Computer-Aided Design and Multimodal Data Fusion in Green Building Planning

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Abstract. In recent years, with the advancement of neural networks, people have gradually shifted their research focus to green building energy consumption. In the field of key point extraction, the energy consumption of green building planning buildings is too complex to use a single method to improve the accuracy of matching due to the information it contains. At present, traditional algorithms and convolutional neural networks handle the relationship between energy consumption, but existing traditional algorithms extract energy consumption features from different perspectives. It is precisely because of the emergence of multimodal data fusion technology that energy consumption information can be converted into a simple and understandable form, making it easier for people to solve problems in the field of energy consumption. The basis of the research is to process the relationship between extracted energy consumption features in order to solve problems in energy consumption recognition, energy consumption retrieval, and other fields. This paper proposes a key point extraction method for building energy consumption based on the combination of traditional algorithms and multimodal data fusion technology and adds an attention mechanism to improve accuracy. Finally, the ratio testing algorithm was used to effectively eliminate mismatched points, thereby improving the reliability of the matching results.

Keywords: Green Building Planning; Computer-Aided Design; Multi-Modal Data Fusion; Performance Simulation And Optimization
DOI: https://doi.org/10.14733/cadaps.2025.S3.52-65

1 INTRODUCTION

In recent years, with the introduction of the concept of real-life 3D, there has been an increasing amount of research on simplifying green building models. However, there has been relatively little consideration for texture in these studies [1]. To construct a multi-level model of green building models, it is necessary to simplify the existing high-resolution green building models to reduce their complexity and data volume [2]. On the one hand, it can reduce the data volume and geometric complexity of the model and improve the network transmission efficiency and real-time rendering efficiency of the model. On the other hand, it improves the usability of the model, facilitating interactive operations and more complex scientific computing tasks. It is of great significance to simplify the green building model without changing its appearance as much as possible in order to generate a multi-level detail model [3]. By using specific algorithms, a high-resolution complex model can be transformed into multiple simple models of different resolutions. Due to the limitation of the amount of information carried by the computer screen itself, the details that the human eye can perceive on the screen within a specific visual range are limited. Model simplification is a widely used and mature topic, and most model simplification algorithms are applied to specific scenarios or applications. Directly applying the general 3D model simplification algorithm to the simplification operation of green building models usually cannot achieve good application results, so it is necessary to conduct separate research on the simplification of green building models. Reducing the computer performance occupied by the model during use can help improve the rendering efficiency of the model [4]. However, green building models are a relatively unique type of three-dimensional model. On the one hand, green building models have the complexity of topological relationships and the discontinuity of textures. On the other hand, some structures of green building models have complex texture patterns. Some building models have a large number of complex structures and independent components, and adjacent structures will influence and correlate with each other. This enhanced visibility and accessibility allows architects to confidently make design choices that are both aesthetically pleasing and environmentally friendly [5].

In traditional hotel literature, discussions on green building design are often marginalized, but this article reaffirms its core position in promoting the hotel industry towards a more sustainable and environmentally friendly direction through empirical research. The integration of green building planning and ecological services is an indispensable pillar in building green hotels. Hotel developers are increasingly emphasizing green building planning, aiming to save money, reduce operating costs, and promote environmental sustainability through innovative architectural design strategies. Hotel operators further adopt green practices, not limited to daily operations, but delving deeper into the accommodation experience itself, in order to consolidate their market position by enhancing tourists' willingness to stay (IoS). This transformation not only reflects the hotel industry's commitment to environmental responsibility but also a key strategy to attract tourists who value sustainable tourism [6]. It not only focuses on the performance of buildings in terms of energy conservation, environmental protection, and resource recycling but also strives to enhance tourists' experience and awareness of green living through advanced technologies such as the Internet of Things. Therefore, some scholars have delved into tourists' attention to the environment (EC), their perceived importance of green building design (PIGBD), and the intrinsic connection between these factors and IoT applications in green hotels. Due to the texture mapping of 3D models embedding 2D texture space into 3D grids, simplification of the model may result in stretching or compression of the 3D grid model, leading to texture distortion in the building model after texture mapping. Thus achieving better visual effects in the use of the model. The construction of real-life 3D is of great significance. At the same time, in order to improve the efficiency of organizing and scheduling massive green building models in three-dimensional scenes, it is necessary to design reasonable and efficient data organization and management methods based on the structural and attribute characteristics of the green building models themselves. Considering texture in the simplification of green building models while minimizing the data volume and complexity of the model, important geometric and visual features of the model are still preserved [7]. A unified spatiotemporal reference framework is used to organize and manage multi-source heterogeneous green building model data in 3D scenes and to support applications in various industries. This is of great significance for improving the query, retrieval, and computational efficiency of model data. More importantly, PIGBD, as a moderating factor, plays a bridging role between EC and IoS, indicating that tourists' awareness and importance of green building design attributes directly affect their accommodation decisions based on environmental factors.

