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Indoor Color Planning Based on Color Image Coordinate System

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Abstract: Because the color configuration in most indoor space design is not ideal, in order to meet people's physiological and psychological needs, indoor color planning based on color image coordinate system is put forward. Design an indoor color configuration system based on RGB-D image. In terms of system hardware, TCS3415 color sensor is used to design color acquisition module, and Kinect equipment is used to design RGB-D image acquisition module. In system software, RGB-D image information extraction function and indoor color configuration function are designed. The experimental results show that: according tor^{2}The distribution table shows that when the significance level is 0.05. When the degree of freedom is 2, r^{2}The critical value of is 5.89. Conclusion: There is no obvious difference between the system in this paper and the color scheme designed by professional designers, which verifies the effectiveness of the system.

Keywords: RGB-D image; Color configuration; Indoor color; system design

1 Introduction

It is very difficult to unify everyone's feelings about color. The uncertainty of personal aesthetics makes it impossible for us to find a "universal" formula to apply when designing interior colors. "Although the lamb is beautiful, it is difficult for everyone to adjust." For the same thing, people will make different choices according to their own artistic accomplishment and aesthetic taste. Similarly, people's choice of color will vary according to their own needs. It is precisely because of the infinite possibility of color that designers pay more and more attention to it, but the professional knowledge and content of color are too complicated for many designers to understand and master. More often, designers do color design work with their own perceptual knowledge [1]. In fact, the application of color in interior design is not irregular. The understanding of color should also be based on the establishment of good cognition, and constantly explore more possibilities of color. Color theory can guide us to match colors scientifically and reasonably, but in the process of interior design, colors are designed in three - dimensional space, which makes color matching more complicated. Usually, space function and decorative materials will get more attention in interior design, but the collocation of indoor color relations often gets less attention. Most people are usually inexperienced in color matching, and everyone's preference for colors in the space leads to the neglect of the overall color relationship in the indoor space, which makes the colors in the space messy. Although

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many designers are constantly trying to use colors, the interior designers' grasp of the color relationship is always unsatisfactory, so it is urgent to study a set of rigorous and practical application methods of interior color design [2]. The continuous development and progress of social life, people's attention to the beautiful living environment and the influence of the environment on people's emotions all put forward new requirements for interior design. Compared with other design elements, color has more urgent practical needs in interior design. What kind of color collocation can bring what kind of visual and psychological experience to the interior space is the theme of the current interior design color discussion.

2 Literature review

Westerners attach importance to the research and development of color theory and occupy a certain active position in the field of color. Color matching theory of color; The physicist Newton's research on spectral colorpromoted the development of color theory, and since then, color theory has entered the stage of scientific development. Various painting schools in the field of modern western art painting have made a very mature discussion on color. The application fields of color are getting wider and wider from painting to design, which is wider than before. Especially in the field of interior design, color has brought new design ideas for interior space design with its creative advantages [3]. Since 1980s, color trend report has been extended to the field of interior design. Personalized design of household products, humanized treatment of indoor space colors and color coordination of indoor environment are constantly expanding the extension of indoor design. In terms of design practice, foreign interior designers are bold and unique in the use of color, and interior design is no longer simply supporting the artistic embellishment of the space derived from architecture. If architecture determines the initial form of space, then color is the second way to change the appearance of space [4]. In recent years, there are many successful cases of interior color design. After extensive analysis and research, the division of labor and cooperation between space design and product design, the combination of space and art, the update of technology and decorative materials, and the personalized development of users' subjective needs make the interior color design abroad show cross-disciplinary characteristics [5].

In terms of related theories, there is no research method of its own color theory and color system in China. The reason is that the academic circles in China pay much attention to color research, but the theoretical research is still in the superficial understanding stage. Due to the complexity of color theory, academic circles have not comprehensively and systematically combed it. However, the understanding of color embodied in China's ancient cultural system is very different from the current situation in China. In ancient China, the understanding of color was very rational, and he had made unique discoveries in color vision, emotion and collocation changes. The color understanding of "ink is better than multicolor" mentioned in China's traditional paintings is also highly praised in modern China art circles, so many artists in China seem to have a negative emotion towards color. Looking at the field of interior design, although there is no systematic theoretical guidance for interior color design in China, there are also some research attempts made by researchers, designers and artists. From the perspective of color geography, this paper explores the methods and laws of landscape color design, and obtains a deeper color theory achievement [6]. No matter a designer or an artist, it is inseparable from the continuous practice and understanding of color. As an interior designer, the related practice of color is also a very challenging work and research.

