Temperature Control Technology in Heating Room Based on Multi-channel Temperature Signal Denoising

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Abstract. In order to improve the accuracy of temperature control in the heating room and make the indoor temperature meet the comfort requirements of people for the living environment, the theory of multi-channel temperature signal denoising is introduced and the research on the technology of temperature control in the heating room based on multi-channel temperature signal denoising is carried out. First, the heating heat load is classified into three levels, namely, first level, second level and third level. On this basis, a heating indoor temperature model is built. Secondly, the pretreatment circuit design is completed to realize the noise removal of multi-channel temperature signals and improve the transmission quality of multi-channel temperature signals. Thirdly, the PID parameters are adjusted, and the temperature in the heating room is PID controlled. The fuzzy PID theory is introduced to design the fuzzy PID control. Finally, introducing fuzzy PID algorithm to make the steady-state error and maximum deviation of the heating temperature control system, the prediction and compensation control of the heating room temperature is carried out. The experimental analysis results show that the introduction of multi-channel temperature signal control technology can achieve high-precision control of indoor temperature in heating in practical application, so that the indoor temperature change can fully meet the comfort requirements of residents for indoor heating.

Keywords: Multi-Channel Temperature Signal Denoising · Indoor · Control · Temperature · Heating

1 Introduction

Heating can solve the basic living problems of people in cold regions in winter, and people's urgent demand for heating increases with the improvement of living standards [1]. With the proposal of national energy conservation and emission reduction, green development concept and the improvement of residents' heating demand, the traditional coal-fired boiler heating mode gradually withdrew from the heating stage due to environmental pollution, low efficiency and rising prices, and the heating modes such as

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electricity instead of coal and electricity instead of oil have been widely used [2]. Electric energy has the characteristics of no noise, no waste gas, the most environmentally friendly and clean. In addition, the current situation of the country is that there is an excess of electricity, while water resources are scarce. In the future, the national power supply and demand will be unbalanced, and the state of serious oversupply will always be. The promotion of heating can increase the power load, which is not only conducive to solving the consumption of surplus electricity, but also can improve air quality, Reducing the consumption of water resources is of great significance for solving the current situation of national power surplus and long-term energy conservation and environmental protection [3].

Therefore, heating is the first choice of people in today's rising prices of other energy sources. The most important parameter in the process of heating is temperature. Room temperature comfort has always been one of the standards to measure the quality of heating [4]. Due to the different use nature of rooms, the required temperature will be different. If the unified constant temperature control strategy is adopted, the unity of heat supply and heat demand is not achieved, and a large amount of electric energy [5] is wasted. It is necessary to provide heating according to needs, change the disadvantages of unbalanced supply and demand in the past, and reduce energy consumption. Make heating more intelligent and humanized.

With the continuous increase of heating scale, the problem of dynamic imbalance in the heating process increases [6]. During static stable heating, heating will stop when the temperature reaches the set upper limit, and will be put into operation when it is lower than the lower limit of heating temperature. Because the thermal insulation of each room is affected by external factors such as height and orientation, all loads are not switched at the same time, which is easy to cause dynamic three-phase power imbalance. It will increase the loss of lines and transformers, affect the safe operation of electrical equipment, and reduce the heating quality in heating. Therefore, it is very important to improve the indoor temperature control performance.