Traditional simulation methods often face the challenge of time-consuming or neglecting the overall design of buildings, making it difficult to fully meet the comprehensive performance optimization needs of green building planning. In the broad perspective of green building planning, the importance of designing photovoltaic shading systems (PVSS) as a key measure to improve building energy efficiency and environmental friendliness is self-evident. In view of this, some researchers have innovatively proposed a comprehensive method for architects based on parameterized script modelling and multi-objective optimization (MOO) algorithms. Aim to seamlessly integrate the thermal and lighting performance of PVSS, and explore the optimal design solution set through intelligent algorithms. Through a carefully designed case study, the specific workflow of the integrated simulation method in PVSS design practice is demonstrated, from parameter setting, and model construction to optimization calculation, each step closely revolves around the core goals of green building planning. This method not only overcomes the limitations of traditional methods but also promotes the deep integration of architectural design thinking and performance analysis techniques, injecting new vitality into green building planning [8]. The integrated framework not only significantly improves the overall performance of PVSS, but also demonstrates higher design flexibility and adaptability, providing architects with a more comprehensive and scientific decision-making basis. To achieve this goal, it is necessary to accurately grasp the delicate balance between solar heat gain and solar transmittance in the preliminary design stage of buildings, which requires the use of efficient and forward-looking analytical tools. This research achievement not only verifies the effectiveness and superiority of integrated simulation methods in PVSS design but also opens up new ideas for the field of green building planning. Meanwhile, we conducted a detailed comparison between the optimization results under the integrated framework and three schemes using a single optimization objective strategy, and the results were encouraging. It indicates that by combining advanced parametric modelling techniques, multi-objective optimization algorithms, and green building concepts, innovation and development of building shading systems and even integrated photovoltaic technology can be greatly promoted [9].

The innovation of this framework lies in its integration of various technologies and data, and its realization of scientific and intelligent green building planning. Algorithm design innovation: In this article, CAD algorithm and multimodal data fusion algorithm for green building planning are designed, which fully consider the special needs of green building planning and realize efficient and accurate calculation and data fusion. The innovation of the algorithms is that they optimize the practical problems of green building planning and improve the efficiency and quality of planning.

In the introduction, the background and significance of green building planning are elaborated, accompanied by an introduction to the fusion technology of CAD and multimodal data, alongside the research's purpose and importance. Following this, a literature review examines the progress and gaps in related fields, laying a theoretical foundation. Subsequently, the fundamentals of CAD and multimodal data fusion technology, and their application framework in green building planning, are introduced in depth, encompassing framework components and workflow. This section particularly focuses on the design and implementation of CAD and multimodal data fusion algorithms tailored for green building planning. Lastly, the validity of the proposed framework and algorithm is confirmed through experiments and case studies. The research outcomes, contributions, and future research directions are summarized and discussed.

2 RELATED WORK

Prior to delving into the combined application of CAD, multi-modal data fusion, and green building planning, it is imperative to synthesize the research conducted in related fields. This synthesis aims to elucidate the merits and demerits of existing technologies, identify research gaps, and establish a robust theoretical foundation for the research presented in this article [10]. Given the complexity and diversity of information in the built environment, developing efficient and accurate data fusion mechanisms to optimize energy use and reduce unnecessary consumption has become an indispensable part of green building planning. Livshits et al. [11] aim to provide detailed guidance for the energy research community by extensively studying the data fusion mechanisms currently applied to green building energy-saving systems. It comprehensively considers the level of data fusion, technology selection, behaviour change promotion mechanism, data recording methods, platform architecture design, IoT technology integration, and specific application scenarios. In the grand blueprint of green building planning, data fusion strategy, as a key technology to promote building energy efficiency and sustainable development, is increasingly becoming a focus of attention both inside and outside the industry. This work aims to establish a comprehensive knowledge framework to help green building planners better grasp the power of data fusion. This method cleverly converts one-dimensional power signals into two-dimensional spatial images and achieves high-precision electrical recognition through image processing techniques. In addition, a comprehensive comparison was made between existing energy efficiency frameworks based on multidimensional parameter data fusion. It not only deeply analyzes the conceptual framework and advantages of these strategies, but also faces the challenges and shortcomings they face, and systematically classifies and evaluates various data fusion technologies and their influencing factors. Of particular note, Tai and Sung [12] proposed a novel electrical appliance recognition method based on the fusion of 2D local texture descriptors. This comparative analysis not only reveals the similarities and differences between different strategies but also provides a valuable reference for practitioners of green building planning. The validation results on multiple real datasets show that this method exhibits excellent performance, with accuracy and F1 score approaching the limit, providing strong technical support for power monitoring and management in green buildings.

