Intelligent Control Method of Indoor Physical Environment in Atrium Under Social Information Network

Hai Huang[1], Linmei Shi[1](✉), and Xian Zhou[2]

[1] Shanghai Dong Hai Vocational Technical College, Shanghai 200241, China
007001007001@163.com

[2] Institute of Economics and Management, Zhi Xing College of Hubei University, Wuhan 430011, China

Abstract. In order to meet the needs of human body for indoor environment, an intelligent control method of indoor physical environment in atrium under social information network is proposed. Considering the fluid dynamic characteristics of the building atrium, the physical environment model of the building atrium is constructed. Use social information network to collect physical environment parameters such as temperature and humidity. Set the environment intelligent control target according to the thermal comfort of human body. The intelligent controller of indoor physical environment is designed by combining fuzzy control and PID control. With the support of control commands, the intelligent control task of indoor physical environment in the atrium of the building is realized. Through the performance test experiment, it is concluded that compared with the traditional control method, the control errors of indoor ambient temperature, humidity and daylighting coefficient are reduced by 0.61 °C, 0.51% and 0.145 respectively, while the control error of sound pressure is reduced.

Keywords: Social Information Network · Building Atrium · Indoor Physical Environment · Intelligent Control

1 Introduction

Stalls space architectural space A form of "outdoor space" refers to the courtyard space inside the building, which is characterized by the formation of "outdoor space" located inside the building. At first, it was the main hall or internal middle hall in a Roman house. The center was open to the sky, and there was usually a pool to collect rainwater. It is a shared space formed by the upper and lower floors in the building. In recent years, with the development of large-scale and comprehensive buildings, large atrium space buildings with several or even dozens of floors have appeared. The atrium building space is relatively large and often connects with the openings of the surrounding buildings and plays the role of vertical traffic. In order to create a better indoor light environment, a large area daylight opening is usually set on the top or side wall of the atrium [1]. The

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solar short wave radiation enters the room through the top lighting glass, and transfers the heat to the indoor furniture, walls and ground through convection or thermal radiation. However, the long wave radiation emitted from the surface of these objects cannot pass through ordinary glass to reach the outside, resulting in heat accumulation indoors, thus forming the greenhouse effect. Another part of the heat of the solar radiation is absorbed by the glass, so that more heat is gathered at the top of the large space in the atrium. In addition, the large use of refrigeration equipment at the height of personnel flow at the bottom of the atrium, there is a large thermal pressure difference in the scale of the atrium perpendicular to the ground, which forms the indoor chimney effect, and the gradient distribution of indoor temperature in the vertical direction is large. In the past, the indoor thermal and humid environment of commercial complexes was mainly regulated by air conditioning equipment, and passive cooling technology was basically not used. The continuous operation of equipment throughout the day caused indoor users to feel too cold or overheated, and a large amount of unnecessary building energy consumption was generated.

The indoor physical environment in building atrium often includes indoor thermal environment, indoor light environment, indoor acoustic environment and indoor air quality. The impact of indoor environmental quality on people can be divided into direct impact and indirect impact. Direct impact refers to the direct effect of the direct factors of the environment on human health and comfort, such as good indoor lighting, especially the use of natural light can promote people's health; The indoor layout and color that people like can ease the tension caused by the pressure of work and life; Appropriate indoor temperature, humidity and fresh air can improve people's work efficiency. Indirect influence refers to the factors that promote the alleviation of the positive or negative effects on people, such as the suitable environment when the mood is stable makes people excited, and the unsuitable environment when the mood is depressed makes people more depressed Fidgety etc. This shows that improving the quality of indoor environment can increase the comfort and health protection of indoor personnel, and meet the requirements of people for indoor environment from both physical and mental health. In order to meet the requirements of human life, an intelligent control method of indoor physical environment in atrium was proposed.

Intelligent control is a control mode with intelligent information processing, intelligent information feedback and intelligent control decision-making. It is an advanced stage of control theory development, mainly used to solve the control problems of complex systems that are difficult to solve with traditional methods. The main characteristics of intelligent control research objects are uncertain mathematical models, high nonlinearity and complex task requirements. At present, the more mature research results of intelligent control methods for indoor physical environment specifically include: intelligent control based on sensors and fuzzy rules, intelligent environment control based on network communication, and environmental intelligent control based on PMV indicators. However, the above intelligent control methods have obvious control accuracy problems in the actual operation process, which is mainly reflected in the large gap between the indoor physical environment parameters of the building atrium and the control objectives. Therefore, the concept of social information network is introduced.