Since the 1970s, Europe has implemented heating metering and charging, which attaches great importance to the energy saving measures of the Hydronics and users, especially in room temperature control, heat metering, and hydraulic balance regulation technology of the heating network. Compared with foreign countries, China's Hydronics lacks the use of heat metering devices and room temperature regulation methods, so it is difficult for users to achieve real-time regulation of heat consumption. Reference [7] proposed a mixed integer Linear programming (MILP) for short-term optimization of network temperature in 5GDHC system. This model includes air source heat pumps, compression coolers, and heat storage devices in central power generation units, as well as heat pumps, coolers, electric boilers, and heat storage devices in buildings. In addition, the model also considers the thermal inertia of the water masses in the network as additional heat storage devices. Reference [8] proposes the application of the variable universe idea in the temperature control system of variable air volume air conditioning. Based on traditional fuzzy PID control, the variable universe idea is introduced to design a controller with variable universe fuzzy PID algorithm. Finally, the fuzzy PID control algorithm and variable universe fuzzy PID control algorithm are respectively simulated to control the temperature of variable air volume air conditioning rooms Although different methods have been used in current research to achieve temperature control, in heating systems, temperature sensors may be subject to various noise interferences, such as electromagnetic interference and sensor noise. These noises can have an impact on temperature measurement results, leading to inaccurate indoor temperature control. In order to reduce or even avoid the waste of heat during heating, this paper will carry out the research on indoor temperature control technology based on multi-channel temperature signal denoising. In the research process, based on the establishment of heating load classification and indoor temperature model, a multi-channel temperature signal denoising preprocessing circuit was designed. Design a fuzzy PID controller for heating system temperature from two aspects: PID parameter tuning and indoor temperature PID control. Finally, achieve indoor temperature control through temperature estimation and compensation control in the heating room.

2 Temperature Control Technology in Heating Room Based on Multi-channel Temperature Signal Denoising

2.1 Classification of Heating Load and Establishment of Heating Indoor Temperature Model

It is assumed that the loads at all levels are evenly distributed on the three phases, that is, the three phase loads themselves are statically balanced [9]. In order to simplify the analysis, it is assumed that the number of loads at each level is the same, and the factory power of each load is different. The load temperature range at each level is set according to the thermal load level, and the temperature range is gradually reduced. Table 1 shows the classification of heating load.

Table 1. Classification of Heating Load

S/N	Load level	temperature range
(1)	Level I load	[22,25]°C
(2)	Secondary load	[18,22]°C
(3)	Level III load	[5, 10]°C

The establishment of the temperature model depends on the heat production of the heater and the heat dissipation and storage capacity of the room. Heat generation of electric heater W equal to the storage capacity of the room W_1 heat dissipation with the room W_2 and. Assuming that the room temperature distribution is uniform, the model can be expressed by the following formula:

$$W = W_1 + W_2 \tag{1}$$

In the formula, W_1 it can be calculated by the following formula:

$$W_1 = C_d T_{\text{int}}/dt \tag{2}$$

In the formula, C_d represents the specific heat fusion in air; T_{int} indicates the indoor temperature; t indicates the heating time. In the formula, W_2 it can be calculated by the following formula:

$$W_2 = (T_{\text{int}} - T_{out})/R = (T_{\text{int}} - T_{out})A\eta/\varepsilon \tag{3}$$

In the formula, T_{out} indicates the ambient temperature; R represents equivalent thermal resistance; A represents the wall area; η represents the heat transfer coefficient of the wall; ε indicates the thickness of the wall. Ignoring the influence of outdoor ambient temperature, the above formula is substituted into the formula above, and the following formula can be obtained by Laplace transformation:

$$W = (C * s * \varepsilon + A\eta)T_{\text{int}}(s)/\varepsilon \tag{4}$$

As the temperature change is accompanied by nonlinear and delayed phenomena, heat generation W and control quantity $U(s)$ is proportional, that is $W = KU(s)$. For delay time τ and the following relationship exists:

$$Y(s) = T_{\text{int}}(s) \tag{5}$$

Substitute the above formula to get:

$$G(s) = \frac{Ke^{-\tau s}}{Ts + 1} = \frac{0.6e^{-330s}}{1850s + 1} \tag{6}$$

In the formula, T represents the time constant; K represents static gain. In combination with the above formula calculation, formula (6) is taken as the transfer function of indoor temperature control for heating, and the subsequent design of indoor temperature control for heating is carried out on this basis.

2.2 Design of Preprocessing Circuit Based on Multi-channel Temperature Signal Denoising

After the classification of heating load and the establishment of indoor temperature model, the pretreatment circuit [10] is designed to denoise the multi-channel temperature signals. The preprocessing circuit mainly consists of input circuit, amplification circuit, multi-channel output modulation circuit, reference terminal (cold terminal) signal processing circuit, reference voltage generation circuit and manual test circuit. Its principle block diagram is shown in Fig. 1.