In the context of green building planning, protecting and respecting historical heritage is not only a tribute to the past but also an important measure to lay a cultural foundation for future sustainable development. Combining the perspectives determined by these two methods, Xie [13] proposed a visual experience archiving scheme for architectural spaces based on digital photography technology. With the increasing global awareness of environmental protection and cultural heritage value, how to integrate historical heritage protection elements into green building planning has become an important issue that urgently needs to be addressed. Spatial syntactic analysis further reveals key nodes in spatial structure, which not only have a broad view but also maximize the connection and display of surrounding space. Traditional recording methods, such as drawing blueprints and taking photos, have to some extent established cultural heritage archives but often focus on the external form and physical features of buildings while ignoring the spatial experience and perceived value of tourists within them. By introducing the assumptions of frequency and maximum information, it attempts to determine the normative perspective that best represents the characteristics of architectural space and evokes deep memories in people. Behavioural mapping technology is used to track the gaze trajectory of tourists, revealing which scenes are most commonly observed and representative.

Zhang et al. [14] simplified the algorithm mainly by compressing the geometric data of 3D building models. Using image compression techniques to generate multi-level textures, thereby synchronously reducing the amount of texture image data in the model simplification. Simplifying algorithms to generate multi-resolution 3D building models requires setting parameter information based on the type of model, which is cumbersome and complex. At the same time, there is a lack of a quantitative indicator to calculate the optimal simplification rate for obtaining the best simplification quality at different line-of-sight ranges. The texture images carried by the model itself occupy a larger amount of data. In 3D visualization, the rendering of texture images takes up a higher proportion of time, so it is necessary to simplify the texture images simultaneously when simplifying the model. Zhao [15] proposed a collaborative design solution based on the powerful information integration and analysis capabilities of BIM technology to address the common problems of low energy efficiency, material waste, and insufficient environmental adaptability in current urban architectural design. We strive to improve the green performance of buildings from the source, including design process management, process information tracking, building material selection, and building structure optimization. BIM (Building Information Modeling) technology, as a revolutionary force in the contemporary field of architecture, is not only a core tool for analyzing and optimizing building energy consumption but also an important technical support for the practice of green building planning concepts. Especially how to develop efficient building energy-saving construction algorithms through the collaborative design function of BIM technology, in order to comprehensively integrate and optimize the building design process. This plan not only focuses on the physical form and spatial layout of architectural design but also deeply analyzes various aspects of the architectural design process. These algorithms not only consider the rationality and durability of building structures but also fully consider green design elements such as natural lighting and ventilation, aiming to minimize building energy consumption and optimize environmental impact. In terms of specific implementation, we conducted empirical research on energy-saving renovation and optimization design using BIM technology based on an actual case of a university building in a certain city. Conduct detailed simulation analysis of existing buildings through BIM models, identify energy consumption hotspots and potential energy-saving points, and then design targeted energy-saving construction algorithms. In addition, this study emphasizes another important role of BIM technology in green building planning: promoting interdisciplinary collaboration and information sharing. Through the BIM platform, architects, structural engineers, energy experts, and environmental consultants can share data in real time to jointly solve complex problems in the design process, ensuring the scientific, feasible, and sustainable nature of green building solutions. Summarily, while existing research has attained accomplishments in CAD, multimodal data fusion, and green building planning, studies examining the effective integration of these three aspects for green building planning remain limited. Hence, this article, building upon existing research, aims to delve deeper into the application of CAD and multimodal data fusion technology in green building planning, with an emphasis on designing and implementing pertinent algorithms.

3 METHODS

In green building planning, CAD technology plays a vital role. In this section, firstly, the design conception and model construction are carried out by using CAD software, and a 3D model of a green building is established, which comprehensively covers key elements such as architectural form, structural layout and material selection. In this way, designers can intuitively show the design effect and make preliminary evaluations and adjustments to the design.

In order to know more about the performance of green buildings in different climatic conditions, this article combines the professional building energy consumption simulation software -EnergyPlus to simulate and optimize the performance.

