Scholar Publishing Group
Kinetic Mechanical Engineering
https://doi.org/10.38007/KME.2021.020305
ISSN 2790-2676 Vol. 2, Issue 3: 39-46

Control Method of Complex Environmental Engineering Machinery Cooling System Integrating Deep Learning and Feature Clustering

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Keywords: Deep Learning, Feature Clustering, Construction Machinery, Cooling System

Abstract: In modern industrial production, due to the continuous development and progress of construction machinery. In the field of construction engineering, the control of mechanical cooling system has attracted more and more attention. In the current construction machinery industry, it is of great significance to study and practice the cooling technology of the heating system. In order to improve the ability of engineering cooling system control, this paper proposes the method of deep learning and feature clustering to optimize the system. This paper mainly uses the experimental method and the comparative method to study the control method of the heat dissipation system of the construction machinery. The experimental data shows that the temperature in different stages is lower than 80 degrees Celsius, and the change in the later stage is lower than 0.3, so the heat dissipation system can well control the heat generated by the IGBT module.

1. Introduction

In the cooling system of construction machinery, mechanical equipment is affected by environmental factors (such as temperature, humidity, etc.). The deep learning-based control method for complex environmental engineering machinery cooling system is a new type of intelligent control system. The model is based on fuzzy theory, and by processing the input data, it uses the idea of iterative approximation to transform a complex problem into a simple and effective problem.

My country has entered the stage of an innovative country, and it is of practical significance to study the fusion of deep learning and feature clustering methods in this context.

There are many research theories on deep learning and feature clustering. There are also a number of people who have raised the relevant arguments for mechanical cooling system control.

For example, some scholars have designed an experimental monitoring system and used WinCC to design a cooling system control system [1-2]. Some researchers combine the unsupervised classification model of convolutional neural network with cluster analysis, introduce the unsupervised algorithm into deep learning, and apply the model to the field of image classification to achieve the effect of control [3-4]. Some researchers also use the heat dissipation control system, control method and shovel of construction machinery to endow the radiator with strong adaptability and ensure the fuel economy of the whole machine [5-6]. Therefore, it is beneficial to the development of the environment and economy to study the control method of the cooling system. In the optimization control of heat dissipation of construction machinery, it is necessary to introduce deep learning and feature clustering.

According to the different ways of system control, this paper designs a resistor network controller and simulates it. Firstly, the multi-feature fusion of deep learning is described, and a radiator model based on neural network structure is proposed. The method realizes the mastery of the law of environmental temperature changes by learning and imitating the human brain's thinking process, knowledge processing ability, reasoning and judgment and other behavioral patterns. Then put forward the composition and working principle of the cooling system. Finally, the cooling system is designed and simulation experiments are carried out.

2. Mechanical Cooling System Control Method Based on Deep Learning and Feature Clustering

2.1. Multi-feature Fusion Based on Deep Learning

Deep learning enables machine learning to achieve many interesting applications in life, and expands the field of artificial intelligence. Deep learning has achieved a variety of challenging tasks in recent years, making almost all machine assistance possible. Deep learning is actually a neural network structure model with multiple hidden layers. The network uses massive training samples to learn more complex feature expressions and complete accurate recognition. The trained model has strong generalization ability [7-8] .

Cluster fusion can be understood as the secondary clustering of the primary clustering results. Better clustering results than any single cluster clustering result. In order to achieve this goal, it is an important guarantee that cluster fusion has a good and important guarantee to generate cluster members with differences and design a consensus matrix that conforms to data characteristics [9-10].

Cluster fusion is to fuse multiple cluster members, which can generate cluster members in a distributed manner, and the clustering effect of this method is less affected by noise data and isolated points, so that the final clustering result has good stability. More importantly, the clustering results obtained by the cluster fusion method are often better than those obtained by a single clustering algorithm [11-12]. It can describe the specific process through Figure 1.

Firstly, the data set is clustered for M times to form M clustering results, and then the M cluster members are fused to obtain the final clustering.