Today, China's indoor color configuration design is mature, but the research on indoor color configuration system is still less. The goal of this paper is to combine theory with practice and design an indoor color configuration system to contribute to creating a more comfortable living environment for residents.

3 research methods

3.1 Hardware Design ofIndoor Color Configuration System

3.1.1 Color acquisition module

The basis of indoor color configuration system is color acquisition. In this paper, color sensor is mainly used to design the color acquisition module of the system. This sensor belongs to a digital color light sensor, which can not only accurately collect the chromaticity and illuminance of ambient light, but also have a digital output with 16-bit resolution. The specific parameters are shown in the following table 1:

Table 1. Parameter Table of Color Sensor

project	parameter
output	300kHz
Operating temperature/℃	-10~50
Operating voltage /V	2.1~3.4
encapsulation	CS
pin	GND、VCC、SCL、SDA

When the color sensor senses external light, the external light will be filtered by the infrared blocking filter of the sensor, and useless IR and UV signals will be weakened, thus obtaining visible light, which will enter their respective channels after passing through the RGB and Clear filters of the sensor, thus outputting digital signals [7]. After the color sensor collects the color, it will directly transmit the color data to the main control chip of the system. At this time, the main control chip will process the RGB value of the color and transmit the processed information to the upper computer for display.

3.1.2 RGB-D image acquisition module

The hardware of RGB-D image acquisition module of color configuration system is mainly composed of Kinect devices,which are RGB camera sensors and depth sensors, as shown in Figure 1:

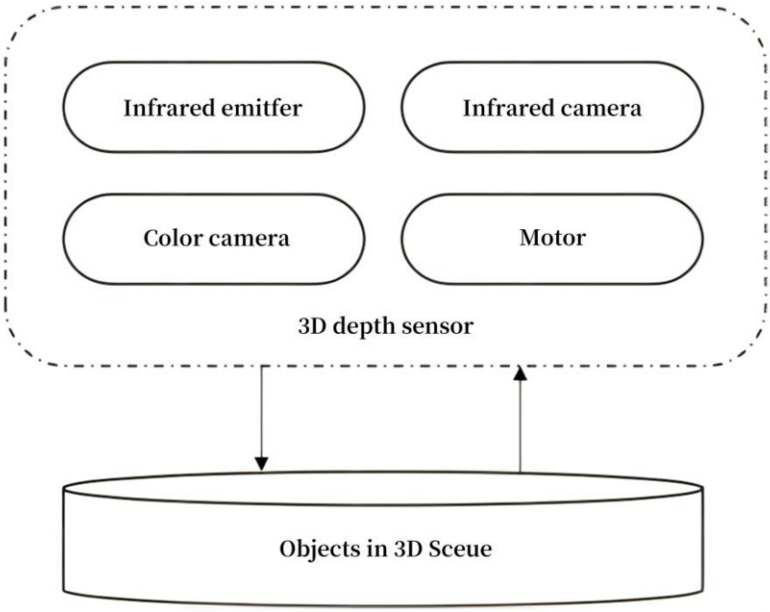

Figure1. overall structural diagram of Kinect equipment

When the RGB-D image acquisition module of the color configuration system acquires the RGB-D image of an object in a 3D scene, the infrared emitter of Kinect equipment willemit infrared light, which will be reflected on the surface of the object, thus forming laser speckle, including object pattern information, and then the infrared camera will capture the reflected infrared light. Because there is a certain displacement between the laser speckle and the baseline of the infrared camera, Therefore, the parallax set of object pixels will be generated, so as to obtain the infrared depth image of the object in the 3D scene. At the same time, the color camera of Kinect equipment will automatically collect the RGB image of the object, and then get the indoor RGB_D image [8]. The resolution of RGB image obtained by Kinect equipment can reach 640×480, and the resolution of infrared depth image can reach 320×240, which can help the color configuration system designed in this paper to have the most direct understanding and cognition of indoor environmental information.