As mentioned above, the preprocessing circuit mainly consists of input circuit, amplification circuit, multi-channel output modulation circuit, reference terminal signal processing circuit, etc. The composition and working principle of the main circuit are briefly introduced below.

The input circuit is composed of 32 input unit circuits, and each input channel is equipped with an input unit circuit. The input unit circuit is specially designed for collecting and processing the thermal resistance signal. It is a bridge composed of precision resistors. The resistors on the three arms of the bridge are R1, R2 and R3 (where R1

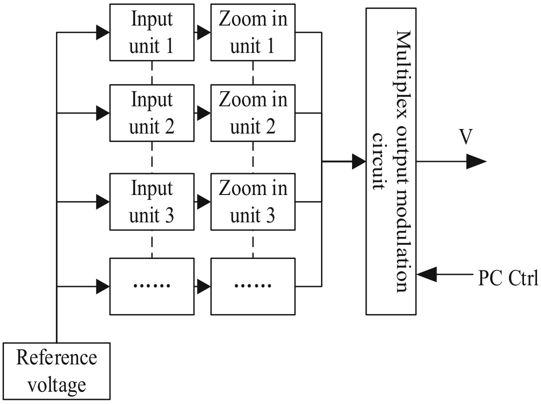

Fig. 1. Preprocessing circuit based on multi-channel temperature signal denoising

= R2 = 10 k Ω, R3 = 100 Ω, and the resistor on the other arm is thermistor Rt.R1 and R2 are respectively on the two upper arms of the bridge road, and Rt and R3 are respectively on the two lower arms of the bridge road. Voltage source of bridge circuit E = +10 V. Platinum thermistor Pt100 is used as thermistor, and its resistance value is R = 100.00 Ω at 0C. When the temperature is 2 °C, the output voltage of the bridge is 0 V. In practical applications, the temperature measurement object is often far away from the test circuit, that is, the temperature measurement object is separated from the bridge, which is to compensate the lead.

We adopt the three wire input connection mode. Since the lead is long on the side of the temperature measurement object, the R3 lead is also extended to one end of the temperature measurement object, connected with Rt to form a common point, and then from the common point lead back to the ground terminal of the test circuit, so that the reciprocating lead resistance is the same, and complete compensation of the lead resistance is obtained. As mentioned before, the input unit circuit is specially designed for collecting and processing the thermal resistance signal. When used to process thermocouple signals, the input unit circuit is bypassed. In this case, the two-wire input mode is adopted.

The amplification circuit is composed of 32 independent amplification unit circuits. Each input channel is equipped with an amplification unit circuit. The unit circuit is composed of ultra-low bias voltage VOS and ultra-low bias voltage drift operational amplifier ADOP07.The amplification unit circuit is a single-stage in-phase amplification circuit with a gain of ×10, ×100 Two gears. It can be selected and set through the gain adjustment jumper. The gain integration nonlinearity of the amplifier unit is better than 1.1%, and the long-term working stability (continuous 10 h of working test) is better than 0.18%. The gain of each amplifier unit has good consistency. The amplification unit has two modes of single end input and differential input, which can be selected by selecting input mode and setting jumper. The output of each amplification unit circuit is connected to a multi-channel output modulation circuit.

It is known from the working principle of the thermocouple that the thermoelectric potential of the thermocouple E_{AB} the size of is not only related to the temperature of the measuring end, but also related to the temperature of the reference end, namely:

$$E_{AB}(t, t_o) = f(t) - f(t_0) \tag{7}$$

In the formula, $E_{AB}(t, t_o)$ express t_o reach t thermocouple thermal potential at time; $f(t), f(t_0)$ represents a function. When using thermocouples, attention must be paid to the $E_{AB} -T$ (Thermoelectric potential and temperature) relationship curve or the thermoelectric potential value listed in its graduation table are given when the reference end is 0 °C (that is, t0 $= 0$ °C).Therefore, in practical application, if the reference end is not 0 °C (that is, t0 $\neq$ 0 °C), it needs to be corrected, which is called cold end compensation. The correction can be carried out according to the following formula:

