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Procedia Engineering 15 (2011) 5111 – 5115

Procedia Engineering

www.elsevier.com/locate/procedia

Advanced in Control Engineering and Information Science

An Analysis of LED Light Distribution Based on Visual Spectral Characteristics

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Abstract

On the analysis of the human visual structure characteristics and LED optical design principle, human visual color image model with background light was constructed in this paper, and the image sharpness function is defined. With high pressure sodium lamps, white light and green light LED as backlight, the model simulation of image sharpness is fulfilled. The results show that the green LED has better clarity and sensitivity with the same condition of radiation energy background light.

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Keywords: human visual characteristics; green LED; visual model of color images

1. Introduction

Since the seventies there has been the world's energy crisis, countries have to take corresponding measures and actively develop new energy sources, do everything possible to conserve existing energy [1]. Reflects the green light is the core of energy efficient lighting, reasonable to select the correct power source is the key to achieving the green light [2].LED (Light Emitting Diode, LED) is a new and efficient solid light source. Its emergence is recognized as the most promising in the 21st century one of the areas of high technology [3]. LED lighting in a variety of more and more people's attention, especially in the development of high-power high-brightness LED lighting has become the development trend of new

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doi:10.1016/j.proeng.2011.08.948

generation of civil [4]. In China, the road currently used mainly high pressure sodium light sources, but the light blue-green light color shade component composition containing less sensitive areas outside of the human eye at night in front of the driver is not easy Panduan cars, pedestrians, obstacles, etc. distance, high incidence of traffic accidents [5]. Many researchers state in the mesopic vision of high pressure sodium, metal halide light, as the efficiency of the study, achieved many result [6]. But in research new LED optical characteristics is inadequate, in this paper analyzes the structural characteristics of human visual design of a consistent feature of human vision LED lighting, the green LED lighting, so that the lamp with the light color components the proportion of green light more, and the distribution of sensitive areas in the human eye, to make up for the lack of yellow high-pressure sodium lamp, the light and colors of light through this model, experimental simulation, obtained better results.

2. The visual structure of the human eye

The structure of the human eye, including: cornea, iris, lens, ofitreous, retina and adtic nerve. The retina is the visual optical and electrical physiological processes during the interface. It divided into cone cells and rod cells. the former well under the conditions specified in the visual detail and color resolution, while the latter has higher sensitivity can feel a very faint light, but can not distinguish the details and colors, the main In the case of dark play. Pyramidal cells in the human eye work, the brightness level of 10cd / ㎡ above vision is called photopic vision. Rodshaped cells work in the human eye, the brightness level 0.003cd / ㎡. Between photopic and scotopic vision are called mesopic vision.

3. Green LED's light color design principles

Green LED light color design in the mesopic vision range, the human eye cone cells and rod cells are simultaneously and the spectral wavelengths of light in different colors depending on the efficiency of different sensitivities. Scotopic vision and photopic vision of the spectrum of light are as the efficiency curve v '(λ) and v (λ) are determined the in CIE 1951 and 1924, respectively as shown in Fig.1 (a):

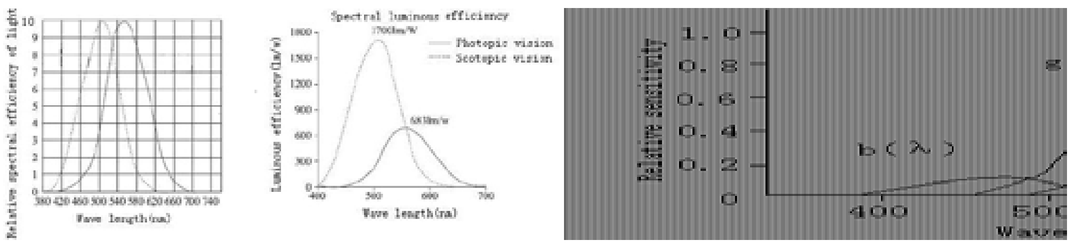

Fig.1. (a) two visual spectral efficiency of light as light as the performance; (b) cones in the human eye's sensitivity to a variety of different color curves.