Social information network refers toSocial individual Relatively stable relationship system formed due to interaction between members, social information Network attention. It is the interaction and connection between people. Social interaction will affect people social behavior. A social network is a social structure composed of many nodes. Nodes usually refer to individuals or organizations. Social networks represent various social relationships. Through these social relationships, social networks transform casual acquaintances into closely connected ones Family relations. All kinds of people or organizations are linked together. The social information network is used to optimize the intelligent control method of the indoor physical environment of the building atrium in order to improve the control effect of the environment.

2 Design of Intelligent Control Method for Indoor Physical Environment of Building Atrium

The indoor physical ambient intelligence control of building atrium can be automatically adjusted and controlled according to the real-time environmental data and user's needs, without manual intervention. This can improve work efficiency and reduce manpower burden. Real-time monitoring of indoor humidity, air quality, light, sound and other environmental parameters through various sensors. Compared with the traditional fixed set-point control mode, the intelligent control method can more accurately perceive environmental changes and make corresponding adjustments.

2.1 Construction of Indoor Physical Environment Model of Building Atrium

The intelligent control method of the indoor physical environment in the atrium of the optimized design building mainly implements the intelligent control program from the aspects of indoor thermal environment, air quality, acoustic environment, light environment, etc. Before environmental control, it is necessary to simulate the flow characteristics of the indoor physical environment in the atrium under natural conditions, and establish the corresponding dynamic environment model [2]. Figure 1 shows the dynamic simulation results of the indoor thermal environment of the atrium.

The state space method discretizes the space of the room envelope, indoor furniture, etc., establishes the heat balance equation of each discrete node, and keeps the temperature of each node continuous in time; Then, the heat balance equations of all nodes in the room are solved, and a series of coefficients representing the thermal characteristics of the room are obtained; On this basis, the room is expressed as a function of thermal response coefficient and various thermal disturbances, and the heat balance equation of air nodes in all rooms is solved simultaneously. The expression of the heat balance equation of the inner wall of the atrium is:

$$-\kappa_{\text{heat}} \frac{\partial t}{\partial x}\bigg|_{x=L} = \kappa_{\text{transfer}}(T_{room} - T) + R_{\text{absorb}} + \sum_{j} \kappa_{\text{radiation}} T + R \tag{1}$$

Variables in Formula (1), κ_{heat}, κ_{transfer} and $\kappa_{\text{radiation}}$ They are the thermal conductivity of the inner wall of the atrium, the convective heat transfer coefficient with the air, and the

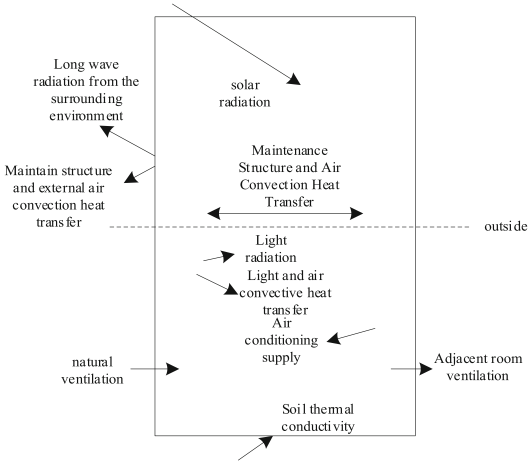


Fig. 1. Dynamic model of indoor thermal environment in atrium

long wave radiation heat transfer coefficient, x and L corresponding to the wall thickness, T_{room} and T represents indoor temperature and internal wall temperature respectively, R_{absorb} and R are respectively the solar radiation heat absorbed by the inner wall of the atrium through the window and the heat transferred to the surface by other indoor heat sources in the form of radiation. Similarly, it can be concluded that the circulation characteristics of indoor ambient air in the atrium of the building are:

$$\frac{d\left(\mathrm{H}_{\text{air}} A \rho_{\text{pollute}} T_{\text{pollute}} C_P\right)}{dt} = \kappa_h + mC_\rho T_0 \tag{2}$$

Among H_{air} is the thickness of the air layer, ρ_{pollute} and T_{pollute} corresponds to the density and temperature of pollutants in the indoor air environment of the atrium, C_ρ is the specific heat of polluted air, κ_h represents the convective heat transfer rate of the pollution plume, T_0 is the temperature value of ordinary air, m is polluted air quality [3]. Similarly, the simulation results of the indoor physical environment characteristics of the atrium can be obtained, and the corresponding model construction results can be obtained.