$$E_{AB}(t, 0) = E_{AB}(t, t_o) + E_{AB}(t_o, 0) \tag{8}$$

In the formula, $E_{AB}(t, 0)$ it indicates that the temperature at the measuring end of the thermocouple is t, the thermoelectric potential at the reference end at 0 °C; $E_{AB}(t, t_o)$ is the temperature at the measuring end of the thermocouple t, reference end is t_o the thermoelectric potential of, that is, the thermoelectric potential value measured by thermocouples; $E_{AB}(t, 0)$ it indicates that the reference terminal temperature of the thermocouple is t_o the correction value that should be added can be found from the scale of the thermocouple used.

According to this principle, the actual temperature value at the measuring end of the thermocouple, that is, the accurate value of the temperature, is $E_{AB}(t, 0)$ the corresponding value. Therefore, when using thermocouples to measure temperature, it is necessary to know the temperature of the reference end. Therefore, the temperature at the reference end must be measured at any time to correct the temperature measured by the thermocouple. We specially designed this circuit to collect and process the temperature signal at the reference end. This circuit is also composed of integrated operational amplifier ADOP07, whose circuit form is an inverse summation amplifier. There are two input branches, one from the static bias current generation circuit to generate a +273 μA's static bias current, the other is from the AD590 temperature sensor. The sensitivity of the device is 1 μA/K linear output current, that is, it will generate 1 μA Current. According to our design, when the temperature rises by 1 °C, it will provide −1 for the summation circuit μA current. Output voltage of reference terminal temperature signal processing circuit:

$$V_t = K(T - T_0) \tag{9}$$

In the formula, K represents the conversion coefficient; T represents the actual temperature at the reference end; T_0 represents the reference temperature, generally taken as $T = 0$ °C. After the circuit is tuned and calibrated, ensure that V t = 10 mV/K. The temperature sensor can be built-in (that is, installed on the circuit board and placed inside the chassis) or external (that is, placed outside the chassis). The machine is external and enters the circuit through the 32nd channel input connector of the instrument. The 32nd channel is designed as a special channel, which can be used as both thermocouple/thermal resistance signal processing channel and reference terminal signal processing channel, and can be preset through jumper.

2.3 PID Parameter Setting and PID Control of Heating Room Temperature

PID control is a classical technology widely used in the field of production control. Because the structure is simple and easy to understand, and the control effect is relatively good, it is widely used in industry. The core idea of PID control is to adjust the PID parameters according to the difference between the set value and the actual value of the controlled object. As long as the PID gain is reasonably adjusted to make the closed-loop control stable, the control goal can be achieved. Figure 2 is the block diagram of PID control principle of temperature in heating room.

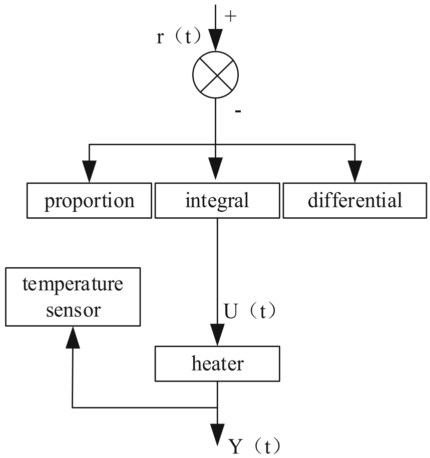

Fig. 2. Structure block diagram of PID control principle for temperature in heating room

When there is deviation in heating temperature control, the proportional link will reduce the temperature deviation in the form of proportion. The speed of adjustment is closely related to the size of the proportional coefficient. Of course, the proportional coefficient should also be properly selected. Too large or too small will have a certain impact on the stability of the control technology. The integration link can restrain the static error to a certain extent, and the effect of integration will vary with the size of the time constant. The larger the time constant is, the worse the effect will be. The smaller the time constant is, the opposite will happen. However, there are both advantages and disadvantages. When the time constant is larger, the overshoot decreases, and the stability effect is better. When the time constant is smaller, oscillation will occur. The differential link can reduce the time required for the system to reach stability. The magnitude of differential time constant will also affect the change of overshoot. Contrary to the integral part, the overshoot of the system will increase with the increase of the differential time. The smaller the differential time, the greater the time for the temperature to reach stability. Therefore, it is very important to choose an appropriate differential time constant.

