International Journal of Advanced Smart Convergence Vol.9 No.4 203-208(2020)
http://dx.doi.org/10.7236/IJASC.2020.9.4.203

IJASC 20-4-27

Desktop-LED lighting for Eye Muscle Movement by Adjusting the Light Illuminance and Color Temperature

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Abstract

In this paper, we propose the design and implementation of a desktop LED stand and smart app that automatically adjusts color temperature and illuminance for optimal brightness and eye health by improving the structural problem of the LED stand. It is a tabletop LED stand that supports optimal brightness through color temperature control and heat transfer through infrared LED to relieve eye strain through blood circulation and muscle movement. The LED stand works with the smartphone to automatically adjust the optimal brightness and color temperature for the user's environment. In addition, the brightness of the infrared LED is adjusted to a living frequency of 4Hz to relax the eye muscles and reduce eye strain. This study implemented an effective measured data-based system of previous studies through the color temperature and illumination of LED lighting, and near-infrared rays, and presented meaningful results by conducting an experiment to prove the effect through subjects.

Key words: *LED, Near-Infrared LED, Desktop Stand, Lighting, Smart Phone, Application, Color Temperature*

1. INTRODUCTION

Lighting is an important part of the environment in which people live. Since the invention of electricity, humans have developed lighting technology as a means of illuminating darkness. In addition, night lighting technology has improved the quality of human life and contributed greatly to industrial development[1].

In general, many lighting devices using LEDs have been proposed. LED lighting is environmentally friendly, free from harmful substances such as mercury vapor and phosphorus, and is more energy efficient than conventional lighting, but flickering can cause eye strain and headache[2]. In addition, the use of lighting using LED is increasing because it has advantages of semi-permanent, inexpensive, and low power consumption, and is widely used as a lighting device due to high energy saving effect due to low power consumption of LED. A technology that applies such LED lighting to help students' academic efficiency or vision is being proposed[3-5]. Looking at the prior art having such a purpose, Korean Public Utility Model Publication No. 20-2011-0008101 " The "SAT desk with LED lighting customized for the subject" is a light-emitting diode (LED, RGB) bar on the upper part of the study desk to protect the eyesight of students studying day and night, and to maximize the learning effect for each subject during study. The purpose is to provide a

Manuscript Received: December 2, 2020 / Revised: December. 6, 2020 / Accepted: December. 7, 2020
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study desk for each subject to support during learning by installing a light-emitting panel equipped with a display lamp.”.

In addition, a technology that can adjust the illuminance in the LED lighting device is proposed[6]. In addition, a technology that automatically provides appropriate light to the user with an illuminance sensor is being applied[8, 9]. However, as in this study, there were limitations in lighting that actively responds to human emotions, such as meticulous control through color temperature control and relax mode, which alleviates eye muscle fatigue in near infrared rays

The purpose of this study is to provide the optimal illuminance by measuring illuminance by applying an LED stand and a smart phone that can adjust illuminance and color temperature, and calculating color temperature according to user mode or learning mode. In addition, in the relax mode, if the infrared LED is exposed to the eye for a certain period of time according to the human body frequency, the effect of inducing blood circulation by expanding the capillaries of the eye muscles to relieve the fatigue of the eye muscles is applied in related eye health aids.

In the paper[7] that studied the psychological changes according to the change of color temperature and illuminance, it was found that he felt comfortable in low-light and low-light color temperature, and was found to be bright as the color temperature increased regardless of illuminance. In addition, it was investigated as a lighting environment that was bright, functional, and cheerful, along with the investigation that it was spacious and clear[4]. In this way, it has been revealed through several research papers that not only illuminance but also color temperature affects the lighting environment in lighting, and the effect of color temperature and illuminance on each individual is different[4, 7].

In this paper, a stand device is designed and a system that controls and monitors the smartphone app through Bluetooth communication is designed to illuminate by determining the level of color temperature that suits the user's most comfortable illumination. In the mode, the wavelength of the near-infrared LED is exposed to the eye area to relieve tension and fatigue in the eyes.

This paper is organized as follows. section 2 discusses the technology to be implemented in this paper and related research, section 3 describes the proposed system configuration and implementation methodology, section 4 deals with the experimental consideration of near-infrared rays, and finally section 5 discusses it as a conclusion. And suggest future research topics.

2. RELATED RESEARCH

2.1 Study on academic achievement according to color temperature and illuminance

Color temperature is a method of numerically displaying light from a light source. When an object is emitting light, the color temperature of the object is determined by using the temperature of a black body that emits light like this light. Usually it has a value slightly higher than the actual temperature, and the color temperature of an object is expressed as the object temperature of the same color light (absolute temperature Kelvin). Comfort depends on the correlation between color temperature and illuminance. In this regard, Cruithof's study showed that humans are comfortable at high color temperature at high luminance and comfortable at low luminance at low color temperature, as shown in Figure 1[11].