2.2 Use Social Information Network to Collect Physical Environment Parameters

In the process of information transmission in a multi-layer social network, the information can only be transmitted from the node with high information trust in the active state to the node with low information trust, rather than back propagation. In the process of communication, the information reliability decreases with the relationship resistance in the direction of communication. For the same information, the greater the network relationship resistance, the more the information reliability decreases, as follows:

$$\delta_x - \delta_y = \kappa_{\text{propagate}} Z_{x,y} \tag{3}$$

Among δ_x and δ_y represent nodes in social information network respectively x and y Information reliability, $Z_{x,y}$ represents a node x and y total relationship resistance between, $\kappa_{\text{propagate}}$ is the propagation coefficient of social network. In the process of network information transmission, after any node receives a certain information, the node will have a certain degree of trust in the information. When it receives the same information from other different neighbors again, the node's trust in the information will be strengthened once [4]. As the node receives the same information from more and more other neighbor nodes, the node's trust in this information will continue to increase, but in any case the node's trust in this information will never exceed 100%, but may exceed the trust of one of the propagation sources in this information. The superposition principle of information reliability can use the Wayne diagram in set theory to remove the overlapping effect. The processing process is as follows:

$$\delta(x \cup y) = \delta(x) + \delta(y) - T(x \cap y) \tag{4}$$

In the above formula $\delta(x)$ and $\delta(y)$ value range of is [0,1]. In the social information network, multiple sensor devices are used to collect the physical parameters in the indoor environment of the building atrium, and then the initial value of the control method is obtained. Install temperature and humidity sensors, illumination sensors and other equipment in the indoor physical environment of the building atrium. The structure of temperature and humidity sensors is shown in Fig. 2.

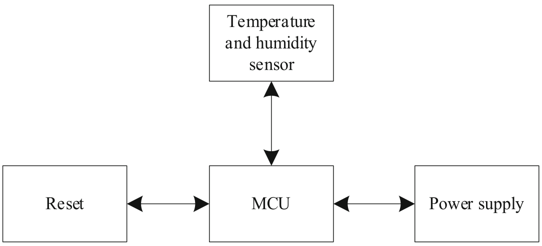


Fig. 2. Structure diagram of indoor ambient temperature and humidity sensor in atrium

The temperature and humidity sensor shown in Fig. 2 transmits data with MCU through a serial interface, which is different from the I2C interface. A set of "start transmission" timing is used to indicate the initialization of data transmission, followed by 8-bit data commands for temperature measurement, humidity measurement, reading and writing of status registers, etc.; After sending the measurement command, wait for the "data ready" signal to read out the data [5]. The upper computer of the system sends control commands to the control node based on the data collected by various sensors, so the effective reading of data by sensors is an important prerequisite for the intelligent control system to achieve control functions. The specific process of the sensor information reading program is: after receiving the query command, send the query command to the lower computer, monitor the data through the serial port. For the received data saved in the database and the number of times of no received commands cleared to zero, the system will report errors and alarm when no data is received and the number of times of no received commands is 3. In this process, the upper computer sends the No. 03 command in the Modbus protocol to the sensor node through the Zigbee communication network. Install illuminance sensor, carbon monoxide sensor, formaldehyde sensor, etc. in the indoor physical environment of the building atrium according to the above method, and complete the collection of physical environment parameters through the process shown in Fig. 3, where the collection result of ambient temperature is:

$$T = \frac{\kappa_{\text{radiation}} T_{air} + \kappa_{\text{Commutation}} T_{\text{radiation}}}{\kappa_{\text{radiation}} + \kappa_{\text{Commutation}}} \tag{5}$$

Among $\kappa_{\text{radiation}}$ and $\kappa_{\text{Commutation}}$ are radiation heat transfer coefficient and convection heat transfer coefficient, T_{air} and $T_{\text{radiation}}$ corresponding is indoor air temperature and average radiation temperature [6]. In addition, the collection results of light environment parameters include: illuminance, contrast sensitivity, etc. The collection results of illuminance parameters are:

$$\psi = \frac{d\Phi}{dS} \tag{6}$$

Among $d\Phi$ and dS are respectively the luminous flux and the area of the panel at a point on the surface, and the illuminance can be added directly. When several light sources illuminate the illuminated surface at the same time, the illuminance on them is the algebraic sum of the illuminance formed when a single light source exists separately. The collection results of contrast sensitivity parameters are as follows:

$$\sigma = \frac{B_{\text{background}}}{\left|B_{\text{target}} - B_{\text{background}}\right|} \tag{7}$$

among $B_{\text{background}}$ and B_{target} It corresponds to the background brightness and target brightness. The collection results of physical environment parameters can be obtained according to the above method, and transmitted to the control terminal through the social information network.

