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Optimization Design of Indoor Living Environment Based on Big Data Algorithms from the Perspective of the Entire Life Cycle

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Abstract: *With the rapid development of cities, the scale of urbanization continues to expand, and the energy consumption of construction enterprises continues to increase. The people's demand for the environmental level is increasing, and the environmental problems make the people put forward higher demand for the living environment. Due to the rapid development of contemporary economy and the continuous improvement of living standards as well as the increasing number of "empty nest" elderly, the limitations of home-based care have begun to emerge. The limitations of home-based care are emerging, and the traditional model has been impacted. All industries are accelerating the pace of digital transformation, especially in the medical industry and interior design industry. It has become a trend to use artificial intelligence technology to enable and achieve life-cycle health management. This paper took the life cycle of the indoor living environment of the "empty nest" elderly as the research object. Based on big data algorithm, artificial intelligence and multimedia technology were used to establish the comfort evaluation model of residential environment elements to achieve the optimal design of indoor residential environment. The simulation results showed that by testing the comfort evaluation model of the residential environment elements, it could not only improve the performance level of the indoor residential environment by 12%, but also realize the sustainable development of indoor living and harmonious coexistence between human and nature.*

Keywords: *Indoor Living Environment, Big Data Algorithm, Artificial Intelligence, Multimedia Technology, Whole Life Cycle*

1. Introduction

In recent years, with the continuous development of computer technology and Internet technology, big data has become an important part widely used in various industries. With the development of society, people have higher and higher requirements for living environment. They no longer simply pursue the beautification of physical environment but pay more attention to their own personality and spiritual pursuit, which has a higher level of demand for interior design. Under the background of big data era, the application of interior design data is becoming more and more valuable, which can bring greater reference to the development of interior design.

Now there are scholars' researches on the indoor living environment of the elderly: Moya's research found that the apartment for the elderly was a very common apartment in the United States. There were various architectural styles of apartments for the elderly, which were mostly independent buildings. Different apartment types were separated and scattered in residential areas [1]. Feng, Zhuangbo emphasized that the main differences between American elderly apartments and other countries were as follows: From different perspectives, they tended to consider humanization and adopted the "graded elderly care" model according to different elderly care needs [2]. Li, Jianqiang found that there were two types of apartments for the elderly in Japan: exclusive apartments and mixed apartments. Exclusive apartments referred to living in the elderly. Mixed apartments for the elderly aimed to enable residents in the apartment and the elderly to live together to improve communication between the elderly and residents of other age levels and avoid negative feelings of loneliness. The main purpose of the Japanese elderly apartment was to expect the elderly to be self reliant during their stay rather than being separated from the society by simple nursing assistance [3]. Chhikara believed that China's exploration of the interior environment design of apartments for the elderly was still in the initial stage of development, and the implementation of the family planning policy caused great pressure on the current young people. In addition, with the increasing number of empty nesters and widowed elderly,

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apartments for the elderly were gradually needed by the general public to meet and solve the problems of some children and elderly people who lacked the care of their relatives [4]. According to Al Horr's research, many apartments for the elderly were transformed by hospitals and hotels, which restricted the design of their buildings and interiors; some elderly apartments were institutionalized, with serious medical diagnosis problems and no sense of belonging; some elderly apartments had insufficient entertainment and leisure space to meet the diversified needs of the elderly; some elderly apartments were located at the edge of remote cities with poor surrounding facilities, which insulated the elderly from urban life [5]. In a word, although there were still some senior citizens' living places with strong sense of responsibility, there were many different problems, which should be paid enough attention to to design a comfortable indoor living environment for the senior citizens.

Now there are relevant researches on big data algorithm by scholars: Xie, Ting believed that with big data as the background, intelligent processing, human-computer interaction and other technologies would be the focus of future development. Artificial intelligence and multimedia technology were used to process network data, and environmental information was subject to some perceptual collection and real-time monitoring, so that users could monitor smart home systems in different places and facilitate people's living [6]. Under the background of big data, Li, Weiwei thought it was very important to process and optimize data reasonably, which was no exception for the interior design industry and medical diagnosis. The optimization of interior design industry and medical diagnosis data belonged to the research of application value. Relevant databases could be built through the optimization and inversion of various information, and then relevant data could be filtered and integrated [7]. Yang, Jun believed that interior design played an important role in people's daily life and work. Only appropriate interior design could meet the functions of different buildings. In addition, different customers had different needs for decorative effects, so designers were required to make original designs in the design process to develop the real value and significance of interior design according to the specific needs of customers [8]. Hamdy believed that the traditional interior design in China started from the emotional point of view. In the interior design process, designers were required not only to meet the needs of customers, but also to meet the basic functions of the interior [9]. Hou, Rui proposed that under the current unstructured big data analysis algorithm and simulation of the Internet of Things based on machine learning, designers also needed to increase their design thinking. By grasping the current market changes in a timely manner, they could enhance their understanding of the internal links of changing things and design more profound works [10]. In the era of big data, the application of data in interior design is becoming more and more valuable, which can bring greater reference to the development of interior design.

