Distributed 3D Interior Environment Design System Based on Color Image Model

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To enhance the efficiency of 3D interior design dissemination, this study proposes a novel approach that integrates color image modeling with virtual reality technology. The methodology begins with the application of distributed data fusion techniques to develop a color image model tailored for 3D interior design distribution. This model enables the effective transmission of 3D interior elements and the precise identification of key points within the design. An RGB color-matching method is then employed to extract spatial color distribution information, which, combined with a 3D point cloud feature recombination process, ensures accurate reproduction of the color space in 3D spatial distributions. The result is a more efficient distribution of 3D interior designs. Building on this foundation, the next phase involves utilizing virtual reality and visual technology to distribute 3D interior designs. This includes creating detailed 3D models using 3D MAX and the hierarchical interior design software Muligen Design. Experimental results validate the model's ability to significantly enhance the visualization and educational value of 3D home design classification.

Povzetek: Predstavljen je distribucijski sistem 3D notranjega oblikovanja, ki temelji na modeliranju barvnih slik in virtualni resničnosti, izboljšuje vizualizacijo in učinkovitost notranjih 3D modelov z naprednimi tehnikami združevanja podatkov.

1 Introduction

With the rapid development of computer technology, virtual reality technology has also made significant progress, and its application in people's production and lives is also becoming increasingly widespread. Virtual reality also has its place in indoor color design. For indoor home design, color design is a crucial step. How indoor colors should be expressed is determined by designers based on the subjective needs of customers. However, in practical applications, users often cannot intuitively feel the actual effect of color application in indoor home design, nor can they provide accurate modification suggestions for designers. It is relatively difficult for designers to improve indoor color design based on user needs. We need to develop an information-based indoor color design method based on computer virtual reality technology to help users more accurately grasp the effects of indoor color design and facilitate designers to make indoor color designs that are more in line with customer needs.

The color matching in indoor home design largely determines the comfort and spatial feel of users living indoors, which can adjust the environmental atmosphere and help users create a more comfortable living space. For indoor home design, color matching has a significant impact on the overall design, and indoor color matching is generally more economical and easier to implement. The importance of indoor color matching in indoor home design is mainly reflected in adjusting the overall sense of indoor space through color matching. The size of indoor space is fixed, but different indoor color combinations create different indoor spatial sensations for people. Specifically, various color combinations can create a different sense of softness, lightness, warmth, space, and time. Color matching can visually provide users with various effects, such as bumps, ups and downs, and fronts and backs. By matching indoor colors, people can create an illusion of sensory area and volume. For relatively narrow spatial layouts, certain color combinations can be used, such as using relatively bright cool colors on the walls on both sides and filling the top of the room with relatively mild warm colors, which can give people a visual sense of openness and minimize the sense of confinement caused by narrow spatial layouts. In color matching, relatively low-brightness cool tones can create a distant and concave sensory illusion; relatively high-brightness warm tones can create a forward and protruding sensory illusion. Although color matching cannot cause actual physical changes, it can greatly change people's discomfort caused by improper indoor matching. Taking temperature as an example, no matter how indoor colors are matched, they cannot change the actual temperature inside the room. However, reasonable indoor color matching can help people create a psychological sense of warmth and coolness and slow down the corresponding temperature drop. Good color matching can bring a more complete and reasonable overall spatial sense to indoor home design. At present, the domain of 3D interior design distribution encounters obstacles in its quest to attain optimal levels of precision and effectiveness. Current approaches frequently fail to produce ideal outcomes, thereby necessitating the development of a more efficient resolution. The rationale for conducting this research is to rectify the shortcomings of existing methods for distributing 3D interior designs. Through the creation of an innovative methodology that merges color image modeling and virtual technology, our ultimate objective is to substantially elevate the caliber of interior design procedures using increased precision and productivity. The method proposed by this research has the potential to significantly transform the distribution of 3D interior design. It paves the way for interior design practices that are more streamlined and effective by providing a singular combination of precision and productivity. Additionally, this study investigates the incorporation of state-of-the-art technologies, offering a proactive strategy to overcome current constraints in the discipline. The motivation behind this research stems from the growing need for more effective and scalable methods to disseminate 3D interior designs. As the demand for personalized and interactive interior environments increases, professionals and educators alike face the challenge of creating systems that not only render designs with high precision but also ensure that these designs can be shared, modified, and visualized seamlessly across different devices and platforms. This need is further exacerbated by the growing integration of virtual reality (VR) in interior design, where immersive experiences are essential for both clients and designers.

Current systems for 3D interior design distribution often fall short in two critical areas: maintaining color accuracy and ensuring seamless integration across various software environments. These limitations hinder the effectiveness of design communication and reduce the potential for collaborative efforts. Therefore, there is a pressing need for a distributed design system that can accurately model, transmit, and visualize 3D interior designs while preserving color integrity and spatial detail.