2.3 Set the Intelligent Control Target of the Indoor Physical Environment of the Atrium

According to the human body's demand for the comfort of the indoor physical environment in the atrium, the control target of the physical environment is set. Thermal comfort refers to the subjective satisfaction expression of people with the thermal environment. The intuitive feeling of human body in the environment is influenced by objective environment and subjective factors. According to the indexes of various building materials, the influence on indoor environment is studied, and the influence degree of various factors on indoor environment is analyzed. The heat exchange between building materials and human body in the air will also have an impact on human thermal comfort [7]. When the human body feels comfortable in the steady heat and humidity environment, it needs to meet three conditions at the same time: the gain and loss of heat between the human body and the environment are equal, that is, the heat storage of the human body in the heat balance equation is equal to zero; The average skin temperature of human body shall be kept within the range corresponding to comfort; The actual sweat evaporation heat loss of human body should be kept in a small range. Under the above conditions, the thermal comfort equation is:

$$M - W = P_a + M(34 - T_{air}) - 8\vartheta\left[(T_w + 273)^4 - (T_h + 273)^4\right] + \vartheta(T_w - T_{air}) \tag{8}$$

Among M and W are the metabolic rate of the human body and the mechanical work done by the human body, P_a is the partial pressure of water vapor in the air, T_w and T_h corresponds to the average temperature of human body surface or clothing surface and the average radiation temperature of the environment, ϑ is the convective heat transfer coefficient. According to the construction result of human thermal comfort equation, determine the intelligent control target of indoor physical environment temperature, air quality, humidity, light and other parameters in the atrium, and mark it as U_{target}.

2.4 Design of Intelligent Controller for Indoor Physical Environment

The intelligent controller of indoor physical environment is the executive element of the control function of the intelligent control method of the indoor physical environment of the building atrium under the social information network. The optimized intelligent controller consists of window opening controller, R&D switch, transponder and other equipment. The internal logic principle of the intelligent controller is shown in Fig. 3.

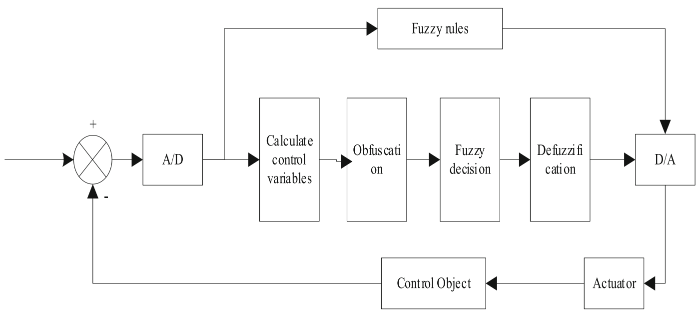


Fig. 3. Logic schematic diagram of intelligent controller

The working logic of the intelligent controller shown in Fig. 3 consists of fuzzy control and PID control. Fuzzy control is an imitative intelligent control method, which mainly imitates the thinking mode of human learning, judgment and selection. Fuzzy set theory, fuzzy language variables and fuzzy logic reasoning are the basic elements of fuzzy control [8]. The working principle of fuzzy control is to fuzzy process the signal of parameter measuring equipment according to the fuzzy rules formulated by relevant personnel, then analyze the signal in the fuzzy rules, and finally add the conclusion output to the execution area of the system. During the implementation of fuzzy control, first of all, the actual value of the controlled variable measured by the measuring equipment is transmitted to the system, and the difference signal is obtained by comparing the value with the standard value as the input port value of the control method. Then, the difference signal is fuzzily processed, and the fuzzy algorithm is used to present its form, and the fuzzy set of difference signals is obtained. Finally, the final output can be obtained by making a decision between the set and the fuzzy relationship. The deviation and deviation change rate of the current building atrium indoor physical environment parameters from the control target are defined as the input items of the controller. The calculation formula of the deviation is as follows:

$$e_U = U_{\text{target}} - U_{\text{gather}} \tag{9}$$

Among U_{gather} is the collection result of the indoor physical environment parameters of the building atrium, including temperature, humidity, illumination, air quality, etc. According to the structure of the intelligent controller, the precise quantity can be used to control the output only after being fuzzed. The fuzzification formula generally uses:

$$\xi = 2\zeta \frac{\mathrm{x} - 0.5(\mathrm{a} + \mathrm{b})}{\mathrm{b} - \mathrm{a}} \tag{10}$$