In short, the development of the big data era has brought great development opportunities and challenges to the interior design industry, and the digital technology has injected more fresh blood into interior design. It can also greatly simplify the work content of each stage and promote the better development and progress of interior design.

2. Hierarchical Evaluation of Interior Environment Design for the Elderly

(1) Elements of living environment

The elements of residential environment are basic materials that are independent of each other and have different attributes as well as consistent with the overall evolution of human living environment. The indoor environment elements that indoor people can perceive include thermal environment, air environment, acoustic environment and light environment. These indoor living environment elements are interrelated, and they jointly assess the role of the indoor living environment on the comfort of indoor residents [11].

1) Thermal environment

This is a factor in the indoor environment, which can cause people to evaluate the cold and hot feeling of room occupants. Its elements are mainly influenced by multiple factors. To build a thermal environment comfort evaluation model, it is necessary to clarify which important environmental parameters would directly cause subjective evaluation of indoor residents' comfort, so as to adjust thermal environment parameters well [12].

2) Air environment

Air environment is the composition and content of air in indoor living environment and its effect on people's psychological and physiological health. To build an air environment comfort evaluation model,

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it is necessary to determine which important environmental parameters directly affect the subjective evaluation of indoor residents' comfort, so as to adjust the air environment parameters well [13].

3) Acoustic environment

It refers to the harm of all noise sources in the indoor living environment to the mental health and physical health of indoor residents. Environmental noise standards refer to the standards set for the allowable noise range to protect the health of indoor residents and improve their living environment. As an environmental element of acoustic environment, noise has seriously affected the evaluation of indoor residents on their comfort [14].

4) Light environment

This is a kind of indoor living environment composed of light in the indoor living environment, which can demand the physical and mental health of indoor residents. Therefore, it would affect the psychological and physical health of indoor residents in many ways. While meeting the visual function needs of indoor residents, light has a great impact on the health and comfort of indoor residents [15].

(2) The needs of the elderly-environmental design

The environmental design aims to provide a comfortable place for people, with the premise of meeting various basic physiological and psychological needs of people, the support of environmental software and hardware, and the ultimate goal of realizing individual self-worth [16]. Therefore, in the interior environment design, it is necessary to meet the needs of the elderly at all levels according to Maslow's hierarchy of needs theory, and take the elderly's self realization of life as the ultimate goal. On the demand level of the elderly, the progressive design goal of the living environment of the elderly apartment room is obtained, as shown in Figure 1:

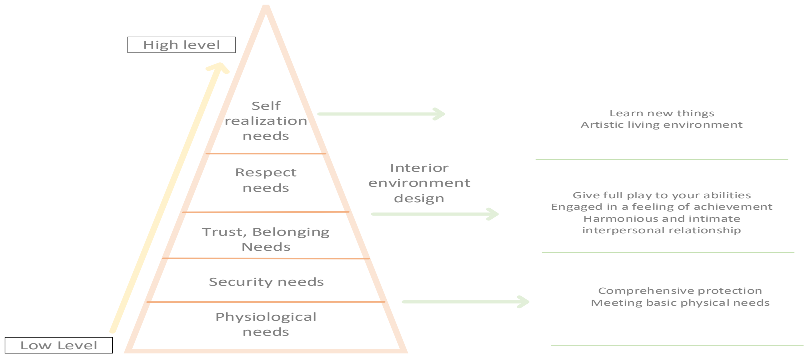

Figure 1: Demand level and interior environment design target level

1) Basic objectives (safety and health)

The ability of self-protection of the elderly is reduced due to the decline of their body. The elderly may not be able to live normally all the time without ensuring their own safety [17]. As the most basic need of the elderly, health also directly affects their food, clothing, housing and transportation. Therefore, the indoor environment design of the apartment for the elderly should take safety and health as the fundamental purpose, and provide the elderly with complete basic facilities and a suitable living environment for the physical environment.

2) The goal of promotion (belonging, respect)

The elderly are separated from their original families. After living in the elderly residence, the requirements for belonging are stronger. The interior environment design of the elderly should meet the requirements of the elderly in both aspects and provide support for them to build harmonious interpersonal relationships [18]. After the elderly retire from their posts, they still hope to reflect their strength in some scenes and do something independently. Therefore, the elderly apartment should provide a place for the elderly to display their abilities and do something with a sense of achievement.

