Temperature Controlling by Air-condition based on Multi-algorithm Integration

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Abstract. According to the problem that the intelligence is not high of the soccer robot, using the mechanical theory as a guide, making some mechanical analyses and calculations on the pressure and transmutation states of chip kick mechanics, and conducting optimal design too, then making the structure of chip kick mechanics more and more rationalization. Experiments show that the new soccer robot controller features a quick response and high servo rigidity, and provide a kind of method for improving and perfecting the soccer robot control system, at the same time, filling the needs of producing.

Introduction

The environmental chamber is the main place for breeding experiment of hybrid rice, it is to use artificial method to simulate natural conditions of four seasons climate change a year, mainly is the simulation of temperature, illumination and humidity of the three meteorological factors. The high precision temperature control requirements, the implementation of temperature control in some of the following problems:

(1) The environmental chamber temperature control equipment of existing three sets of split wall hanging type air conditioner, if adopts frequency conversion air-conditioning or central air conditioning, will get better control effect than ordinary air conditioning. But they are expensive, also have three minutes to warm down the problem, and will increase investment, and the client want to transform the original model, improve the accuracy of temperature control.

(2) the air conditioning refrigeration and heating limited, sometimes by an air-conditioner to keep the artificial climate chamber temperature; if the three air-conditioning and heating or cooling, it will cause a big overshoot, is not conducive to high precision temperature control.

(3) since the protection function of air-conditioning, air conditioning refrigeration / heat commutation to stop three minutes; similarly, air conditioning to the temperature after the shutdown, if need to restart, but also must wait three minutes, it is impossible to realize the continuous control of temperature, which is the biggest problem facing in the system debugging\cite{1}

(4) the temperature control precision air conditioning itself is poor, therefore only by the temperature sensor and control module cannot satisfy the control requirements for air conditioning.

(5) the artificial climate room temperature, humidity and illuminance affect each other, with strong coupling, especially the intensity on the influence of temperature control is quite obvious. Illumination was provided by high pressure sodium lamp, the brightness is higher, the influence of temperature is greater.

(6) with the change of season, outdoor temperature difference, and indoor temperature setting value is different, the indoor and outdoor temperature heat exchange are also different. In general, the room temperature, the more, the unit time of heat exchange is more. In this case, the single pattern only impossible to achieve control objectives.
In view of the above problems, this paper designed the temperature expert with compound control method of fuzzy control system.

The temperature of expert fuzzy control system design requirements and system structure

Design requirements

1. The climate chamber temperature changes according to the predetermined artificial curve, that is, different temperature setting values at different times.
2. The two-level computer control of the control system, the computer uses IPC, the machine adopts the intelligent controller developed.
3. The temperature control precision is ± 0.2 °C requirements.
4. The PC can monitor multiple end stations, with parameter setting, process monitoring, data storage, and communications functions.
5. The lower computer real-time control function, fault occurs in the upper computer can control alone, and to the high reliability.

![System structure and control principle](attachment:image)

Fig. 1 Temperature fuzzy expert control system structure diagram

System structure and control principle

Temperature expert fuzzy control system structure diagram as shown in Figure 1

1. The air conditioner setting value PID correction: due to temperature control precision air conditioning itself is poor, so the controller AC internal as auxiliary controller, the intelligent expert the design of the fuzzy controller as the main controller. At the same time, because the air conditioning controller ± insensitive area of 1 DEG C, and the temperature sensing head is located inside the casing (half of artificial climate chamber), which may cause air to close. This system uses the air conditioner setting value PID correction to solve the problem, namely the air conditioner setting value R'(k) = r(k) + R(k), where R(k) is the setting value, ∆ R(k) is based on the deviation of the E1(k) the PID correction. This ensures that the air conditioner according to instructions to open or close

2. The feedforward compensation: the temperature range of the artificial climate chamber requirement is 16~30 °C, and the temperature range is 0~40 °C outdoor environment, it should consider the heat of indoor and outdoor environment unit time exchange quantity, namely according
to the outdoor environment temperature and the set temperature difference between (represented by \( \text{Tem} \)) to deal with different control mode different. Control mode is the expert fuzzy control rules.