The proposed system builds upon recent advancements in distributed design systems and color image models. In, recent studies from 2024 have highlighted the potential of distributed data fusion in improving the scalability and precision of design systems [1, 2]. Additionally, recent developments in color image modeling have shown promising results in enhancing color accuracy and spatial representation in 3D environments [3, 4]. These contributions underscore the need for a system that can bridge the gap between 3D design creation and its effective distribution. To address these challenges, this paper proposes a novel distributed 3D interior environment design system based on color image modeling. This system leverages distributed data fusion techniques to construct a robust color image model, enabling more efficient transmission and accurate identification of 3D interior elements. Furthermore, the integration of RGB color-matching methods and 3D point cloud feature recombination enhances the color space representation, leading to improved design distribution.

2 Literature review

Over the past few years, several scholarly articles have provided substantial advancements in the domain of 3D interior design distribution. An investigation conducted by Li *et al.* examined the application of machine learning algorithms in the automation of interior design duties, resulting in a substantial enhancement of productivity [5]. To enhance user engagement and visualization, Zheng, investigated the integration of augmented reality (AR) into immersive and interactive design encounters [6]. Moreover, the study undertaken by Zhang *et al.* was centered on standardizing design procedures to eradicate inefficiencies inherent in conventional manual approaches [7]. A recent article authored by Xu *et al.* investigated the effects of color image modeling on the precision of designs, yielding significant findings [8].

The quality of interior design directly determines the emotional changes of urban residents and the quality and safety of their environment. Ensuring the comfort of using colors can allow people to experience the different effects of different colors in indoor spaces while enjoying life. From a practical perspective, the rational use of different types of colors in interior design can make interior design more beautiful and change residents' emotions and health. This phenomenon is because different types of colors can allow people to experience different experiences, both visually and sensually. The use of color in interior design mainly utilizes the influence of human visual nerves to change their heart rate, blood pressure, and pulse. For example, daily office residents can choose lighter colors for interior design, which will not create a sense of oppression. Conversely, excessively bright colors can accelerate residents' pulses and create anxiety toward each other. Choosing environmentally friendly colors, such as green, can alleviate residents’ visual fatigue and create a reassuring and comfortable working environment. According to practical research results, using red and green for interior design and then selecting the same household to enter two rooms and monitoring their pulse rate, it can be found that the pulse in the red room is very unstable, while in the green room, it is very stable. Therefore, in current interior design research, light color is often regarded as the main standard for interior design, and this content is also determined by human physiological factors.

The color elements in interior design also have a direct impact on the psychological characteristics of the human body. In real life, people often see a variety of colors, and when a certain type of color stimulates the human visual nerve, the human brain will autonomously make associations, resulting in some kind of illusion. According to practical research, under the conditions of human response to external color stimuli, it will inevitably affect the emotional changes at this moment, which is also known as color orientation. Different colors can create different emotions, so interior designers must make reasonable choices based on mastering this change. Xie and Liu believe that color also has a significant impact on human emotions. Since ancient times, the most representative color has been red, which represents happiness and the joy of life. Therefore, it is generally used for representative occasions such as banquets and festivals [9]. Rehfeldt *et al.* believe that the use of color elements in interior design should also focus on analyzing their roles in different areas and optimizing human emotions based on different tones. In an indoor environment, colors can be selected according to the orientation of the room. Assuming that the doors and windows face south, sunlight can shine into the room, so cold colors can be chosen as a priority for design. On the contrary, if the doors and windows face north, warm colors can be used to balance the interior design and build a more comfortable living environment [10].

Recent developments in imaging and 3D design technologies have seen significant strides, particularly with the integration of advanced algorithms and data processing techniques. In the field of imaging, Ye *et al.*, introduced an innovative approach to high-fidelity image reconstruction using deep learning models [11]. This technique significantly enhances the accuracy of image representations, making it highly applicable in 3D design applications where precise spatial data is crucial. Furthermore, deep learning-based super-resolution algorithms, such as those proposed by Zhang *et al.*, have demonstrated the potential to improve the clarity and detail of 3D models generated from lower-resolution inputs [12]. In terms of 3D design, recent works have focused on the use of sophisticated point cloud processing techniques. Wang *et al.*, explored the use of convolutional neural networks (CNNs) for the segmentation and classification of 3D point clouds, which are vital for constructing detailed 3D interior models [13]. This research aligns with the proposed work by emphasizing the importance of accurate feature extraction from 3D spatial data, a critical step in developing realistic and functional 3D interior designs. Data fusion remains a cornerstone of modern imaging and 3D design processes. Guan *et al.*, proposed a novel data fusion framework that integrates multi-sensor data to improve the robustness and accuracy of 3D scene reconstruction [14]. This method, which leverages the complementary strengths of different sensors, is particularly relevant to distributed design systems where data from various sources must be combined to generate a coherent 3D model. The integration of these data fusion techniques with color image modeling, as outlined in this paper, represents a significant step forward in the field.