3) Ultimate goal (self realization)

Self realization of the elderly is manifested in three aspects: entertainment, learning and pursuit of beautiful things [19]. The ultimate goal of interior environment design for the elderly is to meet the needs of the elderly to learn new things and have fun, so that they can have an artistic living environment.

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(3) Three levels of demand for the elderly's indoor environment

The physical and psychological characteristics of the elderly determine the particularity of their requirements for the indoor environment of the elderly apartment. On the one hand, based on Maslow's need class theory, the hierarchy required by the elderly for the indoor environment of the elderly is obtained; on the other hand, based on the behavioral space theory, the behavior level and content of the elderly are analyzed to determine the functional composition and attribute type of the elderly indoor space [20]. Combine the above two dominant theories with logical deduction. On this basis, the multi-level demand levels for the elderly can be more comprehensively established, and the specific connotation of each demand level can be accurately positioned. The following is a detailed description of the nature of different levels of demand for elderly apartments. The attributes of functional space and the key points of environmental design that need to be emphatically considered. The "comfortable living" and "livable living" as well as "happy living" are the three target levels in the optimization design of the indoor environment of the elderly apartment. The main design content is concentrated on six environmental requirements, as shown in Figure 2.

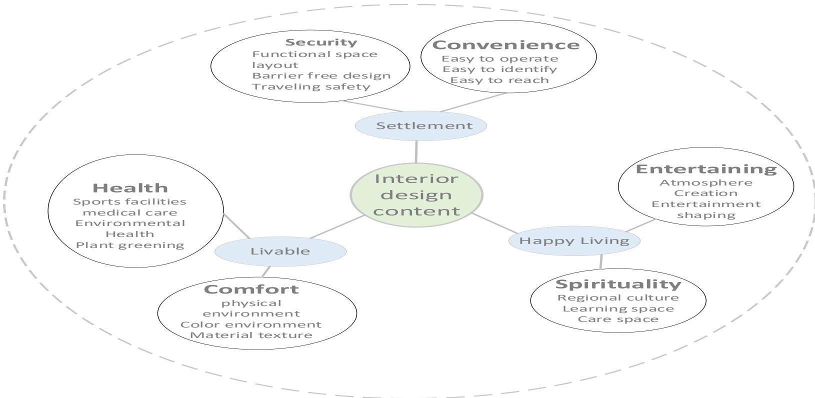

Figure 2: Interior residential design content

3. Life Cycle Cost Theory of Indoor Living Environment

(1) Concept of life-cycle cost theory

In the 1970s, the life-cycle cost theory of the construction industry also developed. During this period, the life-cycle cost theory of the construction industry developed rapidly and gradually formed a life-cycle cost analysis methodology system, which provides some theoretical and technical data support for follow-up research work around the world. However, the theoretical research of life cycle cost in China comes with the research of value engineering theory. However, at that time, Chinese scholars had not carried out in-depth research on this, and the composition and calculation method of life-cycle cost had not yet formed a unified standard. Especially in the field of construction, Chinese scholars only divided the life-cycle cost of buildings into construction cost and cost incurred in use. There is no in-depth study on the above two stages of cost calculation. In the 20th century, foreign scholars first defined the life-cycle cost theory: The life cycle cost refers to the discounted monetary cost of the design, construction, operation and subsequent maintenance and demolition of the building within a fixed time range. The definition of China is the total cost in the whole life cycle from the acquisition of land for construction projects to the design, construction, operation, maintenance and demolition, which is similar to that of foreign countries.

(2) Life cycle phase division

According to the investment management system and project construction procedures, Chinese experts and scholars divide the whole life cycle of a building into four stages: early stage, preparation, implementation and operation, or three stages: early stage, middle stage and late stage. Based on the definition of full life cycle, the indoor full life cycle is divided into decision-making design stage, implementation stage, operation and maintenance stage, and demolition and scrapping stage, as shown in Figure 3.

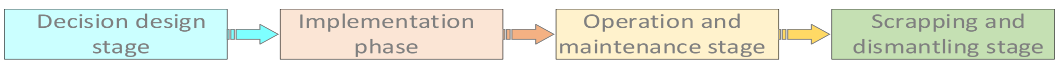

Figure 3: Life cycle phase division

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(3) Cost composition of full life cycle interior design

The cost composition of full life cycle interior design is the total cost of the project from planning, design, construction, operation to demolition. The whole life cycle was first proposed in the United States and applied to the whole process cost management of military industry. The whole life cycle cost consists of production cost and use cost. From the perspective of developer cost, consumer cost, environmental cost and social cost, this paper integrates the social and natural economy as a whole, as shown in Table 1. On the whole, it has achieved the three goals of the indoor residential environment architecture, namely, economy, environment and society.

