

A Study on the Uniformity of Two Types of Lighting on Stage Dance Movement

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Abstract

Dance performances express emotions through body movement. Stage lightings are used in various degrees by changing colors, characteristics or shapes for delivering emotional expressions and visual effects on movements effectively. Thus, the stage lighting and dance are closely related. Recently Stage lightings are changing from halogen to LED lighting and such a change is reflected in various performances, including classical dance performances. On this study, we compare the uniformity of LED lighting, which conform to recent changing stage environment, and the uniformity of light source of conventional halogen lighting to effectively express visual-depth and delicacy in movement of ballet motion. Two dance motions are selected from popular ballet motions: Arabesque and Sous-Sus. The measuring points of two movements are divided into four parts, A (face), B (chest), C (ankle) and D (wrist), to see whether the light was evenly distributed to the fingertips and toes of the dancers. For this purpose, the statistical methods include the average of the measured roughness, the deviation to see how much the measured roughness deviates from the average roughness and the variance to obtain the mean value of the squared deviations. We use standard deviations to see how they are scattered around. Furthermore, we compare the uniformity of LED and Halogen light source using coefficient of variation (CV), which shows the degree of scattering of data relatively. The result shows that the light source of the LED illumination is more even than the halogen illumination and can be effective to express the accurate and visual-depth image of dance motion and dancer's delicate movement. However, it is not possible to use only LED lighting in dance performances that acquire movements and emotions conspired together. We hope the research on lighting to enhance emotion and movement be continued lively in the future.

Key Words: Dance, Stage lightening, Illuminance, Uniformity

1. Introduction

Dance is a comprehensive art that can express visual aesthetic expressions, including movement through the body and external elements such as stage apparatus, costume,

makeup, and music. In particular, ballet performances are expressed by choreographers in the delicate movements of the body, such as fingertips and toes. In dance performances, stage lighting represents space and atmosphere depending on the shape, characteristics, and color of light. It is an essential element that helps to express dancer's movements effectively.

In other words, the lighting used for dancing should be able to shape the dancers' posture and body movements, not only brighten the stage but also sublimate them into aesthetic senses and play a dramatic atmosphere [1]. The stage lighting that plays this role is now changing from halogen lighting to LED lighting.

Halogen lighting, which has been used for a long period of time, are being replaced with the emergence of LED lighting, which has variety of merits. This aspect is being applied to the stage of dance performance.

The use of LED lighting enriches dance performances and makes movements look stereoscopic, enhancing perfection. According to Lee, Jang Won [3], LED lighting is superior to halogen lighting in terms of lightness (illuminance), resulting in a three-dimensional image of a person, which is suitable for lighting a person [2]. In dance performances, movement is assisted by the lighting designer to express the dancer's body, face, and dancer's part, desired expressions and Rosenthal noted that the dancer's hands, neck, and face should be lovingly presented when lighting [4]. There is an experiment on lighting that influenced the atmosphere of the performance as a whole because the illumination of the LED lighting is higher than the halogen lighting in the dance.

However, there is no specific study that relates to the illuminance that helps express the movement of the dancer clearly. Dance and lighting, which are closely related to each other, need to be investigated in detail regarding the relationship between movement and lighting, when a major of dance is changing from halogen lighting to LED lighting.

The aim of this study is to investigate the illuminance of the Arabesque and Sous-Sus in Halogen and LED lighting, and to investigate the uniformity of the light source in the ballet movement.

EXPERIMENTS ON LED LIGHTING AND HALOGEN LIGHTING IN DANCE MOVEMENT

Experimental Method

LEDs and Halogen illuminators were used to measure the intensity of dance action between Arabesque and Sous-Sus 2 motion. The measured illuminance is analyzed by statistical analysis to see how the LED and Halogen lights are distributed in the two dance actions. The statistical methods include average of measured illuminance, deviation to see how measured illuminance is away from average illuminance; variance equation (1) to obtain mean value of deviation square (2) standard deviation was used to determine how the average roughness was scattered around the average roughness.