As a determined system, the indoor temperature control system usually uses the rising curve method to measure the rising curve of the heating temperature control, and then obtain the parameters of the indoor temperature mathematical model, as shown in Fig. 3.

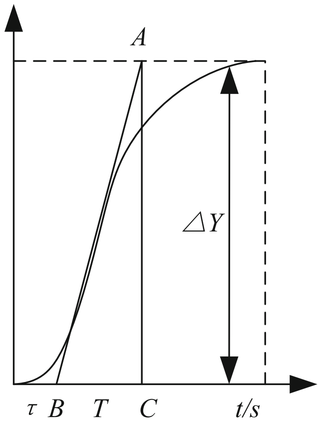

Fig. 3. Temperature Rise Curve in Heating Room

Make a tangent at the point where the temperature changes rapidly, and one end of the tangent is relative to the *B* point on the asymptote of the other end relative to the steady value *A* points, *A* the points mapped to the timeline are *C* point, origin to *B* the time period of the point is the lag time τ, for time constant T *BC* segment representation. In the measurement of the rise curve of the heating temperature control system, after adding the step signal, the heating temperature output will change correspondingly, and finally there will be a stable value, so the temperature control transfer function obtained according to this method is $\tau = 330$, $T = 1850$. This parameter is taken into the above heating load classification and heating room temperature model formula to obtain the temperature control transfer function $G(s)$:

$$G(s) = \frac{Ke^{-\tau s}}{Ts + 1} = \frac{0.6e^{-330s}}{1850s + 1} \tag{10}$$

The principle of PID is simple and easy to understand, and has strong operability. It has its own control mode and has been popularized in the engineering field. The scope of application is relatively wide and practical. As long as the three parameters of PID are set at appropriate values, the control system will be in a closed loop stable state, with small operating fluctuations, which is conducive to better completion of the work. PID control has strong robustness and does not depend on the traditional model. Especially when PID control is applied in such a complex environment as engineering, the parameters cannot be accurately known due to various factors, and the dynamic model is not easy to determine. In this case, the environment is usually considered first, and then the parameters are debugged with reference to the experience and knowledge of technicians. PID can play a good control role when other methods are not applicable.

2.4 Fuzzy PID Control Design of Temperature in Heating Room

In the actual control process, different control requirements need to be formulated for different working conditions, which requires the PDD controller to adjust its parameters accordingly with the change of working conditions, so as to reduce the steady-state error and meet the control requirements. However, this adaptive parameter adjustment strategy is difficult to be realized on the conventional PD controller for control systems that lack accurate identification models at present. The fuzzy controller can work out the corresponding fuzzy rule set according to human knowledge and experience, and realize the control of the control system that is difficult to be represented by mathematical model. Therefore, combining PID control with fuzzy control, a fuzzy PID control algorithm is proposed, which completes the online tuning of the three parameters of the PID controller through the process of fuzzification, fuzzy reasoning, and defuzzification, so that it can meet the corresponding control requirements. In order to further improve the control accuracy of indoor temperature control technology for heating, fuzzy control rules are introduced. The generation of fuzzy control rules needs to comprehensively consider whether they are cross, complete and consistent. The intersection here refers to whether rules are related and interact with each other; The sign that rules have good integrity is that each given input condition has a corresponding rule to execute; The rule consistency means that the conditions between control rules can be the same, but the conclusions cannot be very different, otherwise there will be contradictory situations. In practical application, it is necessary to avoid the occurrence of conflict control rules. Taking the deviation and deviation change rate of heating temperature as two input variables of fuzzy control rules, improving fuzzy control rules is to arrange the number of control rules reasonably and give them appropriate confidence. And optimizing the number of control rules is to ensure that there are neither too many nor too few rules, because when there are too many rules, the controller's processing becomes complex and time-consuming. When there are fewer rules, the controller's output may be incorrect or there may be no corresponding output due to insufficient consideration; The quality form of control rules is also very important, mainly to identify whether the conditions of control rules are reasonable and whether the rules contradict each other.