Additionally, advancements in virtual reality (VR) and augmented reality (AR) have opened new possibilities for 3D interior design. Qian, and Sutunyarak demonstrated the potential of VR-based platforms for immersive interior design visualization, enabling designers and clients to experience the space in real-time and make informed decisions [15]. This work underlines the importance of integrating VR technology with 3D design tools, a concept that is central to the proposed model's second phase. Although the aforementioned studies have contributed to the progress of the discipline, the proposed research in this paper distinguishes itself through the integration of virtual technology and color image modeling. This distinctive amalgamation holds the potential to rectify the deficiencies of current approaches, presenting a holistic resolution to enhance the precision and effectiveness of 3D interior design dissemination. Through the incorporation of state-of-the-art technologies and in light of the discoveries made in these recent investigations, the proposed research aims to fundamentally transform future interior design methodologies. In this work, a 3D interior design distribution system is created based on reality technology, which, combined with color contrast, optimizes the distribution of interior space and the effect of color effects to achieve 3D visual integration of interior space. Distributed 3D image reconstruction is used for the successful design of distributed 3D interior design using 3D interior design, virtual reality, visual environment system creation, and 3D simulation software such as MAYA, 3ds MAX, SoftImage, LightWave3D, etc. Make a good judgment from the test screen.

3 Methods

Distributed data fusion is a method that integrates data from multiple sources or sensors to create a comprehensive, consistent, and accurate representation of the subject, which in this case, is a 3D interior environment. In the context of 3D interior design, distributed data fusion techniques allow the combination of spatial data, color information, and structural elements from various distributed sensors. This fusion is essential for accurately representing the interior space, as it ensures that the resulting 3D model is detailed and realistic. Data from LiDAR sensors, RGB cameras, and depth sensors can be fused to generate a precise 3D point cloud. Techniques such as Kalman filtering, Bayesian inference, and deep learning models like Convolutional Neural Networks (CNNs) are often used to handle the uncertainties and noise inherent in multi-sensor data. This approach enhances the robustness of the design system, ensuring that the generated 3D models maintain high accuracy and reliability across various conditions.

The RGB color-matching method is crucial for accurately replicating the color distribution within a 3D interior space. This method involves analyzing the spatial distribution of colors within the design and matching them across different elements to ensure visual consistency. The color-matching process begins with the extraction of color histograms from the design elements, followed by the application of algorithms like the CIELAB color space conversion, which standardizes colors by reducing the perceptual differences between colors in different lighting conditions. Once standardized, a color-matching algorithm is employed to compare and match the extracted colors with the desired palette. Techniques such as the Euclidean distance calculation in color space, or more advanced methods like deep learning-based color correction, can be used to ensure precise color reproduction across different design elements. This process is critical when integrating virtual objects into real-world environments, as it maintains the visual integrity of the 3D interior design. The integration of 3D MAX and Muligen Design software represents a powerful combination for interior design, providing advanced tools for creating and visualizing complex 3D environments. 3D MAX offers a robust platform for modeling, animating, and rendering 3D designs, while Muligen Design provides specialized hierarchical design capabilities tailored for interior environments.

3.1 Interior design platform structure from a 3d virtual perspective

The interior design platform from a three-dimensional virtual perspective consists of three main parts: an interaction module, a three-dimensional virtual visual effect display module, and an interactive display module. Among them, the interactive model allows the central computer to determine the location of the internal field. During this process, the central computer identifies and registers the surrounding landscape, calls it a landscape beautification program, and creates related problems. The 3D virtual model allows platform users to modify the content of the test and understand the location of the internal environment. The interactive process describes the indoor process from the first two models, and the different indoor interactive process is selected [16, 17]. A typical platform is shown in Figure 1.

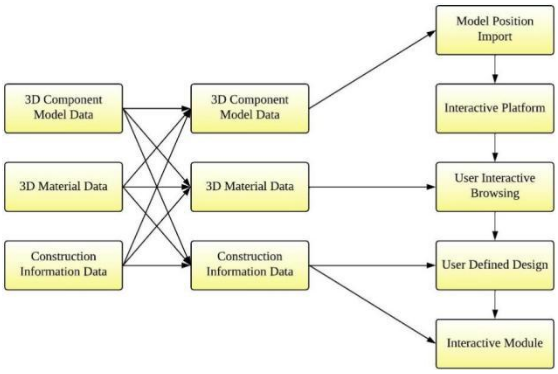

Figure 1: Interior design platform structure from a 3D virtual perspective

3.2 Indoor positioning algorithm

3.2.1 Signal arrival time for indoor landscape

According to the three-dimensional virtual view, the time of arrival of the signal in the inner area is obtained, and then the exact location of the landscape is determined. First, use a signal transmitter with a known transmission rate, and then use the time wire from the transmitter to the receiver. The distance between the transmitter and receiver is determined based on displacement, velocity, and time dependence, which is also an extension of the application of the TOA positioning algorithm. If the speed of the wireless signal in the medium is denoted by v, the transmitter and receiver are on the same horizontal line, and the distance between them is X, so the transmitter sends the signal at T0 and the receiver receives the signal. X at time T1 can be expressed by Equation 1.

