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Fuzzy Pid Research on the Temperature Control System of Central Air Conditioning Based on Genetic Algorithms

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Abstract: The study designs PID mathematical model and algorithm of the central air conditioning temperature control based on genetic algorithm. In order to test availability of the procedure and algorithm, we use the MATLAB software to do numerical simulation on different algorithms. Through calculation we found that delay time of the PID controller based on genetic algorithm designed in this paper is 92 seconds, less than the other two algorithms. The time which needs to adjust is 302 seconds, less than the other two algorithms. The overshoot is 25% which meets the needs of central air conditioning temperature control system. Finally, through the graphics computing functions of MATLAB we get two-dimensional section images of central air conditioning refrigeration effect. From the image we can see the central air conditioning refrigeration effect of PID algorithm based on genetic algorithm is good. It provides the theoretical reference for the study of air conditioning control system

Key words: Denetic algorithm, PID control, temperature control, intelligent, distribution

INTRODUCTION

With the development of control technology, control technology starts toward the direction of intelligent, automation. Central air conditioning refrigeration equipment commonly is used in building (Li *et al*., 2012; Li and Yang, 2011). If we can improve the intelligent and automatic level of temperature control system it can greatly improve the performance of central air conditioner. Hunag and Nelos (1994) also studied in depth on the air conditioning unit and analyzed the theory of fuzzy control method. In the fuzzy control system Fischer proposed predictive control method of heat exchanger, Haissing proposed the adaptive control of air conditioning cooling water system. Research on intelligent temperature control air conditioning is always the emphasis and difficulty of the air-conditioning system research. In this context, we use PID control algorithm based on genetic algorithm to improve the step line of the temperature control system (Li and Yang, 2011; Meng, 2010; Wen and Ho, 2012). And we obtain good delay effect and steady adjustment. It provides the technical reference for the research and development of intelligent products for air conditioning.

STRUCTURE SUMMARY OF CENTRAL AIR CONDITIONING TEMPERATURE CONTROL SYSTEM

Central air conditioning refrigeration process is mainly through exchange between the cooling medium and the external environment in the evaporator heat to

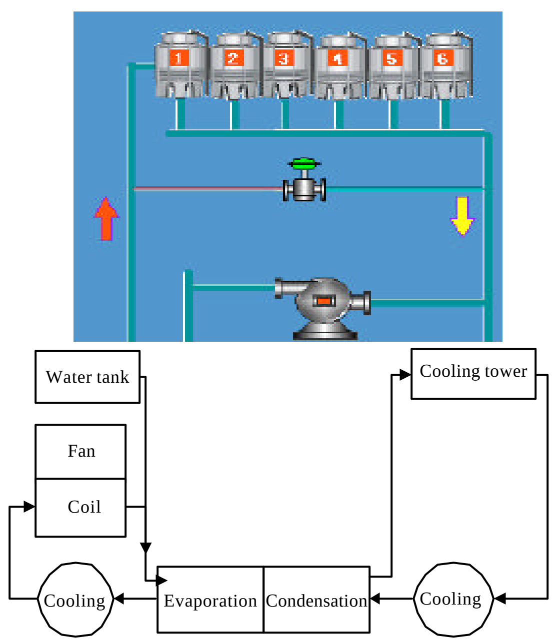

Fig. 1: Schematic diagram of the central air conditioning refrigeration process

achieve the refrigeration effect (Meng, 2010). The cooling medium is evaporated into high pressure gas, cooling water pump push the high-pressure gas into cold water unit and finally into the cooling water circulation system. The concrete structure is as shown in Fig. 1.

Figure 1 shows a schematic diagram of air conditioning refrigeration system. The main power