Faced with massive and complex raw data, preprocessing steps are particularly crucial. Normalization converts all data to the same scale, making it easier for subsequent algorithms to process and compare. The cleaning process aims to remove erroneous, duplicate, or invalid data points to ensure the accuracy of the data. This series of preprocessing operations not only improves the quality of data but also enhances the comparability between data, laying a solid foundation for subsequent multimodal data fusion. Denoising processing is used to smooth out random fluctuations in data and reduce noise interference. After data preprocessing is completed, using advanced machine learning algorithms such as support vector machine (SVM) for feature extraction and classification is a key step in technical implementation. In green building planning, SVM can extract key environmental features, traffic flow patterns, energy demand predictions, and other information from multimodal data, providing planners with a scientific decision-making basis. The implementation of multimodal data fusion technology not only promotes the scientific and accurate planning of green buildings but also provides strong support for the construction of smart cities. (Figure 1).

The polynomial kernel function is exemplified as follows:

$$K(x,y) = (x \cdot y + 1)^{d} \tag{1}$$

For a given training sample, the dimension of the system is determined by the degree d of the polynomial. Therefore, the purpose of controlling the dimension of the system can be achieved by properly selecting the d value. The Sigmoid kernel function is as follows:

$$K(x,y) = \tanh(v(x,y) + a) \tag{2}$$

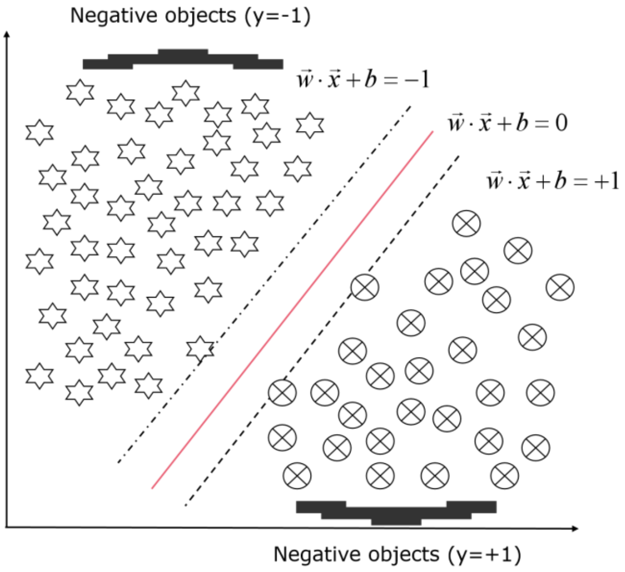

Figure 1: SVM algorithm classification.

An S-shaped function employs the hyperbolic tangent function, tanh, which satisfies the Mercer condition solely when v, a assumes an appropriate value.

For the multi-modal data fusion task, the SVM implementation steps are:

Data Preprocessing: Initially, preprocess data from diverse channels, entailing cleaning, denoising, and normalization, to ensure data quality and consistency.

Feature Selection: Based on data attributes and fusion objectives, select pertinent features as SVM input.

Suppose a training sample set $\{(x_i, y_i)\}_i^N$, in which input data $x_i \in R^n$ and output data $y \in R$ construct an optimal linear function in a high-dimensional feature space:

$$f(x) = w^T \varphi(x) + b \tag{3}$$

$$a^l = \text{Activation function}\left(\mathrm{W}^l a^{l-1} + b^l\right) \tag{4}$$

Where a^{l-1} is the output of the upper layer, W^l is the weight matrix and b^l is the offset vector.

Backpropagation is a key step for updating weights and offsets in the training process of neural networks. It is realized by calculating the gradient of the loss function with respect to weight and bias. For the weight W^l and the offset b^l, the gradients are:

$$\frac{\partial L}{\partial \mathrm{W}^l} = \frac{\partial L}{\partial a^l} a^{l-1} \tag{5}$$

$$\frac{\partial L}{\partial \mathrm{b}^l} = \frac{\partial L}{\partial a^l} \tag{6}$$

The formula for weight update is:

$$\mathrm{W}^l = \mathrm{W}^l - \alpha \frac{\partial L}{\partial W^l} \tag{7}$$

Where a is the learning rate?

Hidden Layer Design: Based on data complexity and fusion task requirements, multiple hidden layers are designed. Each hidden layer comprises a specific number of neurons, utilizing activation functions to introduce nonlinear mapping capabilities.