On the premise of obtaining the membership degree and membership degree value table of fuzzy control PID input and output, as well as relevant fuzzy rules, the parameter fuzzy adjustment matrix table can be obtained through fuzzy reasoning. In order to facilitate the use of the matrix table, the matrix table can be stored in the computer program memory. Fuzzy PID can detect its output through the computer at any time, and can also calculate the two inputs of fuzzy PID control in real time. Then the two inputs are fuzzed. Since the fuzzy matrix table has been stored in the computer, the PID parameter adjustment can be obtained according to the table.

The parameter tuning is mainly to consider the speed of response, the accuracy value under steady state, the size of overshoot, and whether the system control is stable. The specific rules of tuning need to be combined with the system output response curve. The tuning of the three parameters of PID needs to meet the requirements of the input of fuzzy PID control on the control parameters in different situations. Through the fuzzy PID parameter tuning principle, the corresponding regulation control rules of the three PID parameters can be summarized. Therefore, in this chapter, the deviation and deviation change rate of the heating temperature are used as the input of the fuzzy PID heating temperature control, and the output at this time is the adjustment of the three parameters of the proportional integral differential control. The relevant fuzzy subset based on fuzzy PID heating temperature control is expressed by these seven language variables {NB, NM, NS, ZO, PS, PM, PB}. The fuzzy universe of temperature error e and error change rate ec following the error change are {−2, 2}, {−1, 1}, respectively. Table 2 is the fuzzy rule table.

Table 2. Fuzzy rule table

	NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PM	PM	PS	ZO	ZO
NM	PB	PB	PM	PS	PS	ZO	NS
NS	PM	PM	PM	PS	ZO	NS	NS
ZO	PM	PM	PS	ZO	NS	NM	NM
PS	PS	PS	ZO	NS	NS	NM	NM
PM	PS	ZO	NS	NM	NM	NM	NB
PB	ZO	ZO	NM	NM	NM	NB	NB

The contents in Table 2 are used as the basis for fuzzy PID control of the temperature in the heating room. Fuzzy reasoning is also called approximate reasoning. It is mainly based on the corresponding fuzzy rules to transform the relevant fuzzy variables from input to output, and can also be seen as a relationship function of fuzzy variables. There are many types of fuzzy reasoning methods, and different methods will lead to different conclusions. Of course, the length of reasoning will also be different. The most commonly used methods in application are Mamdani method, Zadeh method, Baldwin method, etc. Usually, a simple, convenient and effective reasoning method will be used, which can reduce the reasoning time.

In heating fuzzy PID temperature control, the temperature controllers designed for each load level are embedded into the simulink. The controller part of heating fuzzy PID temperature control uses the fuzzy logic toolbox Fuzzy Logic Toolbox to create a Mamdani type fuzzy inference controller, and uses the maximum minimum criterion (Max Min) as the approximate reasoning method of heating temperature control.

2.5 Temperature Prediction and Compensation Control in Heating Room

Although the introduction of fuzzy PID algorithm has reduced the steady-state error and maximum deviation of the heating temperature control system, the hysteresis characteristics of the temperature system have not changed significantly. Therefore, it is necessary to optimize the fuzzy PID. In this chapter, Smith fuzzy PID controller is obtained by combining Smith predictor on the basis of fuzzy PID. This controller combines the excellent characteristics of fuzzy PID and the compensation function of Smith predictor, which can improve the delay of the system very well. The main idea of Smith predictive compensation control is to calculate the exact transfer function.

A matched compensator is added to weaken or even eliminate the hysteresis effect in the feedback path. Smith compensation can also be called pure lag compensation control. Smith estimation compensation principle block diagram is shown in Fig. 4 below.