3.2 Software design of indoor color configuration system

3.2.1 RGB-D image information extractionfunction

The characteristic information of RGB-D images can well present the indoor scene characteristics, thus helping the color configuration system to better grasp the indoor scene information. Therefore, this paper has set up the RGB-D image information extraction function in the color configuration system, and here this paper uses the structural forest to extract the outline information of RGB-D images. Each pixel on the RGB-D image not only contains color information, but also reflects the three-dimensional coordinate information of the indoor scene,

so the contour information of the RGBD image can be extracted through local geometric features. Firstly, a nonlinear noise model M isused to describe the RGB-D image information, and the expression is as follows (1):

$$M = |Y_0| \in D^2|Y_1| \quad (1)$$

In the formula,γ_0 Is the measurement error of Kinect equipment;γ_1 Is the discontinuity error of RGB-D image;D RGB-D image information. Then, a structured random forest is generated, and each decision tree in the forest is regarded as the extractor of RGB-D image information. The structured random forest has high efficiency in calculating different pixel positions in the RGB-D image, and the edge pixel blocks in the image can well present contour details [9,10]. Suppose the random forest decision tree is $s(x)$, in which x For RGB-D image samples, and can be classified into left and right subtrees, then each node on the structure tree can be regarded as

an extractor and associated with the segmentation function shown in the following formula (2):

$$G(x, s_i) \in \{0,1\} \quad (2)$$

In the formula,i It is a structural random forest node;G Is a binary partition function. In the structured random forest, the training of each decision tree is independent, so this paper trains the decision tree by recursive method, so as to output the extracted RGB-D image information results, and use this information as a theoretical reference for indoor color configuration.

3.2.2 Indoor color configurationfunction

Indoor color configuration function is the key function of the system designed in this paper, which needs to be realized on the basis of strictly following the corresponding rules. Firstly, the extracted RGBD image information and the collected color information are quantized to reduce the difficulty of configuration, and a reasonable color configuration table is constructed according to the quantization results [11]. On the basis of the color table, the indoor color configuration is realized according to the following process: firstly, the RGB-D image color is divided by the median splitting method to find the smallest color value among all colors in the image, and the color dimension components of all pixels of the image are sorted according to the color values, and the indoor colors are configured according to the component order, and soon until the color configuration of all indoor space areas is completed; Then set a standard RGBD image color template, which is mainly used to compare the difference between indoor color configuration and template, and obtain the average and variance of RGB-D image color by threshold method, as shown in the following formula (3):

$$C = \mu \cdot \left(\frac{S}{N}\right) \quad (3)$$

In the formula,C Is the standard RGB-D image color; Is the difference factor of standard RGB-D image color; Configure an offset index for the best color;NIs the number of colors that meet the configuration conditions [12]. Then statistically average the color average calculated by Formula (3) and the pixel value of RGBD image, and take the result as the standard color configuration template. Finally, referring to the RGB-D image color configuration template, the indoor space color is configured. Considering the configuration accuracy and configuration speed, this paper designs

a system to obtain the color difference between them through visual communication technology, and the expression is shown in the following formula (4):

$$T = \sum C \otimes \frac{\alpha}{\beta} \quad (4)$$

In the formula,T An indoor space with colors to be configured;c Is the color to be configured; To configure the chromatic aberration of the color. According to Formula (4), after determining that there is no obvious difference between the color configuration of the actual indoor space and the RGB-D image color configuration template, define the indoor color configuration style and record the configuration results.

4 Result analysis

4.1 Example application

In this paper, a residential district is taken as the design object, and its color configuration is designed by using this system. The whole district has 12 buildings and 1200 rooms, and this time only one room is used for color configuration.

This paper will evaluate and analyze the color scheme, so as to judge whether the system designed in this paper is feasible. The evaluation of color scheme is mainly carried out in the form of experiments, and the seven - level Likert scale is used as the evaluation questionnaire of color scheme [13,14].

The indoor color scheme designed by the system is displayed on the computer, and 20 owners are invited to watch and score the color scheme by using the questionnaire in the table. At the same time, the 20 owners were shown the color scheme designed by professional designers, and the questionnaire was also used for scoring. After collecting all the questionnaires, use SPSS software to analyze the questionnaire evaluation results, and the analysis method is Friedman test, as shown in the following formula (5):

$$F^2 = \frac{12}{nm(m+1)} \sum H_i^2 - 3n(m+1) \quad (5)$$

In the formula,F^2For Friedman's two-way rank variance;n In order to evaluate the number of observations in the questionnaire;m To evaluate the number of questionnaires; H_i Weidi i Rank sum of three evaluation questionnaires. After calculating the statistics of the evaluation questionnaire according to the above formula, the output results of seven groups of semantic phrases in SPSS software are shown in Table 2:

Table 2. Evaluation Results of Color Configuration Scheme

Word meaning phrase	F^2
Open-narrow	5.34
Urgency-slowness	6.03
Hot-cold	7.11
Easy-heavy	5.39
Kindness-alienation	6.18

Excitement-calmness	5.99
Bright-dim	6.13

according toF^2The distribution table shows that when the significance level is 0.05. When the degree of freedom is 2,F^2The critical value of is 5.89, and the values of each semantic phrase in the evaluation results of color scheme obtained in the above table areF^2Both of them are greater than the critical value, which shows that there is no obvious difference between the color perception brought by the color configuration scheme designed by this system and the color perception brought by the color configuration scheme designed by professional designers, which further verifies the feasibility of the system designed in this paper, and the system can provide color configuration schemes that meet the needs of users.

