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Research on Energy Management Method of Intelligent Lighting in Office Buildings

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Research on Energy Management Method of Intelligent Lighting in Office Buildings

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Abstract: Optimizing building intelligent lighting systems is of great significance for energy conservation. Especially now that there are more and more office buildings, energy management research can effectively reduce the loss of energy. This paper introduces the necessity of optimizing the intelligent lighting technology of office buildings. The BP neural network is used to analyze the intelligent lighting energy loss of office buildings, and the proposed measures are proposed.

1. Introduction

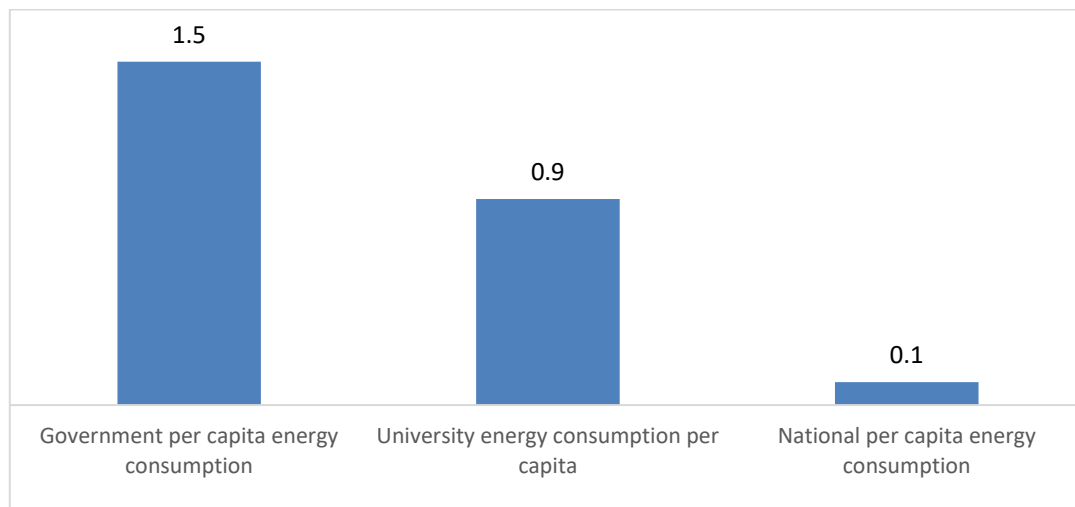
The concept that energy is inexhaustible and inexhaustible has changed with the development of society. In modern buildings, the use of energy-saving lamps is becoming more and more common. Specific to the field of architectural lighting, it is both a technical job and a work that can be regulated. In China, high-energy buildings are increasing year by year, and lighting energy consumption accounts for a large proportion. Research on energy-saving, intelligent optimization design and energy management is the focus of domestic and foreign scholars and technicians.

2. The necessity of optimizing the intelligent lighting technology of office buildings

With the development of society, the buildings are increasing year by year, and their energy consumption is also increasing. China's building energy consumption accounts for 30%-35% of the total energy consumption of the whole society. In order to achieve sustainable energy development, China's future energy conservation work will shift to the direction of "connotation and promotion", that is, it is necessary to deepen the energy saving potential and improve energy efficiency to achieve new energy conservation goals.

The number of office buildings in China is increasing. At the same time, building automation technology and lighting control technology are also developing rapidly. It is an inevitable trend for lighting control systems to adopt advanced energy-saving design and digital control. From the perspective of design, with the continuous development of electronic technology, office building lighting systems have great improvement in terms of lamp selection and electrical design. From the perspective of control management, the current architectural lighting system lacks statistics and analysis of objective data, and lacks energy-saving effects and development trend evaluation of architectural lighting systems.





Remarks: The figure shows the amount of coal used.

Figure 1 Comparison of electricity consumption per capita in China

The intelligent lighting control system integrates various lighting control methods, electronic technologies, communication technologies and network technologies, and solves the problems of relatively scattered control and inefficient management, and can effectively achieve energy saving. The intelligent lighting control system has the following advantages: First, the intelligent lighting control system can make the lighting system work in a fully automatic state. Second, it provides a healthy and comfortable environment for people, and also improves work efficiency and prolongs the use of lamps. Third, through intelligent management, the system can maximize energy conservation. Fourth, the intelligent lighting control system transforms the artificial lighting of the ordinary lighting into intelligent management, greatly reducing the operation and maintenance costs of the building, and bringing a large investment.

Lighting level	Place name	Standard value of daylighting coefficient (%)	Indoor natural light standard value (lx)
II	Design room/drawing room	4.0	600
III	Office/meeting room	3.0	450
IV	Copy room/archive room	2.0	300
V	Walkway/stairwell/bathroom	1.0	150

Table 1 Office building lighting standard

3. Energy consumption prediction and verification based on BP neural network

The establishment of the building energy consumption evaluation index system has made the building's energy consumption situation have corresponding evaluation standards. Back Propagation neural network is the back propagation neural network algorithm, referred to as BP neural network model. As shown in the figure below, it is a schematic diagram of the structure of the BP neural network.

3.1 Forward propagation of BP neural network

The following are the output hidden layer, the output output layer, and the resulting error function.

