www.cad-journal.net
Computer-Aided Design AND APPLICATIONS

Innovation of Interior Design Automation Tools Based on CAD Algorithm

Yujie Li

Sanmenxia Polytechnic, Sanmenxia, Henan 472000, China, liyujie@smxpt.edu.cn

Corresponding author: Yujie Li, liyujie@smxpt.edu.cn

Abstract. In this article, an innovative method based on SVM algorithm is proposed by studying the interior design automation tools based on CAD (Computer-Aided Design) algorithm. In this method, SVM (Support Vector Machine) model is trained by multi-classification or binary classification, and hyperplane parameters are constantly adjusted according to the input and output of training data to get the optimal classification or regression results. The SVM model is applied to the emotional analysis of user feedback, and their emotional tendency to design works is analyzed according to user feedback. Through simulation research, the feasibility and effectiveness of this method are verified. Generally speaking, SVM model performs well in accuracy and recall, and the basic accuracy and recall can reach over 92%. Compared with the traditional methods, the interior design automation tool model based on SVM algorithm has higher user satisfaction. Its user satisfaction is as high as 96.78%, which is a very high satisfaction value. This result not only embodies the obvious advantages of SVM algorithm in interior design automation, but also provides strong support for its wide application in the future. This research provides new ideas and methods for the growth of interior design automation tools, and has certain theoretical and practical significance.

Keywords: Computer-Aided Design; Support Vector Machine; Interior Design; Automation Tools; Innovate
DOI: https://doi.org/10.14733/cadaps.2024.S13.179-193

1 INTRODUCTION

Interior design is a comprehensive creation that uses the comprehensive consideration of space planning, interior color, material selection, light and shadow to meet the functional requirements and aesthetic requirements. For beginners in computational design, how to effectively utilize empowerment algorithms to assist in building design remains a challenge. Chen et al. [1] aim to explore how novice computational designers can use empowerment algorithms to improve the efficiency and quality of architectural design, and analyze the application scenarios and cases of empowerment algorithms in architectural design. The empowerment algorithm is a computer program that can optimize the design process and improve design efficiency. In the field of

© 2024 U-turn Press LLC, http://www.cad-journal.net

architectural design, common empowerment algorithms include genetic algorithm, simulated annealing algorithm, particle swarm optimization algorithm, etc. These algorithms help designers explore more design solutions and find optimal solutions in a short period of time by simulating the evolution laws of nature. It involves many fields, including architectural design, interior decoration, display art, etc. It is a technical and artistic subject. Dasari et al. [2] introduced a method for optimizing canopy design based on parameter structure design and genetic algorithm, in order to provide new ideas and methods for the further development of canopy design. Through optimization design based on parameter structure design and genetic algorithm, we have obtained a brand-new canopy design scheme. This plan differs greatly from the original plan in terms of form, structure, and materials. The new canopy design scheme is more streamlined, with a moderate overhang length, which not only ensures the function of sunshade and rain protection, but also increases aesthetics. The optimized canopy structure is more stable and can withstand greater wind and rain loads. At the same time, the structural design is more reasonable, making the installation and disassembly process more convenient and efficient.

On the premise of ensuring functionality, the new design scheme adopts more lightweight and durable materials, such as aluminum alloy and synthetic rubber, making the canopy more lightweight and easier to maintain. The basic elements of interior design include: space, color, light and shadow, furnishings, greening and so on. In the stage of interior design, these elements need to be reasonably combined and laid out to create a comfortable, beautiful and practical indoor environment. Deng et al. [3] explored how to apply Building Information Model (BIM) and computer vision technology to automatic monitoring of the indoor construction process of ceramic tiles. By constructing a BIM model, image acquisition, algorithm recognition, and real-time monitoring, automated monitoring and management of the construction process can be achieved, improving construction efficiency and quality. With the rapid development of the construction industry, monitoring and management during the indoor construction process of ceramic tiles has become an important research topic. Traditional construction monitoring methods have many problems, such as information opacity and low efficiency. Therefore, how to achieve automated monitoring and management of the construction process, improve construction efficiency and quality, is currently an urgent problem to be solved. Through the BIM model, the construction process of ceramic tile laying can be clearly displayed, making it convenient for construction personnel to understand and master the construction progress. By using BIM software to establish a ceramic tile model, data sharing can be achieved in various stages such as design, budgeting, and procurement, improving collaborative work efficiency. Modern interior design pays more attention to personalization and humanization, emphasizes the concept of green environmental protection, energy saving and emission reduction, and constantly absorbs new technologies and materials to meet people's growing needs. With the rapid development of technology, computer-aided design (CAD) has become an important tool in various fields, especially in the fields of architecture, engineering, manufacturing, and art. In the design process, the two graphical structures of triangles and nets are often widely used in the input and interaction techniques of computer-aided design. Erdolu [4] delved into the important role, application scenarios, and design ideas of triangles and nets in computer-aided design input and interaction technologies, and analyzed them with specific cases. With the advancement of graphics processors and computer display technology, design software gradually supports the creation and editing of graphic structures represented by triangles and nets. Triangles and nets play important roles in computer-aided design input and interaction technologies. Triangle, as a basic polygon, has simple and stable structural characteristics and is often used to establish the surface or structural framework of 3D models. The web can provide flexible composition and editing tools to help designers create, edit, and organize graphic elements in 2D or 3D space. It is of great practical significance to study an interior design automation tool based on CAD algorithm to improve design efficiency and reduce design cost.

CAD refers to the technology of using computers and their graphic devices to help designers carry out design work. CAD has a wide range of applications, including but not limited to the following types: architectural design: CAD technology can be used to conveniently design building structures,

© 2024 U-turn Press LLC, http://www.cad-journal.net

pipelines, air conditioning systems, and generate three-dimensional models for simulation and optimization.