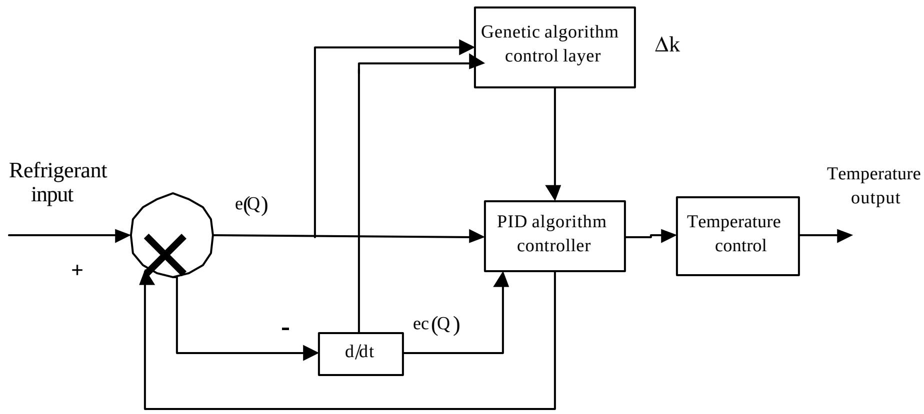

Fig. 2: The structure diagram of central air conditioning control

transmission is cooling fan and cooling pump (Hu, 2010). To realize intelligent automatic control of temperature must control the whole process of refrigeration. This paper uses PID control principle based on genetic algorithm to realize the temperature control process. The main control process is shown in Fig. 2.

Figure 2 shows the central air conditioning control structure diagram of PID genetic algorithm. The overall control structure is divided into four parts, including the input, output, the genetic algorithm controller and PID controller. Through genetic algorithm crossover and learning methods, we improve the intelligent control level of PID algorithm.

MODEL AND PROGRAM DESIGN OF PID CONTROL GENETIC ALGORITHM

The cooling system of central air conditioning system has three main parts, the first part is the transfer of cooling liquid in the pipe wall and exchanging hear with internal surface of tube; the second part is the cooling liquid transfer from the inner tube to the outer tube and the cooling liquid exchanges heat with outside of the tube; the third part is cooling liquid flowed into the air, the cold fluid exchange heat with hot air. According to the heat transfer process and the principle can be established for central air conditioning refrigeration system heat transfer equations as follows (Hu, 2012). According to the heat transfer process and the principle we can establish heat transfer equations of central air conditioning refrigeration system as follows:

$$\begin{aligned} &Q = K_1 \bullet S_1(T_1 - T_2) \\ &Q_{Total}\text{-}Q = C_1 m_1 \frac{dT_1}{dt} \\ &Q\ \text{-}Q_1 = C_2 m_2 \frac{dT_2}{dt} \\ &Q_1 = K_2 \bullet S_1(T_2 - T) \end{aligned} \quad (1)$$

Q means loss of cold energy coolant in the transfer process, Q_{total} means the input total cold energy of cooling liquid per unit time, Q_1 means energy exchange between coolant and external heat air environment, C_1 means specific heat of pipe transmission components, m_1 means specific heat of building air, C_2 means quality of pipeline transmission components, m_1 means the quality of building air, m_2 means heat transfer area, S means heat transfer coefficient, T, T_1, T_2, Respectively means the external environment temperature, transmission environment temperature and the temperature of the cooling liquid.

In the control engineering domain, PID is the most commonly used and it is a simple structure of the linear controller (Desbourough and Miller, 2011). The structure is as shown in Fig. 3.

This study uses PID controller to control the cooling liquid cooling central air conditioning. The control equation is shown in Eq. 2:

$$u(Q) = k_b e(Q) + k_j \sum_{i=0}^{q} e(i)T + k_w \frac{e(Q) - e(Q-1)}{T} \quad (2)$$

Among them, k_b means integral coefficient; k_w means differential coefficient; T means sampling period; e means calculation error. We use genetic algorithm to control the PID controller. The main control structure has three layers, as shown in Fig. 4.

Figure 4 shows the control structure of PID algorithm for genetic. The structure has three layers which includes the input layer, the calculation layer and output layer of cross reasoning for genetic algorithm (Hasan *et al*., 2009). The mathematical expression for each hierarchy is as shown below.