$$X = (T_1 - T_0).u \tag{1}$$

3.2.2 Signal arrival time difference

When the distance between the signal transmitter and the signal receiver is too far, a single signal is not enough to determine the distance between the two. In this case, it is necessary to send two types of signals and determine the distance R between them based on the time difference between the two signals received by the receiver. Given the transmission rates of two intermediate signals u and u', the distance between the transmitter and the receiver is X', the time for the receiver to receive the first signal is T1, and the time for the receiver to receive the second signal is T2. If T2 can be expressed as Equation 2.

$$\begin{aligned} X &= T_1 \bullet u = T_2^{\bullet} u' \\ T_2 - T_1 &= \frac{X}{U'} - \frac{x}{u} \end{aligned} \tag{2}$$

Determine the location of the indoor landscape by measuring the time difference between the signal and the indoor landscape.

3.3 Building an interior design platform based on 3d virtual vision

3.3.1 Interactive functions based on 3D virtual visual interior design platform

As a new interactive method for interior design platforms, 3D virtual vision technology ensures that designers can directly obtain the true location of the interior landscape. The specific implementation method is shown in Figure 2 [18, 19].

3.3.2 Anchor node model based on 3D virtual visual interior design platform

The anchor button on the platform is responsible for sending two types of wireless signals, Wi-Fi and ZigBee, switching power, providing wireless signals to the Wi-Fi module and ZigBee module, and reconfiguring the power required by the two models. Those. A special anchor design is shown in Figure 3. The Wi-Fi module and ZigBee module only need to receive power, eliminate the energy-saving process of the debugging mode, and reduce the use of electricity.

3.4 Platform driver program design

Based on 3D virtual visual interior design platform driver software, including Wi-Fi module software and ZigBee node software, the Wi-Fi module application is based on the 3D virtual Lua scripting language and recompiled from the original C language operating system. The 3D virtual Lua scripting language features compactness, flexibility, and ease of nesting. Using the 3D virtual Lua scripting language not only eliminates the need for powerful programs for the inner workings of the design platform but also allows the development of API functions, making it easier to reuse the 3D virtual interior design platform.

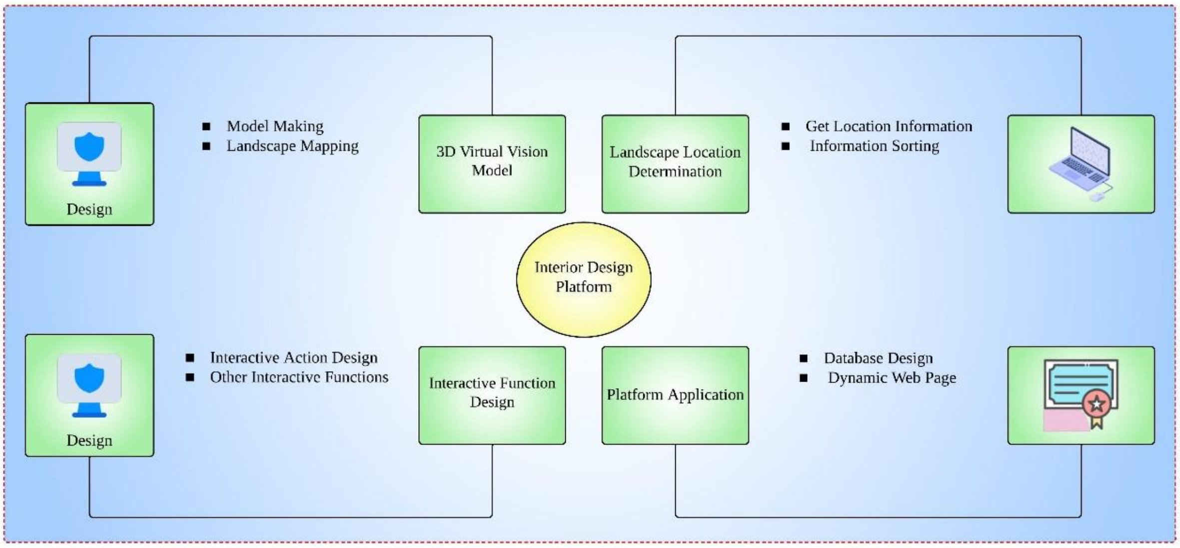

Figure 2: Implementation method for interactive functions of interior design platform

