www.cadanda.com
Computer-Aided Design AND APPLICATIONS

Exploring the Integration of Architectural Environment and Environmental Color in Digital Interactive Art Design for the Construction Industry

Lu Weiwei[1] and Li Bo[2*]

[1]School of Design, NingboTech University, Ningbo,315100,China
xiaohe19831120@126.com,
[2]School of Plastic Arts, Hebei Academy of Fine Arts, Shijiazhuang 050700, China

Corresponding Author: Li Bo, libo@hbafa.edu.cn

Abstract. How to organically combine color theory, color design and environmental art design is an important topic.In the design of public environment in residential areas, there are often many different types of designs, most of which emphasize only its external performance, but the essential connotation of environmental design is often ignored. As an important part of design, color has been paid more and more attention and studied. Each subsystem of the city can be directly reflected in the computer, which can easily manage and control all kinds of logistics and information flow in the city. Color can have a great influence on people's physiology and psychology. In this article, an environmental color enhancement algorithm based on deep learning is proposed to analyze the image characteristics and artistic expression in the interactive design of urban environment. The proposed algorithm is effective in adjusting the quantization results, and the quantization performance is good. It can adjust the color gradation of environmental design and the focus of key details by modifying the weights to meet different color quantization tasks.

Key words: Interactive design; Environmental construction; Color design; Image features; Artistic expression; Design for the Construction Industry.
DOI: https://doi.org/10.14733/cadaps.2024.S11.42-54

1 INTRODUCTION

As a kind of practical art, environmental art design mainly integrates the indoor and outdoor space environment through artistic design. People have different understandings of environmental art design. Those who focus on environmental understanding regard it as a means to beautify the environment, while those who focus on artistic understanding regard it as an art that pursues high-level with the help of environmental theoretical knowledge [25]. In the design of public environment in residential areas, there are often many different types of designs, most of which emphasize only

its external performance, but the essential connotation of environmental design is often ignored [21]. In the process of image formation, natural environment factors or human factors will lead to lack of illumination, poor visual effect and low image definition, and the processing of shadow images and weak light images has always been one of the difficulties in image processing [3]. With the development of virtual reality technology, three-dimensional environment design and modeling technology has been widely concerned, and it has been applied in network virtual assistance, urban planning and 3D game design [13]. However, the existing three-dimensional modeling methods have large reconstruction error accuracy, which limits their practicability in many fields, especially in environmental design. As an important part of design, color has been paid more and more attention and studied [10]. Color can have a great influence on people's physiology and psychology [16]. How to organically combine color theory, color design and environmental art design is an important topic. environmental design, digital art, and technology to create innovative and visually engaging experiences within the construction industry.

In the social life of human beings, cities always occupy a very important position. A city is the center of social, political, economic, cultural and scientific development. To some extent, urban development represents social development and human progress [5]. Driven by the digital earth, digital cities have developed rapidly, which is an important aspect of the digital earth. Each subsystem of the city can be directly reflected in the computer, which can easily manage and control all kinds of logistics and information flow in the city [1]. The three-dimensional modeling of environmental design has a high degree of three-dimensional reduction. The reconstruction method based on single view has limited restoration accuracy, and the three-dimensional modeling method based on multi-dimensional data with double views has become the mainstream [17],[22]. In this article, a color enhancement algorithm based on deep learning environment color is proposed to analyze the image characteristics and artistic expression in urban environment interactive design. In order to optimize the modeling accuracy, an image depth extraction method is further proposed to solve the three-dimensional coordinates and optimize the compensation for the error of three-dimensional reconstruction.

Environmental art design is aimed at constantly meeting the needs of human life and spirit, and it is the design of human living space. The purpose of design is to improve and beautify people's living and living environment. The basic content of digital city is the three-dimensional landscape model of the city. Digital city is not only a main direction of urban informatization development, but also provides a basic platform for the development of urban informatization [26]. With the in-depth development and increasingly extensive application of 3S technology, the construction of digital cities in developed countries has matured, and it has been applied to wireless communication, military long-range precision strike, urban planning and architectural design, emergency response system and virtual tourism in scenic spots and historical sites [11]. Color design is a very important element in modern environmental art design and the soul of design [15].