The input expression of input layer is:

$$\begin{cases} Z_1(1) = e(Q) \\ Z_2(2) = ec(Q) \end{cases} \quad (3)$$

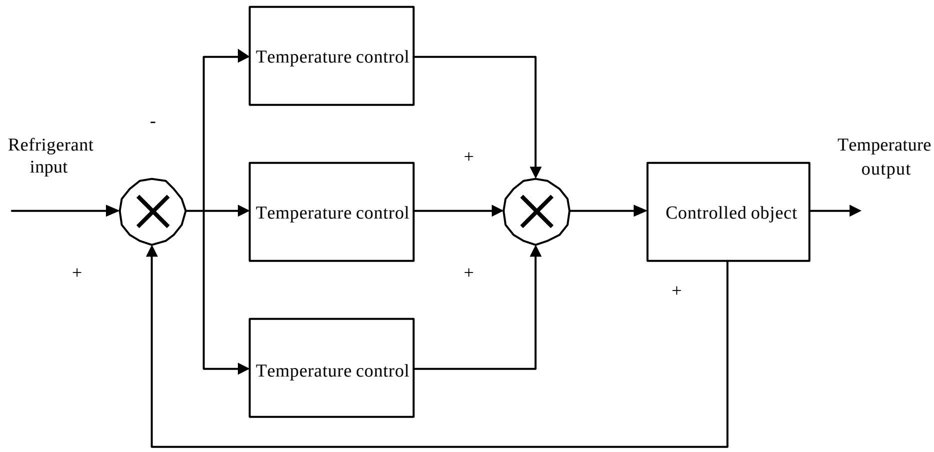

Fig. 3: The structure of PID controller

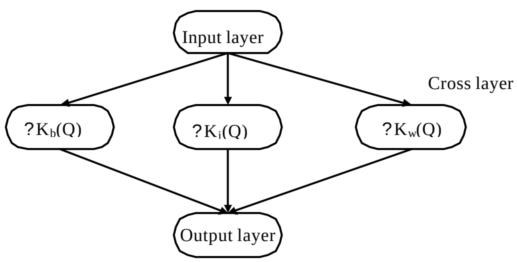

Fig.4: The control structure of PID algorithm

The output expression of input layer is:

$$F_1(i,j) = Z_1(i) \quad (i = 1, 2 \quad j = 1, 2, ..., n) \tag{4}$$

The input expression of crossover study layer of genetic algorithm is:

$$e(Q) = \frac{1}{2}(y1(Q) - y2(Q))^2 \tag{5}$$

In which, $y_1(Q)$means ideal value of theory; $y_2(Q)$ means time output value.

The control of output layer uses the incremental PID algorithm to control. Its expression is as shown in equation 6:

$$\begin{aligned} \Delta u(Q) = k_b(e(Q) - e(Q-1)) + \\ k_j e(Q) + k_w(e(Q) - \\ 2e(Q-1) + e(k-2)) \\ u(Q) = u(Q-1)) + \Delta u(Q) \end{aligned} \tag{6}$$

The program mainly uses a genetic cross learning algorithm and adds the PID control algorithm. The main procedures are as follows:

```
function y=DPID(x)
global Q Kb Kj Kw T e
e(Q)=x;
u=0;
for i=1:N
 u=u+e(i);
end
y=Kp*x+[(Kp*T)/Ti]*u+[(Kp*Td)/T]*[e(N)-e(N-1)];
for i=1:N-1
 e(i)=e(i+1);
end
net=train(net,Q,K);
function [sol, val]
= gabpEval(sol,options)
Q=premnmx(Q);
K=premnmx(K);
P=Q;T=K;
R=size(P,1);
S2=size(T,1);
S1=1000;
S=R*S1+S1*S2+S1+S2;
for i=1:S,
 x(i)=sol(i);
end;
[T, val]=gadecod(x);
……
```

NUMERICAL SIMULATION RESEARCH ON CENTRAL AIR CONDITIONING TEMPERATURE CONTROL SYSTEM

In order to verify the validity of the genetic PID algorithm's control on central air conditioning refrigeration control system, we design numerical simulation experiment of control system. Data simulation method uses a common programming software MATLAB7.0. The MATLAB7.0 version has advanced module of engineering analysis, the Simulink simulation module can realize the control algorithm. This paper verifies the step response of PID algorithm. The step response curve is as shown in Fig. 5.