The input precision is in the range $[a, b]$, which is converted to the interval through the above formula $[-\zeta, \zeta]$ triangular distribution is selected as the membership function of the four fuzzy control variables. According to the basis for formulating the control rules described above, a suitable fuzzy rule table is established, and the fuzzy sets obtained by fuzzy reasoning are converted into accurate control quantities after anti fuzzy processing [9]. The area center of gravity method is selected, and the center of gravity of several continuous points within the output range is obtained through Formula 11, or discrete values within several output ranges are selected and calculated.

$$\Delta = \frac{\int U e_U(U) dU}{\int e_U(U) dU} \tag{11}$$

In the PID part of the intelligent controller, the transfer relationship of the control function is shown as follows:

$$G(s) = K_P \left(1 + \frac{1}{K_i e} + K_d e \right) \tag{12}$$

among K_P, K_i and K_d respectively corresponding to proportional gain and product/differential time constant, PID discrete control law is as follows:

$$g = K_p \left\{ e(i) + K_i \sum e(i) + \frac{K_d}{t_{\text{sampling}}} [e(i) - e(i-1)] \right\} \tag{13}$$

Variables in Eq. (13) t_{sampling} is the sampling period. Put the calculated deviation into the fuzzy control module and the PID control module, complete the design of the intelligent controller for the indoor physical environment, and generate the intelligent control instructions for the indoor physical environment of the building atrium.

2.5 Realize Intelligent Control of Indoor Physical Environment of Building Atrium

From the aspects of temperature and humidity, air, light, sound, etc., the intelligent controller with optimized design is used to complete the intelligent control of the indoor physical environment in the atrium of the building. Taking indoor ambient temperature parameters as an example, its control principle is mainly to control the air valve, adjust the temperature and amount of air supply. The humidity of air supply is adjusted by humidifier, which depends on solenoid valve control. The coordination between various components plays a good role in control. According to the law of conservation of energy, the change rate of energy storage in the air conditioning environment is equal to the heat flowing into the air conditioning environment per unit time minus the heat flowing out, and the equation is expressed as:

$$\begin{cases} Q_0 - Q_1 + Q_2 + Q_3 = c_{air} dT \\ Q_0 - Q_1 = Wc_p(T_0 - T) \\ Q_3 = \kappa_c S_{\text{exterior wall}} \left(T_{\text{outdoor}} - T + \frac{\kappa_{\text{surround to guard}}}{\kappa_c} \Delta T \right) \end{cases} \tag{14}$$

Among Q_0、Q_1、Q_2 and Q_3 heat brought into the room by the supply air, the heat that can be taken away by the return air, the heat generated by indoor personnel, mechanical and electrical equipment, and the heat transferred from outside the room, c_{air} and c_p are air heat capacity and air specific constant pressure heat capacity respectively, W supply air volume for air-conditioned rooms, $S_{\text{exterior wall}}$ represents the area of the exterior wall, T_{outdoor} represents the average comprehensive outdoor temperature, $\kappa_{\text{surround to guard}}$ and κ_c corresponds to the heat transfer coefficient of the inner surface of the enclosure and the heat transfer coefficient of the enclosure, ΔT is the temperature fluctuation on the inner surface of the enclosure [10, 11]. In the actual intelligent control process, the air conditioning amplification factor and air supply temperature input to the controller are:

$$\begin{cases} \gamma = \dfrac{Wc_p}{Wc_p + \kappa_{c\,\text{exterior wall}}} \\ T_{\text{Air supply}} = \dfrac{\kappa_c S_{\text{exterior wall}} T + \frac{\kappa_{\text{surround to guard}}}{\kappa_c} \Delta T + Q_2}{Wc_p + \kappa_c S_{\text{exterior wall}}} \end{cases} \tag{15}$$

With the support of the controller, control instructions are generated and applied to the corresponding control end to complete the intelligent control of the indoor physical environment temperature in the atrium of the building [12, 13]. In the same way, with the support of intelligent controller optimization design, it can realize the intelligent control of environmental parameters such as humidity, air quality, light, sound, etc. in the indoor physical environment of the building atrium, can automatically adjust and control the physical environment in the atrium of the building according to real-time environmental data and user needs, so as to provide a more comfortable and healthy living and working environment.

3 Experimental Analysis of Control Performance Test

The control performance design test experiment of the intelligent control method for the indoor physical environment of the building atrium under the social information network of the test optimization design is mainly aimed at the control accuracy performance test, that is, to observe the error between the indoor physical environment parameters of the building atrium and the control target under the effect of the optimization design method. Through the statistics of relevant data and the comparison with traditional methods, the advantages of optimal design methods in control performance are reflected.