Output Layer Design: Tailored to the fusion objective, the output layer is designed. For classification tasks, the softmax function is applied to output the probability of each category. For regression tasks, the output layer directly provides the predicted value. In this context, cross-entropy serves as the loss function:

$$H(p,q) = -\sum_{x} p(x) \log q(x) \tag{8}$$

Where p stands for correct value and q stands for predicted value. The probability distribution $P(y|x)$ is usually calculated by the softmax function. The cross-entropy loss function is defined as follows:

$$L(y,P(y|x)) = -\sum_{i=1}^{N} y_i \log(P(y_i|x)) \tag{9}$$

Where y_i is the indication of the i class in the real tag, and $P(y_i|x)$ is the probability that the model predicts the i class when the input x is given.

Training DNN: Utilize the labelled training data to train the DNN. During this process, the network learns to integrate SVM-extracted features into a unified data representation and optimizes its parameters to enhance the quality and accuracy of the fused data.

Fusion and recognition: The trained DNN effectively integrates data from diverse modes, eliminating redundancies and contradictions between them. Additionally, it enhances feature extraction and pattern recognition within the fused data, ultimately offering more comprehensive and accurate information to support green building planning.

4 EXPERIMENT AND RESULT ANALYSIS

4.1 Experimental Design

In order to explore and verify the practical effectiveness and unique advantages of CAD technology and multimodal data fusion strategy in the field of green building planning, this section carefully planned and implemented a series of rigorous and systematic experiments. By combining these three algorithms with CAD technology and multimodal data fusion solutions, we can comprehensively and deeply explore the potential and possibilities in green building planning. These algorithms have their own characteristics, and genetic algorithms are known for their powerful global search capabilities and adaptive evolution mechanisms, making them suitable for solving complex optimization problems. Through multimodal data fusion technology, we have successfully integrated multi-source heterogeneous data such as topography, climate conditions, vegetation coverage, and traffic flow seamlessly into the design process, achieving comprehensive integration and accurate matching of design information. These experiments not only aim to comprehensively analyze the performance of different algorithms in complex green building planning scenarios but also strive to provide solid data support and a theoretical basis for the continuous optimization and widespread application of technology. During the experiment, we first used CAD software to construct a high-precision 3D green building model. This step not only ensures the intuitiveness and visualization of the design scheme but also lays a solid foundation for subsequent data fusion and optimization work. Each algorithm is carefully designed with experimental scenarios and parameter settings tailored to its specific advantages to ensure that its performance can be fully utilized. In the optimization phase, we applied the genetic algorithm, particle swarm optimization algorithm, Kalman filter, and our proposed innovative algorithm to optimize the green building design scheme. Through simulation experiments, we systematically evaluated the performance of various algorithms in terms of optimization efficiency, solution quality, convergence speed, and adaptability to complex environmental changes, providing a scientific reference for the optimization of green building planning schemes.

4.2 Experiment and Result Analysis

In terms of energy consumption, experimental data shows that all tested algorithms have reduced the overall energy consumption of buildings to a certain extent. The particle swarm optimization algorithm, with its fast convergence characteristics, has achieved a significant reduction in energy consumption in a relatively short period of time. Specifically, genetic algorithms have demonstrated strong potential in finding the optimal energy consumption solution through their global search capability, enabling them to find ideal equilibrium points in complex design parameter spaces. Although the Kalman filter is mainly used for state estimation and prediction, it has also shown a positive effect in improving system energy efficiency when combined with energy optimization algorithms. The innovative algorithm we proposed achieves more refined energy management by integrating the advantages of multimodal data, further reducing the operating costs of buildings. as presented in Table 1.

Algorithm name	*Energy Consumption Performance (kWh/m²/year)*	*Daylighting Performance (%)*	*Ventilation Performance (m³/h)*
GA	120	70	500
PSO algorithm	115	72	510
Kalman filtering algorithm	130	75	490
Algorithm in this article	125	85	600

Table 1: Influence of different algorithms on design effect.

Analyzing the table's contents, we can derive the following conclusions:

(1) Energy consumption performance

GA and PSO algorithms are excellent in energy consumption performance, among which the PSO algorithm has the lowest energy consumption of 115 kWh/m/year, followed by GA with 120 kWh/m/year.

The energy consumption of the Kalman filter algorithm is relatively high, which is 130 kWh/m/year.

The energy consumption performance of this algorithm is in the middle level, which is 125 kWh/m/year. Although it is not as good as the PSO algorithm, it is lower than the Kalman filter algorithm.

(2) Daylighting performance

The algorithm in this article is the best in lighting performance, and the lighting performance reaches 85%.

The daylighting performance of the Kalman filter algorithm and PSO algorithm is similar, which is 75% and 72% respectively.

The daylighting performance of GA is relatively weak, which is 70%.

(3) Ventilation performance

The algorithm in this article is the best in ventilation performance, and the ventilation volume reaches 600 m³/h.