Table 1: Cost composition of full life cycle interior design

Life cycle stage	Developer Costs	Consumer Costs	Environmental and social costs
Decision design stage	Cost of feasibility study, financing, survey, design, test and other processes		
implementation phase	Bidding, contract signing, labor, materials, machinery, management and other costs		Cost of pollution, garbage, health damage, etc
Operation stage	Transportation, storage, insurance, publicity and other expenses	Transportation, storage, energy materials, maintenance, equipment replacement and other costs	Packaging, pollution, garbage, health damage, etc
Scrapping and dismantling stage		Recovery and scrap costs	Cost of pollution, garbage, health damage, etc

4. Indoor Environment Detection Based on Big Data Algorithm and Artificial Intelligence

(1) Data analysis in big data indoor environment

1) Air data in indoor environment

Indoor air quality in residential environment would have a direct impact on human health. With the rapid development of urban construction, living standards are also improving, and decoration materials can directly affect the indoor ambient air quality. Therefore, through the analysis of indoor ambient air quality data, it is possible to effectively control various harmful substances in the air environment and take effective measures to control them. Various building materials would release various harmful substances under various environments and humidity, and the release rate of harmful substances varies greatly. By collecting a large number of air pollution gas data and taking targeted treatment measures to control indoor air quality, it is hoped that indoor ambient air quality would not harm people's health.

2) Lighting data in indoor environment

The lighting of indoor environment plays a very important role in normal life. It can not only provide lighting for the surrounding environment, but also make the living environment more harmonious and provide decoration for indoor space. When the room color temperature is assumed to be below 3300K, the room space would be dry. If the room color temperature is higher than 3000K and lower than 5000K, the space would be refreshing. If the color temperature is higher than 5000K, it can make people feel cool. In the same space, different color temperature difference would make the space perception effect different. Designers can effectively carry out targeted design in combination with the indoor environment to design different light source effects according to the actual application of each room in the indoor environment, so that people can have different feeling effects due to color temperature difference in different indoor spaces.

3) Acoustic data in indoor environment

The different structures of the indoor environment have different functions, so the requirements of the indoor structures of different districts on the room sound are very different. In order to achieve the various acoustic indicators of different indoor environments, designers should first make effective estimates based on the materials used in the interior structural design to ensure that the interior structural design can meet the needs of people in actual use. Before interior decoration, the sound

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absorption capacity and interior area of the materials used shall be effectively evaluated to ensure that the actual construction process is carried out according to the actual needs after careful calculation, so as to ensure that the phenomenon effect after construction is consistent with the preliminary design and meet the actual use requirements.

4) Relevant data of concealed lines in indoor environment

After the interior decoration is completed, the route hidden in the cement often breaks down. Therefore, it is very important to effectively detect the data related to hidden lines in the indoor environment. The water and electricity lines during construction can be detected in real time through wireless sensors, and the water and electricity data of hidden lines in the indoor environment can be effectively analyzed through the statistical data. The timely analysis of a large number of problems in the past design and construction can effectively provide reference for the following interior design. Designers can analyze the final problems from the aspects of relevant problem analysis, final results and causes of problems. The designer analyzes the use of hidden lines and indoor environment during construction, and can adopt reasonable construction methods, or design manholes to facilitate follow-up personnel to inspect hidden lines during construction, so as to minimize the probability of accidents and reduce property losses caused by failures.

(2) Construction of monitoring environment based on artificial intelligence and multimedia technology

1) Indoor thermal environment control based on machine learning

The traditional indoor thermal environment control is mainly based on the temperature setting value, and the temperature setting value is set by the operation manager or room user through the temperature controller. It is difficult to care about the different preferences of indoor users for the thermal environment through the settings of the operation manager, and the values set by the indoor users themselves often lead to irrational temperature settings. The research on the actual building shows that nearly 50% of the set values of the room temperature controller have reached the comfortable temperature range recommended in the design manual. These temperature settings are unreasonable. Machine learning in artificial intelligence technology can be used to classify the two-dimensional plane of indoor temperature and humidity into cold area, hot area and comfort area according to the cold and hot feeling points of users in each room, as shown in Figure 4. Through this machine learning, each room user's personalized comfort zone is determined to achieve the purpose of personalized thermal environment control, which increases user satisfaction and avoids problems such as overcooling, overheating and energy waste.

