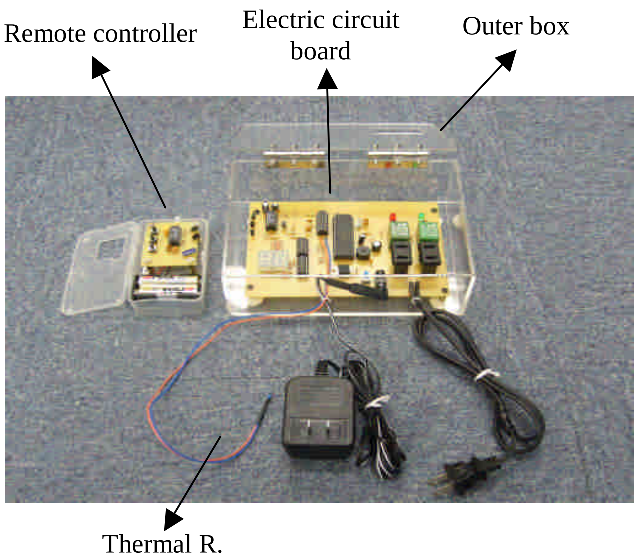


Fig. 9 The proposed temperature stabilization system with an infrared remote control function

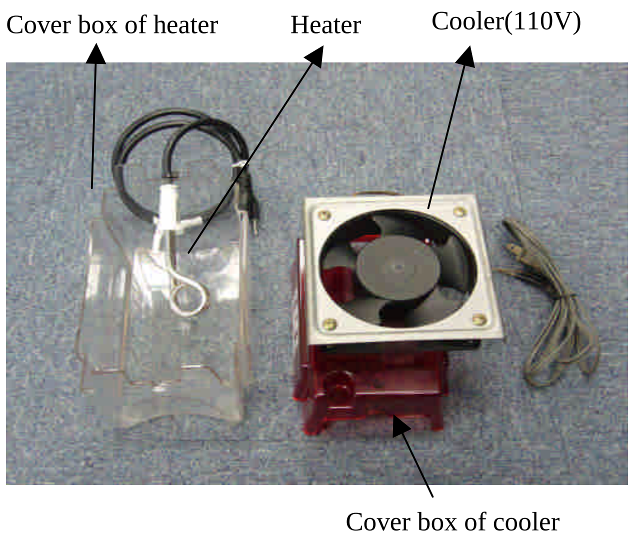


Fig. 10 Heater and Cooler device

Fig. 11 A design of a class of temperature stabilization system

5 Conclusions

In this paper, based on the feedback control theory, we combined with the microchip MC89C51 and sensors technology to propose "A design of a class of temperature stabilization system". The design was implemented in a type of the fish tank temperature control. The simulation results showed that proposed design could efficiently stabilize the temperature in the fish tank environment. Furthermore, the proposed device with the infra-red remote control functions can easily operate the controller. Moreover, the proposed design can also be used for health care systems as well as the high tech thermostat temperature control system.

Acknowledgements

This research work was partially supported by National Science Council in Taiwan under grand # NSC 97-2221-E-129-017. The authors wish to thank Mr. M.-J. Chauo, S.-F. Jung, J.-U. Li and K.-M. Lin for their efforts in setting up the hardware environments.

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