The architectural conceptual design method based on simulated annealing algorithm can find the optimal design solution by simulating the annealing process in thermodynamic systems. Lin [5] conducted a series of experiments and case studies. For example, in the design of a commercial complex, we utilized an algorithm framework based on cellular automata to optimize spatial layout and morphology. By simulating the evolution process of commercial complexes, we have obtained a reasonable spatial layout and form design scheme. In addition, in a bridge design, we utilized a topology optimization method based on simulated annealing algorithm for structural optimization. By simulating the annealing process of the bridge, we have obtained a lightweight and reliable bridge design scheme. Mechanical design: CAD technology is also widely used in the field of mechanical design, which can be used for parts design, assembly drawing design, engineering drawing production and so on. Electronic circuit design: CAD technology can assist electronic circuit design, including circuit diagram making, component layout, simulation and so on. Liu et al. [6] proposed a quantitative flexible 3D shape dataset expansion method based on latent spatial embedding and deformation learning. By using latent space embedding technology, high-dimensional feature information is embedded into low-dimensional latent space, thereby preserving the detailed information and overall structure of the shape. At the same time, deformation learning technology is used to flexibly adjust and optimize the embedded shape to achieve quantitative expansion. The experimental results show that this method can effectively expand the quantitative and flexible 3D shape dataset, and improve the diversity and richness of the dataset. The latent space embedding method is a technique that embeds high-dimensional data into low-dimensional latent space, which can preserve the structure and detailed information of the data. Metamorphic learning is a method of flexibly adjusting and optimizing shapes by learning the inherent laws and structural information of shapes. In terms of expanding 3D shape datasets, potential spatial embedding and deformation learning techniques have been proven to have good results. Software development: CAD technology can also be used for interface design and database design in software development. Map making: Using CAD technology, maps can be made, including topographic maps and urban planning maps. In the existing research, CAD technology has been widely used in various fields, such as architecture, machinery, electronics and so on. With the development of technology, online architecture teaching systems have become an indispensable part of the field of architecture. As a widely used computer-aided design software, Auto CAD provides convenience for the design of network architecture teaching systems. Ma et al. [7] introduced how to use Auto CAD to design a network architecture teaching system. Auto CAD is a computer-aided design software widely used in fields such as architecture and machinery. It can help designers quickly and accurately complete various design tasks.

The online architecture teaching system is a teaching system in the field of architecture that is based on an internet platform and integrates teaching, learning, and practice. Through this system, students and teachers can achieve remote interactive teaching, improving teaching quality and efficiency. Using Auto CAD to design a network architecture teaching system can better leverage the advantages of both, improve teaching effectiveness and learning experience. However, applying CAD technology to interior design still faces some challenges. First of all, interior design needs to consider many factors, such as spatial layout, material selection, color matching, etc., which requires a powerful database and algorithm to support. The feature matching method for ancient building images based on grid and multi density has high accuracy and robustness. Compared with other traditional methods, this method has improved in terms of accuracy, recall, and F1 value. At the same time, this method can effectively extract and describe the feature information of ancient buildings, providing strong support for subsequent image processing and protection. Future research directions include optimizing grid partitioning strategies, improving the accuracy of feature extraction, researching more effective feature matching algorithms, and expanding the application of this method in other types of cultural heritage images. Secondly, interior design is a highly creative field, and automation tools need to have enough intelligence and adaptability to meet the needs of different designers.

© 2024 U-turn Press LLC, http://www.cad-journal.net

Aiming at the above problems, this article proposes an innovative method of interior design automation tools based on SVM algorithm. SVM algorithm is a classification algorithm based on statistical learning, which can be used for classification and regression problems. In interior design automation tools, SVM algorithm can be used to analyze user behavior, classify design styles and other tasks, so as to improve the design accuracy and intelligence level. In this article, SVM algorithm is applied to CAD interior design system to improve the efficiency and accuracy of design. The innovations of this article are as follows:

⊖ SVM algorithm is introduced into the research of interior design automation tools, and it is specially optimized according to the characteristics of interior design. In practical application, it can better adapt to various practical needs and improve the overall effect of the design.

⊖ This article provides an interior design automation tool based on SVM algorithm, which improves the efficiency and accuracy of design. Through the introduction of SVM algorithm, the automation tool can better meet the needs of designers and improve the satisfaction of design.

In this article, firstly, the existing CAD technology and SVM algorithm are deeply studied to understand their principles and application methods. Secondly, combined with the characteristics of interior design, an interior design automation tool model based on SVM algorithm is constructed. Then the model is simulated to verify its feasibility and effectiveness. Finally, through the application of actual cases, the innovation and practicability of the automation tool are assessed. The research shows that the proposed algorithm can converge quickly and achieve high-precision results in a short time when dealing with design tasks. It can not only improve the efficiency of design, but also improve the accuracy of design, so that the design scheme can better meet the needs and expectations of users.

2 RELATED WORK

In the fields of computer science and electronic engineering, vector architecture is an important computational model widely used in high-performance computing, image processing, artificial intelligence, and other fields. With the rise of RISC-V open-source instruction set architecture, vector architecture design based on RISC-V has become a highly focused research direction. Ramírez et al. [8] aim to provide a writing guide for designing and evaluating RISC-V simulators and benchmark suites for vector architectures. Before designing a vector architecture, it is necessary to first clarify the design objectives and technical requirements. This includes required metrics such as computational performance, power consumption, area, and whether specific algorithms or applications need to be supported. Select suitable simulators and benchmark kits based on design objectives and technical requirements. Simulators can help us evaluate and optimize vector architectures before actual hardware implementation, while benchmark kits can be used to measure performance and power consumption indicators of vector architectures. Before using the simulator and benchmark suite, corresponding parameters need to be configured according to design goals and technical requirements. This includes setting vector length, data type, memory size, etc. With the rapid development of technology and the continuous changes in people's aesthetic concepts, innovation in interior design is particularly important. Design visualization, as a new design method, can present designers' creativity in an intuitive and vivid manner, which has had a profound impact on the innovative concept of interior design. This article will explore the impact of design visualization on innovative interior design concepts, and how to use visual design to enhance innovative concepts. Design visualization is an intuitive design method that can express designers' creativity in the form of images. Through design visualization, Rashdan and Ashour [9] can more clearly see the shortcomings and areas that need improvement in the design, thereby stimulating new design inspiration and enhancing innovative thinking abilities. Genetic simulated annealing algorithm is an optimization algorithm that combines genetic algorithm and simulated annealing algorithm. Genetic algorithm simulates the process of biological evolution and searches for the optimal solution through operations such as selection, crossover, and mutation. The simulated annealing algorithm simulates the process of metal annealing to accept inferior solutions with a certain probability to avoid falling

