

Design of light utilization model in interior design

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Abstract. during the study process of implementation method for lighting effects in interior design, the light environment is designed in simplification when the current algorithm is used for interior design the desired rendering frame rate cannot be achieved. For this, a method for designing light utilization model in interior design is proposed based on the ray tracing algorithm. Firstly, the influence of visual and interior illumination design, artificial lighting, light and dark cycle of human body and light pollution are analyzed, to build scattering model of interior light, and ray tracing algorithm is utilized for optimizing facets intersection, spherical and surface intersection, rectangular and surface intersection, then the optimization algorithm and light and shadow algorithm are combined to form the illumination model of interior design, so as to achieve the lighting design in interior architecture. The simulation results show that, the method for designing light utilization model in interior design is proposed based on the ray tracing algorithm have comprehensive analysis, and the effect is ideal.

Introduction

As living standard of people is rising, interior design and home decoration has become a social focus of attention, the emergence of this phenomenon, is the inevitable consequences of rapid economic development and steady improvement of living quality (1.2.3). How to through the interior design to create a high-quality light environment has become the primary task that interior design needs to solve, attracts the attention of a lot of experts and scholars (4.5.6). Due to the design method of light utilization model in interior design has far-reaching significance for development, it has also become a focus topic in industry, and has been widespread concerned, also a lot of good methods are camp up with (7).

At present, the algorithm of light utilization model used in mainstream interior design mainly includes SH algorithm, basis function theoretical algorithm, CPU global illumination algorithms and a new spectral similarity measure algorithm. Among them, the most commonly used is the model design method for light utilization model based on SH algorithm, but these methods only to simplify the design of the light environment, the desired rendering frame rate cannot be achieved.

In view of the above problems, the design method for light utilization model in interior design is proposed based on ray tracing algorithm. This method have comprehensive analysis and ideal effect.

Analysis of the factors affecting the light in interior design

During the design process for light utilization model in interior design, the factors influencing indoor light environment quality are mainly in the following parts: the environment lighting coefficient, environment sunshine hours, environment space redundancy, the average level of lighting, environment glare, color rendering of residence, color chart, color contrast. In the design process for light utilization model in interior design, luminous effect for indoor from light in fixed time period is considered in general, through analyzing lighting characteristics of indoor in the optimal irradiation time, to establish light induction characteristics at the best time, the design effect of light utilization model in interior design at analysis time is best.

Principle of light utilization model optimization design method in interior design

Establishment of interior architecture light scattering model

During the design and optimize process for light utilization model in interior design, firstly, the influence of visual and interior illumination design, artificial lighting, light and dark cycle of human body and light pollution are analyzed, to build scattering model of interior light, the specific steps are as follows in detail:

During the design and optimize process for light utilization model in interior design, daylight to conduct visual penetration, light intensity is scattering by exposing into indoor, the expression is:

$$I(x) = J(x)t(x) + A(1-t(x)) \quad (1)$$

Through above formula to construct Lagrange function propagating in the indoor, wherein, a_i is the Lagrange multiplier of light emission intensity. The optimization function of light in residential environment light intensity is expressed as:

$$J_1(\omega, e) = \frac{\mu}{2} \omega' \omega + \frac{1}{2} \gamma \sum_{i=1}^N e_i^2 \quad (2)$$

$$s.t. y_i = w^T \varphi(x_i) + b + e_i \quad (3)$$

In the formula, $\varphi(\bullet)$ is the kernel space mapping function of light wave length.

During the design and optimize process for light utilization model in interior design, the channel where light penetrated is setting as following respectively:

$$J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A \quad (4)$$

$$P(\eta_M(x, y)) = \begin{cases} \frac{r}{4} \\ 1 - \frac{r}{2} \\ \frac{r}{4} \end{cases} \eta_M(x, y) = -1, \quad \eta_M(x, y) = 0, \quad \eta_M(x, y) = 1 \quad (5)$$

During the design and optimize process for light utilization model in interior design, phase difference between the light and fluorescent light is calculated, α equation is:

$$\frac{\det(D)}{\text{trace}^2(D)} = \frac{\alpha \cdot \beta}{(\alpha + \beta)^2} = \frac{\gamma}{(\gamma + 1)^2} \quad (6)$$

The light scattering model of the interior design is obtained, which provides favorable conditions for light utilization model optimization in interior architecture design.