Figure 5 shows the step response curve of the central air conditioning control process through

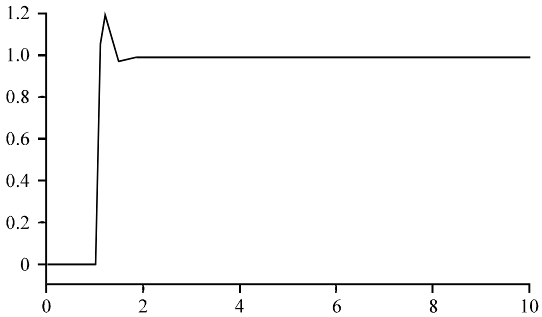

Fig. 5: MATLAB step response curve

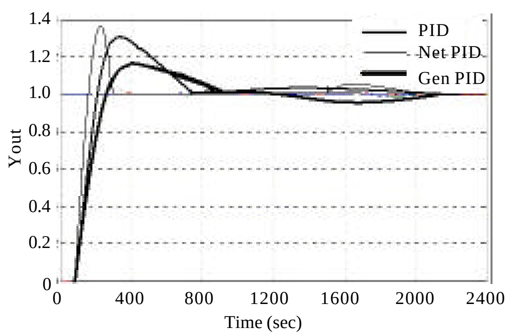

Fig. 6: The step response curve of control system with different algorithm

Table 1: The step response parameters of different algorithms

Algorithm	Delay	Adjusting time	Overshoot (%)
PID	98	1052	32
Net PID	92	302	25
Gen PID	103	785	11

MATLAB numerical simulation calculation (Hasan *et al*., 2009). From it we can see the step response curve has certain delay characteristics and it needs some adjustment response time to reach steady state which is consistent with the actual situation. In order to verify the validity of the PID algorithm designed in this paper, we choose three different forms of algorithm to verify, in addition the net PID algorithm designed in this paper and including the common PID algorithm and Gen PID algorithm. The three types of step curve are aggregated, so we get contrast curve as shown in Fig. 6.

Figure 6 shows the step response curve of control system with different algorithm (Zhang and Hrnjak, 2010). From it we can see, the delay and adjusting time of different algorithms are different, the overshoot calculation is different. The three results are obtained as shown in Table 1.

Table 1 shows the step response parameters of different algorithms. From table 1 we can see delay time of the PID controller designed in this paper is the least, only 92S, adjusting time is also least, only 302s and the overshoot is 25%. It is consistent with the central air conditioning temperature control system.

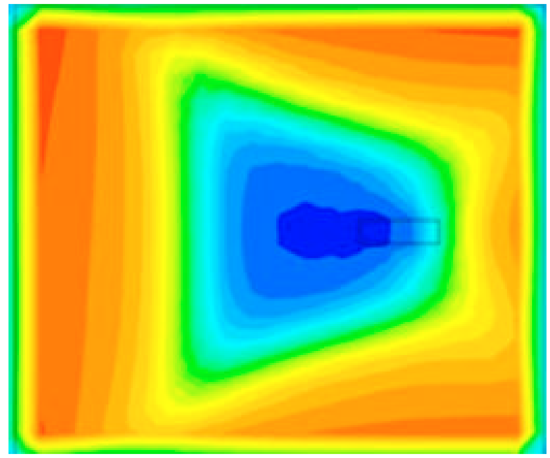

Fig. 7: Section image of the central air conditioning refrigeration effect

In order to display PID algorithm visual effect of central air conditioning, we use MATLAB to draw temperature distribution of air conditioning refrigeration effect. Different colors in the image represent the different temperature value. From blue to red represents the temperature from low to high. The center is the position of air conditioner refrigerator. From the chart, the temperature reaches the minimum in the air ambient which means the air conditioning having cooling effect (Joardar and Jacobi, 2011). From the middle to the surrounding the temperature is more and more high, this is consistent with the actual situation and it verifies the effectiveness of the proposed algorithm.

CONCLUSION

In this stusy we apply PID genetic control algorithm to the central air conditioning temperature control system. And we analyze the system response and temperature regulation effect, establish PID genetic algorithm mode. This model includes the input layer, output layer and control layer of genetic algorithm. We design the MATLA program. In order to test the availability of the model and algorithm, the step response of the system is simulated. The time delay and adjusting time of three different algorithms are calculated. The longest delay time is the Gen PID algorithm with 103 seconds. The lowest is PID algorithm with 92 seconds. While the delay time of net PID algorithm in this paper is only 302 seconds with better response effect. Finally we use MATLAB to draw temperature distribution of air conditioning refrigeration effect. It provides the technical reference for the development of air conditioning system.

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