3.1 Selection of Indoor Environment of Building Atrium

In this experiment, the atrium space of several buildings in a commercial building is selected as the experimental research environment. The commercial building integrates the functions of catering, sports and leisure, culture and entertainment, office and banking, which plays an important role in improving the quality of the city in the location. The landscaping and humanized environment of the commercial building atrium space is an excellent shared space for shopping, leisure, entertainment and communication. Its artistry is changeable in form and rich in content. It often creates a gorgeous and dazzling business atmosphere to attract customers. The comfortable environment atmosphere affects customers' consumption psychology and affects their shopping behavior. The commercial atrium has the characteristics of facility. The atrium space is a space for people to rest and communicate, improve public service facilities such as rest, transportation, health and information provision in the space, and increase consumers' comfort and sense of belonging. It enables people to carry out shopping behavior and social interaction activities in high-quality indoor leisure and shared atrium space. The indoor environment of the atrium of the selected building adopts the typical polymerization enclosed atrium space, surrounded by the store space on all sides, and the glass roof is the main natural lighting interface. The roof at the top elevation of 42m adopts the structural form of I-shaped steel beam with a height of 1.2m, and the composite floor is laid on it, which solves the problem of formwork erection in large-span space construction. The light colored stone floor and stone wrapped columns in the atrium space make them an integral whole. The escalator wrapped with white aluminum plate and the glass handrail together look very light. The natural light through the glass roof, combined with the artificial lighting to set off the goods, makes the space more lively and rich, and creates a comfortable light environment.

3.2 Setting Initial Values and Control Objectives of Indoor Physical Environment

Through the operation control of fans, air conditioners and other equipment, the initial value of the indoor physical environment in the atrium of the building is set, and the environmental control objectives are determined in combination with human needs. Table 1 shows the setting of initial values and control objectives of indoor physical environment.

The measuring points in Table 1 are located on the floor, wall and ceiling of the indoor physical environment of the building atrium, and the distance between any two measuring points shall not be less than 2 m.

Table 1. Initial Values and Control Objectives of Indoor Physical Environment

No. of measuring point	Initial value of indoor physical environment				Indoor physical environment control objectives			
	Temperature (°C)	Humidity (%)	Daylighting coefficient	Sound pressure (Pa)	Temperature (°C)	Humidity (%)	Daylighting coefficient	Sound pressure (Pa)
1	28.3	22	0.2	35	25	50	0.5	12
2	30.2	18	0.3	28	25	50	0.5	12
3	29.5	20	0.3	36	25	50	0.5	12
4	21.4	16	0.8	47	25	50	0.5	12
5	18.6	75	0.7	39	25	50	0.5	12
6	9.4	68	0.6	40	25	50	0.5	12
7	10.5	63	0.2	42	25	50	0.5	12
8	14.7	32	0.2	45	25	50	0.5	12

3.3 Installation and Commissioning of Environmental Intelligent Control Equipment

The indoor environment of the atrium of the selected building is equipped with European sun shading louvers and FSS ceiling curtains as the control objects of the light environment. The European sun shading louvers have a leaf width of 68 mm, a wall thickness of 0.8 mm, a stainless steel silver color, and an arc shaped section with folded edges. It is resistant to moisture, heat and bumps. The FSS ceiling curtain is made of 30% polyester fiber 60% PVC, with an opening rate of about 5%, a weight of 500 $g/m^2 \pm 5\%$, a thickness of 0.8 MM $\pm$ 5%, and a UV shading rate of about 96%. It is characterized by tensile strength, tear resistance, fire resistance, light resistance, anti-bacterial mildew resistance, environmental protection and no odor. In order to adjust the extremely hot and humid indoor environment, the atrium is equipped with several air conditioners and dehumidifiers. The actual layout is shown in Fig. 4.

Three split air conditioners are arranged between the wall mounted fans, each with a cooling capacity of about 2.0 horsepower. Although this cooling capacity is not enough to fully meet the cooling demand of this large space, it alleviates the problem of indoor temperature overheating to a certain extent, and the layout position of the air conditioners also simulates the layout of the air conditioning outlets in the mall, which can play a role in cooling pedestrians walking in the corridor to a certain extent. In addition to the control object, it is also necessary to install the intelligent controller and sensor devices at the designated locations. Before the experiment starts, it is necessary to debug all hardware devices in the physical environment of the building atrium to determine whether the control object, controller and sensor are in normal operation. If the debugging shows that the device is operating abnormally. Relevant equipment shall be replaced in time.