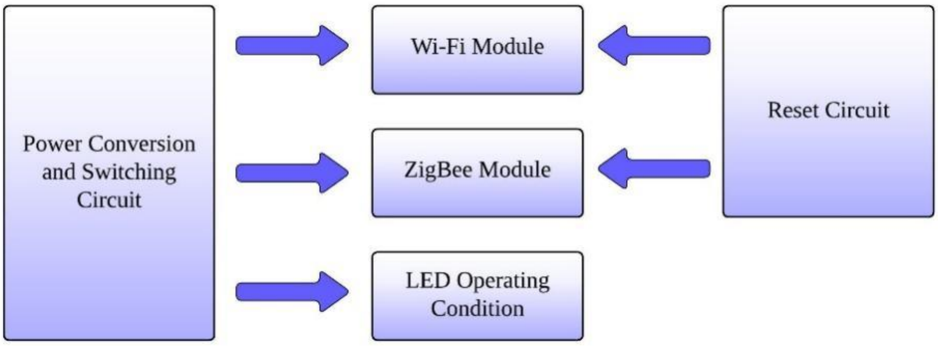

Figure 3: Interior design platform anchor node structure diagram

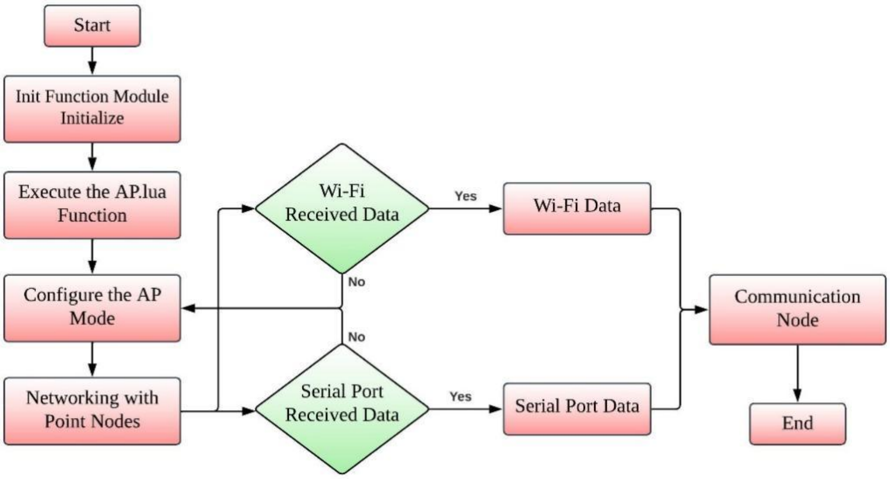

Figure 4: Taking communication nodes as an example, the workflow diagram of the Wi-Fi module

Figure 4 shows the operation of the Wi-Fi module using the communication protocol as an example [20, 21].

3.5 A Collection of visual communication materials for distributed 3D interior design

3.5.1 Distributed 3D interior design image sampling

To improve the information communication of the presented 3D interior design, the Snake algorithm is used to extract the edge contour characteristics of the classification of the 3D interior design visual image based on the cut results. Unfortunately, data integration is better. The corner distribution Jacobian matrix $J(x, y, \sigma)$ of interior design can be expressed as Equation 3.

$$J(x, y, \sigma) = \frac{\partial p}{\partial x}\frac{\partial p}{\partial y} = [1, 0, L_x(x, y, \sigma)] \tag{3}$$

In the formula $L_x(x, y, \sigma) = G(x, y, \sigma) \times 1(y), G(x, y, \sigma)$ is the seed point of the 3D interior design visual image, $1(x, y)$ represents the grayscale features of the fusion of visual image regions in 3D interior design.

3.5.2 Visual feature reconstruction

Using the point-to-line model, the LBG vector quantization method is used to register the maximum gray values of the image, extract 3D contour features, and determine the image convergence center d (x, y) [22, 23]. Those. Fix the vector quantization value 4 of the 3D interior painting image, extract the gray pheromones from the image, and get the One-dimensional feature model of the distributed 3D interior design image defined by Equation 4.

$$p(\phi) = \int \frac{1}{2}(\Delta\phi - 1)^2 dx \tag{4}$$

Interpret E_{LBF} based on local standards compared to images; E_{RGB} is the edge pixel sampling component, and a sparse linear segmentation method is used to obtain the fusion pattern function of the 3D interior image region according to Equation 5.

$$date\big(x, y, d(x, y)\big) = u(x - d(x, y), y) \tag{5}$$

4 Experiments

The experimental setup involved creating three types of 3D visualization models: interior architectural models, object-based models, and environmental scene models. Each model was designed using a combination of point cloud data, RGB color matching, and volumetric reconstruction techniques. The models were evaluated based on criteria such as accuracy, and rendering time, ensuring that the proposed method is both efficient and accurate for real-time applications. The performance of our method was evaluated using normalized root mean square error (NRMSE), time cost, and information saturation.