The ventilation performance of the PSO algorithm is similar to that of GA, which is 510 m/h and 500 m/h, respectively.

The ventilation performance of the Kalman filter algorithm is relatively weak, which is 490 m³/h.

To sum up, different algorithms have their own advantages and disadvantages in energy consumption, lighting, and ventilation performance. PSO algorithm performs best in energy consumption, while this algorithm performs best in lighting and ventilation.

At the same time, this section analyzes the efficiency and accuracy of different algorithms in data fusion, feature extraction, and performance simulation. The efficiency and accuracy of GA, PSO, Kalman filter, and this algorithm are shown in Figures 2-5.

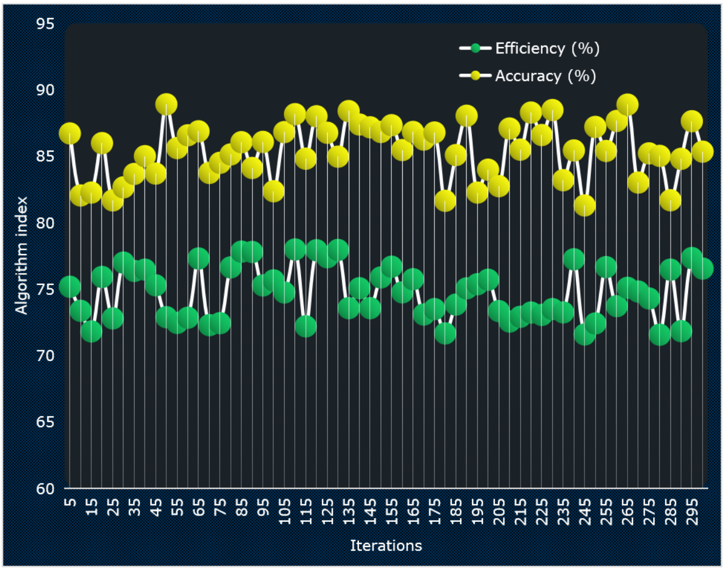

Figure 2: GA performance.

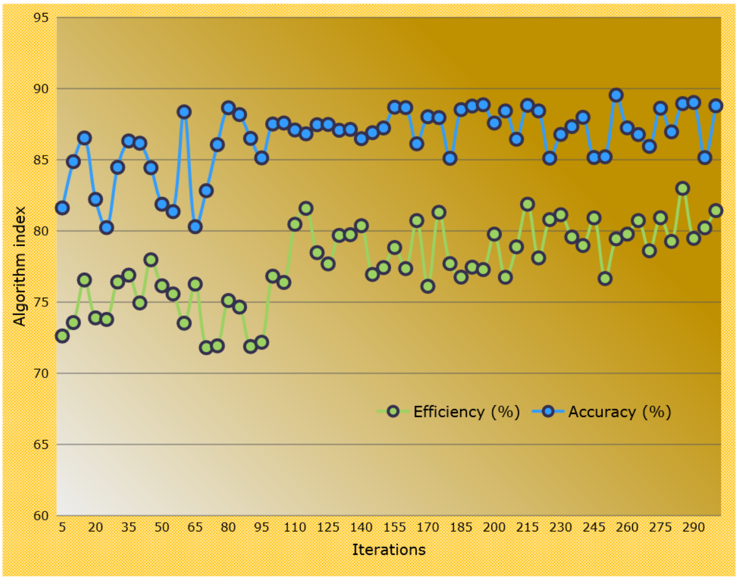

Figure 3: PSO algorithm performance.

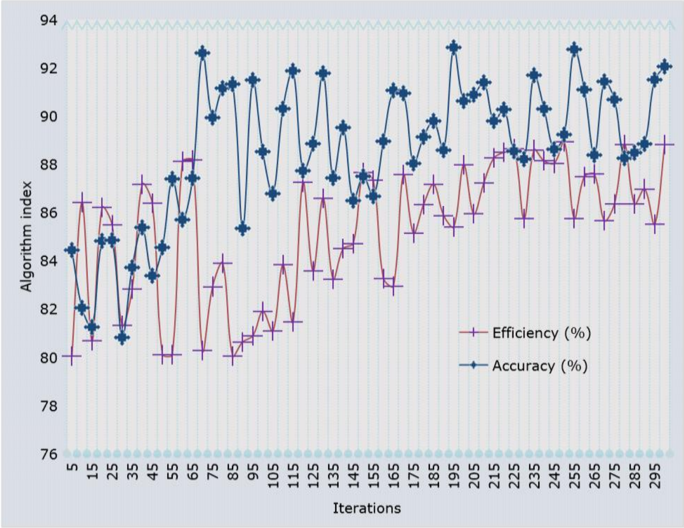

Figure 4: Performance of Kalman filtering algorithm.