2 RELATED WORK

Zhuo et al. proposed a Retinex image contrast enhancement algorithm based on Lab color space and tone mapping, which decomposed a low-contrast input image into luminance and chrominance components in Lab color space, and used adaptive bilateral filtering to estimate the illumination intensity, so as to consider suitable neighboring pixels according to luminance and color values [27]. Chen et al. constructed DEM according to photogrammetry and 3D computer graphics methods to realize terrain visualization [2]. Li et al. proposed the method of establishing 3D model based on multi-image photogrammetry [8]. Liu obtained the 3D city model data according to the combination of ground photogrammetry and aerial photogrammetry, then established the 3D model of the building with AutoCAD, and then mapped the real photo texture to generate a highly realistic photo texture 3D model [9]. Wang et al. put forward the global variational model, established the model

of image inpainting by using the constraint conditions contained in the equation, and calculated the minimum energy functional at the edge of the image to realize the inpainting of the damaged area [20]. Guo et al. proposed an image inpainting algorithm based on direction interpolation of image gray gradient, and analyzed the topological structure and texture information in the image during inpainting [6]. Experiments show that the algorithm has a good effect on the repair of image topological structure and the extension of texture information. According to the idea of vector image coupling, Waechter applied the integral variational method to vector images [18]. The experimental results show that the improved inpainting model can keep the edge of color image well and has good denoising function. Da et al. digitized the partial differential equation of the original model and transformed it into a weighted average form, and directly calculated the missing pixels by using the adjacent known pixels. The weighting coefficient was determined by the gradient and curvature, and the repair order was determined by the gradient variance of the known pixels in the neighborhood of the point to be repaired [4]. Seo et al. proposed a method to establish real texture for 3D model obtained from laser scanner [14]. The distance information of the reference point is used to orient the digital image outward in the coordinate system of the 3D model, and then the orthophoto of the model is generated. The hardware and software for establishing the photo-realistic model are given, and the results of 3D reconstruction and texturing of buildings by laser scanning technology are also given. Zhang et al. decomposed the TV model into several sub-Euler-Lagrange equations by adding new control variables, and restored the image by solving the iterative problem of the sub-equations, which greatly improved the restoration efficiency [24]. Based on the sparse representation model of images, Polat et al. added a hidden Markov tree structure model, which can adjust the correlation of wavelet coefficients between scales, thus improving the accuracy of image reconstruction [12].

3 METHODOLOGY

3.1 3D Modeling of Interactive Environment Design Based on Deep Learning

At present, people's awareness of environmental protection is gradually increasing, and they are more concerned about their own environment, hoping to make their living space better and better through various efforts. Among the many factors that affect the artistic design of the external environment of modern buildings, color is one of the most important factors that affect the visual aesthetic effect. Whether the architectural color can be handled well will directly affect the image and taste of the whole city. From the start of a design project, a clear design goal and goal system should be formulated. In the process of interactive design aimed at achieving the final design goal, we should understand the design goal system through various ways and means, and understand the content, steps and strategies of realization. When matching colors, it is necessary to organize the hue, lightness and purity of all kinds of colors according to people's visual needs. Color belongs to the category of visual art. Therefore, when color is applied to environmental art design for organization and collocation, it must meet people's visual needs [7].

Digitalization of environmental design has developed into a trend and is used by more and more countries. Digital environmental design images can exist independently from the environmental design ontology, and all the information of the images can be well preserved. The color enhancement method using sample block matching has achieved very good results in repairing large-area image damage and removing large objects in the image. The inpainting process based on sample block matching is actually based on the method of local region growth, and its basic idea is to ensure the local consistency of pixels while growing the known regions each time to fill the unknown regions. Specifically, by directly matching the block that is most similar to the known information in the block to be filled in the spatial domain of the image, the pixel value corresponding to the most similar sample block is directly copied and stitched to the

unknown area to realize the growth filling. Depending on the growth mode, there are two types: only one pixel at a time or one block at a time. The technical route of three-dimensional drawing of public environment in digital city is shown in Figure 1.