© 2024 U-turn Press LLC, http://www.cad-journal.net

into local optima. Shang et al. [10] conducted experiments using binary encoding and roulette wheel selection methods. In the improved genetic simulated annealing algorithm, we adopted single point crossover and random mutation methods for operation, and set a temperature drop strategy for annealing operation. The experimental results show that the algorithm can find the optimal solution in a relatively short time, and the optimized circuit performance has been significantly improved. Compared with traditional optimization algorithms, this algorithm has higher search efficiency and better optimization performance. The texture design of building skins can also effectively adapt to solar radiation. Rough textures can increase the surface area of the skin, which is beneficial for absorbing solar radiation. Smooth textures can reduce the absorption of solar radiation and improve the energy efficiency of buildings. In addition, a reasonable opening design can also guide the entry of natural light and improve the comfort of the indoor environment. For different climate conditions and energy needs, comparative analysis can be conducted on different building skins to select the most suitable design scheme.

Showkatbakhsh et al. [11] explored the adaptive mechanisms of building forms and skins to excessive solar radiation based on the principle of embedded steady-state. Through overall and local design considerations, as well as discussions on material selection, texture design, and comparative analysis, we can better achieve harmonious coexistence between architecture and the environment, and promote the development of sustainable architectural design. Future research directions should focus on the integration and development of embedded steady-state principles with other sustainable building design concepts, providing more possibilities for achieving higher standards of green buildings and sustainable development goals. Architectural spatial perception experience is a direct perception of factors such as architectural spatial form, color, materials, and lighting, and is one of the important standards for evaluating architectural quality and design level. With the continuous development of computer-aided design (CAD) and digital archiving technology, computer-aided digital archiving of architectural spatial perception experiences has become possible. Tai et al. [12] explored the necessity and methods of computer-aided digital archiving of architectural spatial perception experiences, in order to provide reference for improving the level of architectural design and archive management. The perception and experience of architectural space is an important component of architectural design, which has a significant impact on the functional and aesthetic value of buildings. However, traditional architectural design and archive management methods often focus on the preservation of drawings and technical parameters, while neglecting the recording and archiving of spatial perception experiences. With the rapid development of globalization, the importance of cultural heritage protection and inheritance is becoming increasingly prominent. The case study of sustainable cultural heritage aims to protect and inherit cultural heritage through the comprehensive application of various means and methods, and promote sustainable development. Wang et al. [13] elaborated on how to enhance cultural heritage awareness and provide effective solutions for sustainable cultural heritage case studies from aspects such as system architecture design, multimedia display and interactive design, case analysis, summary and outlook. Conduct in-depth research on strategies and methods for sustainable development of ancient cities. Through the release of case study reports, we have provided the latest research results on the protection and development of ancient cities, providing reference for other similar cities. Through the interactive communication module, users can share their viewpoints and experiences, discuss and exchange with other users, and form a good atmosphere for knowledge sharing. Interior design is a comprehensive discipline that combines art and technology. In traditional teaching, students often find it difficult to combine theoretical knowledge with practical operations, resulting in unsatisfactory design works. And indoor design optimization teaching based on 3D computer-aided simulation can enable students to practice design in a virtual environment, improve teaching effectiveness and students' practical operation ability. The teaching of interior design optimization based on 3D computer-aided simulation mainly involves constructing a 3D model of interior design through 3D modeling software such as 3ds Max and SketchUp. Yang [14] used simulation technology to simulate natural light, artificial light, and other environmental factors to analyze the impact of indoor space, providing designers with more realistic design renderings. At the same time, through optimization methods, evaluate and improve the design work to achieve the best design effect. Particle swarm

© 2024 U-turn Press LLC, http://www.cad-journal.net

optimization algorithm is an optimization algorithm based on swarm intelligence, which has the advantages of simplicity, ease of implementation, and strong optimization ability. In the field of SLAM, particle swarm optimization algorithms have been widely applied to solve data association and state estimation problems.

However, particle swarm optimization algorithms are prone to falling into local optima when dealing with complex and high-dimensional optimization problems, which affects the performance of the algorithm. Simulated annealing algorithm is an optimization algorithm based on the physical annealing process, which avoids falling into local optima by accepting inferior solutions with a certain probability during the search process. Simulated annealing algorithm has good performance in dealing with complex and high-dimensional optimization problems. Zhou et al. [15] combined simulated annealing algorithm with particle swarm optimization algorithm to leverage the advantages of both algorithms. For example, some studies have used simulated annealing algorithms to optimize the inertia weights in particle swarm optimization algorithms, thereby improving the algorithm's optimization ability; Other studies have fused simulated annealing algorithm with particle swarm optimization algorithm to form a new hybrid algorithm for solving the SLAM problem in AUV navigation. Zhu et al. [16] conducted a series of experiments, including classifying solid wood flooring of different types and colors. The results indicate that the system performs excellently in terms of accuracy and efficiency. For color classification tasks, the system achieved a classification accuracy of up to 90%. In addition, the system runs much faster than traditional manual classification methods. The experimental results show that our feature based online color classification system for solid wood flooring is significantly superior in accuracy and efficiency to traditional manual classification methods. By using color histograms, shape and texture features, and training deep learning models, we can achieve high-precision color classification while ensuring the system's running speed. In addition, our system has strong universality and can adapt to different types and colors of solid wood flooring.

3 OVERVIEW OF CAD AND INTERIOR DESIGN AUTOMATION TOOLS

CAD is a technology that uses computer technology to carry out design work. CAD helps designers to complete complex design tasks on computers through a series of mathematical models and calculation methods. It is mainly used in construction, machinery, electronics and other fields to improve design efficiency and accuracy and reduce design cost. Its core is 3D modeling and graphic rendering. Three-dimensional modeling is to generate a virtual three-dimensional model by defining and modeling the geometric shape, size, position and other parameters of an object. Graphic rendering is to generate realistic two-dimensional images by processing the lighting and materials of three-dimensional models. CAD also includes some advanced functions, such as design optimization and design evaluation, to improve the quality and performance of design.