Fig. 4. Realistic view of air conditioning equipment layout

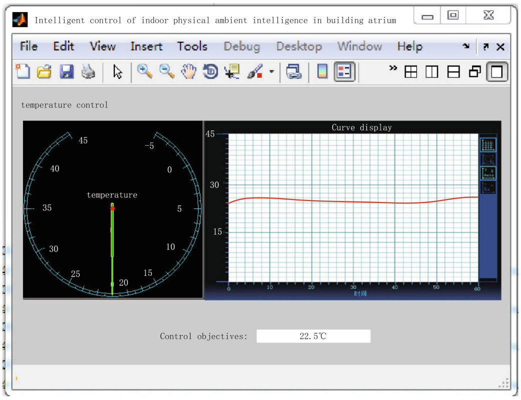
3.4 Describe the Test and Experiment Process

The experiment was conducted from four aspects: ambient temperature, humidity, light and sound. Simulink was used as the operating platform for optimizing the design of intelligent control methods for the indoor physical environment of the building atrium under the social information network. Simulink, as a software integration, was based on the block diagram design environment of MATLAB, and could support multi rate systems at the same time. It plays a good role in digital signal processing. At the same time, the unique GUI interface of the platform simplifies the development process of the method. It does not require input language, but only selects the properties on the interface, which can be completed by simple clicking and moving. The running program corresponding to the intelligent control method of the indoor physical environment of the atrium under the social information network is substituted into the main testing computer to complete the development of the optimization design method. Connect the hardware equipment successfully debugged into the control program, input the environmental control target, and get the intelligent control results of the indoor physical environment of the building atrium, including the control results of temperature, light environment and sound environment, as shown in Fig. 5.

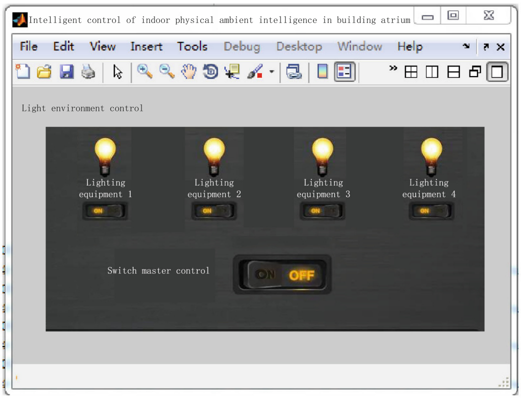
According to the above method, the intelligent control results of various environmental parameters on all measuring points in the indoor physical environment of the building atrium can be obtained. In order to reflect the advantages of the optimization design method in the control performance, the traditional intelligent control based on sensors and fuzzy rules and the intelligent environment control based on network communication are set as the comparison method of the experiment, and the development of the comparison method is realized according to the above way, and the corresponding intelligent control results are output.

3.5 Set Quantitative Test Indicators of Control Performance

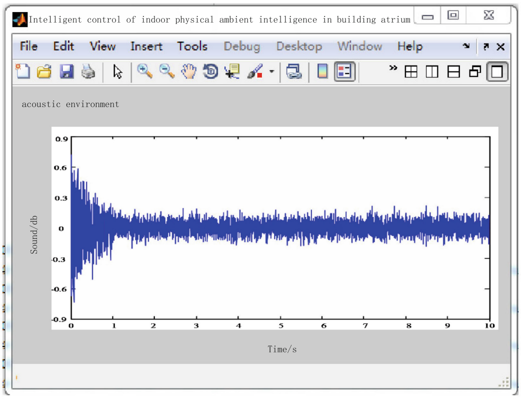
In this experiment, temperature control error, humidity control error, daylighting coefficient control error and sound pressure control error are respectively set as quantitative



(a) Physical ambient temperature



(b) Physical light environment



(c) Physical acoustic environment

Fig. 5. Intelligent Control Results of Indoor Physical Environment in Atrium

test indicators of control performance. The test results of temperature control error, humidity control error and daylighting coefficient control error are as follows:

$$\begin{cases} \varepsilon_T = \left| T_{\text{control}} - T_{\text{target}} \right| \\ \varepsilon_\chi = \left| \chi_{\text{control}} - \chi_{\text{target}} \right| \\ \varepsilon_\upsilon = \left| \upsilon_{\text{control}} - \upsilon_{\text{target}} \right| \end{cases} \tag{16}$$

Among T_{control} and T_{target} are the control value and control target value of temperature, χ_{control} and χ_{target} corresponding to the control value and control target value of humidity, $\upsilon_{\text{control}}$ and υ_{target} respectively represent the control value and control target value of the daylighting coefficient. In addition, the numerical results of sound pressure control error are as follows:

$$\varepsilon_{P_{\text{sound}}} = \left| P_{\text{sound - control}} - P_{\text{sound - target}} \right| \tag{17}$$

Variables in the above formula $P_{\text{sound - control}}$ and $P_{\text{sound - target}}$ are respectively the control value and control target value of sound pressure. Finally, the smaller the control error is, the better the control performance of the corresponding method is proved.