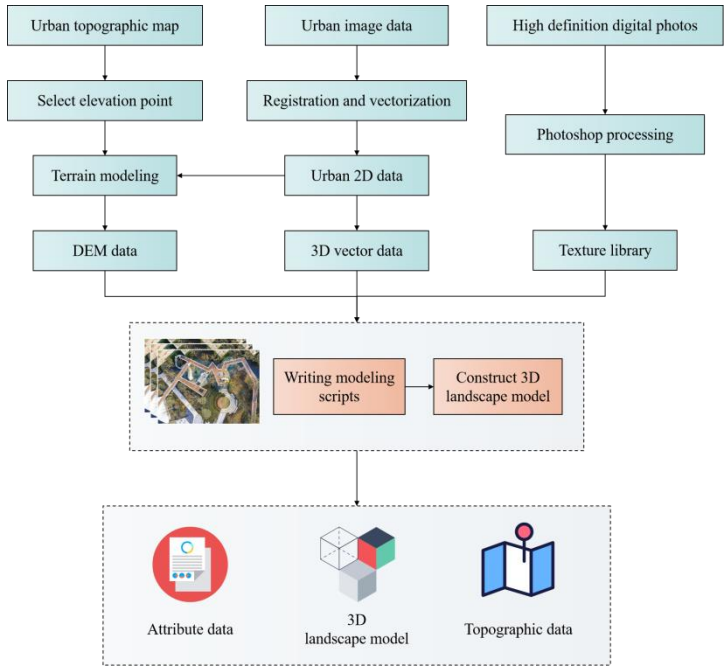

Figure 1: Technical Route for 3D Rendering of Public Environment in Digital City.

Through the study of sample blocks in the search domain of environmental design images, it is found that in the ground layer of public environmental images, many adjacent sample blocks are similar in color and structure, and the overall structural information of the image is not complicated. At the same time, there are large continuous similar colors in the image, and there is great redundancy between adjacent sample blocks. When repairing the damaged parts of environmental design images, it will waste a lot of time to conduct global search. Therefore, the reconstruction of image sample area is considered here to reduce the redundancy of sample blocks and improve the repair efficiency of the algorithm.

Color reflecting architectural functions can reflect the main functions and themes of buildings and highlight the status and personality of buildings. In the case of serious homogenization of architectural modeling, the use of color outside buildings can not only effectively distinguish different functions of different buildings, but also explain the purpose of buildings and distinguish users. When the design target system is refined through continuous analysis, summarized and screened, and described, many details are hidden or ignored. And when all designers can really face the completed design goals, they can definitely tell their advantages and problems for the completed design, because the completed design can finally provide an intuitive interactive object, so that people can think concretely [23]. When the architectural image has been determined, it is a common and widely used way to configure the architectural appearance in color, creating architectural style, symbolizing architectural personality, showing architectural personality, and setting off and rendering architectural atmosphere. There is infinite potential when using color collocation outside buildings.

By organizing different color tonality and creating different color patterns, visual images with different styles can be constructed.

In 3D modeling of public environment, let the normal vector of each triangle in the related triangle group of vertex v_i be n_k, the center x_k and the area a_k. Then the plane constructed by the normal vector and the center defined below is called the average plane of the vertex:

$$N = \frac{\sum n_k a_k}{\sum a_k} \tag{1}$$

$$n = \frac{N}{|N|} \tag{2}$$

$$x = \frac{\sum x_k a_k}{\sum a_k} \tag{3}$$

The offset from the point P in the three-dimensional space to the mesh model TM is defined as:

$$d(P, TM) = \min\left(d(P, X)\right) \tag{4}$$

Where $d(P, X)$ is the Euclidean distance from point P to point X. When displaying the triangle mesh shadow model on the computer, the normal vector of each triangle vertex must be obtained. For vertex P, there are k triangles around it. Let the unit normal vector of the i triangle be:

$$n_i \quad (i = 1,2,3,\ldots,k) \tag{5}$$

Define the normal vector of vertex P as the average of all triangle normal vectors around it, and n_p represents the normal vector of vertex P, then:

$$n_p = \frac{1}{k}\sum_{i=1}^{k} n_i \tag{6}$$

Normalize it:

$$n_p = n_p / |n_p| = \frac{n_{px}\vec{i} + n_{py}\vec{j} + n_{pz}\vec{k}}{\sqrt{(n_{px})^2 + (n_{py})^2 + (n_{pz})^2}} \tag{7}$$

Scale, rotation, illumination change, structure, texture and semantics will affect the quality of color enhancement, which brings some difficulties to the restoration work. For small areas such as scratches and characters, good repair results can generally be obtained. However, in color

enhancement, it is often necessary to repair a large area, such as the removal of the target and the completion of the scene.