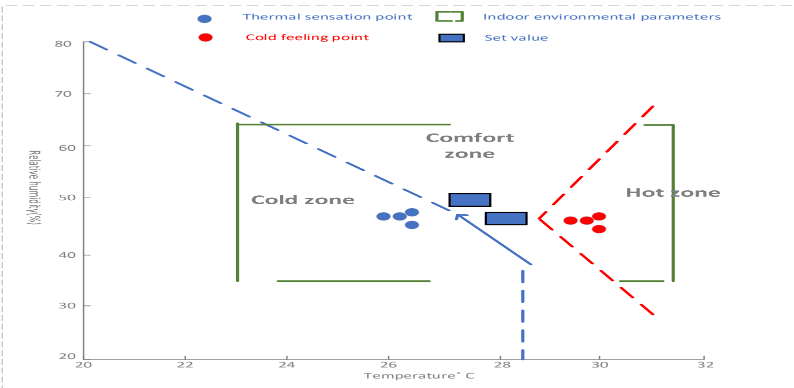

Figure 4: Machine learning of user thermal sensation based on classifier model

2) Indoor thermal environment control based on computer vision

There is a clear correlation between people's thermal sensation and skin temperature. If the skin temperature of indoor users can be known, the thermal feeling state of users can be predicted, and then the indoor thermal environment parameters can be intelligently adjusted to avoid the thermal environment that makes users feel uncomfortable. Computer vision technology helps to easily obtain the user's skin temperature. Some scholars have proposed a non-contact skin temperature measurement method that uses ordinary cameras to take pictures of the user's skin and speculates on the user's skin temperature based on the image chromaticity and saturation, which can achieve an accuracy of ± 2 ° C. Although the practicability of this method needs further study, its low cost, convenient use and non-contact measurement features make it still have a promising prospect. Compared with the use of

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ordinary imaging to estimate skin temperature, the use of infrared thermal imaging technology has higher accuracy and practicality for skin temperature detection. A predictive monitoring system for indoor thermal environment based on the thermal perception of users by infrared thermal imaging is developed. The experimental results show that the indoor thermal environment monitoring system based on infrared thermal imaging is higher than the conventional monitoring system based on the set value given by users in terms of user comfort. However, the infrared thermal imaging camera is expensive based on the infrared thermal imaging control method. It is necessary to develop science and technology to reduce costs.

3) Indoor thermal environment control based on natural language and body language recognition

Speech recognition technology has been developed rapidly in recent years, and has been used more and more widely in life. The use of speech recognition technology to achieve intelligent control of indoor thermal environment through speech expression would greatly facilitate room users and provide users with experience. In addition, the voiceprint recognition algorithm still needs to be broken through, that is, the algorithm to judge which user feels hot and cold according to the voice. The existing artificial intelligence technology still has some difficulties and needs to be broken through.

The indoor thermal environment control based on body language recognition is another promising application of artificial intelligence technology in indoor thermal environment control. At present, the research on body language recognition has been relatively rich, which has laid the basic conditions for indoor thermal environment control based on body language recognition. Relevant researchers have summarized human motion recognition as obtaining motion data through computer detection and then extracting symbolic motion information to understand motion features, so as to achieve motion recognition. By using artificial intelligence tools such as natural language and body language recognition, users' hot and cold feelings can be predicted, and users' personalized and dynamic thermal comfort models can be built. On this basis, the creation of indoor thermal environment that meets the requirements of personalized comfort is an artificial intelligence application with great application potential.

5. Comfort Evaluation Model of Living Environment Elements

This paper selects the indoor living environment monitoring system as the key research goal, starting from the perspective of the whole life cycle. On the basis of big data algorithm, the comfort evaluation model of residential environment is constructed, and the collected historical environmental parameter index data is compared with the comfort evaluation model of indoor residential environment constructed. The comfort evaluation value of indoor living environment is calculated and compared with the subjective evaluation value of residents to verify, so as to achieve the purpose of optimizing the indoor living design.

As a feedback function of indoor residents in the life process, there are many influencing factors. However, it is closely related to the emotion generated by indoor residents, that is, it mainly includes two aspects: One is the elements of indoor living environment and the other is the subjective emotion of indoor residents. The evaluation model of indoor living environment elements is constructed. Taking the subjective evaluation of indoor residents as an example, the evaluation model of indoor living environment is verified. The values of "0", "1", "2" and "3" are given to the indoor residents, and the comfort evaluation model of each element of the indoor living environment is established. The comfort evaluation models "0", "1", "2" and "3" of various factors of indoor living environment correspond to the subjective evaluation of "comfort", "slightly uncomfortable", "uncomfortable" and "very uncomfortable" of indoor residents.