4.2 Research object ofdominant color in interior design

In the choice of research objects, it can't coverall interior designers or design institutions at home and abroad. The reference for the choice of research objects comes from the number of Baidu search results, so if these conclusions are taken as the research basis, it will be insufficient. At the sametime, due to time and geographical constraints, it is impossible to collect color information directly from interior design cases, which will have a certain impact on the objectivity of the research results of leading colors in interior design. Because there is almost no information about the dominant color in interior design at home and abroad, the research on the dominant color in interior design in China is not only in the exploratory stage, and there are also a few designers and scholars who think that the dominant color does not exist at all. Therefore, in the choice of research objects, in addition to considering the quantitative factors of Baidu search results, we should try our best to choose the design works of representative interior designers and design institutions that are familiar to the industry [15,16].

4.2.1 Liang Zhitian Interior Design Case Analysis

Liang Zhitian, one of the top ten designers in Hong Kong, founded Liang Zhitian Architects Co., Ltd. and Liang Zhitian Design Co., Ltd. in 1997 [17]. Through the collection and analysis of RGB data of Liang Zhitian design cases, we can get the pie chart of "RGB numerical analysis of color sampling in Liang Zhitian interior design cases" and "percentage of RGB average value of color sampling in Liang Zhitian interior design cases" (see Figure 2). After rounding, the average values of RGB values in design cases are R (red) 124,G (green) 96,B and B (blue) 70. According to the principle of RGB color mode, red, green and blue Three Lamps District lights are superimposed on each other, and the colors are mixed. When the value of one light is greater than the other two lights, the color mixing result will be biased towards the color tone with the largest value. According to the above RGB data and charts, the average value of RGB values in Liang Zhitian design case tends to warm color.

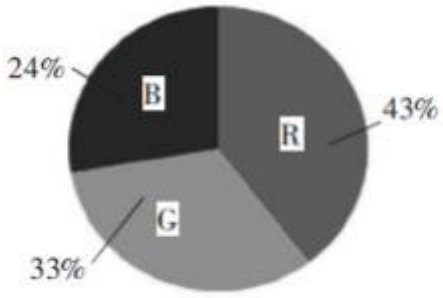

Figure 2. Percentage of RGB average value of color sampling in Liang Zhitian interior design case

4.2.2 Gao Wenan Interior Design Case Analysis

GaoWenan, a senior interior designer in Hong Kong, is known as the father of interior design in Hong Kong and won the Lifetime Achievement Award of the Hong Kong Interior Design Association. Through the collection and analysis of RGB data of GaoWenan design cases, we can get the corresponding pie chart of "RGB numerical analysis of color sampling of Gao Wenan interior design cases" and "percentage of RGB average value of color sampling of Gao Wenan interior design cases" (see Figure 3). After rounding, the average values of RGB values of design cases are R (red) 132,G (green) 109,B and B (blue) 92. According to the above RGB data and charts,

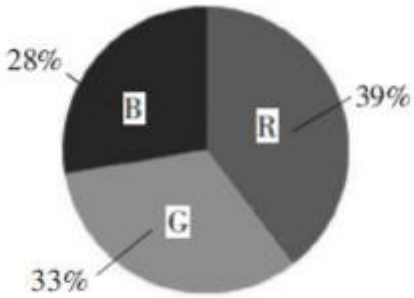

Figure 3. Percentage of RGB average value of color sampling in Gao Wenan interior design case

5 Conclusion

Color allocation in indoor space design is the key factor to create a good environment atmosphere, which can improve the health of residents from two aspects: psychological efficacy and physiological efficacy. Therefore, on the basis of following the human visual characteristics and the principles of indoor color allocation, this paper introduces RGB-D images to design an indoor color allocation system. And the application results of an example show that the system can provide users with a satisfactory indoor color configuration design scheme, and can also provide guidance for the color configuration design of other functional spaces in China. Of course, the design of indoor color configuration is a complicated study. In the future, the author

will continue to improve the functions of this design system in combination with the actual psychological demands of users.

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