Output hidden layer:

$$O_j = f \left(\sum_{i=1}^n w_{ij} x_i - \theta_j \right)$$

Output o-layer:

$$Y_k = f \left(\sum_{j=1}^1 o_j w_{jk} - d_k \right)$$

Set difference function:

$$E_k = \frac{1}{2} \sum_k (H_k - Y_k)^2$$

In summary, the output node of the error function is used to derive the following formula:

According to the above formula:

$$E_k = \frac{1}{2} \sum_k \left(H_k - f \left(\sum_{j=1}^1 w_{jk} f \left(\sum_{i=1}^n w_{ij} x_i - \theta_j \right) - d_k \right) \right)^2$$

Using the error function derivative calculation formula, it is calculated:

$$\frac{\partial E_k}{\partial w_{jk}} = -(H_k - Y_k) * f' \left(\sum_{j=1}^1 O_j w_{jk} - d_k \right) * O_j$$

The error formula of the output node is as shown in the following formula 1. After formula 2 is obtained, the correction formula of the output layer weight and the valve value is obtained by 3 and 4.

$$\frac{\partial E_k}{\partial d_k} = (H_k - Y_k) * f' \left(\sum_{j=1}^1 O_j w_{jk} - d_k \right)$$

$$\delta_k = (H_k - Y_k) * f' \left(\sum_{j=1}^1 O_j w_{jk} - d_k \right)$$

$$\frac{\partial E_k}{\partial w_{jk}} = -\delta_k O_j$$

$$\frac{\partial E_k}{\partial w_{jk}} = -\delta_k O_j$$

Normalized processing:

According to the actual situation of this paper, after normalizing the above data, it is concluded that:

$$X = \frac{x - x_{\min}}{x_{\max} - x_{\min}}$$

3.2 Analysis of energy saving modules

Combined with the model structure of the BP neural network, the above four main influencing factors are selected as the input of the energy consumption model, and the building energy consumption is taken as the output, as shown in the following figure.

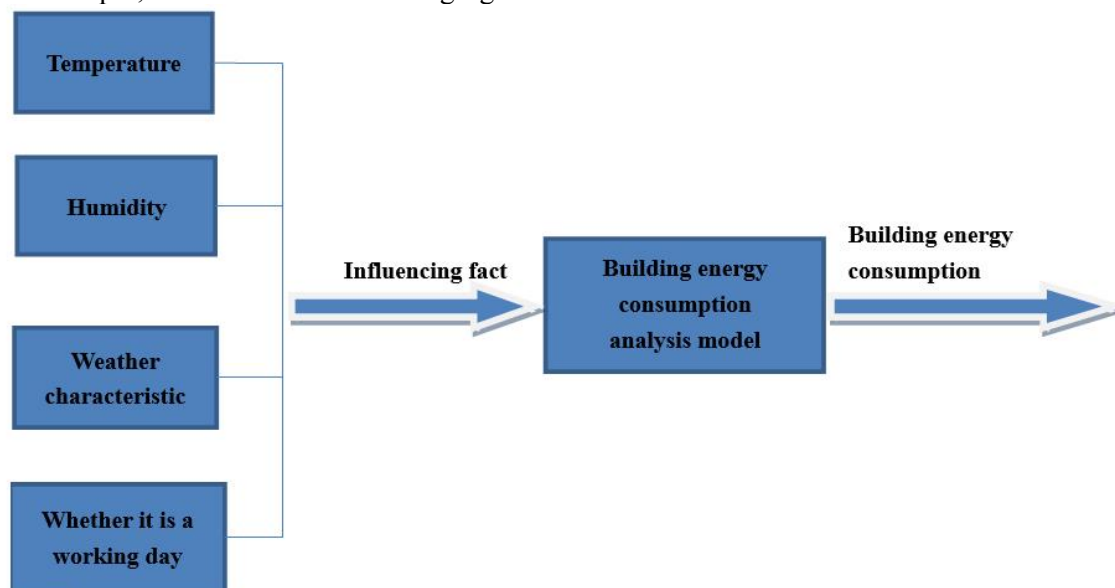


Figure 2 Main influencing factors on energy consumption model and building energy consumption

The analysis shows that the statistical analysis table of the predicted value and the test value can be obtained, and the error rate of the model prediction is objective and reasonable. In this paper, based on BP neural network method, the energy consumption prediction model of office buildings is established. Due to the limitation of data samples, the network model is trained based on the data samples of daily building energy consumption and some data are randomly selected for comparison with predicted values.

4. Energy saving strategy

4.1 Design principles

The energy consumption of a building depends not only on the load of the energy-consuming equipment, but also on many factors. It is mainly affected by the building body shape coefficient, building window to wall ratio, building envelope structure and so on. Therefore, the following principles should be followed when designing energy consumption for office buildings:

(1) Scientific and reasonable principles. Building energy consumption evaluation indicators should be scientific and reasonable, and the evaluation results should have certain accuracy and reliability. Only when the evaluation indicators are scientific and reasonable, can the evaluation results be referable, and the substantive significance of energy conservation supervision can be brought into play to further promote building energy conservation work.

(2) The principle of all-round, multi-angle. Not only should we pay attention to the indicators of the amount of energy consumption of buildings, but also from the perspective of building energy efficiency, through the establishment of building energy consumption evaluation index system, technical

design.

(3) The principle of comfort and unity. On the basis of ensuring the reasonable energy demand of the building, the comfortable standard and the level of building energy consumption are combined to save energy and improve the energy efficiency of the building while satisfying the comfort of the building.

(4) The principle of operability. The evaluation process of building energy consumption should have strong operability, so as to ensure the effective collection of correct energy consumption data and the value of building energy supervision platform.

4.2 Specific strategies

The first is to increase the installation coverage of the lighting control system to achieve 100% coverage, thus eliminating the situation of one person using an office lighting device.

The second is to replace energy-saving lamps and give full play to the characteristics of high efficiency, good lighting effect and long life of energy-saving lamps, fully embodying the concept of “energy saving and material saving” in green buildings.

The third is to overhaul the energy-using equipment to ensure the normal use of the adjustable function of the gear position, so as to prevent full-load work when it is not needed.

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