The metabolic heat production M in the human body provides energy for the body's activities, and some of it is used in the W of the human body for doing work to the outside world. The net heat production of human beings is M-W, which conducts heat exchange with the external environment through the skin surface (q_{sk}) and respiratory tract (q_{res}). When the net heat production exceeds the heat exchange capacity, there is heat residue, which is specifically manifested in the rise of body temperature. On the contrary, there is deficiency and hypothermia. The surplus or deficit value is collectively referred to as the savings value S. The heat exchange between people and the surrounding environment is carried out through the skin by means of convection heat exchange E_{sk} and radiation heat exchange ruler, and the total heat lost E is evaporated from the skin; the human respiratory heat

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loss mainly consists of sensible heat c_{res} and latent heat E_{res}. According to the heat exchange principle, the formula is as follows:

$$M - W = q_{sk} + q_{res} + S = \left(C + R + E_{\mathrm{sk}}\right) \tag{1}$$

In the formula, R is the radiation heat exchange.

$$R = \varepsilon f_{el} f_{eff} \sigma\left(T_{el}^4 - T_t^4\right) \tag{2}$$

Among them, ε is the emissivity of human body surface; the value of σ pairs of ash is equal to the absorptivity; f_{eff} is Stephen Boltzmann constant; T_{el} is the effective coefficient of human posture influence; T_{t} is the average ambient radiation temperature. Let the formulas be:

$$R = 3.96\times 10^{-8} f_{el}\left[\left(t_{el} + 273\right)^4 - \left(t_t + 273\right)^4\right] \tag{3}$$

$$C = f_{el} h_e\left(t_{el} - t_{\mathrm{t}}\right) \tag{4}$$

Among them, C is convection heat transfer.

$$E_{\mathrm{sk}} = E_{\mathrm{dif}} + E_{rsw} \tag{5}$$

Among them, E_{sk} is the evaporation heat loss of skin and $E_{\mathrm{dif}} = 3.05\left(0.254T_{sk} - 3.335 - p_a\right)$.

T_{sk} is the skin surface temperature:

$$T_{\mathrm{sk}} = 35.7 - 0.0275\left(M - W\right) \tag{6}$$

E_{rsw} is the evaporation heat loss of sweat, W/m:

$$E_{rsw} = 0.42\left(M - W - 58\right) \tag{7}$$

Sensible heat dissipation c_{res} is as follows:

$$c_{res} = 0.0014M\left(34 - t_a\right) \tag{8}$$

Latent heat dissipation E_{res} is as follows:

$$E_{res} = 0.0173\left(5.87 - p_a\right) \tag{9}$$

The evaluation models PMV_{TMP} of air temperature comfort are as follows:

$$PMV_{TMP} = 16.01\log\frac{X_{TMP}}{24}\left(X_{TMP} > 24\right) \tag{10}$$

$$PMV_{TMP} = 16.01\log\frac{24 + X_{TMP}}{24}\left(X_{TMP} < 24\right) \tag{11}$$

The evaluation model PMV_{RH} of air relative humidity comfort is as follows:

$$PMV_{RH} = 9.80\log\frac{X_{RH}}{50}\left(X_{RH} > 50\right) \tag{12}$$

When the air relative humidity does not exceed 50%, the environmental parameter air relative

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humidity in the thermal environment is the independent variable X_{RH}; the relative air humidity comfort evaluation model PMV_{RH} is defined as:

$$PMV_{RH} = 13.69\log\frac{50+X_{RH}}{50}\left(X_{RH} < 50\right) \tag{13}$$

The evaluation model PMV_{TE} of thermal environment comfort is as follows:

$$PMV_{TE} = MAX\left(PMV_{TMP}, PMV_{RH}\right) \tag{14}$$

The carbon dioxide comfort evaluation index model PMV_{CO_2} is as follows:

$$PMV_{CO_2} = 6.364\log\frac{X_{co_2}}{485} \tag{15}$$

Residential Safety Program (RSP) comfort evaluation model is as follows.

$$PMV_{PM10} = 2.096\log\frac{X_{PM10}}{0.02} \tag{16}$$

The comfort evaluation model of formaldehyde PMV_{HCHO} is as follows:

$$PMV_{HCHO} = 2\log\frac{X_{HCHO}}{0.01} \tag{17}$$

The evaluation model of air environment comfort is as follows:

$$PMV_{AQ} = MAX\left(PMV_{CO_2}, PMV_{PM10}, PMV_{HCHO}\right) \tag{18}$$

The comfort evaluation model PMV_{VO} in acoustic environment is as follows:

$$PMV_{VO} = 5.09\log\frac{X_{VO}}{35} \tag{19}$$

The evaluation model PMV_{LU} of light environment parameter comfort is as follows:

$$PMV_{LU} = 4.11\log\frac{X_{LU}}{400}\left(X_{LU} > 400lx\right) \tag{20}$$

6. Evaluation of Indoor Environment Comfort Evaluation Model

(1) Analysis of comfort evaluation model of air temperature

The relationship between indoor air temperature comfort evaluation model and subjective evaluation of indoor residents' comfort at low and medium temperatures is shown in Table 2:

Table 2: Relationship between comfort evaluation model of air temperature and subjective evaluation of residents' comfort

Temperature (°C)	Air temperature comfort model	Comfort evaluation
11	2	Discomfort
24	0	comfortable
28	1	Slightly uncomfortable
32	2	Discomfort
34	3	Extremely uncomfortable

There is a comparative relationship between the indoor air temperature comfort evaluation model

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and the subjective evaluation value of residents' comfort, as shown in Figure 5.