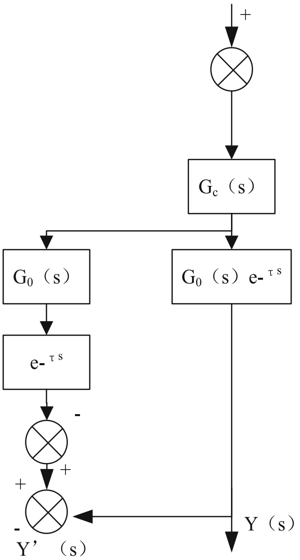

Fig. 4. Schematic Diagram of Smith Estimation Compensation

The transfer function of the controlled object is expressed as follows:

$$G(s) = G_0(s)e^{-\tau s} \tag{11}$$

In the formula, $G(s)$ represents the transfer function of the controlled object; G_0 represents an item without hysteresis. Add a compensator to eliminate the lag term $G_s(s)$ the compensator should be connected with the object in parallel, and can also be regarded as a new compensation object, and the controller should be designed according to the normal steps $G_c(s)$. In this article $G_c(s)$ it is a heating fuzzy PID controller, so the equivalent transfer function of Smith predictive compensation new compensation object can be expressed as:

$$G_r(s) = G_0(s)(1 - e^{-\tau s}) \tag{12}$$

In the formula, $G_r(s)$ indicates the compensation value. After Smith estimated compensation, due to $e^{-\tau s}$ it is outside the closed loop, so it does not affect the stability of the system. Smith predictor has the function of compensation, so its ultimate purpose is to use this function to minimize the influence of delay time on system stability. In the previous section, the fuzzy PID has shown good anti-interference ability in the temperature control of the heater, but its algorithm control effect still has room for improvement in the aspect of time delay in the temperature control. So the fuzzy PID control algorithm based on Smith predictor compensation is quoted, and this algorithm can make up for the disadvantage that Smith predictor is sensitive to the parameters of the controlled object model. When heating Smith fuzzy PID temperature control, the parameters of the predictor have been determined by the parameters of the controlled object model of heating temperature control, so the most important part to be solved is to design a fuzzy PID controller, and the fuzzy PID control has been designed in the previous section. According to the above discussion, the prediction compensation of the temperature control in the heating room is realized, so that the temperature control technology in this paper has higher control accuracy in practical application.

3 Experimental Analysis

3.1 Experiment Preparation

The traditional indoor temperature control technology for heating has the problems of inertia and delay lag in practical application. Although the temperature can be stabilized eventually, it will take a long time to adjust, and there will be some overshoot. To solve this problem, in order to verify whether the newly proposed control technology can be solved and further optimize the temperature control performance, the following comparative experiments are designed. Control the ventilation of the laboratory to maintain the stability of indoor temperature. Select semiconductor temperature sensors to collect temperature signals from different indoor locations, and use data acquisition equipment to convert the analog signals collected by the temperature sensors into digital signals and record them. Based on a residential building, select three rooms with the same area, indoor environment and other conditions in the residential building, and number the rooms as Room A, Room B and Room C. The control technology based on multi-channel temperature signal de-noising, the control technology based on fuzzy logic control and the control technology based on improved BP neural network proposed in this paper are respectively used and set as the experimental group, control group A and control group B to control the temperature in the heating room of the three rooms. Figure 5 shows the temperature change curve of the heating room according to the requirements of the residential building.

It can be seen from Fig. 5 that the temperature of the standard curve of temperature change in the heating room is controlled above 22 °C to meet the needs of indoor people for environmental temperature.

3.2 Result Analysis

Taking the curve in Fig. 3 as the basis, compare the curve with the temperature change curve in the heating room obtained after the application of each control technology, and get the results as shown in Figs. 6, 7 and 8.