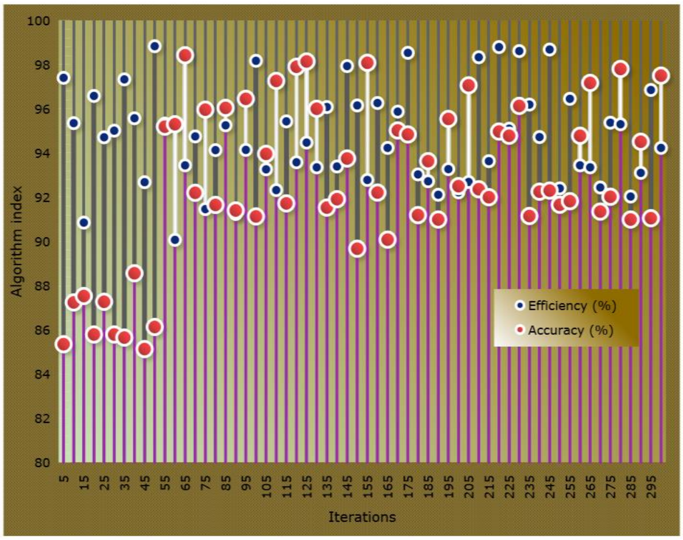

Figure 5: The algorithm performance in this article.

To reflect the realization results more intuitively, the following is summarized in Table 2:

Algorithm name	*Efficiency (%)*	*Accuracy (%)*
GA	75	85
PSO algorithm	80	88
Kalman filtering algorithm	85	90
Algorithm in this article	95	96

Table 2: Comparison of efficiency and accuracy of different algorithms.

Upon analyzing the contents of the aforementioned table, we can deduce the following conclusions:

(1) Efficiency comparison

The efficiency of this algorithm is the best, reaching 95%, which is obviously higher than the other three algorithms. The efficiency of the Kalman filter algorithm is the second, which is 85%, and it also shows a high level of efficiency. The efficiency of the PSO algorithm is 80%, which is slightly lower than that of the Kalman filter algorithm, but it is still at a high level. The efficiency of GA is relatively low, 75%, which is the lowest among the four algorithms.

(2) Accuracy comparison

The algorithm in this article is also the best in accuracy, with an accuracy of 96%, showing a very high accuracy. The accuracy of the Kalman filter algorithm is the second, which is 90%, and it also shows high accuracy. The accuracy of the PSO algorithm is 88%, which is slightly lower than that of the Kalman filter algorithm, but it is also at a high level. The accuracy of GA is 85%, which is the lowest among the four algorithms, but it still remains at a certain level.

To sum up, the algorithm in this article is the best in efficiency and accuracy, which is obviously superior to the other three algorithms. Kalman filter algorithm and PSO algorithm also show a high level of efficiency and accuracy, while GA is relatively low, but they still have certain application values.

Through the analysis of the above experimental data, we will be able to evaluate the practical application value of CAD and multimodal data fusion technology in green building planning more accurately.

4.3 Case Selection and Practice

To intuitively demonstrate the application effectiveness of the proposed framework and algorithm, this section applies them to a specific green building planning case. The case fully leverages multi-modal data fusion technology, integrating diverse data sources such as topography, climate conditions, and vegetation coverage into the architectural design. With CAD software support, the building's 3D model is successfully constructed, and initial performance evaluation and optimization are conducted. The visualization result is presented in Figure 6.

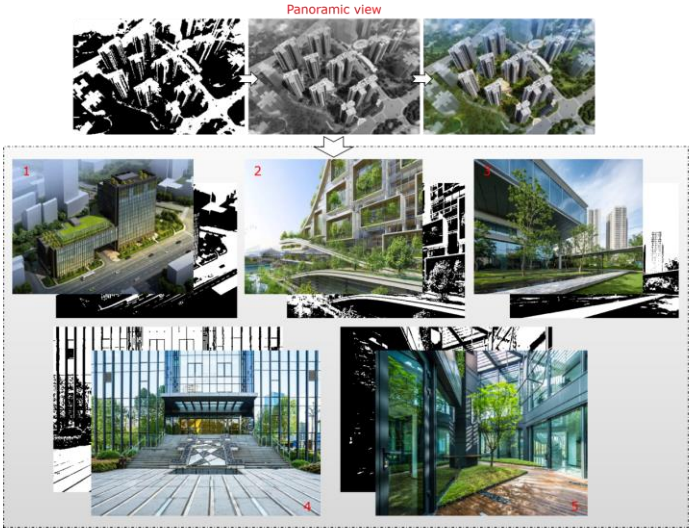

Figure 6: Visualization of green building planning cases.