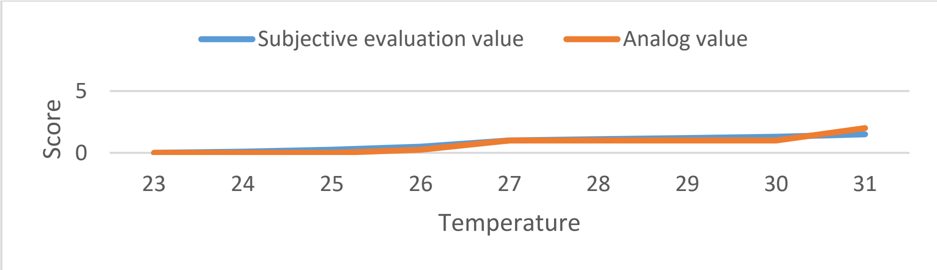

Figure 5: Comparison between comfort model of air temperature and subjective evaluation value of comfort

The indoor living environment in Figure 5 has a high evaluation on the comfort of indoor residents, so the temperature should be controlled below 27 ℃. At this time, the corresponding air temperature comfort model is $PMV_{TMP}=1$.

(2) Analysis of the evaluation model of air relative humidity comfort

In the relatively low and medium humidity room, the relationship between the thermal environment parameter air relative humidity comfort evaluation model and the subjective evaluation of indoor residents' comfort is shown in Table 3:

Table 3: Relationship between comfort evaluation model of relative air humidity and subjective evaluation of indoor residents' comfort

Relative humidity (%)	Air relative humidity comfort model	Comfort evaluation
20	2	Discomfort
50	0	comfortable
60	1	Slightly uncomfortable
80	2	Discomfort
90	3	Extremely uncomfortable

The comparative relationship between the indoor thermal environment parameter air relative humidity comfort evaluation model and the subjective evaluation value of indoor residents' comfort is established, as shown in Figure 6:

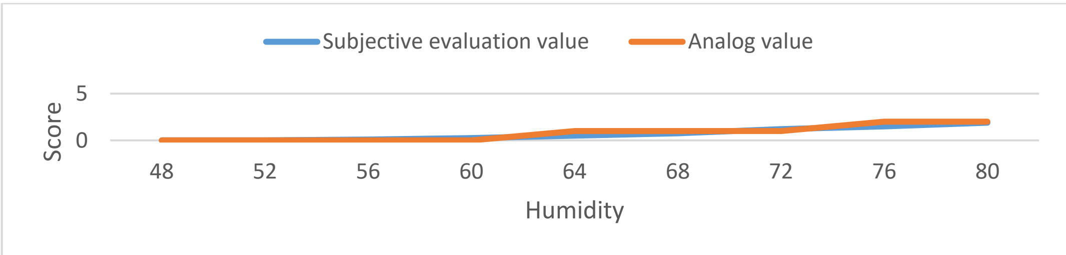

Figure 6: Comparison between the comfort evaluation model of air relative humidity and the subjective evaluation value of comfort

According to Figure 6, to create an indoor living environment where indoor residents have a high subjective evaluation of comfort, the relative humidity should be kept below 64%. At this time, the relative air humidity comfort model is $PMV_{RH}=1$.

(3) Analysis of thermal environment comfort evaluation model

Based on the air temperature and air relative humidity environmental parameter index information obtained by the residential environment monitoring system, the thermal environment comfort evaluation model is constructed with the air relative humidity and air temperature as the comprehensive index. The thermal environment comfort and the subjective evaluation value of residents' comfort as well as the relevant data of thermal environment air temperature and air temperature environmental parameters are compared, as shown in Table 4:

The comparison relationship between indoor thermal environment comfort evaluation model and

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subjective comfort evaluation value of indoor residents is shown in Figure 7:

Table 4: Computational thermal environment comfort evaluation model

Scene	Air temperature comfort model	Air relative humidity comfort model	Thermal environment comfort evaluation model
1	2.82	2.31	2.82
2	1.63	1.87	1.87
3	2.78	2.26	2.75
4	1.09	1.56	1.56
5	1.54	1.73	1.82
6	2.77	2.24	2.83
7	1.46	1.64	1.64
8	1.60	1.78	1.78
9	0.95	1.45	1.45

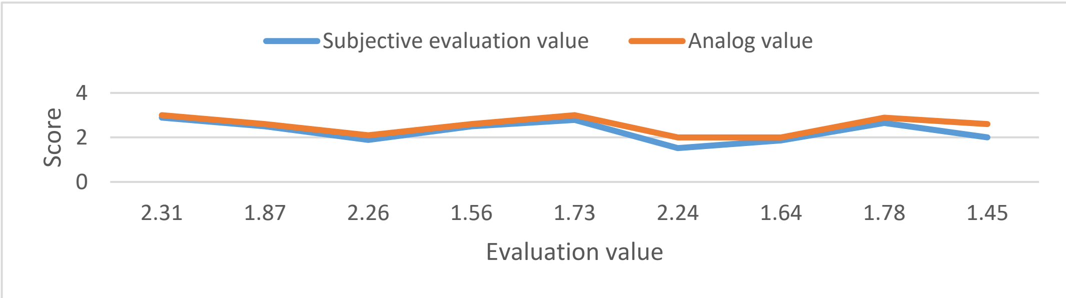

Figure 7: Comparison between thermal environment comfort evaluation model and subjective comfort evaluation value

It can be seen from Figure 7 that the corresponding relationship between thermal environment comfort evaluation model and residents' subjective evaluation of comfort is basically the same. To create an indoor living environment where residents have a high subjective evaluation of comfort, the air temperature should not be lower than 27 ℃ and the air relative humidity should be lower than 64%. At this time, the corresponding air temperature comfort evaluation model is $PMV_{TE}=1$, and the air relative humidity comfort evaluation model is $PMV_{AQ}=1$.

(4) Analysis of evaluation model of light environment comfort

The relationship between the evaluation model of light environment comfort and subjective evaluation of residents' comfort under low and medium light conditions is shown in Table 5:

Table 5: Relationship between light environment comfort evaluation model and subjective evaluation of indoor residents' comfort

Illuminance (lx)	Evaluation model of light environment comfort	Comfort evaluation
200	1	Slightly uncomfortable
300	0.5	comfortable
400	0	comfortable
500	0.5	comfortable
700	1	Slightly uncomfortable

The comparative relationship between the light environment comfort assessment model and the occupant comfort assessment value is shown in Figure 8.

To sum up, in order to deeply understand the role of various environmental elements in the residential environment on residents' comfort, this paper reasonably divides the environment that affects residents' comfort into thermal environment, air environment, acoustic environment and light environment, and constructs an evaluation model for the comfort of various environmental elements. It not only improves the performance level of indoor living environment by 12%, but also realizes the optimal design of indoor living environment on the basis of big data and artificial intelligence.

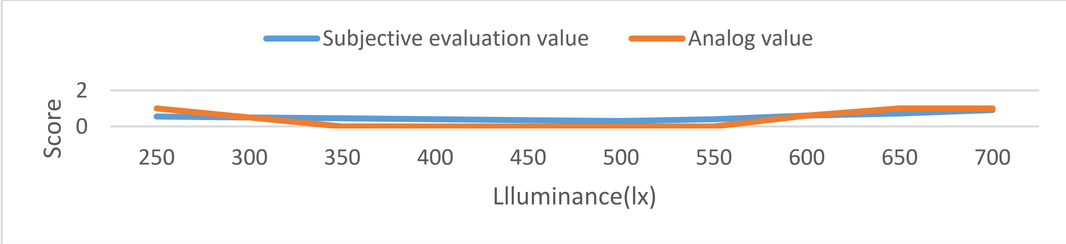

Figure 8: Comparison between evaluation model of light environment comfort and subjective evaluation value of comfort

7. Conclusions

This paper selected the monitoring system of the elderly indoor living environment as the key research goal. Focusing on the safety problem of whether the environmental parameters such as formaldehyde and inhalable particles in the indoor air environment exceed the standard, this paper planed to systematically design a set of indoor living environment monitoring system based on the combination of big data and artificial intelligence to ensure the health, comfort and personal and property safety of indoor residents. The comfort evaluation model of the corresponding environmental parameters of each environmental element in the residential environment was constructed, and the accuracy of the comfort evaluation model of the environmental elements was verified by the subjective evaluation of the comfort of the residential environment by residents. Although this paper has summarized the indoor living environment monitoring system, there are still some deficiencies in some details. The details of the system robustness, system market popularity and comfort comprehensive evaluation model still need to be further improved.

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