The realization of light utilization model optimization design method in interior design

During the design process for light utilization optimized model in interior design, after scattering model of interior light is built, ray tracing algorithm is utilized for optimizing facets intersection, spherical and surface intersection, rectangular and surface intersection, then the optimization algorithm and light and shadow algorithm are combined to form the illumination model of interior design, so as to achieve the lighting design in interior architecture. The specific steps are as follows in detail:

During the design process for light utilization optimized model in interior design, many facets constitute the surface of object, therefore, intersection calculation of light ray and facets is regarded as the basis of intersection calculation. Parameter equation of detected light as follows:

$$x = o + vt \quad (7)$$

The plane equation for facets of polyhedron:

$$N \cdot (X - P_i) = 0$$

In the design for light utilization optimized model in interior design, sphere is the most commonly used objects, because the intersection is simple to calculate, and the normal vector is

always from the center of the sphere, thus, sphere is often used as bounding box for objects. The spherical intersection optimization is:

$$(x-x_c)^2 + (y-y_c)^2 + (z-z_c)^2 = R^2 \quad (8)$$

In the formula, (x_c, y_c, z_c) is the center.

In the design for light utilization optimized model in interior design, a very common object is rectangular in the light ray tracing intersection calculation, under the vast majority of complex scenes, when calculating the intersection of light and irregular object, usually irregular objects is viewed as rectangular for intersection calculation. Six surfaces of a AABB rectangular can be expressed with the following 6 plane equations:

$$\begin{cases} x = 0 \\ x = r_2 \\ y = 0 \\ y = r \\ z = r_2 \\ z = 0 \end{cases} \quad (9)$$

The basic process of the optimized design of light utilization model is divided into three steps:

(1) In the optimization design of light utilization model in the interior design, the depth texture is established. The light source is made as the view point to draw scene, then the depth values in buffer zone are stored in the specified texture, this texture is called depth texture.

(2) In the optimization design of light utilization model in the interior design, shadow testing is made. The view point is used to draw scene, and made shadow testing one by one for each pixel.

(3) In the optimization design of light utilization model in the interior design, according to the shadow testing results to modify the color cache, if the pixel is in the shadow, the color value of this pixel is multiplied by the coefficient of the shadow.

In the optimization design of light utilization model in the interior design, the optimization algorithm and the light shadow algorithm are combined to form the illumination effect model in interior design with the following expression:

$$t = \frac{r_x - O_x}{V_x} \quad (10)$$

In conclusion, it can be explained that by the analysis of the design method for light utilization model in interior architecture design based on the ray tracing algorithm is comprehensive, effect is ideal, which can satisfy the actual demand of interior design.

The experiment and simulation

In order to prove the effectiveness of the design method for light utilization model in interior design based on ray tracing algorithm, there is the need for an experiment, the traditional algorithm and the improved algorithm are applied to the light utilization design. The processed results of illumination effect are shown in Figure 1, figure 2:



Figure 1 light utilization design with the traditional method



Figure 2 light utilization design with the improved algorithm

From Figure 1 and Figure 2, we can see that the improved algorithm has a better performance in designing light utilization model, and illumination effect is good.

Conclusion

With the current algorithm for interior design, light environment is designed in simplification, thus, the desired rendering frame rate cannot be achieved. For this, a method for designing light utilization model in interior design is proposed based on the ray tracing algorithm. Firstly, the influence of visual and interior illumination design, artificial lighting, light and dark cycle of human body and light pollution are analyzed, to build scattering model of interior light, and ray tracing algorithm is utilized for optimizing facets intersection, spherical and surface intersection, rectangular and surface intersection, then the optimization algorithm and light and shadow algorithm are combined to form the illumination model of interior design, so as to achieve the lighting design in interior architecture. The simulation results show that, the method for designing light utilization model in interior design is proposed based on the ray tracing algorithm have comprehensive analysis, and the effect is ideal.

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