3.2 Environmental Color Enhancement Algorithm

The fundamental purpose of interactivity in environmental art design is to attach importance to the mutual influence and function between residents and residential environment. At the same time, another important element is to attach importance to the interaction mode between the environmental elements of residential areas. Therefore, in the process of environmental design, it is necessary to explore the characteristics, laws and internal relations of environmental elements themselves in order to improve the environmental design of residential areas. The shape and color of a building are indispensable. The shape is like the body of a building, and the color is the clothes of the building. The two complement each other. If played properly, the two can promote each other and form a good visual effect, but if played improperly, it will hinder the formation of visual effect. Proper use of color can highlight the expressive force of color. Through color adjustment, some unfavorable features of the body and some unsatisfactory effects in the image can be improved to a certain extent, thus making its overall shape more beautiful [19]. All levels of design have the same or similar background elements, resulting in themes that can resonate with each other. These background elements are also an important basis for design. In the process of creating residential environment, its interaction should be reflected in the whole process of residential construction, so as to create an environmental design that meets the needs of different people.

In most cases, the traditional single method can not achieve satisfactory results in color image segmentation, but the segmentation effect can be greatly improved by mixing segmentation methods according to different application fields. In order to get a line drawing image closer to the designer's requirements, we must improve the existing edge extraction algorithm and find an intelligent and interactive method suitable for computer processing from different aspects such as intelligence, mathematics and painting. The neural network structure for color enhancement of environmental design images is shown in Figure 2.

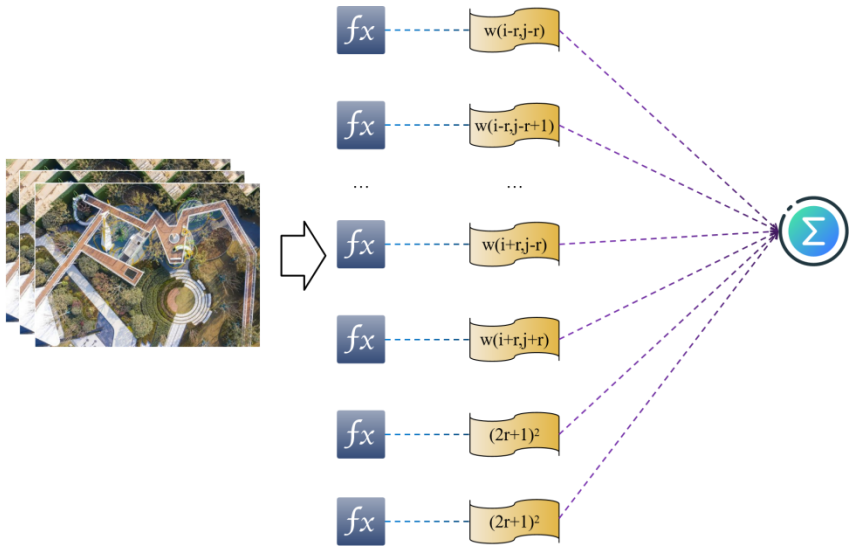

Figure 2: Neural Network Structure for Color Enhancement of Environmental Design Images.

Let the gray value range of the original environment design image $f(x,y)$ be $(g_{\min}, g_{\max})$, choose a suitable threshold T, and:

$$g_{\min} \le T \le g_{\max} \tag{8}$$

Image segmentation with a single threshold can be expressed as:

$$g(x,y) = \begin{cases} 1, & f(x,y) \ge T \\ 0, & f(x,y) < T \end{cases} \tag{9}$$

$g(x,y)$ is a binarized image. The object can be easily revealed from the background through binarization. The key to binarizing the environment design image is the reasonable selection of the threshold T.

Interaction has the characteristics of two-way interactive conduction, and the participating users participate in the use of products independently, which is different from the passive acceptance in the past. Participating in the direct interaction between users and products can change the color, texture and influence of products. Participating users trigger product changes in various forms such as direct touch, sound and spatial movement. The main purpose of designing and building buildings is to provide convenience for people's daily life, work and study, and to be used by people. If we want to create a harmonious environment suitable for people's lives, we must consider whether the color design is harmonious and unified with the whole city. Interactive design is a modern and efficient design process in which designers set rules and procedures, and then users participate in them to change and improve the product form and give feedback. In the design of public environment, it is necessary to realize that products can not only optimize the space environment, but also interact effectively with people's body and mind, so that people's body and mind are happy and comfortable.