It is difficult to compare the degree of illumination of the LED with the Halogen illumination with only the two data obtained from Eq. (1) and (2). Therefore, we compare the LED and Halogen illuminance using Equation (3) for the coefficient of variation (CV), which shows the relative scattering of the data as a percentage.

$$s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n} \quad (1)$$

$$s = \sqrt{s^2} = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}} \quad (2)$$

Coefficient of variation (CV) = standard deviation / (sample mean) × 100 (3)

Configuration of experiment

In order to understand the optical characteristics of the LED and Halogen lights on the dance action, an LED and a Halogen illuminator were installed on a 1.5m height stand as shown in <Figure 1>, and the dancers were illuminated 6.5m away from the light source.

Halogen ERS19 with a capacity of 750W and color temperature of 3200K, LED ERS19 with a capacity of 150W and color temperature of 3200K were used in the experiment, and light reaching to the surface of a dancer in a white tutu costume was illuminated with the illuminometer LX-104 respectively.

Dance movement and intensity measurement were measured at four body parts (A, B, C, D) with Arabesque and Sous-Sus, respectively,



Figure 1. Experiment configuration picture

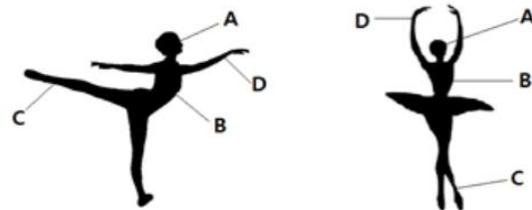


Figure 2: Arabesque (L), Sous-Sus (R): Location of illumination (A. Face, B. Chest, C. Ankle D. Wrist)

Table 1 and Table 2 are the measured values of the light intensity of the LED and Halogen illuminator falling on the body parts of the dancer. Deviation is the difference in illuminance of each body part. The deviation is squared in order to prevent negative values generated and the sum being zero. The variance is the sum of all the variance squares of the data, divided by the number of data, to produce an average.

The LED showed the highest value with a deviation of -386 and a deviation of 149286 from the Arabesque motion D (wrist) and the lowest with 53.625 and 2876 of deviation at C (ankle).

The LED showed the highest value with deviation of -329.375 and deviation of 108488 in the acceptance movement D (ankle), the deviation of B (chest) of 280.625 and the deviation of face (A) of 242.625.

Halogen showed the highest C (ankle) deviation of 451.875, deviation of 204191, and D (wrist) deviation of 5.875 and 35 of deviation, respectively. Halogen showed the highest value of C (ankle) deviation of -742.125, deviation of 550750, and A (face) deviation of -22.125 and 490 of deviation, respectively.

Table 1. LED lighting illuminance measurement value

Dance movement	Part of a body	LUX	$X_i - \bar{X}$	$(X_i - \bar{X})^2$
Arabesque	A	1516	110,625	12238
	B	1621	215,625	46494
	C	1459	53,625	2876
	D	1019	-386.375	149286
Sous-Sus	A	1648	242.625	58867
	B	1686	280.625	78750
	C	1218	-187.375	35109
	D	1076	-29.375	108488
Sum		11,243	0	492,108

Table 2. Halogen illuminance measurement value

Dance Movement	Part of a Body	LUX	$X_i - \bar{X}$	$(X_i - \bar{X})^2$
Arabesque	A	936	-36.125	1305
	B	1303	330.875	109478
	C	1424	451.875	204191
	D	978	5.875	35
Sous-Sus	A	950	-22.125	490
	B	1268	295.875	87542
	C	230	-742.125	550750
	D	688	-284.125	80727
Sum(Intensity of the light)		7,777	0	1,034,518

<Table 3> shows the measured illuminance of LED and Halogen illuminator. It is an analysis of which illuminance distribution each LED and Halogen illuminator shows. Halogen showed higher dispersion, standard deviation and coefficient of variation than LED.

Table 3. Analysis of illuminance distribution of LED and halogen

ILLUMINANT	AVERAGE	VARIANCE	STDEV	CV
LED	1405	61513	248	18
HALOGEN	972	129315	360	37

The average illuminance was 433 [lx] higher than that of Halogen, and the standard deviation of Halogen was 112 higher than that of LED. The coefficient of variation is a percentage of the degree of scattering of the data. The larger the value of the coefficient of variation, the greater the relative difference is

In this experiment, the coefficient of variation (CV) of Halogen was 2 times higher than that of LED.

RESULTS AND DISCUSSION

Figure 3 shows the result of measuring the illuminance of Arabesque and Sous-Sus motion by face, chest, ankle and

wrist using LED and Halogen illuminator. The sequence can be interpreted as follows.

