Alternative Method for Determination of Color Correction Factor of Illmunance Meters

Ghufron Zaid, Nam-Joon Yoo*, Yong-Wan Kim**, Seung-Nam Park**

KIM-LIPI indonesia, *Department of physics Hannam University, **Temperature and Optics metrology group KRISS

(gzaid@yahoo.com)

1. Introduction

The objective of an illuminance meter calibration is to determine its illuminance responsivity [A/lx or, readings/lx]. The calibration is performed at the Illuminant A condition (2856K) with a luminous-intensity standard lamp (source-based method) or a reference photometer (substitution method) as the reference. Having known the value of the illuminance responsivity, illuminance of a source measured by the device can be determined by dividing the output with the value.

When the device is to be used to measure light sources having a spectral power distribution different from the standard source from which the device is calibrated, i.e. at the illuminant A, a spectral mismatch error will occur. Therefore, during calibration, it is necessary to determine correction for this error, commonly known as color correction factor, ccf*.

The common approach to determine the ccf* necessitates measurement of spectral responsivity of the illuminance meter under test which requires a sophisticated spectral comparator facility utilizing amongst others, a double grating monochromator, and takes a considerable amount of time. The ccf* can then be subsequently calculated for different color temperatures using the appropriate equation. This work tests and discusses an alternative approach requiring a less complicated set up. The discrepancy between the two methods is discusse despecially at low color temperature range.

2. Measurement

The proposed approach makes use of a working standard lamp as a variable illuminance source operating at different temperatures and thus output illuminances. It follows that two photometers, a standard photometer (STD) and a device under test (DUT), exposed to the lamp should measure the same level of illuminance. The measured illuminance, E(T), is determined by the standard photometer using equation; $E(T_i) = c_f \times OP \div R_v$, where, c_f is correction factor and assumed to be dominated by the ccf*, OP is output current of the photometer and R_v is the illuminance responsivity of the device. Having known the illuminance, E(T), therefore, the value of ccf* of the DUT can be determined using the same equation. Values of R_v and ccf* of the standard photometer can be found from its calibration certificate. Value of R_v of the DUT can first be determined by measuring illuminance at the illuminant A temperature of 2856 K where the value of ccf* for both devices is unity.

Illuminance values ranging from 60 lx to 2600 lx which correspond to a temperature range of 2200 K to 3200 K were measured during the experiment. A crucial part of the work was the determination of an input current for the lamp to give the color temperature of 2856 K since the output signals were then used to determine the Value of R_v of the DUT. A calibrated spectroradiometer was used to determine the color temperature of the lamp at each input current setting. Values of ccf* of the standard photometer at each color temperature were determined using the knowledge of the spectral responsivity of the standard photometer. The values of the ccf* of the DUT at each corresponding temperature were then calculated using the above equation.

For the purpose of comparison, the DUT was previously calibrated using the spectral comparator facility to determine its spectral responsivity and its ccf*.

It was found out that the difference between values of ccf* determined using the illuminance method and that using the spectral responsivity method ranges from 0.012% at the high temperature to 0.42% at the lower temperature (Table 1).

Table 1. Percentage error of ccf* determination

CCT (K)	ccf* of STD	ccf* of UDT		ccf* error
		Illuminance method	Spectral response method	
2185	0.9916916	0.993542794	0.997660165	0.414%
2322	0.994156733	0.9948796	0.998190814	0.333%
2388	0.995141657	0.99730861	0.998435197	0.113%
2565	0.997310465	0.998643454	0.99905813	0.042%
2854	0.999845554	0.999845554	0.99998515	0.014%
3065	1.001194316	1.000991807	1.000600159	−0.039%
3193	1.001350326	1.001636608	1.000678203	−0.096%

The difference may result from the fact that in the illuminance method, color temperatures were determined experimentally by measuring spectral irradiance using the spectroradiometer. On the other hand, in the spectral responsivity method, the spectral irradiance was calculated using Plank's Law at selected temperatures. Therefore, it is argued that the illuminance method results in a more realistic value than the spectral responsivity method. Significant uncertainty contributions in the illuminance method are expected from the measurement of the spectral irradiance as well as the determination of illuminant A color temperature of 2856 K to calculate the value of illuminance responsivity, R_v of the DUT.

3. Conclusions

An alternative method for the determination of ccf* of illuminance meter has been proposed and experimentally tested. The proposed method utilizes a less sophisticated facility compared to the commonly used spectral responsivity method and therefore is more applicable for most calibration laboratories. A percentage error ranging from 0.012% to 0.42%, as compared to the spectral responsivity method, has been obtained in the experiment. It is argued that the new method provides a more realistic value of ccf* since it uses experimentally−obtained value of parameters to calculate the ccf*.

Reference

[1] Casimer Decusatis, "Handbook of Applied Photometry", 143−145 (1997)

[2] Yoshihiro Ohno, "Improved Photometric Standards and Calibration Procedures at NIST", Journal of Research of the NIST vol.102 no.3 323−324 (1996)