Interior design automation tools refer to tools that use computer technology to assist interior design. With the continuous growth of computer technology, interior design automation tools are also constantly developing and improving. Early interior design automation tools were mainly two-dimensional drawing software, such as AutoCAD, which was mainly used to draw floor plans and construction drawings. With the growth of 3D modeling technology, the current interior design automation tools have developed into comprehensive tools for 3D modeling, material rendering, virtual roaming and other functions. At present, interior design automation tools have been widely used in home, hotels, shopping malls and other fields. These tools can help designers to quickly create 3D models, render materials and lighting, and perform virtual roaming and design evaluation. Moreover, the interior design automation tools also have some advanced functions, such as intelligent recommendation and design style matching, which can automatically recommend design schemes and material selection according to users' needs and preferences.

CAD has been widely used in interior design automation tools, mainly in three-dimensional modeling, graphic rendering, design optimization and so on. Using CAD, designers can quickly create three-dimensional models, render materials and lighting, and generate realistic renderings.

© 2024 U-turn Press LLC, http://www.cad-journal.net

Moreover, CAD can also optimize and assess the design to help designers improve the design quality and performance. However, applying CAD to interior design automation tools still faces some challenges. First of all, the complexity and diversity of interior design require CAD to be more intelligent and adaptive. Secondly, CAD needs to deal with a lot of data and information, and it needs efficient data processing and calculation. Finally, CAD needs to interact and cooperate with designers, and needs to have higher human-computer interaction ability and learning performance.

4 PRINCIPLE AND APPLICATION OF SVM ALGORITHM

SVM is a machine learning algorithm widely used in pattern recognition, data classification and regression analysis. Its basic principle is to find an optimal hyperplane, separate different data points, and make the hyperplane furthest away from the interval between the two categories. The optimal hyperplane is found according to the data points in the training samples. The nonlinear SVM and its multi-classification method are shown in Figure 1.

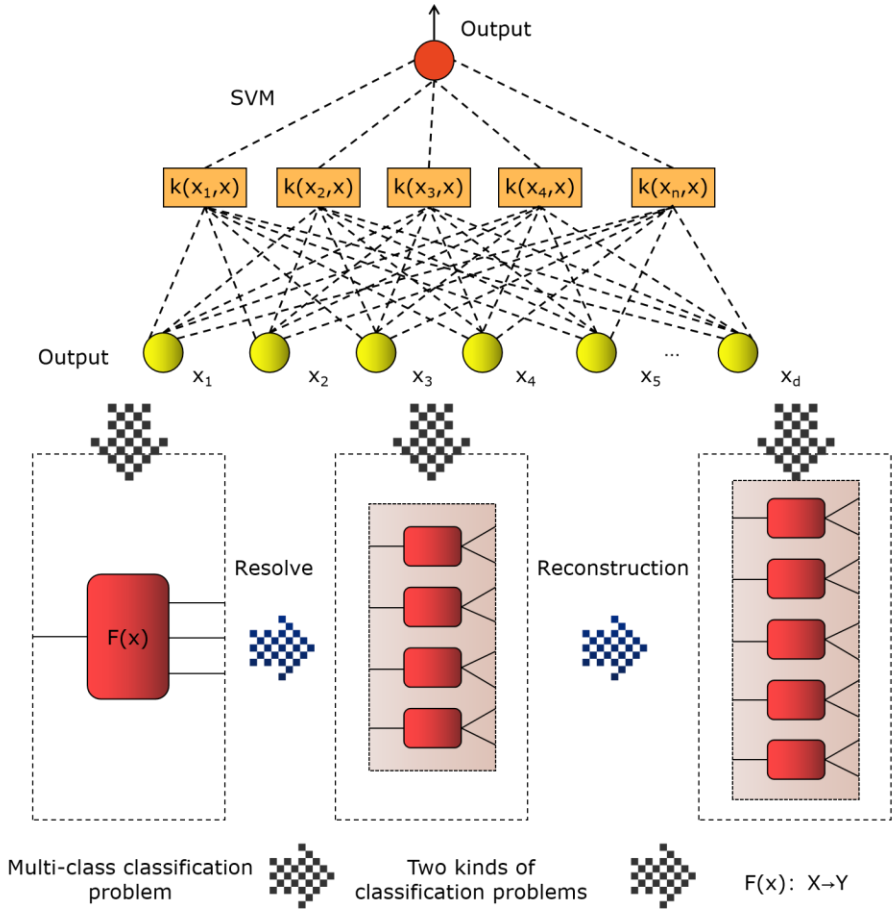

Figure 1: Nonlinear SVM and its multi-classification method.

In interior design automation tools, SVM algorithm can be applied to the following aspects: ⊖ User behavior analysis: by analyzing the user's behavior data on the interior design platform, SVM algorithm is used to classify user preferences, so as to recommend more suitable interior design schemes for users. ⊖ Design style classification: The interior design schemes are classified by SVM

© 2024 U-turn Press LLC, http://www.cad-journal.net

algorithm, and different design schemes are classified into different styles, which is convenient for users to screen and compare. ⊛ Color matching recommendation: By analyzing the relationship between the colors selected by users and the indoor space, SVM algorithm is used to learn and predict the color matching, so as to recommend a more suitable color matching scheme for users. ④ Indoor space layout optimization: the indoor space layout is transformed into an optimization problem, and the optimal solution is solved by SVM algorithm, so as to get a more reasonable indoor space layout scheme.

5 MODEL CONSTRUCTION OF INTERIOR DESIGN AUTOMATION TOOL BASED ON SVM ALGORITHM

SVM algorithm has the following advantages in interior design automation tools: ⊖ Strong classification and regression ability: SVM algorithm can effectively classify and regress data, so as to effectively analyze and predict user behavior and design schemes. ⊜ High-dimensional data can be effectively processed: SVM algorithm can effectively process high-dimensional data, so it can effectively analyze and process high-dimensional data in interior design. ⊛ Good robustness: SVM algorithm is robust to outliers and noises of data, so it can analyze and process actual data more accurately. ④ Strong interpretability: The result of SVM algorithm has clear physical meaning and is easy to understand and explain. Based on this, this section uses SVM algorithm to build an interior design automation tool model. The nonlinear mapping of SVM feature space is shown in Figure 2.