First, in both the arabesques and the Sous-Sus, the LED lighting maintains a higher illuminance than halogen. These results can be practical in performances that utilize high illuminance such as duets and solos in ballet.

In addition, the average illuminance of LED lighting is higher than that of halogen. In terms of energy efficiency, LED is high, and positive effect can be expected in production of dance performance.

Second, in ballet motion, LED lighting affects the body more uniformly than halogen lighting. Dance transmits emotions to the audience through delicate movements. To enhance the body features, LED lighting is used rather than halogen lighting.

The standard deviation of how much the average illumination value is scattered, the halogen illumination is 112 higher than the LED illumination. This result shows that Halogen does not project light evenly onto the surface than LED. It can also be seen that the variation coefficient (CV) measured by halogen and LED illumination is more than two times different in the four different measurement areas in the two dance motions.

The above graph shows that the LED lighting has more influence on the dancer than the halogen lighting in order to

express the precise and stereoscopic images of the dancer's movements and dance movements.

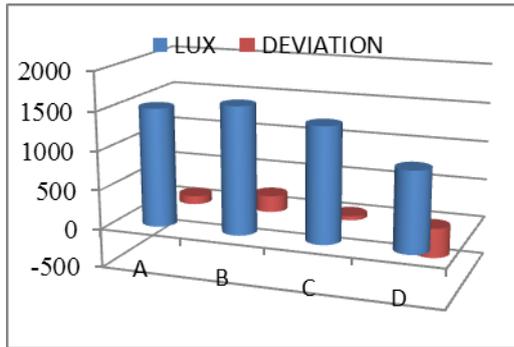


Figure 4. LED illumination in Arabesque

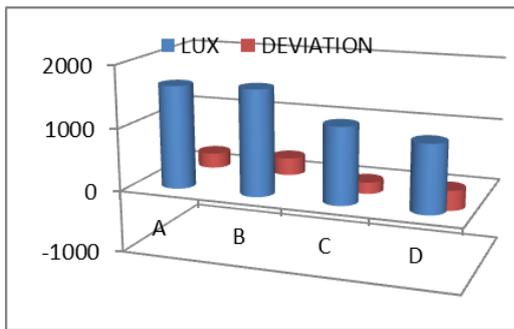


Figure 5. LED illumination in Sous-Sus

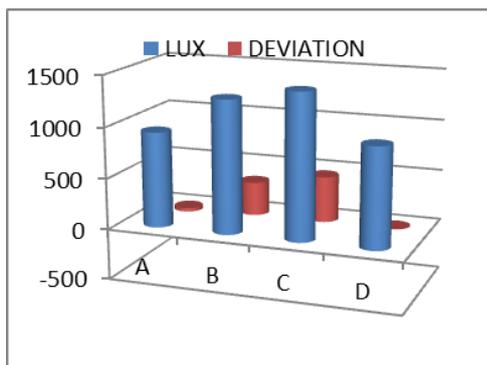


Figure 6. Halogen LED illumination I in Arabesque

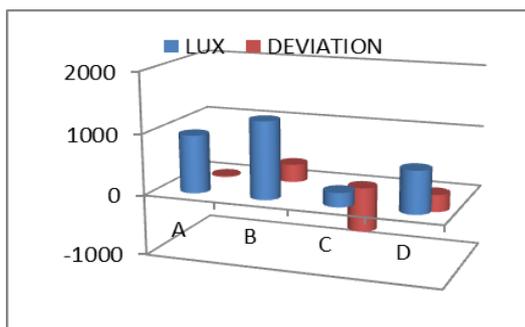


Figure 7. Halogen illumination in Sous-Sus

CONCLUSION

As the use of halogen lighting has been replaced by LED lighting, the use of LEDs is also increasing in dance performances. Therefore, this researcher wanted to analyze in detail the relationship between dance and lighting, which is closely related to each other in terms of ballet major, dance person concerned with choreography and directing.

This study illuminated the halogen lamp and the LED lighting to the arabesques and the ballerina which operated the light. We measured the illuminance on the face, chest, ankle and wrists, and found the average deviation. By looking at the coefficient of variation, it was found that the LED illumination project uniformed and higher light than the halogen illumination.

We hope that these results will help us to express visual-depth and delicacy in ballet which emphasizes beautiful lines.

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