According to the analysis of the experimental results obtained, only the temperature change curve in the heating room under the application of the experimental group control technology is consistent with the change of the standard curve, and the difference is not more than ±3 °C. Compared with the application of Group A control technology, the change trend of the temperature in the heating room is basically the same, but the

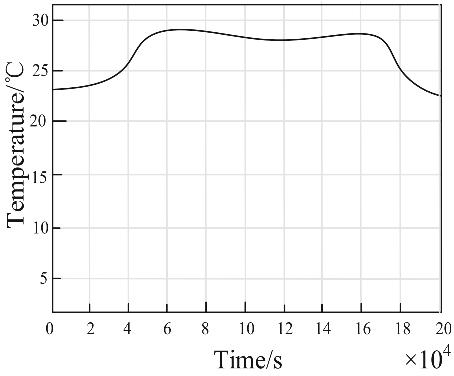

Fig. 5. Standard Curve of Temperature Change in Heating Room

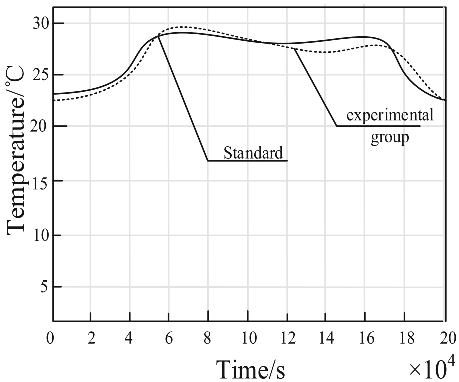

Fig. 6. Indoor temperature change of experimental group control technology heating

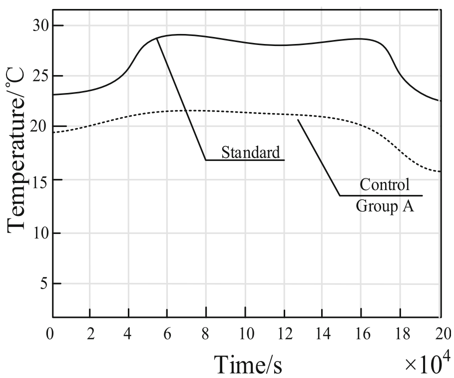

Fig. 7. Temperature change in heating room with control technology of Group A

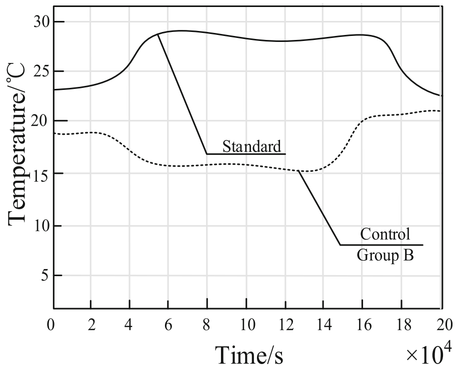

Fig. 8. Temperature change in heating room with control technology of Group B

specific temperature values differ greatly, and the temperature is generally lower than 20 °C, which cannot meet the residential requirements of indoor residents. Under the application of control technology of Group B, the change trend of temperature in the heating room is inconsistent with the standard curve, and the temperature difference at the same time exceeds 10 °C. Therefore, the above experimental results can prove that the control technology designed in this paper based on multi-channel temperature signal denoising has higher control accuracy in practical applications, can fully meet the needs of indoor temperature changes in heating, and provide residents with a more comfortable indoor environment.

4 Conclusion

During heating, temperature, as an important indicator of heating comfort, needs to be controlled in different ranges according to the needs of room temperature. Based on this, this paper proposes a heating room temperature control technology based on multi-channel temperature signal de-noising, and uses comparative experiments to verify the feasibility of this control technology. In practical application, the temperature control technology in this paper can classify the heat load according to the room properties and control the temperature in different ranges. With the development of artificial intelligence and the Internet of Things technology, intelligent algorithms can be applied to indoor temperature control of heating based on multi-channel temperature signals in the future. By analyzing a large amount of temperature data and other environmental parameters, the system can automatically learn and optimize temperature control strategies, achieving more intelligent and adaptive indoor temperature control. In addition, it is believed that in the future, technology based on multi-channel temperature signal denoising can be integrated with other fields of technology, such as machine learning, fuzzy control, optimization algorithms, etc. This can further improve the accuracy and stability of temperature control, and achieve more efficient management of heating systems.

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