3.6 Control Performance Test Results and Analysis

The test results of temperature control error, humidity control error and daylighting coefficient control error are obtained through the statistics of relevant data, as shown in Table 2.

Table 2. Test Results of Temperature, Humidity and Daylight Coefficient Control

No. of measuring point	Intelligent control based on sensors and fuzzy rules			Intelligent environment control method based on network communication			Intelligent control method of indoor physical environment in atrium under social information network		
	Temperature (°C)	Humidity (%)	Daylighting coefficient	Temperature (°C)	Humidity (%)	Daylighting coefficient	Temperature (°C)	Humidity (%)	Daylighting coefficient
1	25.6	50.7	0.5	25.5	50.7	0.6	25.1	50.3	0.5
2	25.8	50.9	0.8	25.4	50.3	0.6	25.0	50.2	0.4
3	25.7	50.8	0.8	24.7	49.5	0.7	24.9	50.1	0.5
4	26.0	50.7	0.6	24.5	49.6	0.7	25.0	50.3	0.5
5	26.2	49.1	0.9	24.4	50.4	0.6	25.0	49.8	0.6
6	24.1	49.2	0.7	25.4	50.6	0.6	24.9	49.9	0.5
7	24.3	51.1	0.4	25.6	50.5	0.4	25.1	50.1	0.4
8	24.0	51.4	0.9	25.5	50.5	0.3	24.9	50.2	0.5

The data in Table 1 and Table 2 are substituted into Formula 16 to obtain the calculation results of the control error of temperature, humidity and daylighting coefficient. The average temperature control error of the two comparison methods is 0.86°C and 0.48°C, the average humidity control error is 0.91% and 0.49%, the average value of the control error of daylighting coefficient is 0.23 and 0.14, and the average value of the temperature, humidity. The average values of daylighting coefficient control errors are 0.06°C, 0.19% and 0.04 respectively. In addition, the test comparison results of sound pressure control error are obtained through the calculation of Formula 17, as shown in Fig. 6.

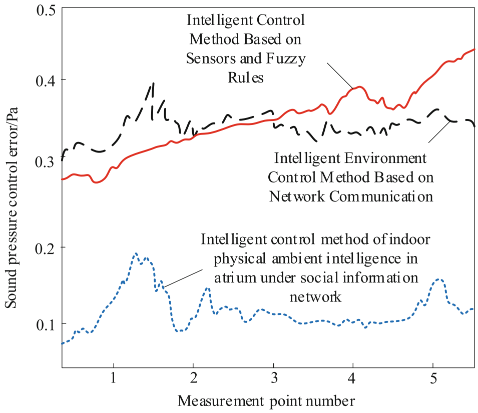


Fig. 6. Comparison Curve of Sound Pressure Control Error Test

It can be seen intuitively from Fig. 6 that the control error of the optimal design method is significantly lower than that of the two comparison methods, that is, the optimal design method has obvious advantages in control performance.

4 Conclusion

In this paper, a physical ambient intelligence control method of building atrium under social information network is proposed. This method considers the dynamic characteristics of fluid in building atrium and constructs the indoor physical environment model of building atrium. Using social information network to collect physical environment parameters such as temperature and humidity; According to the thermal comfort of human body, the ambient intelligence control target is set, and the indoor physical ambient intelligence controller is designed. With the support of control instructions, the indoor physical ambient intelligence control task of building atrium under the social information network is realized. The intelligent control method of the indoor physical environment of the building atrium can display the indoor environmental parameters in real time, and can control the work of household appliances intelligently through the terminal control device, effectively ensuring the safety and comfort of the indoor environment.

In the future, the indoor physical ambient intelligence control method of building atrium will continue to develop and innovate, creating a more intelligent, sustainable and healthy indoor environment for people. The following is the prospect of future work:

(1) With the continuous progress of artificial intelligence and big data technology, the indoor physical ambient intelligence control method of building atrium will be more

accurate and intelligent. By analyzing huge data sets, intelligent control systems can learn and predict users' behaviors and preferences, thus providing personalized environmental adjustment and services.

(2) Future work will pay more attention to energy management and sustainability. Intelligent control system will combine energy monitoring and analysis technology, optimize energy utilization and management strategy, realize energy efficient utilization and saving, and reduce the impact on the environment.

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