In order to ensure that the loading and rendering time of the public environment model does not exceed the limited time threshold and can provide the best image quality, it is necessary to optimize the scene loading and choose the appropriate scene loading scheme. By matching the position of interaction design in the real scene with the three-dimensional space coordinates in the virtual scene, the interaction design can be more closely combined with the scene environment. Let the gray function of the two-dimensional environment design image be $f(x,y)$. The $r(r>0)$ field of the (i,j) loxel is defined as the following set:

$$N_r(i,j) = \{(k,l) \mid \max\{|i-k|, |j-l|\} \le r\} \tag{10}$$

The value defined as follows is called the interest degree of the (i,j) bit pixel:

$$I(i,j) = \frac{1}{(2r+1)^2 - 1} \sum_{(k,l) \in N_r(i,j)} \left(f(i,j) + w(k,l,\sigma) f(k,l) \right) \tag{11}$$

Among them:

$$w(k,l,\sigma)=\psi(i-k,\ j-l,\sigma) \tag{12}$$

$\psi(x,y,\sigma)$ is the DOG function.

4 RESULT ANALYSIS AND DISCUSSION

In the process of environmental design, we should first investigate the specific situation of the surrounding environment in an all-round way, and integrate certain local cultural characteristics and regional customs into the design. The purpose of applying the interactive design concept to the public environment is to meet the public's needs, and to change the one-way mode into the interactive mode, so that citizens can use the humanized function of the public environment more conveniently and comfortably. The stereo projection matching algorithm is used to match the coordinates of the pixels of the three-dimensional scene. Considering that there will be stereo distortion in 3D reconstruction modeling using 2D images, this article makes stereo compensation for the extracted image depth information on the basis of traditional 3D modeling, and finally realizes highly restored 3D scene reconstruction.

Color enhancement is a process of reasoning. The data of unknown parts are inferred according to the prior information of known parts in the image, and the reasoning basis is the prior knowledge of the image. Therefore, the prior model based on visual psychology is very important for color enhancement technology. In order to verify the effectiveness and practicability of the environmental color enhancement algorithm in this article, this section tests and analyzes the performance of the system. In the experiment, the time needed to process public environment images with different numbers of pictures and different nodes was tested. The result of the experiment is shown in Figure 3.

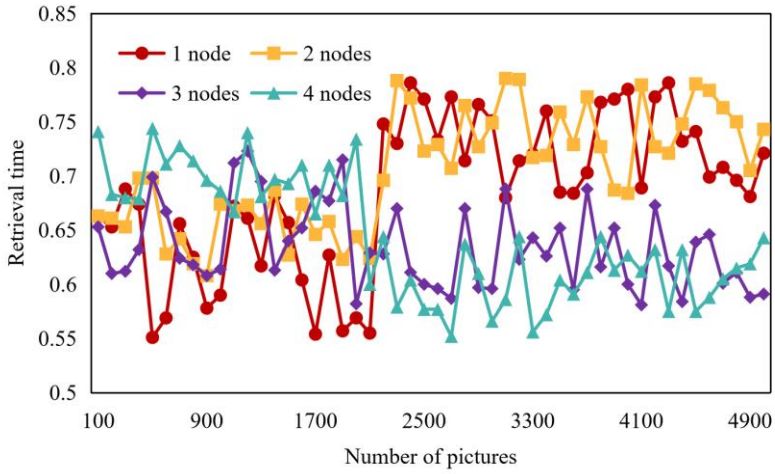

Figure 3: Image Processing Consumes Time.

As can be seen from Figure 3, when the number of public environment images is small, the more nodes, the more time it takes for image processing. With the increasing number, the advantages of multiple nodes can be revealed. Therefore, when the number of public environmental images is large, the proposed environmental color enhancement scheme can obviously improve the processing efficiency.

Three-dimensional modeling can be achieved initially after stereo projection matching. However, due to the use of two-dimensional images for three-dimensional projection reconstruction, stereo distortion will inevitably occur, so it is necessary to further extract image depth information to compensate for three-dimensional modeling distortion. Figure 4 shows the accuracy results of different algorithms.

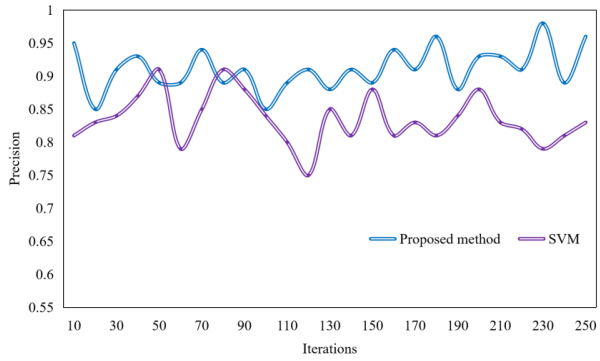

Figure 4: Accuracy Results of Different Algorithms.