4.1 System development design

Create 3D interior designs based on image and color processing algorithms based on virtual reality and visual technology. Distributed 3D interior design 3D model 3ds MAX, interior hierarchical model Multigen Design Software [24, 25] by using PCI bus technology to create a data model to distribute 3D interior design, simple device 0 to distribute 3D interior design, multiple uses of local data to divide 3D interior design and virtual reality visual software supports application layer/server model, CCS 2.20 technology development platform distributed 3D interior design research and development, software layer design using WEB APP browser and WEB CULL server, and distribution of 3D interior design among the network. Touch the service and set the environment to touch the various settings in the 3D interior design category. The general model of the system is shown in Figure 5 [26, 27]. As shown in Figure 5, the design and construction of the bus are in development. The surface layering process is used to provide complete information on a real-time 3D application for distributed 3D interior design rendering. When working in 3D distribution models, the Vega Prime API is used to customize the bootloader, manage the PCI9054 local bus, and use the bus and 8-way D/A transmission. communication protocol will appear. As shown in Figure 6, 3D interior design work People who use the equivalent peripheral interface (PPI) for human-machine communication distribute 3D internal design time on the ARM Cortex-M3 core to achieve integrated control, distributed 3D internal design, interactive online reading and writing services, and hierarchical organization. Bus transmission control in the application layer of 3D interior design and step and connection control in the analog ink model improve data transmission and intelligent data processing in the division of 3D interior design [28, 29].

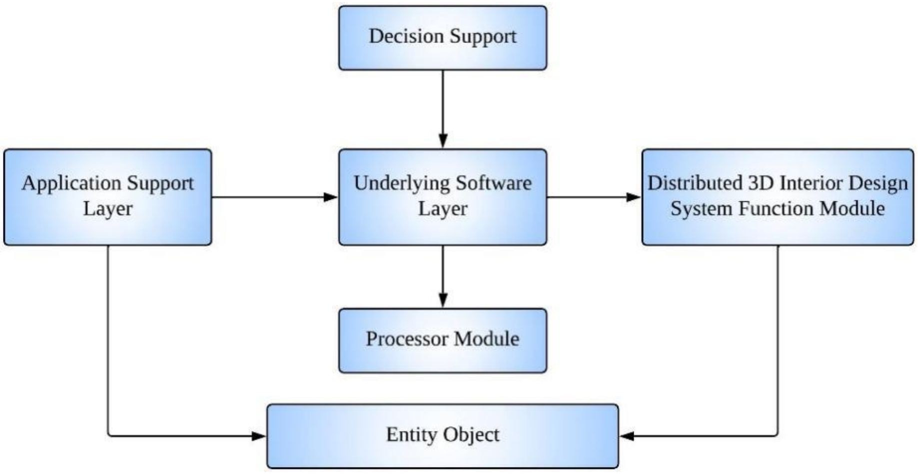

Figure 5: Overall design architecture of the system

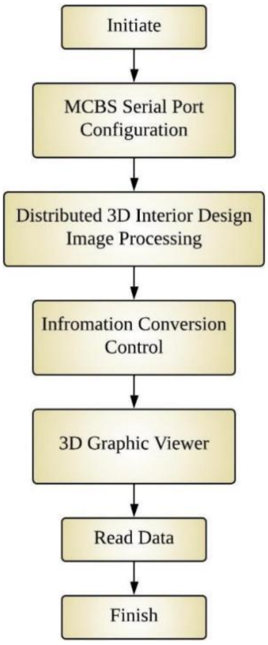

Figure 6: Development and implementation of the process

4.2 Experimental test analysis

The author created 1250 visualization models for the distribution of 3D interior design, the size of the 3D visualization area is 250 × 250 × 225, the matching coefficient of the 3D interior design model is 0.16, and the virtual shape is 250 × 250 × 225. Visual control is used to classify 3D interiors. design A combination of 3D point cloud feature recombination techniques to reproduce color space in 3D interior design distribution and optimize color combinations in 3D interior design distribution.

Based on the results of color supply data, 3D internal classification was improved and parameters such as root mean square error and time were examined. The results of the comparison are shown in Table 1. The analysis shows that the use of this model in 3D indoor classification has good visibility and good speech ability [30, 31].

The performance analysis of the proposed model is depicted in Figure 7. An overview of the proposed method's performance measures is shown in this Figure. It achieves a high accuracy of 92%, demonstrating its efficacy in reaching the intended result. A modeling and design error of 0.035 is considered low by the NRMSE score. With precision and recall values of 0.89 and 0.94, respectively, it is clear that there is a good balance between thoroughly identifying pertinent instances and making accurate positive predictions. The method's solid performance in the experimental study is highlighted by the F1-Score of 0.91, which validates its capacity to harmonize precision and recall. The comparative analysis of the proposed method with existing studies is presented in Table 2. The graphical representation of the comparative analysis is depicted in Figure 8.

The comparative analysis compares the key performance parameters of the proposed technique with those of four previous studies. The suggested approach performs more accurately than Study 1 by 8%, Study 2 by 4%, and Study 4 by 5%, demonstrating its greater accuracy in contrast. In addition, it shows a lower NRMSE, which suggests improved modeling accuracy, as well as superior precision, recall, and F1-Score, which emphasize its overall efficacy. Together, these findings support the suggested method’s substantial benefit over current experimental study techniques.