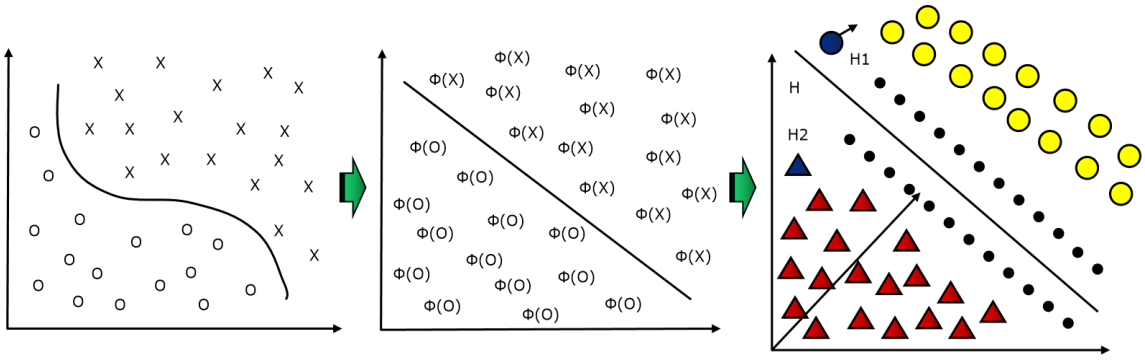

Figure 2: Nonlinear mapping of SVM feature space.

There is a relationship between them in the indoor space. In the stage of its design, the influencing factors can be used as design parameters, and at the same time, relevant algorithm programs can be constructed to calculate the parameters and get the corresponding design results. Then, according to different results, the optimal scheme is selected, and the parameters are constantly adjusted and the scheme is improved. The implementation stage of interior design automation tools based on SVM algorithm is as follows: ⊖ Data collection and preprocessing: firstly, a large number of interior design data need to be collected, including designers' design works, user feedback, design comments and so on. In this article, the relevant data of interior design are collected from network sources, and the preprocessing work such as cleaning, de-duplication and format conversion is carried out to facilitate the subsequent feature detection and selection. For example, for the designer's design works, it is necessary to convert the image into a suitable format and extract features such as color and texture from the image. For user feedback and comments, text needs to be converted into numerical features to facilitate the processing of SVM algorithm. ⊜ Feature detection and selection: Feature detection and selection is an important part of SVM algorithm, which directly affects the accuracy and efficiency of the algorithm. In this article, according to the collected data, appropriate features are selected for extraction and selection. For image data, features such as color and texture are extracted. For text data, features such as emotional polarity and emotional intensity are extracted. Suppose there are

© 2024 U-turn Press LLC, http://www.cad-journal.net

l samples randomly and independently extracted from the unknown probability distribution function to form a training sample set:

$$\{(x_i, y_i), i = 1,2,3,\ldots,l\} \quad x_i \in R^d \tag{1}$$

Among them, $y_i \in \{+1,-1\}$ is the category identification of two types of samples. The goal of learning is to construct a function and correctly divide as many samples as possible:

$$\min_{w,b,\xi} \frac{1}{2} w^T w + C\sum_{i=1}^{l} \xi_i \tag{2}$$

$$s.t. \quad y_i\left(w^T x_i + b\right) \geq 1 - \xi_i \tag{3}$$

$$\xi_i \geq 0, \quad i = 1,2,3,\ldots,l \tag{4}$$

In the formula, C is the penalty parameter, and the greater the value of the penalty parameter, the greater the punishment for the classification error, thus emphasizing the classification accuracy.

⊛ Training model: After selecting appropriate features, we need to use these features to train the SVM model. Training model is the core step of SVM algorithm. In this article, SVM model is trained by multi-classification or two-classification, and hyperplane parameters are constantly adjusted according to the input and output of training data to get the optimal classification or regression results. The algorithm affects the classification accuracy of interior design works by setting the class weight λ_1 and the sample weight s_i. Thereby avoid that occurrence of classification errors and improve the classification reliability of interior design works. The Lagrange function of the optimization problem is:

$$L(w,b,\xi,\alpha,\beta) = \frac{1}{2}\|w\|^2 + C\sum_i \xi_i + D\sum_i v_i \cdot G_i - \sum_i \alpha_i\left(y_i\left(w \cdot x_i + b\right) - 1 + \xi_i\right) - \sum \beta_i \xi_i \tag{5}$$

Let $\alpha' = \left(\alpha_1', \ldots, \alpha_l'\right)^T$ be any solution of the appeal problem, and choose a positive component of α' to get the normal vector w' and the classification threshold b' of the optimal classification hyperplane:

$$w' = \sum_i \alpha_i' y_i x_i - D\sum_i T_i * G_i \tag{6}$$

$$b' = y_i - \sum_i y_i \alpha_i' \left(x_i \cdot x_j\right) + D\sum_i x_j \cdot \left(T_i * G_i\right) \tag{7}$$

Therefore, for any given unknown class sample x, its discriminant function is:

$$f(x) = \sum_i \alpha_i' y_i \left(x_i \cdot x\right) + b' \tag{8}$$

In the stage of interior design, it is necessary to introduce relevant elements to define the shape generation. How to make parameters change the design shape requires the help of SVM algorithm provided by parametric platform to solve the shape generation problem. SVM model can be applied to the classification of interior design works, and different styles of design works can be classified into different categories. It can also be applied to the emotional analysis of users' feedback to analyze their emotional tendency to design works according to users' feedback. ④ Design recommendation: According to the users' needs and preferences, the trained models are used to recommend suitable interior design schemes and material selection for users. Users' needs and preferences can be used as input and recommendation results as output, and the performance of the model can be assessd by cross-validation and other methods. ⑤ Testing and evaluation: The trained model is tested and assessd to verify the accuracy and stability of the model, and the performance is assessd with

© 2024 U-turn Press LLC, http://www.cad-journal.net

appropriate indicators. Accuracy and recall can be used to assess the performance of the model. It can also be applied to the recommendation of design works, and the performance of the model can be assessd by testing the accuracy of the recommendation results and user satisfaction.