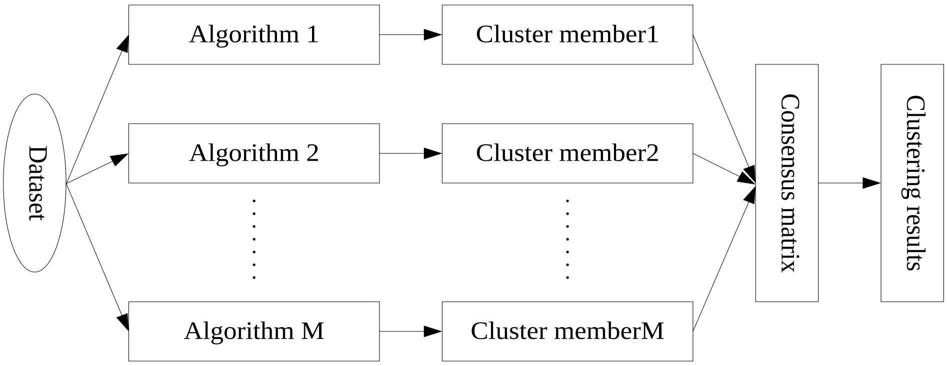

Figure 1. General process of clustering and fusion algorithm

2.2. Composition and Working Principle of Cooling System

The test of the cooling system uses intelligent control methods to keep it within an effective working temperature range, so that the performance of each component of military construction machinery can be optimal. In short, we need to integrate the various parts of the cooling system, so that the temperature of each part of the system is maintained in a suitable temperature range [13-14].

What we use today are generally electronically controlled cooling systems. First, the temperature signal of the water and the temperature signal of the oil are collected, analyzed and converted, and transmitted to the control system, and then the corresponding judgment is made, and the collected temperature signal is analyzed. Convert it into a digital signal, make a logical judgment, and then output the corresponding control signal to control the speed of the fan, so that the temperature can be maintained in an appropriate range. And when the temperature of the coolant changes, the fan can adjust its own speed in time according to the situation. There are engine cooling system, pressure cooling system and other systems that provide a lot of heat to the equipment [15-16].

The simplest and most primitive method of cooling the hydraulic system. A throttle valve and a radiator are installed in parallel on the oil return line of the hydraulic system. The flow through the radiator is changed by controlling the size of the orifice, and the greater the flow through the radiator. The better the heat dissipation effect, the worse the vice versa. This solution is suitable for the heat dissipation of the hydraulic system of low-power construction machinery and equipment. For the hydraulic system of some large-scale equipment on construction machinery, the power loss and heat generation are serious. If the oil temperature cannot be lowered in time, the efficiency of the hydraulic system and the service life of the medium will be seriously affected. [17-18].

By adjusting the pressure of the accumulator, the reversing valve changes the working state, thereby changing the working circuit of the heat dissipation control system. After the accumulator is charged by the hydraulic pump to reach its set pressure, the sensor feeds back to the controller to open the accumulator, so that the control oil circuit pressure of the hydraulic control reversing valve is greater than the pre-tightening force set by the spring, and the reversing valve. When the upper position works, the pump supplies oil to the radiator to achieve cooling of the oil. The biggest feature of this scheme different from other schemes is the use of an accumulator, and the length of the heat dissipation time of the heat dissipation system is controlled and adjusted by controlling the accumulator charging time and working pressure [19-20].

2.3. Design of Cooling System

In the heat dissipation system in this paper, three basic methods of heat transfer are involved, namely heat conduction, heat convection and heat radiation. The thermal conductivity equation is:

$$p = -\tau \frac{cw}{ca} \tag{1}$$

Among them, τ is the thermal conductivity. Thermal convection is the mutual displacement between various parts of the fluid, and the heat transfer process in which the hot and cold fluids penetrate each other. The formula is expressed as:

$$p = g(w_m - w_n) \tag{2}$$

where p is the surface heat transfer coefficient, and g is the surface heat transfer coefficient. Thermal radiation is the transfer of energy in the form of electromagnetic waves. The formula for calculating the radiant heat flow of an object:

$$\Theta = \Im S \lambda W^4 \tag{3}$$

Where W is the thermodynamic temperature of the black body and S is the radiation surface area.