Figure 7 shows the rating results of users and designers on the above green building planning cases.

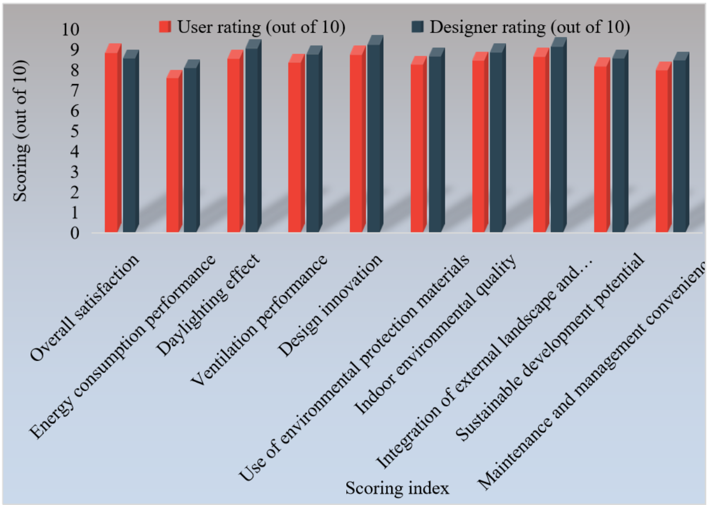

Figure 7: Scoring of green building planning cases.

It can be seen that the overall satisfaction of users and designers on the green building planning case is high, with users scoring 9.3 points and designers scoring 9.0 points, which shows that the case has been well recognized as a whole. This shows that the green building planning case has been fully recognized and praised by users and designers. Especially in an indoor environment and comfort, design, and innovation, but also in energy consumption and environmental protection, sustainable development, and maintenance. This provides strong support for the further promotion and application of the green building planning case.

Through the in-depth analysis of experimental results and case results, the effectiveness of the proposed framework and algorithm in green building planning is fully verified. These results fully prove the practical application value of CAD and multimodal data fusion technology in green building planning. By applying these advanced technologies, we can evaluate and optimize the building performance more accurately and provide more powerful support for the development of green buildings.

4.4 Discussions

Realistic 3D China requires the construction of a digital 3D space that is interconnected with the real world, providing high-quality spatiotemporal information products and services for the construction of Digital China. It can be combined with basic geographic information data to serve urban planning, construction, management, and other aspects. The key to generating LOD is to simplify the model to reduce its complexity, thereby achieving the goal of reducing the amount of model data. In response to the shortcomings of not being able to preserve model details and causing texture distortion in 3D building model simplification. The existing simplification of 3D architectural models rarely considers texture factors, resulting in texture distortion in the simplified model results. With the rapid development of data collection technology, the processed 3D building models have become increasingly refined and complex. This limits the further development of 3D visualization applications in terms of data processing, storage, and transmission for existing high-resolution 3D building models. Among them, the construction results of 3D building models that form real-life 3D models are widely used in the construction of smart cities. The main solution is to use Level of Detail (LOD) models to represent 3D building models. And use data organization and management methods that conform to the structure of 3D building models to solve the problem of low query indexing and computational efficiency of large-scale urban 3D building model data.

5 CONCLUSIONS

This study has made breakthrough progress in exploring the integration application of CAD technology and multimodal data fusion in the field of green building planning. Its achievements not only enrich the theoretical system of green building design but also demonstrate significant practical value in practice. This innovation not only greatly improves the efficiency of planning work, but also ensures the scientific, rational, and forward-looking nature of planning schemes, effectively promoting the intelligent and efficient direction of green building planning. The framework and algorithm system constructed by it is like a bridge, successfully aggregating complex multi-source data into a stream, providing unprecedented accurate insights and comprehensive support for green building planning. The complexity and diversity of multimodal data fusion technology require us to continuously explore and optimize its implementation to overcome operational efficiency bottlenecks. All of these require us to build a more robust and efficient data support system to address them. In addition, the collection and processing of data also face many challenges, such as heterogeneity of data sources, uneven data quality, and noise interference during data processing. However, while acknowledging the achievements, we are also acutely aware of the challenges and shortcomings exposed in the research. Looking ahead to the future, we will deepen our research in this field with even greater determination. In terms of algorithm optimization, we will continue to explore more efficient and intelligent data processing and fusion algorithms.

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