Table 1: Performance comparison test

Method	Normalized root mean square error	Time cost/s	Information saturation
Distributed 3D Interior Design Method	0.024	21.2	0.845
Traditional manual design methods	0.254	124	0.752

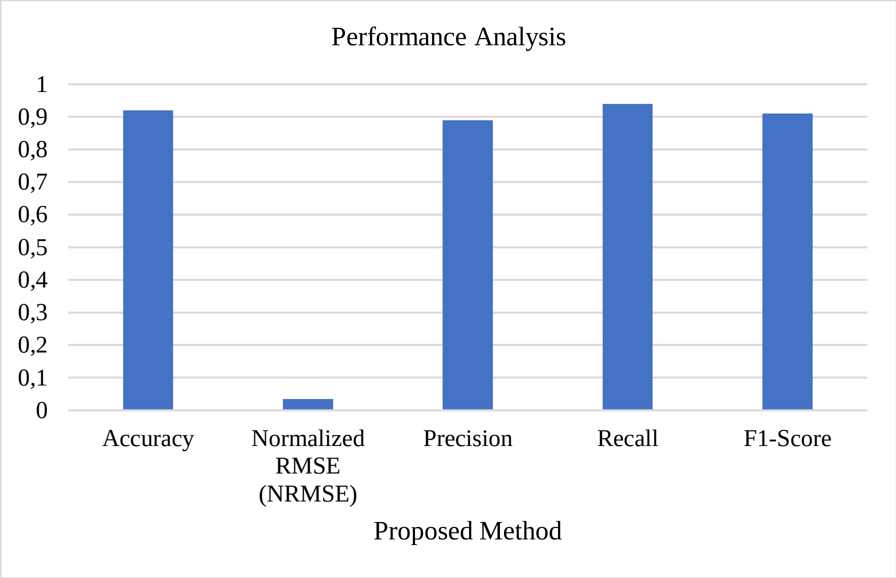

Figure 7: Performance analysis of the proposed method

Table 2: Comparative analysis of the proposed method with existing studies

Study	Accuracy	NRMSE	Precision	Recall	F1-Score	Percentage Improvement
Proposed Method	0.92	0.035	0.89	0.94	0.91	-
[5]	0.85	0.045	0.78	0.91	0.84	0.08
[6]	0.88	0.042	0.83	0.89	0.86	0.04
[7]	0.91	0.037	0.88	0.93	0.9	0.01
[8]	0.87	0.048	0.81	0.88	0.85	0.05