3. Experimental Study of Cooling System

3.1. Experimental Design

In this experiment, the main purpose is to collect the temperature values of the IGBT module and the radiator. The temperature value of the IGBT module is convenient for us to measure its heat dissipation effect, and the temperature value of the radiator is convenient for calculating the thermal resistance of the radiator and selecting the radiator. Compare with the required thermal resistance value. The key points of this experiment are mainly around the formation of temperature and the measurement of each temperature monitoring point. During the experiment, five temperature monitoring points were arranged, three of which were arranged on the IGBT module substrate in working state, and the other two were arranged on the profile heat sink.

3.2. Experimental Platform

The experimental equipment used in this experiment mainly includes AC power supply, printed circuit board, IGBT module, electrolytic capacitor, load, aluminum radiator, temperature inspection instrument, temperature sensor, thermal grease, thermal insulation material, sealant, etc. During the experiment, the program compiled by the DPS development board realizes the control of the IGBT driver part, and generates a PWM wave to control the turn-on and turn-off of the IGBT module, thereby causing it to generate heat loss; the current of the main circuit part passes through the rectifier circuit and the intermediate electrolytic capacitor, and then It is partially inverted to AC by each IGBT module, and finally passes through the load.

3.3. Experimental Process

After completing the construction and testing of the experimental platform, the experiment can be started. The whole experiment should be carried out step by step under the condition of following the basic principles of experimental design to avoid the failure of the experimental equipment or the inaccurate experimental data obtained. The experimental process of this experiment can be specifically expressed as:

Check the experimental equipment and the main circuit of the experiment, whether the various circuit parts of the inverter can work stably, whether the connection between the temperature sensor and the temperature inspection instrument is correct, etc. Start the fan and keep the speed unchanged to ensure the normal operation of the cooling system. At this time, supply power to the circuit board of the inverter, so that the IGBT power module can be taken away by the cooling system from beginning to end to avoid damage to the device due to excessive temperature. According to the different stages of the inverter, each IGBT module is driven separately. After all the indications of the temperature inspection instrument are stable, the temperature value of each temperature monitoring point is recorded. After the above steps are completed, first cut off the power of the main circuit of the inverter, then stop the work of the fan, and finally cut off the power of the DSP development board and the IGBT driver. The experimental data were finally collated.

4. Experimental Results and Analysis

4.1. Comparison of Experimental Results and Simulation Results

Carry out experiments on several stages when the frequency converter is working in turn, and record the experimental data of the corresponding temperature monitoring points, as shown in Table 1. The contact temperature sensor used in this experiment collects temperature every few seconds. Considering the accuracy of the temperature sensor, there may be slight errors in the collected data.

Table 1. Experimental data on temperature changes at each stage

	Temperature 1	Temperature 2	Temperature 3	Temperature 4
1	22.0	22.0	22.0	22.0
2	34.5	33.6	37.4	30.5
3	47.6	45.5	59.1	39.3
4	47.5	45.2	59	39.4

As shown in Figure 2, we can see that when the IGBT module works for a certain period of time, the data detected by the temperature detector will tend to be stable, which means that the heat generated by the IGBT module and the heat dissipated by the radiator have reached a balance state. In the third stage to the fourth stage, the temperature change difference is only about 0.1~0.3.

Compared with the simulation results, the data in Table 2 are obtained. In Table 2, we can find that the hot spot temperature of the device reaches the highest value in the second stage, which takes nearly 2 minutes. The positions of the IGBT modules working in the first and third stages are relatively uniform, so the overall temperature is lower and the heat dissipation effect is better.