A study on enhancing the learning effect according to the wavelength of color temperature and illuminance was conducted[11]. In this paper, a meaningful result of determining the most effective color temperature and luminance values for each region through EEG measurement is presented by changing lighting into mathematical, language, and creative regions according to color temperature and illuminance.

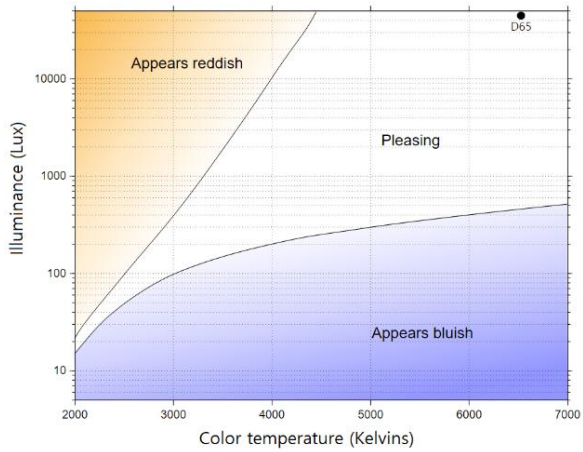

Figure 1. Cruithof Curve

2.2 Near-Infrared (NIR)

Colors classified in sunlight are composed of light that cannot be seen other than visible light that can be seen by humans, and infrared rays other than red have a longer wavelength than the red area of visible light, which is a type of electromagnetic wave that has a large thermal action. In general, if the near-infrared ray exceeds 1200 nm, the range from 700 nm to 1200 nm is classified as far infrared ray[12]. Many studies have been conducted to utilize such infrared rays. In particular, near-infrared rays are being used as health aids in many areas for living body healing. It is known that near-infrared rays do not heat air and transmit heat by penetrating wavelengths into the skin, thereby recovering fatigue through blood circulation. However, if near-infrared rays are directly irradiated with the eyes for a certain period of time or longer, it is warned that there is a risk factor for retinal damage or cataracts.

However, as shown in Figure 2 the human body is always exposed to light other than visible light from the sun, but except for ultraviolet rays, moderate exposure is known to relieve fatigue and help sleep by producing melatonin. It can be said to be effective for rhythm.

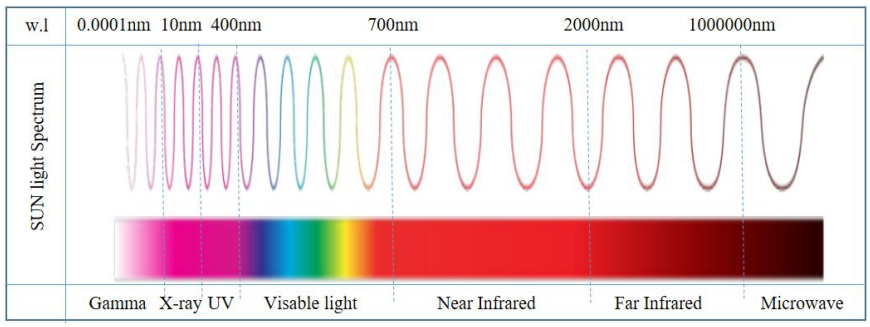

Figure 2. SUN light spectrum and Wave length

3. SMART LED STAND STRUCTURE AND FUNCTION

3.1 Smart LED stand Block Function

The LED stand and smart phone are connected via Bluetooth communication. Figure 3 shows a block diagram of the

Smart Stand designed in this study and the functional modules configured in the remote mobile phone.
The illuminance for the stand is measured by the sensor of the smartphone, and the illuminance and color temperature are calculated according to the user's desired mode and transmitted to Smart Stand. In addition, it is configured to adjust the illuminance of the light emitting unit, apply a color temperature to the control unit of the LED stander, and perform normal operation in response to the result of the smartphone.