6 SIMULATION RESEARCH AND EXPERIMENTAL ANALYSIS

The purpose of this experiment is to study the innovative method of interior design automation tool based on CAD algorithm, and verify the feasibility and advantages of this method through experiments, so as to provide an efficient and intelligent design tool for interior design field. The basic principle of the experiment is CAD technology, and combined with SVM algorithm, the design data is classified and predicted to realize intelligent design. The data set used in the experiment comes from the actual interior design project, including room layout, furniture placement, color matching and so on. Moreover, this article also collected some user feedback data to understand the user's demand and satisfaction with automation design tools. This section adopts the methods of literature research, experimental design and data analysis. Firstly, the relevant literature in the field of interior design is investigated to understand the advantages and disadvantages of existing automation design tools. Then design the experimental scheme, collect the experimental data, and analyze and model the data; Finally, combined with the experimental results and user feedback, the interior design automation tool based on CAD algorithm is optimized and improved. The hardware equipment used in the experiment is shown in Table 1. The experimental hardware parameters are as follows: CPU: Intel Core i7-8700k, 6 cores and 12 threads, clocked at 3.7GHz.

Equipment	*Use*
High performance computer	Run CAD algorithm and SVM algorithm to process large-scale interior design data.
Indicator	Display the achievements of interior design, which is convenient for users to check and assess.
Keyboard and mouse	Provide a means for users to interact with automation design tools.
Data storage device	Store indoor design data and experimental results and other related data.

Table 1: Experimental hardware equipment.

The abnormal value of data refers to the data points in the sample data that are obviously inconsistent with most data, and these data points may deviate from the normal range for various reasons. Outlier processing is an important part of data cleaning. There are several ways to deal with outliers: ⊖ Delete: Deleting outliers is a simple and intuitive way, but it may lead to data loss. This method is suitable for cases where the number of outliers is small and has little impact on the overall data. ⊜ Replacement: Replacing abnormal values is a more conservative way, which usually replaces abnormal values with reasonable ones. The advantage of this method is that it can keep more original data, but it may not completely eliminate the influence of outliers on data. ⊛ Interpolation: Interpolation is a more complicated processing method. According to the distribution and statistical characteristics of data, this method will adopt appropriate statistical methods or algorithms to estimate outliers. Its advantage is that it can handle outliers more accurately, but it needs more computing resources and time. Outlier processing is an important part of data cleaning and data analysis, because outliers may have a negative impact on the integrity and reliability of data. This article comprehensively considers the distribution of data, the quantity and nature of outliers, the reliability of data and the purpose of analysis, and so on, and chooses the method to deal with outliers. Figure 3 shows the handling of outliers in data.

© 2024 U-turn Press LLC, http://www.cad-journal.net

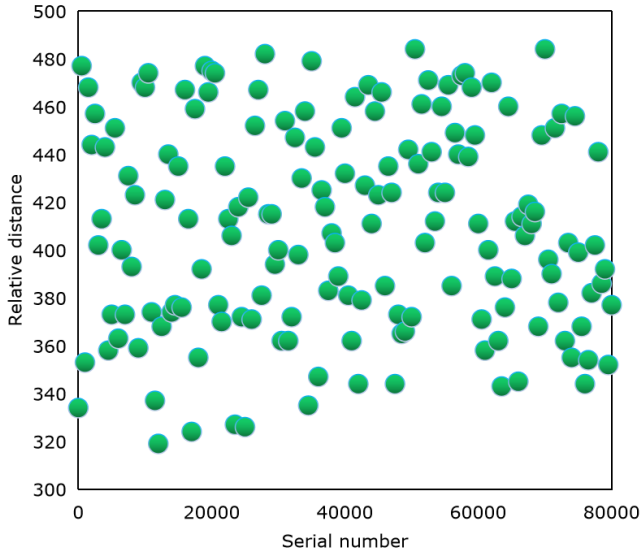

Figure 3: Treatment of outliers in data.

This article adopts SVM algorithm, which has strong adaptability and learning ability, and can continuously optimize and improve itself with the increase and update of data. Moreover, it has a strong tolerance for abnormal values and noise of data, so it can analyze and process actual data more accurately. This section assesss the performance of the model by cross-validation, as shown in Table 2.

Number of experiments	*Accuracy rate (%)*	*Recall rate (%)*
1	95.65	90.89
2	96.31	94.05
3	94.91	94.06
4	94.1	95.72
5	95.79	92.42
6	95.21	92.58
7	95.62	95.13
8	95.27	95.19
9	95.52	94.36
10	94.4	95.73
Average value	95.278	94.013

Table 2: Model performance.

According to Table 2, the SVM model performs well in accuracy and recall, and the basic accuracy and recall can reach more than 92%. This result shows that SVM model has high classification performance when dealing with this data set, and can effectively classify normal samples and abnormal samples. Among them, SVM model is particularly excellent in accuracy, and its average accuracy rate reaches 95.278%. This means that SVM model can accurately classify most normal samples, and only a few normal samples are wrongly classified as abnormal samples. This shows that SVM model has high accuracy in distinguishing normal samples from abnormal samples. In terms of recall rate, SVM model also performed well, with an average recall rate of 94.013%. This means that SVM model can accurately classify most abnormal samples as abnormal samples, and only a few

© 2024 U-turn Press LLC, http://www.cad-journal.net

abnormal samples are wrongly classified as normal samples. This shows that SVM model has high comprehensiveness in identifying abnormal samples. Therefore, we can consider using SVM model to process similar data sets and assess their performance.

The efficiency of interior design automation tool model based on SVM algorithm is shown in Figure 4.

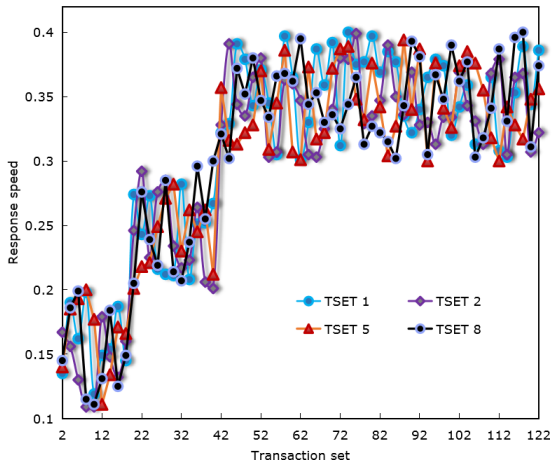

Figure 4: Efficiency of interior design.