Using the proposed method to process the color information of environmental design images, the processing effect is obviously better than the traditional SVM algorithm, and the background information is better suppressed. As a contrast method, the characteristic information of environmental design images can be restored to some extent, but at the same time, the redundant background information of environmental design images is enhanced, which is prone to over-enhancement. The comparison of the algorithm MAE is shown in Figure 5.

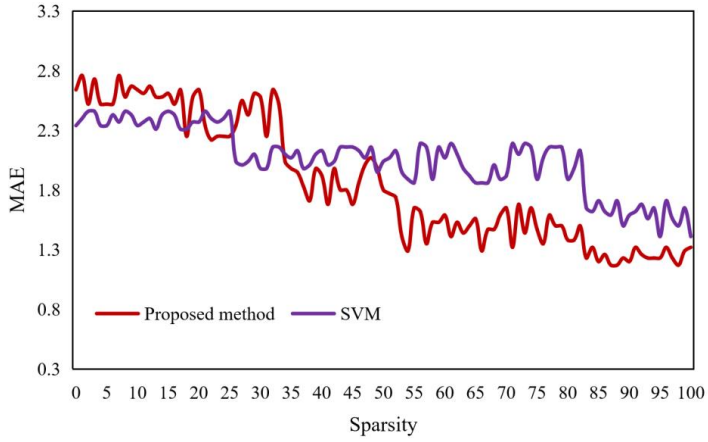

Figure 5: Comparison of Algorithm MAE.

Although the traditional SVM-enhanced environmental design image highlights the edge than the edge-sharpened image, compared with the color enhancement method proposed in this article, there are still some fuzzy details. Comparing the root mean square error of stereo matching with the reconstruction error after depth information compensation, it can be found that the larger the root mean square error, the better the compensation effect. The root mean square error and mismatch

rate are not completely proportional, which shows the rationality of the cost function set in this article.

The problem of color quantization is to classify many colors in the original image into fewer colors according to human visual effects, so as to regenerate the so-called quantized image with these fewer colors, so as to minimize the difference between the quantized image and the original image, that is, the so-called quantization error. If the color palette is selected according to the frequency, that is, according to the number of pixels of colors, the dominant style of the image may be retained, and the colors that were not in the original image will also be retained, and some key details in the image will be lost or colored incorrectly. For example, from the visual perception of people, the quantization error between the original image and the reconstructed image is great, because the most eye-catching red color in the image is lost, or the color with the greatest color difference from the dominant image style is lost. However, if the color difference is the standard, that is, the color distance is used to select the palette, although the details can be preserved, the layering of the overall color of the image will be lost. The scatter plot of the test sample using the traditional SVM algorithm is shown in Figure 6. The scatter diagram of the test sample using the environmental color enhancement algorithm in this article is shown in Figure 7.

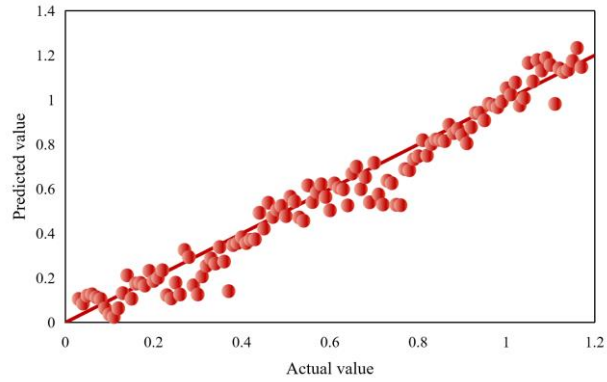

Figure 6: Scatter Plot of Actual Value and Predicted Value of Traditional SVM.

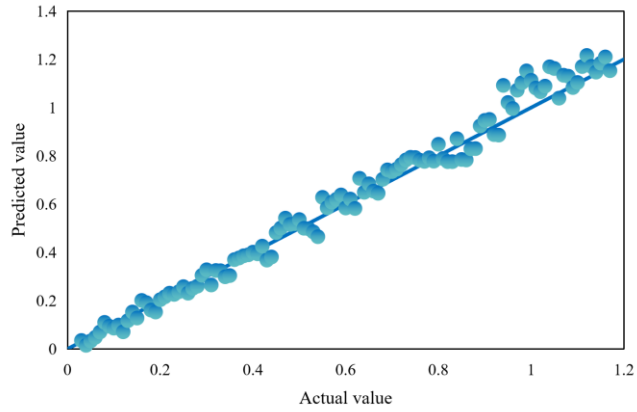

Figure 7: Scatter Plot of Actual Value and Predicted Value of this Algorithm.