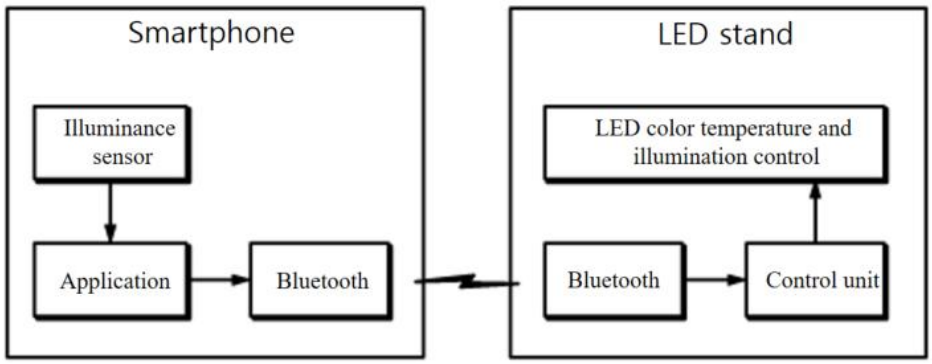

Figure 3. Smart LED Stand Block Diagram

3.2 Smart LED Stand Architecture

In the light emitting part of the stand, the socket-type LED is the main lighting, and green LEDs and near-infrared LEDs are arranged at the bottom, and for even irradiation of the LEDs, a reflector is used for even irradiation. These LEDs are programmed to adjust brightness or color temperature in response to the value read by the smart phone's illuminance sensor, and communicate with the smart phone through Bluetooth communication with control information and data. The smartphone app was produced with App Inventor and tested, and the recovery of eye muscle fatigue through NIR LED was verified to have a significant effect through the subjects.

With the hardware structure of Figure 4 and the smart stand, socket LED is used as the main light source of lighting, and green LED and near-infrared LED can be controlled by the user. The control unit controls the dimming by PWM modulation to control the color temperature of the LED module, and it is a control module capable of adjusting the color temperature of the LED module when the control value is received from the smartphone.

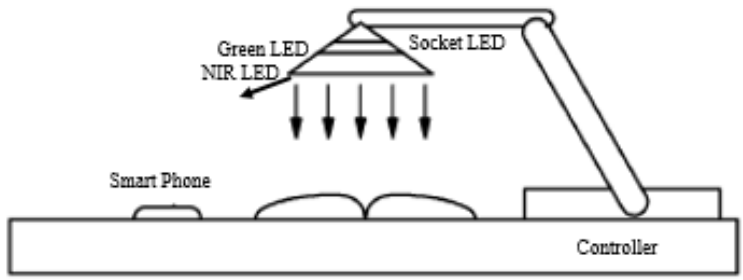

Figure 4. Smart Stand Module

3.3 Smart Phone Application

The smart phone provides 4 control modes as shown in Figure 5 (a). Auto mode (b) is a mode that enables

automatic control after user recognition by setting user-set color temperature and illuminance values, and Study mode (c) allows you to set illumination and color temperature suitable for math, language, and art areas. To be. User mode (d) allows the user to set the desired illumination and color temperature, and the color temperature is scrollable in 9 steps from 3000K to 7000K. Relax mode (e) is a mode in which you set the desired time, close your eyes, rest for a while, and relax while listening to music set as a mode that relieves your inner muscles from fatigue.

(a) (b) (c)

(d) (e)

Figure 5. Smart Phone User Interface

The smart phone automatically detects the illuminance by its own illuminance sensor and displays it on the screen, and if necessary, illuminance and color temperature can be adjusted through the control unit.

4. EXPERIMENTAL ANALYSIS

The results of this study aimed at the development of a smart stand system that can be applied to real life based on the state that the effects in various areas of the existing illuminance and color temperature have been verified. Various a priori proofs for releasing the eye muscles were applied, and through a visual acuity measurement, the condition of the tired eye under LED lighting was observed through a limited subject, and a significant effect was verified. 10 subjects in their 20s playing games under LED lighting It was attempted to detect the difference in visual acuity intuitively by the visual acuity chart when the eyes were closed for 30 minutes and the NIR LED was irradiated for 3 minutes and the NIR LED was not irradiated. Ten NIR LEDs

were arranged horizontally and the distance to the subject was irradiated at 30 cm. The subject's far-sighted vision and changes in visual acuity due to the relaxation mode experience or 3 minutes rest after the game were measured. When learning by focusing on the LED light, the fatigue of the eye muscles increases after a certain period of time, and therefore, generally take a break Recommend. However, by investigating this near-infrared LED, a meaningful result was derived that the eyeball comfort and vision were restored after relaxing the body and mind.

5. CONCLUSION

This study is designed to support various user modes to create a comfortable environment through illumination and color temperature as a tabletop LED stand by applying the NIR LED to the LED stand, and allowing the user to select a comfortable brightness and color temperature. In particular, it provides a relax mode with NIR LED applied to relieve eye fatigue through relaxation and contraction of the eye muscles, and a smart LED stand device that has stability and convenience by supporting automatic recognition and automatic setting between the stand device and a smartphone. Was developed, and verified through the subjects to verify the NIR LED effect that relieves eye muscle fatigue.

ACKKNOWLEDGEMENT

This work was supported by a 2-Year Research Grant of Pusan National University.'

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