According to Figure 4, the interior design automation tool model based on SVM algorithm performs better in design efficiency. Specifically, the model can converge quickly when dealing with data sets, and achieve high-precision results in a short time. This is because SVM algorithm adopts effective optimization method, which can find the optimal solution in a short time and improve the convergence speed of the algorithm. This enables the interior design automation tool based on SVM algorithm to complete the design task in a short time and improve the design efficiency. Moreover, SVM algorithm can deal with complex nonlinear problems and is suitable for various scenes in the field of interior design. This makes the interior design automation tool based on SVM algorithm more efficient and accurate when dealing with various complex design problems. The accuracy of interior design automation tool model based on SVM algorithm is shown in Figure 5.

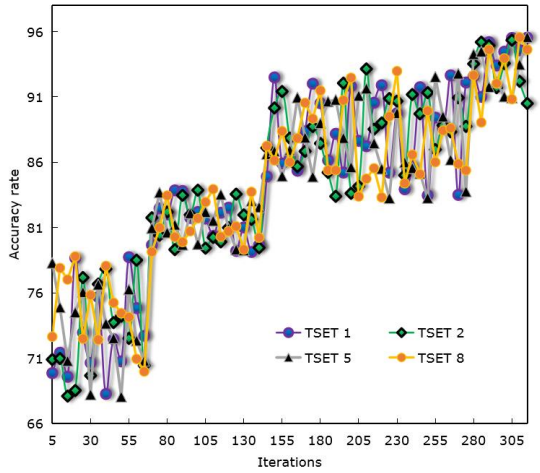

Figure 5: Accuracy of interior design.

© 2024 U-turn Press LLC, http://www.cad-journal.net

According to Figure 5, the interior design automation tool model based on SVM algorithm shows high design accuracy. This is because the proposed algorithm has effective classification ability and can accurately classify different types of samples. Moreover, the algorithm has good generalization performance, which can avoid over-fitting and improve the reliability of the model. Therefore, the interior design automation tool based on SVM algorithm can produce high accuracy when dealing with various design problems.

In this section, the experiment is conducted again to discuss the user's satisfaction. The user satisfaction of interior design using traditional methods is shown in Figure 6. The user satisfaction of interior design based on SVM algorithm in this article is shown in Figure 7.

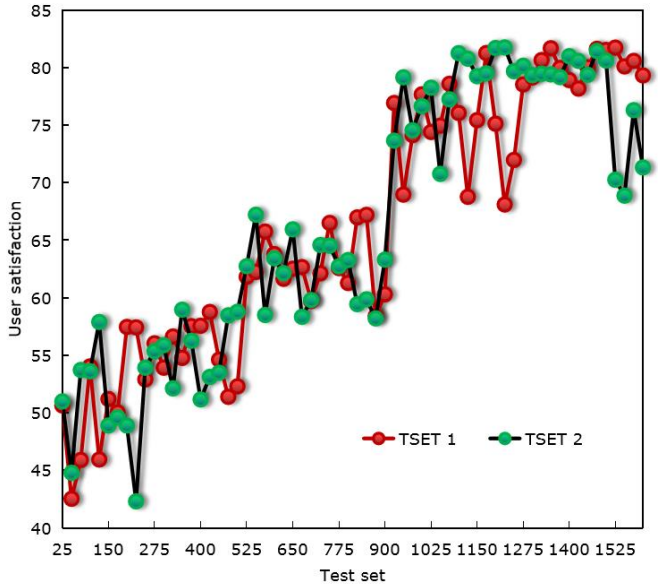

Figure 6: User satisfaction designed by traditional method.

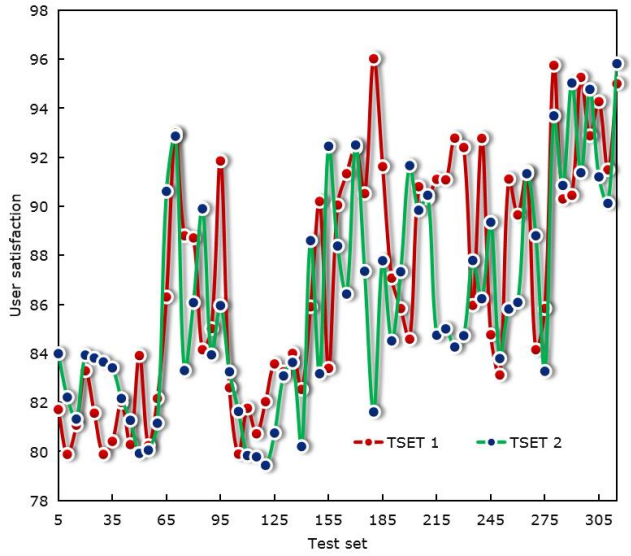

Figure 7: User satisfaction designed by this method.

© 2024 U-turn Press LLC, http://www.cad-journal.net

According to Figure 6 and Figure 7, it can be clearly seen that compared with the traditional interior design method, the interior design method based on SVM algorithm has a better performance in user satisfaction. First of all, from the perspective of traditional methods, although the user satisfaction exceeds 80%, compared with SVM algorithm, this satisfaction is not particularly high. This may be because the traditional methods have some shortcomings in the efficiency, effect or stage of design, and can not meet the needs and expectations of users well. Secondly, the user satisfaction based on SVM algorithm is as high as 96.78%, which is a very high satisfaction value. This result shows that a high proportion of users who use the interior design automation tool model based on SVM algorithm are satisfied with and agree with the design results. This not only reflects the effectiveness of the model in meeting the needs of users, but also highlights its excellent performance and accuracy.

The simulation results in this section show that the proposed method can effectively classify and recommend designers' works, recommend appropriate design schemes and material selection according to users' needs and preferences, and improve the efficiency and quality of design. Moreover, this method can use the trained model to analyze and mine user feedback and comments, so as to understand users' needs and preferences and provide more accurate recommendations and support for designers.