③ The decoupling compensation control: the artificial climate chamber control system is a system of mutual coupling, the interaction between the indoor temperature, humidity and illumination. Indoor illumination is provided by a high pressure sodium lamp, high pressure sodium lamp is lit, it will generate substantial heat, impact on the temperature. Illumination is stronger, the greater the influence. This is equivalent to improve the outdoor environment temperature, so it could be this kind of coupling relation is equivalent to the disturbance of temperature controlling system, a feed-forward compensation. The illumination value multiplied by a scaling factor applied to the outdoor environment temperature, \( \text{Tem} \) value by the formula (1) to get

\[
\Delta \text{Tem} = g(0) \cdot g - \text{OutdoorTem} - \text{LightToTem}
\]  

In the formula, \( g(0) \cdot g \) as given value; \( \text{OutdoorTem} \) for the outdoor environment temperature; \( \text{LightToTem} \) is the corresponding illumination value over the temperature conversion.

④ The feedback control: the use of feedback control air conditioner wind. Air conditioning is big, in, small three wind. The wind is big, heat / cold efficiency is higher. In process control in temperature, if the change of wind force, great influence to control precision. For example in the deviation is 0 and the temperature rise quickly when circumstances, to choose the wind, so as not to cause large overshoot. In this system, the fuzzy control rules self correction algorithm to determine the wind patterns, as shown in (2).

\[
\bar{U} = -[\alpha E + (1 - \alpha) E_c]
\]  

In formula \( \bar{E}, \bar{E}_c \) respectively for the type of fuzzy variables the rate of change of the deviation of e ec was obtained after quantization and fuzzy, \( \bar{U} \) fuzzy variable control quantity of \( u \), \( \alpha \) as the correction factor.

By formula (2) shows, control effect depends on the error and the error change rate, by adjusting the size \( \alpha \), you can change the different weighted degree of deviation \( \bar{E} \) and deviation change rate requirements. Control system in different states, different weighted degree of deviation and deviation change rate requirements. If the deviation is larger, the main task of the system is to eliminate bias, the weighted deviation should be greater; when the deviation is smaller, the main task of the system is to make the system stability as soon as possible, Jian Xiaochao, at the request of weighted larger deviation change rate. In order to get good control performance, using operations research in the "optimization" of values are modified on-line,as

\[
\alpha(k + 1) = \begin{cases} 
\alpha(k) + 0.618 \times [1 - \alpha(k)], & |E| \geq 3 \\
0.618 \times \alpha(k), & |E| < 3
\end{cases} \quad 0.3 \leq \alpha(k) \leq 0.7
\]  

By the formula (3) control the amount \( \bar{U} \) calculated as fuzzy expert controller input database facts.

⑤ The deviation of online correction: in the system debugging process, the temperature deviation is asymmetry, sometimes positive deviation, sometimes negative deviation, the impact on the control accuracy of the system. In view of this situation, the system adopts the peak - valley value correction method, which uses an temperature waveform cycle peaks and troughs values, the deviations are online correction, as the database facts input. Adopting such measures, can obtain a temperature setting curve basically symmetrical peaks and troughs values, effectively improves the precision of temperature control. The bias flow chart correction as shown in figure 2.
Fuzzy controller design expert

The basic structure of fuzzy controller[2]

An expert system is a practical problem by using a considerable number of authoritative knowledge to solve specific areas, including the expert knowledge base, database and reasoning mechanism, according to the input data, information stored in the system, using expert experience or knowledge, judgment, conclusion, with high efficiency, the advantages of precise control. In this system, the expert system and fuzzy control together effectively, the expert fuzzy controller design, mainly for the relationship between output control and system temperature, as shown in figure 3.

![Fig. 3 Expert and fuzzy controller](image)

The design of knowledge base[3]

1. The acquisition of knowledge

Expert system, knowledge base is the core of the system. The knowledge base is required for storage for control of various expert knowledge is a subset of the system, the establishment and maintenance of an important issue in knowledge is knowledge representation. This system uses the regular production representation method to represent knowledge based on module, it has strong, easy to add, modify the information and can effectively express the heuristic knowledge etc., and can be based on the level of experience, expert data reliability, gives credibility factor, to facilitate the realization of imprecise (fuzzy) reasoning. It is suitable for the characteristics of temperature control requirements.

![Fig. 3 Expert and fuzzy controller](image)

Production rule is a "if this condition is satisfied, we must take this" representation of the statement. The interaction between small each rule. The general rules of the form: IF XX.THEN.XX., respectively, accurate expression and fuzzy knowledge. Every rule has two parts,
first part is the rules can be applied condition, after describes the application of this rule the action or conclusion. Database is a major center of production rules, each production left said before enabling this rule database must be prepared. Executing change rule operation will cause the database, this makes the other production rules conditions may be satisfied.