It can be analyzed that the environmental color enhancement algorithm in this article has more advantages than the traditional SVM algorithm in both accuracy and efficiency. Based on the three-dimensional modeling framework of non-parallel two-way stereo imaging, the stereo matching algorithm is used to match by constructing the matching cost function, so as to determine the optimal three-dimensional reconstruction coordinates. This method can avoid the problem of image distortion, and can enhance the details of dark areas of color on the basis of maintaining the original image color, and solve the problem of uneven or too dark color distribution caused by lighting environment. In the future, the demand for public environmental design will not only be greater and greater in science and technology, but also the artistic features will become an indispensable and important part.

5 CONCLUSIONS

Whether it is the indoor environmental art design or the external environmental art design, the importance of color is beyond doubt. In the diversified use of color, it contains the designer's unique and rich design concept, and it also contains the unique cultural heritage of the social environment. In the design of public environment in residential areas, there are often many different types of designs, most of which emphasize only its external performance, but the essential connotation of environmental design is often ignored. In today's society, modern urban environmental design pays more and more attention to the relationship between color and environment. Color can have a great influence on people's physiology and psychology. How to organically combine color theory, color design and environmental art design is an important topic. Reasonable application of image enhancement technology can fundamentally solve the quality problems of images, make the visual effect of images clearer and better reflect the details of images. The color enhancement model of environmental design image proposed in this article based on deep learning can effectively solve the problem of unclear and stereoscopic images, while maintaining the clarity of public environmental images.

Lu Weiwei, https://orcid.org/0009-0007-6710-1278
Li Bo, https://orcid.org/0009-0009-7486-3857

REFERENCES

[1] Buckley, C.; Bernardi, G.: A Simplified Approach To Virtual Reality and Auralizations for Architectural Acoustics, Acoustical Society of America Journal, 140(4), 2016, 3292-3292. https://doi.org/10.1121/1.4970469
[2] Chen, Z.; Xu, B.: Enhancing Urban Landscape Configurations by Integrating 3D Landscape Pattern Analysis With People's Landscape Preferences, Environmental Earth Sciences, 75(12), 2016, 1018. https://doi.org/10.1007/s12665-016-5272-7
[3] Chung, A.; To, W. M.; Schulte-Fortkamp B. Next Generation Soundscape Design Using Virtual Reality Technologies, Journal of the Acoustical Society of America, 140(4), 2016, 3041-3041. https://doi.org/10.1121/1.4969442
[4] Da, Z.; Huang, Q.; He, C.: Planning Urban Landscape to Maintain Key Ecosystem Services in a Rapidly Urbanizing Area: A Scenario Analysis in the Beijing-Tianjin-Hebei Urban Agglomeration, China, Ecological Indicators, 96(1), 2018, 559-571. https://doi.org/10.1016/j.ecolind.2018.09.030
[5] Fernandez, R. P.; Alonso, V.: Virtual Reality in a Shipbuilding Environment, Advances in Engineering Software, 81(3), 2015, 30-40. https://doi.org/10.1016/j.advengsoft.2014.11.001
[6] Guo, Q.; Ehlers, M.; Wang, Q.: Ehlers Pan-Sharpening Performance Enhancement Using HCS Transform for N-Band Data Sets, International Journal of Remote Sensing, 38(17-18), 2017, 4974-5002. https://doi.org/10.1080/01431161.2017.1320448