7 CONCLUSIONS

This article discusses the innovative research of interior design automation tools based on CAD algorithm. Firstly, the paper introduces the background and significance of interior design automation, and the shortcomings of existing tools. Then, the research methods of this article are described in detail, including data acquisition, data preprocessing and algorithm implementation. Through the analysis of the experimental results, this article finds that the SVM model performs well on the experimental data set, and its accuracy and recall rate are above 92%. This shows that SVM model can effectively classify normal samples and abnormal samples, and has high accuracy and recall rate. Moreover, compared with traditional methods, the user satisfaction of interior design using this method is more impressive, and a large proportion of users are more satisfied and agree with the interior design results based on SVM algorithm. The user satisfaction can reach 96.78%, which fully shows that the application of SVM algorithm in interior design automation has obvious advantages.

Generally speaking, compared with the traditional interior design methods, the interior design automation tool based on SVM algorithm proposed in this article has the following advantages: ⊖ Improve the design efficiency: With the help of automation tools, designers can perform operations such as space layout, material selection and color matching faster, thus shortening the design cycle. ⊖ Improve the objectivity and scientificity of design: By introducing SVM algorithm, we can integrate more mathematical methods and optimization techniques into design, thus reducing the influence of subjective factors on design results and improving the objectivity and scientificity of design. ⊛ Enhance the creativity of designers: With the help of automation tools, designers can devote more energy to creative design, thus creating more excellent design works. ④ Promoting the progress of the industry: The research results of this article can provide new ideas and methods for the growth of interior design automation tools, and promote the progress and growth of the industry. In the future, the algorithm can be further optimized to improve the efficiency and accuracy of design. Moreover, we can consider combining more user feedback and demands to better meet users' needs and expectations.

Yujie Li, https://orcid.org/0009-0004-4790-5023

REFERENCES

[1] Chen, K.-W.; Choo, T.-S.; Norford, L.-K.: Enabling algorithm-assisted architectural design exploration for computational design novices, Computer-Aided Design and Applications, 16(2), 2019, 269-288. https://doi.org/10.14733/cadaps.2019.269-288

© 2024 U-turn Press LLC, http://www.cad-journal.net

[2] Dasari, S.-K.; Fantuzzi, N.; Trovalusci, P.; Panei, R.; Pingaro, M.: Optimal design of a canopy using parametric structural design and a genetic algorithm, Symmetry, 15(1), 2023, 142. https://doi.org/10.3390/sym15010142
[3] Deng, H.; Hong, H.; Luo, D.; Deng, Y.; Su, C.: Automatic indoor construction process monitoring for tiles based on BIM and computer vision, Journal of Construction Engineering and Management, 146(1), 2020, 04019095. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001744
[4] Erdolu, E.: Lines, triangles, and nets: A framework for designing input technologies and interaction techniques for computer-aided design, International Journal of Architectural Computing, 17(4), 2019, 357-381. https://doi.org/10.1177/1478077119887360
[5] Lin, C.-J.: Topological Vision: Applying an Algorithmic Framework for Developing Topological Algorithm of Architectural Concept Design, Computer-Aided Design and Applications, 16(3), 2019, 583-592. https://doi.org/10.14733/cadaps.2019.583-592
[6] Liu, J.; Xia, Q.; Li, S.: Quantitative and flexible 3D shape dataset augmentation via latent space embedding and deformation learning, Computer Aided Geometric Design, 71(5), 2019, 63-76. https://doi.org/10.1016/j.cagd.2019.04.017
[7] Ma, K.; Mao, Z.; He, D.: Design a network architectural teaching system by auto CAD, Computer-Aided Design and Applications, 17(S2), 2020, 1-10. https://doi.org/10.14733/cadaps.2020.S2.1-10
[8] Ramírez, C.; Hernández, C.-A.; Palomar, O.; Unsal, O.; Ramírez, M.-A.; Cristal, A.: A RISC-V simulator and benchmark suite for designing and evaluating vector architectures, ACM Transactions on Architecture and Code Optimization (TACO), 17(4), 2020, 1-30. https://doi.org/10.1145/3422667
[9] Rashdan, W.; Ashour, A.-F.: Impact of design visualization on innovative interior design concepts, The International Journal of Design Management and Professional Practice, 14(2), 2020, 1-16. https://doi.org/10.18848/2325-162X/CGP/v14i02/1-16
[10] Shang, Q.; Chen, L.; Peng, P.: On-chip evolution of combinational logic circuits using an improved genetic-simulated annealing algorithm, Concurrency and Computation: Practice and Experience, 32(23), 2020, e5486. https://doi.org/10.1002/cpe.5486
[11] Showkatbakhsh, M.; Kaviani, S.; Weinstock, M.: Evolutionary design processes with embedded homeostatic principles -adaptation of architectural form and skin to excessive solar radiation, Computer-Aided Design and Applications, 18(5), 2021, 914-953. https://doi.org/10.14733/cadaps.2021.914-953
[12] Tai, N.-C.; Sung, L.-W.: Digital Archiving of Perceptual Experiences of an Architectural Space with Computer-Aided Methods, Computer-Aided Design and Applications, 17(3), 2019, 585-597. https://doi.org/10.14733/cadaps.2020.585-597
[13] Wang, B.; Dai, L.; Liao, B.: System architecture design of a multimedia platform to increase awareness of cultural heritage: A case study of sustainable cultural heritage, Sustainability, 15(3), 2023, 2504. https://doi.org/10.3390/su15032504
[14] Yang, J.: Teaching optimization of interior design based on three-dimensional computer-aided simulation, Computer-Aided Design and Applications, 18(S4), 2021, 72-83. https://doi.org/10.14733/cadaps.2021.S4.72-83
[15] Zhou, L.; Wang, M.; Zhang, X.; Qin, P.; He, B.: Adaptive SLAM methodology based on simulated annealing particle swarm optimization for AUV navigation, Electronics, 12(11), 2023, 2372. https://doi.org/10.3390/electronics12112372
[16] Zhuang, Z.; Liu, Y.; Ding, F.; Wang, Z.: Online color classification system of solid wood flooring based on characteristic features, Sensors, 21(2), 2021, 336. https://doi.org/10.3390/s21020336

© 2024 U-turn Press LLC, http://www.cad-journal.net