②The processing of fuzzy knowledge[4]

Environmental chamber temperature control system, the existence of a large number of fuzzy knowledge. For example, when ∆Tem is small, it should be the refrigeration, the refrigeration quantity cannot too big. In the practical control we found, what is the scope of "small", what is "the refrigeration quantity cannot too big", it is difficult to measure the precise language of mathematics. The fundamental reason is that, these knowledge contain large uncertainties. Therefore, must use the knowledge of fuzzy mathematics to solve. Using the concept of membership function to quantifying the qualitative statement. For example, if ∆Tem at -17~6 ℃, be regarded as Δ Tem is smaller (NS, negative small); three air conditioners in refrigeration, can be regarded as the refrigeration quantity is not too large (NS, negative small). Based on the two assumptions, it can be combined with the knowledge of experts in the field, quantitative this experience: if ∆Tem at -17~6 ℃, three air conditioners refrigeration alternate

Through the long-term field test, summed up the system of expert fuzzy control rules, as shown in Table 1, according to its type (1) Δ Tem calculated different and adopt different control modes

### Table 1 Expert fuzzy control rule table

| ∆Tem (℃) | Control model |
|----------|---------------|
| <-25     | I             |
| -25~21   | II            |
| -21~17   | III           |
| -17~6    | IV            |
| -6~1     | V             |
| 6~15     | VI            |
| 15~21    | VII           |
| 21~23    | VIII          |
| >23      | IX            |

In the experiment, the three air conditioning units numbered 1, 2, 3, respectively play different roles. For example, when the ∆Tem is relatively small, setting -17~6 ℃, use the control mode IV, the rules for 1, 2 and 3 air conditioning rotation refrigeration; when ∆Tem is very small, set < -25 ℃, use the control mode Ⅰ, then rule 1, No. 2, No. 3 air conditioning refrigeration air conditioning rotation, has been refrigeration. Considering the cooling / heating reversing air conditioning machine three minutes, in the mode specified in an air conditioner only in a single work, namely only heating or cooling, and as far as possible to ensure that no disturbance switching control mode, avoiding the indoor temperature values oscillate back and forth.

In order to ensure the stability of the indoor temperature, corresponding to each control mode, also designed the corresponding sub control mode. For example, when ∆Tem is close to 0℃, indoor, basically no heat exchange, artificial climate chamber temperature is stable in air conditioner does not work in the case of. So that the deviation in a certain range (-0.2 ℃), air conditioning need not open, otherwise it will destroy this stability. Table 2 lists the mode VI in the sub control mode.

### Table 2 Mode VI in the sub control mode

| ∆Tem (℃) | -1~0 | 0~1 | 1~2 | 2~4 | 4~6 |
|----------|------|-----|-----|-----|-----|
| Air conditioning delayed opening deviation (℃) | -0.2 | -0.15 | -0.1 | -0.05 | -0.02 |

The design of reasoning machine

The reasoning machine is capable of using knowledge reasoning to solve a problem or function module. According to the process of data input (i.e., Δ Tem said earlier the added decoupling compensation value, the actual indoor temperature and bias temperature value, amount $\bar{U}$ is controlled by feedback control with fuzzy processing obtained), and the application of the knowledge in the knowledge base, reasoning methods according to problems the solution

This system adopts the form of control knowledge reasoning run forward inference, namely from the process data, the known information of original data and rules, let the front part of front part
matching, the conclusion part execution rules, namely the control part of the system operation section performs the consequents of the rules content (with large, or small way to start an air conditioner refrigeration / heat to complete the task, and the three air conditioning units coordination control, the completion of the established control task).

**Conclusion**

In the artificial climate chamber temperature control requirements, all sorts of problems and temperature control, this paper presents the composite control method includes a feedback control, feedforward compensation. The experts in the compound control method based on fuzzy system has been realized by single chip computer. The design of the system, debugging, installation debugging and running after a year or so, and got control results ideal: fast response speed, good tracking performance of the temperature control, the control precision is ± 0.2 ℃. Due to the use of the software and hardware design more perfect and anti-jamming measures, ensure the safety and reliability of the system work, and effectively meet the requirements of temperature control for breeding test. At the same time, the compound control algorithm used in this system has strong applicability, can be applied to the control system in similar.

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