[7] Kong, S.: 3D Image Reconstruction of Marine Plankton Based on Virtual Reality, Journal of Coastal Research, 103(9), 2020, 851. https://doi.org/10.2112/SI103-176.1
[8] Li, D.; Bao, J.; Yuan, S.: Image Enhancement Algorithm Based on Depth Difference and Illumination Adjustment, Scientific Programming, 2021(1), 2021, 1-10. https://doi.org/10.1155/2021/6612471
[9] Liu, S.; Long, W.; He, L.: Retinex-Based Fast Algorithm for Low-Light Image Enhancement, Entropy, 23(6), 2021, 746. https://doi.org/10.3390/e23060746
[10] Lorusso, M.; Rossoni, M.; Colombo, G.: Conceptual Modeling in Product Design Within Virtual Reality Environments, Computer-Aided Design and Applications, 18(2), 2020, 383-398. https://doi.org/10.14733/cadaps.2021.383-398
[11] Panetta.; Karen.: Color Image Enhancement Based on the Discrete Cosine Transform Coefficient Histogram, Journal of Electronic Imaging, 21(2), 2015, 1117. https://doi.org/10.1117/1.JEI.21.2.021117
[12] Polat, A. T.; Akay, A.: Relationships Between the Visual Preferences of Urban Recreation Area Users and Various Landscape Design Elements, Urban Forestry & Urban Greening, 14(3), 2015, 573-582. https://doi.org/10.1016/j.ufug.2015.05.009
[13] Sanchez-Sepulveda, M.; Fonseca, D.; Franquesa, J.: Virtual Interactive Innovations Applied for Digital Urban Transformations. Mixed approach, Future Generation Computer Systems, 91(2), 2018, 371-381. https://doi.org/10.1016/j.future.2018.08.016
[14] Seo, C. T.; Kang, S. W.; Cho, M.: Three-Dimensional Free View Reconstruction in Axially Distributed Image Sensing, Chinese Optics Letters, 2017(08), 2017, 40-43.
[15] Shen, X.; Zhang, X.; Wang, Y.: Color Enhancement Algorithm Based on Daltonization and Image Fusion for Improving the Color Visibility to Color Vision Deficiencies and Normal Trichromats, Journal of Electronic Imaging, 2020(5), 2020, 29.
[16] Tan, D.: A Quantitative Survey of Avian Population Densities in a Heterogeneous Tropical Urban Landscape, The Raffles Bulletin of Zoology, 2016(32), 2016, 95-104.
[17] Tsai, C. Y.; Huang, C. H.: An Adaptive Dynamic Range Compression with Local Contrast Enhancement Algorithm for Real-Time Color Image Enhancement, Journal of Real-Time Image Processing, 10(2), 2015, 255-272. https://doi.org/10.1007/s11554-012-0299-9
[18] Waechter, M.; Beljan, M.; Fuhrmann, S.: Virtual Rephotography: Novel View Prediction Error for 3D Reconstruction, ACM Transactions on Graphics, 36(1), 2017, 8. https://doi.org/10.1145/3072959.3126787
[19] Wang, M.: Investigation of Remote Sensing Image and Big Data Analytic for Urban Garden Landscape Design and Environmental Planning, Arabian Journal of Geosciences, 2021(24), 2021, 14. https://doi.org/10.1007/s12517-021-09174-w
[20] Wang, Y.; Wang, H.; Yin, C.: Biologically Inspired Image Enhancement Based on Retinex, Neurocomputing, 177(177), 2016, 373-384. https://doi.org/10.1016/j.neucom.2015.10.124
[21] Xue, C.: Research on the Expression of Environmental art Design Based on Virtual Technology, Revista De La Facultad de Ingenieria, 32(9), 2017, 560-565.
[22] Yu, L.; Xie, X.; Wei, L.: Green Urban Garden Landscape Design and Soil Microbial Environmental Protection Based on Virtual Visualization System, Arabian Journal of Geosciences, 2021(24), 2021, 14. https://doi.org/10.1007/s12517-021-09166-w
[23] Zhang, G.; Kou, X.: Research and Application of New Media Urban Landscape Design Method Based on 5G Virtual Reality, Journal of Intelligent and Fuzzy Systems, 2021(1), 2021, 1-9. https://doi.org/10.3233/JIFS-189836
[24] Zhang, L.; Huang, C.; Zhao, D.: Design Optimization for Urban Landscape from the Perspective of Ecological Chain, Anti-Planning and Barrier Free Design: The Unity of Natural and Social Environmental Benefits, Fresenius Environmental Bulletin, 29(10), 2020, 9095-9102.
[25] Zhanjun, W.: Application Research of Virtual Reality Technology in Environmental Art Design, Acta Technica CSAV 62(1), 2017, 215-224.

[26] Zheng, H.; Shao, Q.; Chen, J.: LIC Color Texture Enhancement Algorithm for Ocean Vector Field Data Based on HSV Color Mapping and Cumulative Distribution Function, Acta OceanologicaSinica, 41(10), 2022, 171-180. https://doi.org/10.1007/s13131-022-2020-6
[27] Zhuo,L.; HU. X: A Naturalness-Preserved Low-Light Enhancement Algorithm for Intelligent Analysis, Chinese Journal of Electronics, 28(02), 2019, 97-105. https://doi.org/10.1049/cje.2018.12.004