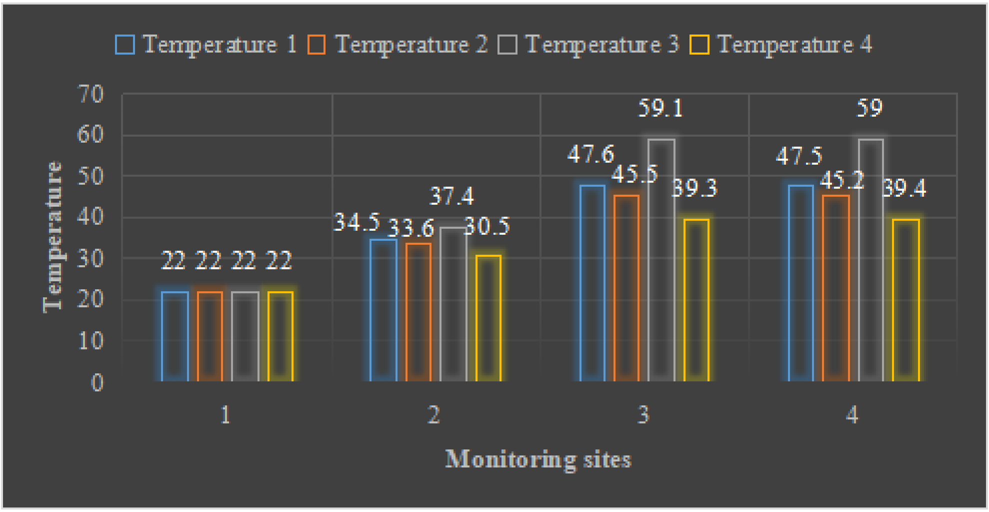

Figure 2. Experimental data on temperature changes at each stage

Table 2. Experimental results and simulation results compare with the highest temperature

	Experiment value(℃)	Simulation value(℃)	Time(s)
Temperature 1	55	57	108
Temperature 2	67	73	119
Temperature 3	62	64	122
Temperature 4	66	69	130

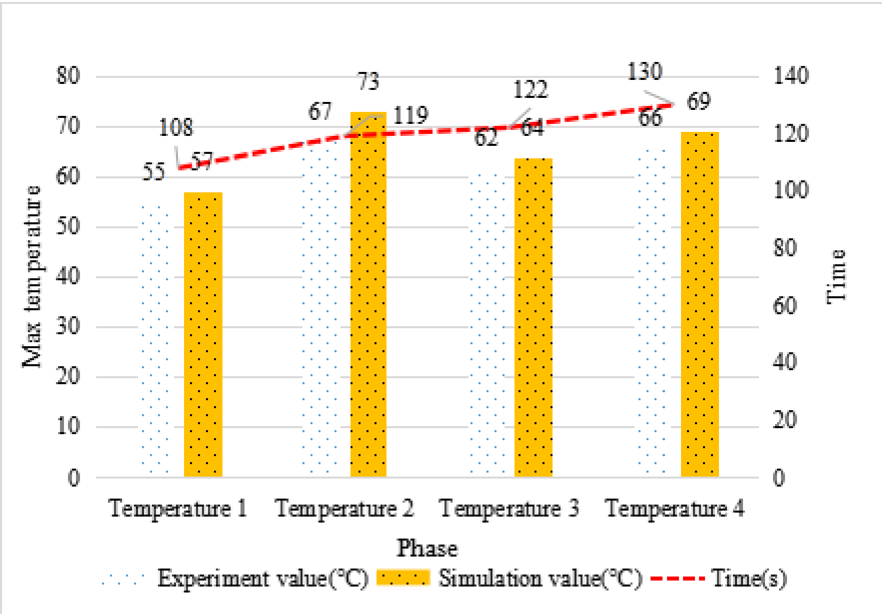

Figure 3. Experimental results and simulation results compare with the highest temperature

As shown in Figure 3, we can know that the simulation results are not much different from the experimental results, and the periodic temperature changes reflect that the maximum temperature of each temperature monitoring point satisfies the heat dissipation requirements of the IGBT module of the inverter system. The reliability of its working process is guaranteed.

5. Conclusion

The traditional control method of cooling system is based on experience and temperature measurement in complex environment. The control of heat dissipation system of complex environmental engineering machinery based on feature clustering is a complex nonlinear and multi-objective optimization problem, and these characteristics need to be considered comprehensively. The modeling and processing of thermal network model based on fuzzy theory, grey relational analysis and genetic algorithm requires a lot of data processing. Therefore, the fusion of deep learning and feature clustering proposed in this paper can greatly simplify the calculation steps. In order to improve the role of the cooling system in complex environments, it is necessary to further study the advantages of deep learning and feature clustering in image processing and judgment to achieve the effect of controlling heat.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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