As shown in fig.1(a), in the photopic visual conditions, the human eye is most sensitive to 555nm wavelength green light and lumineous efficiency of 683lm / W; but with the lower level of the human eye adapt to light and shade, color, space and response features as the feelings have to change, the human eye fovea and the edge detection becomes as easy as some of the perceived, and color perception gradually weakened, while the human eye will make the most sensitive optical wavelength from the Min 555nm of the green vision when the maximum efficiency, and gradually change to scotopic vision of the 507nm the most efficient. So according to this characteristic, if the light source of the radiation spectrum of content and blue-green shade, you can make much more eye pupil contraction, it will have a better visual effect.

3.1. Model of human visual analysis of color images

Pyramidal cells in the human eye to various different colors of light relative sensitivity curve shown in Fig.1 (b): It reflects the energy equivalent to the human eye to different wavelengths of light relative visual sensitivity. Reference [10] Table 4 provides the data for intermediate vision research, the use of least squares data fitting, you can get the middle of the visual spectrum of light as the performance curve shown in Fig. 2:

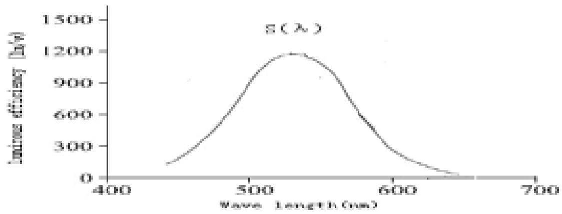

Fig.2. spectrum of luminous efficiency

It reflects a certain brightness level and the wavelength of light depending on the relationship between performance. Eye on the overall strength of the feelings of colored light can be sensitive to each color intensity of the visual cells integrated into a synthesis of the impulse to pass into the brain, and then produced a color image. The visual model of color image shown in Fig.3:

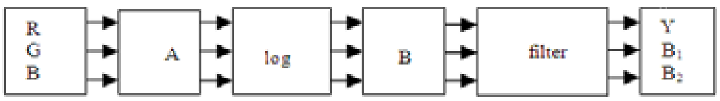

Fig.3. visual model of color image

The function of this model to simulate the human eye for color images to achieve the process of perception, according to the input of different R, G, B values, the human eye can see different colors and brightness of the color image, R, G, B expression is as follows:

$$R = \int_{380}^{780} \mathrm{K}_m S(\lambda) r(\lambda) d_\lambda \quad G = \int_{380}^{780} \mathrm{K}_m S(\lambda) g(\lambda) d_\lambda \quad B = \int_{380}^{780} \mathrm{K}_m S(\lambda) b(\lambda) d_\lambda \tag{1}$$

According to the literature [9] as the performance of the mescopic vision, combined with visual selection between the scope of this article, K_m values for the 1190 lm / W; $S(\lambda)$ is the mesopic vision spectrum of light as the effectiveness of distribution; $r(\lambda)$, $g(\lambda)$, $b(\lambda)$ represent the red, green, and blue sensitivity of cells to different wavelengths. Perception of color images is as follows:

1) chromatic adaptation transform
2） non-linear compression
3） color separation

4） spatial filter processing

Filter selected the following equation:

$$\mathrm{H}_k(\xi_{1,}\xi_2) = k\sum_i \omega_i E_i \tag{2}$$

Where $E_i = k_i \exp\left[-\left(\xi_1^{\ 2} + \xi_2^{\ 2}\right)/\sigma_i^2\right]$, κ is the coefficient of factor accumulation and to make the filter1,the coefficient factor E_i is accumulation to 1. Parameters σ_i and ω_i are used to change the size of the filter.

5） color image output.