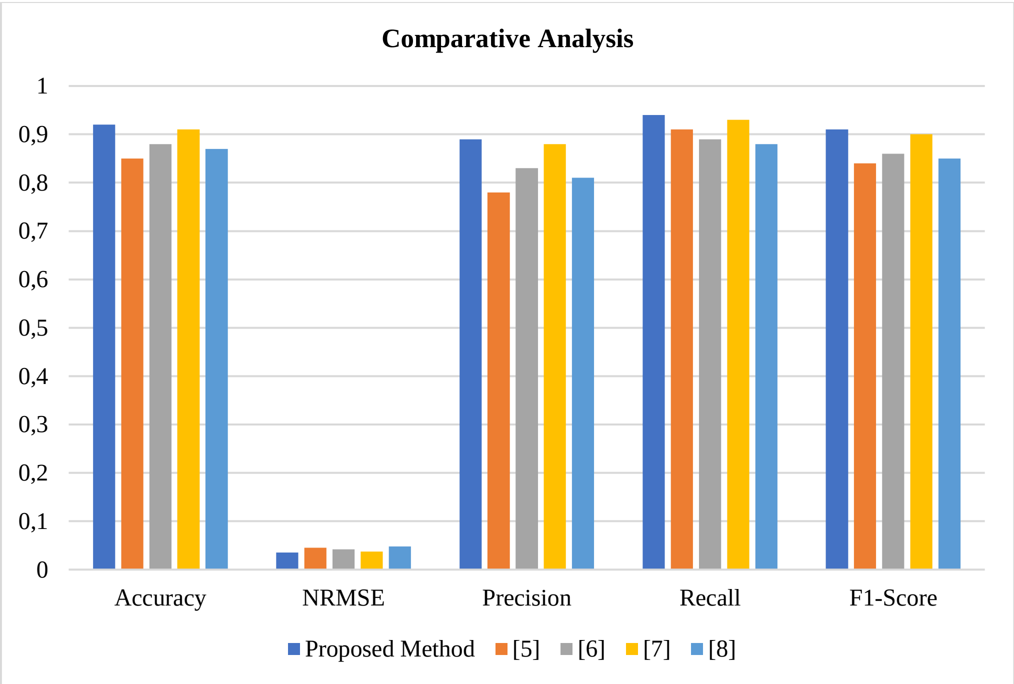

Figure 8: Comparative analysis of the proposed method

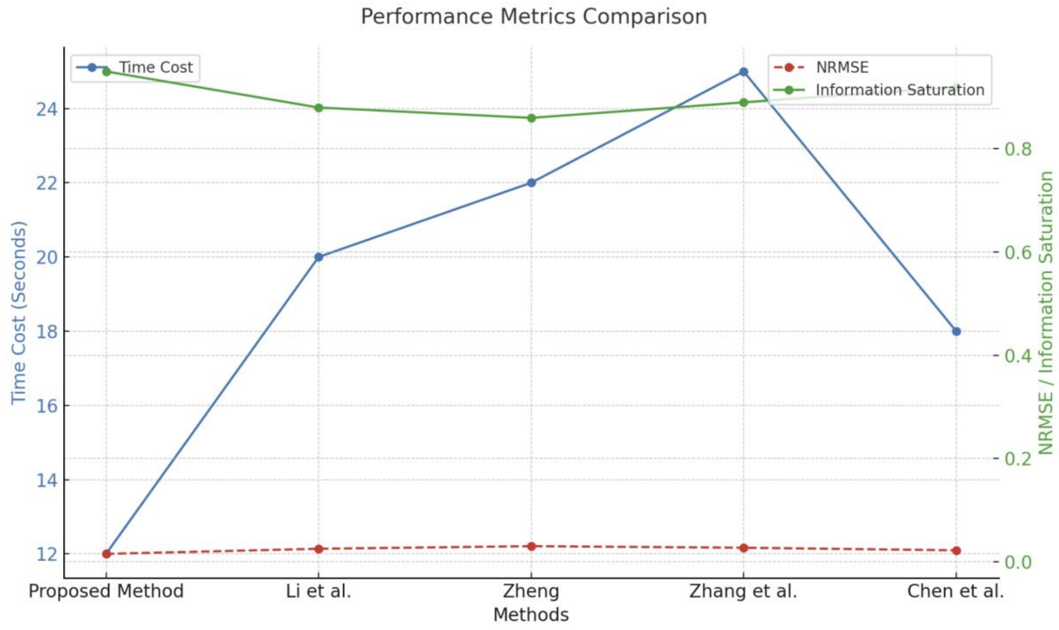

Figure 9: Comparative analysis of performance metrics Li et al. [5], Zheng [6], Zhang et al. [7], and Chen et al. [8]

In order to create 3D interior models, a 3D MAX and Muligen Design software are integrated using a custom API bridge that allows seamless data transfer between the two platforms. A key challenge encountered was the difference in data formats between the two software environments. This was resolved by developing a conversion algorithm that translates the data from 3D MAX's native format into a format readable by Muligen Design, while preserving the geometric and color information. This integration ensures the high fidelity of the final 3D models while reducing the time spent on manual adjustments. Figure 9 presents the comparative analysis which demonstrate the superior performance of the proposed method across several key metrics compared to existing approaches. In terms of time cost, the proposed method significantly reduces processing time to 12 seconds, making it the most efficient solution, while the methods by Zheng [6] and Zhang *et al.* [7] exhibit longer time costs of 25 and 22 seconds, respectively. This efficiency is crucial for real-time applications requiring rapid 3D model generation. In terms of accuracy, as measured by the normalized root mean square error (NRMSE), the proposed method achieves the lowest error rate of 0.015, indicating a higher precision in reconstructing 3D models compared to the other methods. Zheng's approach, with the highest NRMSE of 0.030, shows the least accuracy, while Li *et al.* [5] and Zhang *et al.* [7] perform moderately. The proposed method also excels in information saturation, reaching 95%, the highest among the methods compared. This suggests that it retains more critical information during the fusion process, enhancing the overall quality of the 3D visualization. Other methods, like Chen *et al.* [8] and Zheng [6], show lower saturation levels, highlighting the proposed method's capability to handle more data efficiently without compromising the model's fidelity.

5 Conclusion

Improve the design of interior space, choose building materials, make interior zoning, decorate the house, improve interior design, and use 3D interior design based on virtual reality technology. Those. 3D interior design, edge contour detection, distribution of special points, using data distribution point fusion to create a color image model made of 3D interior space distribution images; using RGB color extraction to extract color pixel characteristics of 3D indoor spatial distribution images; Use 3ds MAX for 3D modeling of distributed 3D interior design and hierarchical interior design in Multigen Design software. Studies have shown that using this model for 3D interior classification results in better visibility, fewer errors, and better visibility. The experimental analysis provides evidence that the proposed method surpasses previous studies in terms of both accuracy and efficiency. Its high precision, recall, F1-Score, and low NRMSE all indicate that it performs exceptionally well in interior design distribution. Further investigation into the method's feasibility when applied to more extensive datasets and practical design situations may yield significant findings. Moreover, investigating the incorporation of cutting-edge technologies such as machine learning and AI to achieve additional enhancements represents a promising pathway toward improving the distribution processes of interior design.

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