3.2. The definition of image resolution

In recent years, researchers through the ambiguity and noise on the clarity of the definition [9], this image based on this model output resolution is defined as follows:

$$D = X_1 Y + X_2 B_1 + X_3 B_2 \tag{3}$$

D: image clarity, the greater the value is the clearer of image. Y: the image brightness, the range of 0.1 ~ 3cd / ㎡. B1, B2: represent the red-green and yellow-blue contrast, in the range between 0-1. x_1, x_2, x_3: respectively coefficient and $x_1 + x_2 + x_3 = 1$.

4. Simulation examples

4.1. Simulation model selection

1） the background radiation in the same energy , model A and B parameters are chosen as follows:

$$A = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.127 & 0.724 & 0.175 \\ 0.000 & 0.066 & 1.117 \end{bmatrix} \qquad B = \begin{bmatrix} 21.5 & 0.0 & 0.00 \\ -41.0 & 41.0 & 0.00 \\ -6.27 & 0.0 & 6.27 \end{bmatrix}$$

2） spatial filter parameters are as the following table:

Table1 spatial filter parameter

channel	ω_i	σ_i
	0.049	10.60
Black and White	0.025	2.356
	- 0.805	0.076
Red and Green	0.039	7.738
	0.29	0.642
Yellow and Blue	0.048	5.761
	0.255	0.8216

4.2. Analysis of simulation results

Table2 experimental results

channel	HPS	LED White light	LED Green light
Y	0.95	2.64	2.98
B1	0.32	0.75	0.89
B2	0.81	0.56	0.55
D（Definition）	0.621	1.487	1.692

We carried it through the software Matlab7.1simulated results are as follows:

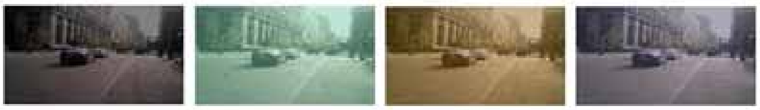

Fig.4. (a) original image; (b) LED green light; (c) HPS; (d) LED White light.

5. Conclusion

Based on the analysis of the structure in human vision and sensitivity, the different wavelength is different from the design of a green LED lighting. Through modeling is simulation of the high-pressure sodium lamp, yellow and white LED, green LED. Then carried out by Matlab7.1 simulation of light and color, from the comparative analysis of the results obtained the green LED at the same level of brightness, the clarity is better than high pressure sodium lamp and white LED, it is more suitable for road lighting can achieve the best results.

References

[1] Bing Treekui, Jie Gao. LED lighting engineering [J]. Illuminating Engineering Journal, Vol.21, No.5,2010, 101 ~ 108.

[2] Liu Yaobin, Hu Guanmin. China's LED industry status, trends and strategic choice [J]. Science Technology Progress and Policy, Vol.27, No.12, 2010,77 ~ 81.

[3] Zhao Xing, Fang Zhiliang, Mu Guoguang. LED projection light source chromaticity characteristics [J], Physics Vol.56, No.5, 2007,37 ~ 40.

[4] Chen Zhonglin. With a visual road lighting research [J], lamps and lighting, 2005,18 ~ 20.

[5] Zhou Taiming, Lin Yandan. Light spectrum and low-light level based on the mesopic vision [J], China Illuminating Engineering Journal, Vol.20, No.4, 2009,1 ~ 4.

[6] Liu Oingxiang, Jiang-day hair. Color and grayscale conversion algorithm between images [J], Wuhan University of Technology (Transportation Science & Engineering), Vol.27, No.3, 2003,344 ~ 346.

[7] Han Bo. Based on digital image processing [M], Tsinghua University Press, 2006.

[8] Chen Zhonglin, Hu Yingkui. Mesopic vision performance of the maximum of the light [J], Chongqing Architecture University,Vol.30,No.4,2008,15~18.

[9] Cao Yang, Yuan Zongjie, Lin Yandan and so on. Visual function method in road lighting application [J], China Illuminating Engineering Journal, Vol.16, No.4, 2005,44 ~ 49.

[10] HUT, CU, NPL. Performance based model for mesopic photometry [R]. Finland: Helsinki University of Technology, 2005.